NC STATE UNIVERSITY

2000

COURSE Catalog

North Carolina State University
Raleigh, North Carolina

This course catalog is intended for informational purposes only. Requirements, rules, procedures, courses and informational statements set forth herein are subject to change. Notice of changes will be conveyed to duly enrolled students and other appropriate persons at the time such charges are effected.

This catalog contains only course descriptions. Information on Academic Fields of Study and Degrees are available in separate graduate and undergraduate publications. The World Wide Web URL to access these publications are:

Graduate - http://www.fis.ncsu.edu/grad/catalog/catalog.htm
Undergraduate - http://www.ncsu.edu/ncsu/provost/info/publications/ugcat/
Course Catalog - http://www2.acs.ncsu.edu/reg_records/crs cat/directory.html

NC State University

North Carolina State University is a national center for research, teaching, and extension in the sciences and technologies, in the humanities and social sciences, and in a wide range of professional programs.

Founded March 7, 1887, by the North Carolina General Assembly under the provisions of the national Land-Grant Act, the University has marked more than a century of service to the state and the nation. Sharing the distinctive character of Land-Grant universities nationwide, NC State has broad academic offerings, national and international linkages, and large-scale outreach, extension, and research activities.

Teaching and Research

The University is organized into nine colleges, the School of Design, the Graduate School, and the Division of Undergraduate Affairs. The colleges are Agriculture and Life Sciences, Education and Psychology, Engineering, Forest Resources, Humanities and Social Sciences, Management, Physical and Mathematical Sciences, Textiles, and Veterinary Medicine. These colleges and schools offer baccalaureate degrees in 89 fields, master's degrees in 80 fields, and doctoral degrees in 51 fields. Together with more than 30 research centers and institutes, these colleges and schools also support a broad spectrum of more than 1,200 scientific, technological, and scholarly research endeavors.

Campus

The central campus of the University, located west of the downtown area of Raleigh, consists of 179 major buildings on 623 acres. Adjacent to the central campus are the new 1,000-acre Centennial Campus and the College of Veterinary Medicine campus. Nearby are research farms; biology and ecology sites; genetics, horticulture, and floriculture nurseries; forests; and Carter-Finley Stadium that together extend over 2,700 acres. Elsewhere across the state are research farms and a research forest of 82,000 acres.

Faculty

The University has approximately 6,200 employees, of which approximately 1,570 are instructional faculty. Among the many honors and recognitions received by members of the faculty are nine memberships in the National Academy of Science and nine in the National Academy of Engineering, 60 named professorships, 21 University Distinguished Professorships, 108 Alumni Distinguished Undergraduate Professors, and currently over 355 members of the Academy of Outstanding Teachers.

Students

In the 1998 fall semester, the university's regular term headcount enrollment totaled 27,960. Included in this number were 18,933 students in undergraduate degree programs, 5,101 in graduate degree programs, 301 First Professional, and 3,164 Lifelong Education students. The combined undergraduate and graduate enrollments by college were: Agriculture and Life Sciences - 4,267; Design - 715; Education and Psychology -1,694; Engineering - 6,561; Forest Resources -1,070; Humanities and Social Sciences - 3,060; Management - 2,660; Physical and Mathematical Sciences - 1,292; Textiles - 991;Veterinary Medicine - 411; and First Year College - 1,670. The student population included 2,719 African-American students; 1,935 other minority students, and 11,640 female students. Students at the university come from all 50 states, three United States territories, and approximately 87 foreign countries. The international enrollment is a distinctive feature of the institution as nearly 1,147 international students give the campus a cosmopolitan atmosphere.

Associations

The University is a member of the National Association of State Universities and Land-Grant Colleges, the American Council on Education, the American Council of Learned Societies, the Association of Governing Boards of Universities and Colleges, the Oak Ridge Associated Universities, the North Carolina Association of Colleges and Universities, and the Cooperating Raleigh Colleges.

ACCREDITATION

North Carolina State University is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools (1866 Southern Lane, Decatur, Georgia 30033-4097: Telephone number 404-679-4501) to award the doctoral, master's, baccalaureate, and associate's degrees.

In addition, many of the University's professional programs and departments are accredited by national professional associations including:

Accreditation Board of Engineering and Technology	1992
Accreditation Board of Engineering and Technology (Environmental Engineering)	1994
Accreditation Board of Engineering and Technology (Industrial Engineering)	1995
American Animal Hospital Association	1995
American Association for Accreditation of Laboratory Animal Care	1993
American Chemical Society	1996
American Psychological Association	1996
American Veterinary Medical Association	1992
Council for Accreditation of Counseling and Related Educational Programs	1994
Computing Sciences Accreditation Board	1992
Council on Social Work Education	1995
Landscape Architectural Accreditation Board	1993
National Architectural Accrediting Board	1995
National Association of Schools of Public Affairs and Administration	1993
National Council for Accreditation of Teacher Education	1996

National Recreation and Park Association	1992
Society of American Foresters	1995
Society of Wood Science and Technology	1995

NC State's Student Health Services was accredited by the Joint Commission on Accreditation of Health Care Organizations in 1996.

NC State's Department of Athletics' Division I programs were certified by the National Collegiate Athletic Association in 1995.

NONDISCRIMINATION POLICY

NC State is committed to equality of educational opportunity and does not discriminate against applicants, students, or employees based on race, color, national origin, religion, sex, age, or disability. Moreover, NC State is open to people of all races and actively seeks to promote racial integration by recruiting and enrolling a larger number of black students.

NC State is dedicated to equality of opportunity within its community. Accordingly, NC State does not practice or condone discrimination, in any form, against students, employees, or applicants on the grounds of race, color, national origin, religion, sex, age, or disability.

NC State commits itself to positive action to secure equal opportunity regardless of those characteristics.

NC State supports the protection available to members of its community under all applicable Federal laws, including Titles VI and VII of the Civil Rights Act of 1964, Title IX of the Education Amendments of 1972, Sections 799A and 845 of the Public Health Service Act, the Equal Pay and Age Discrimination Acts, the Rehabilitation Act of 1973, the Vietnam Veteran's Readjustment Assistance Act of 1974, Executive Order 11246, and the Americans with Disabilities Act of 1990.

ADMINISTRATION

Marye Anne Fox, *Chancellor*
Kermit L. Hall, *Provost and Vice Chancellor for Academic Affairs and Professor of History*
Debra Stewart, *Vice Chancellor and Dean of Graduate School*
Charles G. Moreland, *Vice Chancellor for Research, Outreach and Extension*
George Worsley, *Vice Chancellor for Finance and Business*
Thomas H. Stafford Jr., *Vice Chancellor for Student Affairs*
Terry G. Wood, *InterimVice Chancellor for University Advancement*

Deans of Colleges and Schools

J. L. Oblinger, *Dean, Agriculture and Life Sciences*
Marvin J. Malecha, *Dean, Design*
Joan J. Michael, *Dean, Education and Psychology*
Nino A. Masnari, *Dean, Engineering*
Larry W. Tombaugh, *Dean, Forest Resources*
Margaret A. Zahn, *Dean, Humanities and Social Sciences*
Jon W. Bartley, *Dean, Management*
Daniel Solomon, *Interim Dean, Physical and Mathematical Sciences*
A. Blanton Godfrey, *Dean, Textiles*
Oscar J. Fletcher, *Dean, Veterinary Medicine*

Graduate School

D. W. Stewart, *Dean*
R. S. Sowell, Senior *Associate Dean*
P. Banks-Lee, Associate Dean
M. F. King, *Associate Dean*
R. C. Rufty, Associate Dean

Provost Office

Kermit L. Hall, *Provost and Vice Chancellor for Academic Affairs and Professor of History*
C. Frank Abrams, *Sr. Vice Provost for Academic Affairs and Chief of Staff*
James A. Anderson, *Vice Provost for Undergraduate Affairs*
Samuel F. Averitt, *Vice Provost, Information Technology*
John F. Cudd, Jr., *Interim Vice Provost for Continuing Studies*
George R. Dixon, *Vice Provost for Enrollment Management and Services and Director of Admissions*
Bruce Mallette, *Vice Provost for Administration, Budget and Personnel*
Thomas K. Miller III, *Interim Vice Provost for Time-Enhanced Learning*
Susan K. Nutter, *Vice Provost and Director of the NCSU Libraries*
John N. Wall, *Interim Director of the Honors Program*
Joanne Woodard, *Vice Provost for Equal Opportunity, Equity and Diversity*

Division of Enrollment Management And Services

George R. Dixon, *Vice Provost for Enrollment Management and Services and Director of Admissions*
John F. Cudd, Jr., *Director of Adult Credit Programs and Summer Sessions*
Julia R. Mallette, *Director of Financial Aid*
Martha M. O'Donnell, *University Registrar*

ACADEMIC CALENDAR

2000 FALL SEMESTER

August	21	Monday	First day of classes
August	28	Monday	Last day to add a course without permission of instructor
September	4	Monday	Holiday (Labor Day)
September	5	Tuesday	Classes resume at 8:05; 8:35 a.m. Centennial Campus
September	5	Tuesday	Last day to register (includes payment of tuition and fees) or to add a course. Last day to drop a course, or change from credit to audit with a refund or reduction (NOTE: *The tuition and fees charge is based on the official number of hours and courses carried at 5:00 p.m. on this day.)* Last day for undergraduate students to drop below 12 hours TRACS closes at 5:00 p.m. (after this day, drops processed in 1000 Harris Hall)
October	2	Monday	Last day to withdraw or drop a course without a grade at the 400 level or below. Last day to change from credit to audit at the 400 level or below. Last day to change to credit only.
October	13	Friday	Fall vacation begins at 10:20 p.m.
October	16-17	Mon.-Tues.	Fall Break
October	18	Wednesday	Classes resume at 8:05 a.m.; 8:35 a.m. Centennial Campus
October	20	Friday	Last day to withdraw or drop a course without a grade at the 500-800 level Last day to change from credit to audit at the 500-800 level
October	23	Monday	Registration advising for 2001 Spring Semester begins
November	22	Wednesday	Thanksgiving vacation begins at 1:15 p.m.
November	23-24	Thurs.-Fri.	Thanksgiving Holidays
November	27	Monday	Classes resume at 8:05 a.m.; 8:35 a.m. Centennial Campus
December	4-8	Mon.-Fri.	Last week of classes. In order that students may complete semester projects, take lab tests, and prepare for final examinations, faculty members shall not give any tests or quizzes or assign any additional papers or projects during the final week of the semester. Exceptions to this policy must be approved in advance by the department head and the dean of the college involved.
December	8	Friday	Last day of classes
December	11-19	Mon.-Tues.	Final examinations
December	20	Wednesday	Fall Graduation Exercise

2001 SPRING SEMESTER

January	8	Monday	First day of classes
January	15	Monday	Holiday (Martin Luther King, Jr. Day)
January	16	Tuesday	No classes
January	17	Wednesday	Last day to add a course without permission of instructor
January	24	Wednesday	Last day to register (includes payment of tuition and fees) or to add a course. Last day to drop a course, or change from credit to audit with a refund or reduction. Last day for undergraduate students to drop below 12 hours TRACS closes at 5:00 p.m. (after this day, drops processed in 1000 Harris Hall)
February	21	Wednesday	Last day to withdraw or drop a course without a grade at the 400 level or below. Last day to change from credit to audit at the 400 level or below Last day to change to credit only.
March	9	Friday	Last day to withdraw or drop a course without a grade at the 500 or 600 level Last day to change from credit to audit at the 500 or 600 level Spring vacation begins at 10:20 p.m.
March	12-16	Mon.-Fri.	Spring Break
March	19	Monday	Classes resume at 8:05; 8:35 a.m. Centennial Campus Registration advising for 2001 Summer Sessions and Fall Semester begins
April	11-12	Wed.-Thurs.	No classes
April	13	Friday	Holiday (Good Friday)
April	16	Monday	Classes resume at 8:05; 8:35 a.m. Centennial Campus
April-May	30-4	Mon.-Fri.	Last week of classes. In order that students may complete semester projects, take lab tests, and prepare for final examinations, faculty members shall not give any tests or quizzes or assign any additional papers or projects during the final week of the semester. Exceptions to this policy must be approved in advance by the department head and the dean of the college involved.
May	4	Friday	Last day of classes
May	7-15	Mon.-Tues.	Final examinations
May	19	Saturday	Spring Commencement

2001 FIRST SUMMER SESSION

May	23	Wednesday	First day of classes
May	24	Thursday	Last day to add a course without permission of instructor
May	28	Monday	Last day to register (includes payment of tuition and fees) or to add a course. Last day to drop a course with a refund (NOTE: *The tuition and fees charge is based on the official number of hours and courses carried at 5:00 p.m. on this day.)*
			TRACS closes at 5:00 p.m. (after this day, drops processed in 1000 Harris Hall)
June	6	Wednesday	Last day to withdraw or drop a course without a grade at the 400 level or below. Last day to change from credit to audit at the 400 level or below
			Last day to change to credit only.
June	8	Friday	Last day to withdraw or drop a course without a grade at the 500-800 level
			Last day to change from credit to audit at the 500-800 level
June	26	Tuesday	Last day of classes
June	27	Wednesday	Reading Day
June	28-29	Thurs.-Fri.	Final examinations

2001 SECOND SUMMER SESSION

July	5	Thursday	First day of classes
July	6	Friday	Last day to add a course without permission of instructor
July	10	Tuesday	Last day to register (includes payment of tuition and fees) or to add a course. Last day to drop a course with a refund (NOTE: *The tuition and fees charge is based on the official number of hours and courses carried at 5:00 p.m. on this day.)*
			TRACS closes at 5:00 p.m. (after this day, drops processed in 1000 Harris Hall)
July	19	Thursday	Last day to withdraw or drop a course without a grade at the 400 level or below
			Last day to change from credit to audit at the 400 level or below
			Last day to change to credit only
July	20	Friday	Last day to withdraw or drop a course without a grade at the 500-800 level
			Last day to change from credit to audit at the 500-800 level
August	8	Wednesday	Last day of classes
August	9-10	Thurs.-Fri.	Final examinations

COURSE DESCRIPTIONS

The courses listed in this catalog are planned for the academic year 2000-2001 unless indicated.

The course descriptions are arranged first in alphabetical order according to course prefix reflecting the department or discipline of the course. Some courses are cross-listed, indicating that they are offered in two or more departments or disciplines. Within each of the prefix groups, the course descriptions are arranged by course number: numbers 100-299 are courses intended primarily for freshmen an sophomores; numbers 300-499 are courses intended primarily for juniors and seniors; numbers 490-498 are seminar, project or special topics courses; number 499 is for undergraduate research.

Courses at the 500-800-level are graduate courses, but 500-level courses are open to advanced undergraduate students, unless otherwise specified. Graduate standing is a prerequisite for all 500-level courses.

A typical course description shows the prefix, number, and title followed by prerequisite, credit, and offering information. **Prerequisites** are courses or levels of achievement that a student is expected to have completed successfully prior to enrolling in a course. **Corequisites** are courses which should be taken concurrently by students who have not previously completed the corequisites. Prerequisites and corequisites for a given course may be waived by the instructor of the course or section. It is the student's responsibility to satisfy prerequisites, or obtain from the instructor written waiver of prerequisites, for any course in which he or she may enroll. Failure to satisfy prerequisites may result in removal from enrollment in the course. Consent of the department is required for all practicum and individual special topics or special problems courses as well as internships and thesis or dissertation research. Some courses also have **restrictive statements,** such as "Credit in both MA 141 and MA 131 is not allowed." Restrictive statements for a given course may be waived only by a college dean.

An example of credit information is: 4(3-2). The 4 indicates the number of semester hours credit awarded for satisfactory completion of the course. The (3-2) normally indicates that the course meets for three hours of lecture or seminar each week and for two hours of laboratory, problem, or studio work each week. Some courses are offered for variable credit, and a listing of 1-6 indicates that from one to six semester hours of credit may be earned as arranged by the department offering the course.

Other abbreviations used in the course descriptions are : grad., graduate; undergrad., undergraduate; sr., senior; jr., junior; soph., sophomore; fr., freshman; lab., laboratory; lect., lecture; and sem., seminar.

CONTENTS

ACC Accounting
AEE Agricultural and Extension Education
ADN Art and Design
ALS Agriculture and Life Sciences
ANS Animal Science
ANT Anthropology
ARC Architecture
ARE Agricultural and Resource Economics
AS Aerospace Studies
BAE Biological and Agricultural Engineering
BCH Biochemistry
BIO Biological Sciences
BIT Biotechnology
BMA Biomathematics
BO Botany
BUS Business Management
CBS Comparative Biomedical Sciences
CE Civil Engineering
CFR College of Forest Resources
CH Chemistry
CHE Chemical Engineering
CL Comparative Literature
COM Communication
CS Crop Science
CSC Computer Science
DAN Dance
DF Design Fundamentals
DN Design
E Engineering
EAC Adult & Community College Education
EC Economics
ECD Counselor Education
ECE Electrical and Computer Engineering
ECG Economics - Graduate
ECI Curriculum and Instruction
ECO Ecology
ELP Educational Leadership and Program Evaluation
EMS Mathematics/Science Education
ED Education
ENG English
ENT Entomology
EOE Occupational Education
ES Environmental Sciences
FL Foreign Languages and Literatures
FLC Foreign Languages and Literatures – Chinese
FLE Foreign Languages and Literatures - English
FLF Foreign Languages and Literatures - French
FLG Foreign Languages and Literatures - German
FLH Foreign Languages and Literatures - Hebrew
FLI Foreign Languages and Literatures - Italian
FLJ Foreign Languages and Literatures - Japanese
FLK Foreign Languages and Literatures - Swahili
FLN Foreign Languages and Literatures - Hindi
FLP Foreign Languages and Literatures - Portuguese
FLR Foreign Languages and Literatures - Russian
FLS Foreign Languages and Literatures - Spanish
FOR Forestry
FPS Fiber and Polymer Science
FS Food Science
FW Fisheries and Wildlife Sciences
GC Graphic Communications
GD Graphic Design
GEO Geography
GN Genetics
GR Special Graduate Categories
GRK Greek
HA History of Art
HI History
HS Horticultural Science
HSS Humanities and Social Sciences

IA	Industrial Arts
ID	Industrial Design
IE	Industrial Engineering
IMM	Immunology
IMS	Integrated Manufacturing Systems Engineering
LAR	Landscape Architecture
LAT	Latin
LOG	Logic
M	Management
MA	Mathematics
MAE	Mechanical and Aerospace Engineering
MAT	Materials Science and Engineering
MB	Microbiology
MDS	Multidisciplinary Studies
MEA	Marine, Earth and Atmospheric Sciences
MLS	Liberal Studies
MS	Military Science
MUS	Music
NE	Nuclear Engineering
NR	Natural Resources
NS	Naval Science
NTR	Nutrition
OR	Operations Research
PA	Public Administration
PE	Physical Education
PEC	Physical Education - Coaching
PEH	Physical Education - Health Studies
PEO	Physical Education - Outdoors
PES	Physical Education - Sports
PHI	Philosophy
PHY	Physiology
PMS	Physical and Mathematical Sciences
PO	Poultry Science
PP	Plant Pathology
PRT	Parks, Recreation and Tourism Management
PS	Political Science
PSY	Psychology
PY	Physics
REL	Religion
SOC	Sociology
SSC	Soil Science
ST	Statistics
SW	Social Work
T	Textiles
TAM	Textile and Apparel Management
TC	Textile Chemistry
TE	Textile Engineering
TED	Technology Education
TES	Textile Engineering and Science
TMS	Textile Materials Science
TOX	Toxicology
TT	Textile Technology
TTM	Textile Technology Management
VMS	Veterinary Science
WGS	Women's and Gender Studies
WPS	Wood and Paper Science
ZO	Zoology

ACCOUNTING

ACC 100 Introduction to Accounting Profession. *1(1-0) . F.* Introduction to accounting profession and career opportunities.

ACC 210 Accounting I Concepts of Financial Reporting. *3(3-0) . F,S,Sum. Credit may not be received for both ACC 210 and 280.* Financial reporting concepts, the accounting information generating process, reporting practices, financial statement preparation, and the interpretation and analysis of financial statements. Basic accounting principles and concepts, the accounting cycle, income measurement, and internal controls.

ACC 220 Accounting II - An Introduction to Managerial Accounting. *3(3-0) . F,S,Sum. Preq: ACC 210. Credit may not be received for both ACC 220 and 280.* Analysis of accounting data that are useful in managerial decision making and in the control and evaluation of the decisions made within business organizations. An introduction to basic models, financial statement analysis, cost behavior analysis and cost control procedures.

ACC 280 Managerial Accounting. *3(3-0) . F,S. Credit may not be received for both ACC 280 and ACC 210, or 220.* Principles underlying financial reporting. Analysis of cost and other quantitative data for managerial decision making. Focus on uses of accounting information.

ACC 300 The Accounting Profession. *1(2-0) . S. Preq: Students must enroll during the spring semester prior to anticipated career interviews.* Integration of work values, career interests, and skills with organizations and career paths related to accounting. Ethics, certification, continuing education, and research. Minimal fee assessed to cover cost of career test administered during course.

ACC 310 Intermediate Financial Accounting I. *3(3-0) . F,S,Sum. Preq: ACC 210 with a C- or better, PHI elective, M 200. Coreq: ENG 331 or 332 or 333.* Conceptual framework of financial accounting and application of professional standards. Measurement and reporting issues related to cash, accounts receivable, inventories, operating assets, and intangibles.

ACC 311 Intermediate Financial Accounting II. *3(3-0) . F,S,Sum. Preq: ACC 310 with a grade of C- or better, COM 110 or 146.* Theory and professional standards for analyzing and reporting enterprise liabilities and equities. Valuation of liabilities, contingencies, stock transactions, and dividends. Measurement and reporting issues related to leases.

ACC 320 Managerial Uses of Cost Data. *3(3-0) . F,S,Sum. Preq: ACC 220 with grade C or better, M 200 MA 121 and 132 or equivalent, PHI elective, and EC 201 Coreq: BUS 350 and ENG 331 or 332 or 333* Managerial uses of cost data in planning, controlling, and evaluating organizational activities and in making business decisions. Budgeting, cost behavior, product costing and pricing, and decision-making frameworks.

ACC 330 An Introduction to Income Taxation. *3(3-0) F,S Preq: ACC 210 with a grade of C or better, EC 201, COM 110 or 146, PHI elective, and ENG 331 or 332 or 333.* Principles and procedures of individual and business entity income taxation. Basic definitional tax concepts of income, deduction, credit, and gain or loss. Tax research methodology and tax planning techniques.

ACC 407 Business Law for Accountants. *3(3 0) F,S,Sum Preq: EC 201 or ARE 201. Credit may not be received for ACC 407 and any of the following. BUS 305, BUS 307, or ARE 306.* Legal principles affecting the conduct of trade related to accountants. Personal and real property; contract law; negligence and accountants legal liability; business and the Constitution.

ACC 410 Governmental and Special Reporting. *3(3 0) F,S,Sum Coreq: ACC 311* Fund accounting for governmental units and not-for-profit organizations. Financial issues related to accounting for pensions, deferred income taxes and earnings per share. Concepts and applications of financial statement analysis.

ACC 440 Accounting Information Systems. *3(2-2) F,S Preq: ACC 310, ACC 320 with a grade of C- or better, BUS 340 or CSC 200, M 200.* System concepts, including the theory, principles, and controls inherent in computer-based accounting systems analysis, design, and development. Subsystems of the total accounting system including sales/receivable, purchases/payable, cash receipts, cash disbursements, payroll, inventory, and production subsystems.

ACC 450 Auditing Financial Information. *3(3-0) . S Preq: ACC 311 with a grade of C- or better, ACC 440, BUS(ST) 350.* Financial auditing objectives, theory, and practices; application of generally accepted auditing standards and determination of sufficient competent evidential matter including: auditor reports, analytical procedures and statistical sampling; EDP systems; auditor ethics; and other auditing services: compilation, review and other attestation services.

ACC 470 Accounting Theory. *3(3-0) . Preq: ACC 410 (312).* Major concepts, problem areas and trends in accounting thought and practice, including a review of the most prominent controversies in current publications and the most recent relevant pronouncements of professional institutions.

ACC 480 Accelerated Survey of Financial and Management Accounting. *3(3-0) . F. Credit may not be received for both ACC 480 and ACC 220 or 280. Intended for graduate students and advanced undergraduates not majoring in Accounting or Management.* Accelerated survey of basic concepts underlying accounting in profit-oriented firms: data measurement, summarization and reporting practices as a background for use of accounting information; content of published financial statements; and uses of accounting for management decisions in product costing, budgeting, and operations.

ACC 490 Senior Seminar in Accounting. *3(3-0) . S. Enrollment in this course is restricted to accounting majors in their final semester of study. PBS students admitted by permission of department head.* Integration of financial, managerial, tax, and governmental accounting. Application of appropriate accounting methods to problem resolution.

ACC 495 Special Topics in Accounting. *1-6. Preq: Consent of Instructor.* Presentation of material not normally available in regular course offerings, or offering of new courses on a trial basis.

ACC 498 Independent Study in Accounting. *1-6. F,S,Sum.* Detailed investigation of topics of particular interest to advanced undergraduates under faculty direction on a tutorial basis. Credits and content determined by faculty member in consultation with the associate department head.

ACC 508 Advanced Commercial Law. *3(3-0) . S. Preq: BUS 307.* The principles of statutory law and common law relevant to corporate and public accountants. Legal research.

ACC 510 Advanced Financial Accounting. *3(3-0) . F. Preq: ACC 410.* Accounting principles and problems related to business combinations, financial reporting for consolidated enterprises, transactions with foreign entities and advanced partnership accounting. Introduction to international accounting practices.

ACC 515 Accounting Theory and Current Issues. *3(3 0) . S. Preq ACC 310.* Accounting theory and current issues related to financial reporting with emphasis on research methods, database use, written and oral communication skills, ethical issues and team work.

ACC 519 Integrated Accounting Practice. *3(3-0) . S. Preq: Grad. standing and consent of department.* Integration of financial accounting, managerial accounting, taxation, and auditing. Application of legal and professional standards and analytical methods to accounting problems.

ACC 521 Production Cost Analysis and Control. *3(3-0) . S. Preq: ACC 320 or ACC 480; BUS 350.* Advanced managerial accounting practices: cost calculation, cost estimation, cost allocation and control using matrix algebra, statistics and other quantitative techniques.

ACC 525 Advanced Management Accounting. *3(3-0) . F. Preq: ACC 320 or ACC 480; EC 301 or ECG 701; BUS 350.* Uses of accounting data for management decisions within the firm: applications of formal analytical models including decision theory, statistical analysis of cost behavior and optimization models. Management and control of decentralized operations. Design and evaluation of accounting systems. Designed primarily for students in Master of Science in Management program.

ACC 530 Advanced Income Tax. *3(3-0) . F. Preq: ACC 330. Credit may not be received for both ACC 533 and 530.* Federal income tax treatment of corporations; partnerships; estates; trusts; and profit and loss distributions to shareholders, partners and beneficiaries. Introduction to wealth transfer taxes and family tax planning.

ACC 533 Accounting and Tax Research. *3(3-0) . F. Preq: ACC 330, Grad. standing.* Research techniques applicable to tax laws, accounting standards, with emphasis on developing issues and facts, assessing authority, analytical skills, professional judgment, and formal communication of findings; use and application of traditional and computerized research databases; future of accounting discipline; ethics.

ACC 534 Taxation of Corporations and Shareholders. *3(3-0) . F. Preq: Grad. standing. Coreq: ACC 533.* Selected topics of federal income taxation pertaining to corporations and their shareholders including corporate formation, distributions, liquidations and reorganizations; tax problems of consolidated income tax returns; and tax planning opportunities involving the corporation and its shareholders.

ACC 535 Taxation of Partnerships and S Corporations. *3(3-0) . F. Preq: Grad. standing. Coreq: ACC 533.* Legal and federal income tax aspects of the partnership as a business entity; measurement of partnership profits and losses; distributions to partners; and transactions between partners and the partnership. Legal and business aspects of the S Corporation as a business entity and tax planning for S Corporation shareholders.

ACC 536 Taxation of Estates, Trusts and Gifts. *3(3-0) . S. Preq: ACC 533; Grad. standing.* Examination of federal excise tax levied on transfers of property via gift or from a descendant's estate, including fundamental concepts of estate planning using planned giving and trusts; income taxation of estates and trusts with an emphasis on integration of estate, gift and income taxes.

ACC 537 Tax Planning and Business Strategy. *3(3-0) . S. Preq: ACC 533; Grad. standing.* Development of a tax planning framework for use in analyzing a wide variety of decision settings including compensation planning, multinational transactions, organizational and capital structure, property transactions, and mergers and acquisitions. Policy implications of existing laws and alternatives.

ACC 550 Assessing Risks of Information Technology. *3(3-0) . F. Preq: ACC 440, ACC 450, Grad. standing.* Recognition of information technology risks. General and application internal controls for information systems environments. Client/server, end-user computing, and service bureau internal control environments. Computerized auditing techniques. Risks of emerging technologies.

ACC 551 Advanced Auditing. *3(3-0) . F. Preq: ACC 440, ACC 450; Grad. standing.* Current issues and regulation of the auditing profession; application of generally accepted auditing standards and determination of sufficient competent evidential matter including analytical procedures and statistical sampling. Auditor ethics, other auditing services, government auditing, compilation, review, and other attestation services

ACC 552 Advanced Accounting Cases. *3(3-0) . S Preq: ACC 510, ACC 530.* Financial reporting and financial management cases with perspectives for either tax or audit professionals. Emphasis on problem identification and analysis with oral and written communication of findings. Choice of either tax or audit perspective in this team-taught course.

ACC 580 Survey of Accounting. *3(3-0) . F, Sum Preq: Graduate Standing. May not be taken for credit by students majoring or minoring in accounting* Accelerated survey of basic concepts underlying accounting in profit-oriented firms: concepts for decision making in manufacturing; content and interpretation of published financial statements; data measurement; product costing; budgeting.

ACC 588 Special Topics in Accounting. *1-6. F,S. Preq: Consent of department.* Course objectives dependent upon unique circumstances motivating offering of course. Timely curriculum innovation the primary motivation.

ACC 630 Independent Study. *1-6. F,S. Preq: Consent of department.* Advanced topics not otherwise included in curriculum by advanced graduate students on a tutorial basis. Determination of credits and content by participating faculty in consultation with Director of Graduate Programs.

ART AND DESIGN

ADN 111 Two Dimensional Design for Non-Design Majors. *3(0-6) . F,S. This course is not open to School of Design students.* An introduction to the fundamentals of design studies through two dimensional problems. The basic elements and concepts of design explored as abstract and applied problems through design issues. Provides non-design students an introduction to design principles and a language of design.

ADN 112 Three Dimensional Design for Non-Design Majors. *3(0-6) . F,S. This course is not open to School of Design students.* An introduction to the fundamentals of design studies through three-dimensional problems. The basic elements and concepts of design explored as abstract and applied problems through the design issue. Provides non-design students a working knowledge of design principles and a language of design.

ADN 202 Design Studio: Art & Design in Context. *6(0-9) S. Preq. DF 101 and DF 102 or two studios.* Investigative problem solving in visual communication in the human environment. Emphasis on visual language applied to specific contexts.

ADN 212 Basic Photography. *3(2-2) F,S. Preq: DF 102.* Introduction to the processes and visual skills necessary for the beginning photographer. Darkroom experimentation, pinhole camera, basic rudiments of camera use, film development and printing. Exploration of issues related to the quality of visual communication.

ADN 219 Digital Imaging. *3(2-2) . F.S. Preq: DF 102* Introduction to exploring, creating, and modifying images through the use of computers. Emphasis is on creativity, experimentation, and intuitive image-making using various computer techniques.

ADN 231 Design History for Engineers and Scientists. *3(3-0) F S* Study of historical connections among various disciplines and across cultures from prehistory to the present, with an emphasis on design. Students develop visual timelines of events to better understand how seemingly disparate disciplines affect one another. Special attention paid to scientific, artistic, and philosophical "revolutions" and their impact upon each other and upon other intellectual and practical endeavors.

ADN 272 Introduction to Printing and Surface Design. *3(0-6) . F,S Preq. A grade of C or better in DF 101, ADN 111 or ADN 112.* Design and production of screen printed, painted and pattern-dyed fabrics. Development of design abilities (color use, pattern generation) and technical skills (screen printing, painting, use of fabric dyes). Production of fabric samples, studies, yardage, and/or end products. Awareness of industrial processes.

ADN 273 Fibers Materials and Processes. *3(0 6) . F,S. Preq: DF 101 or ADN 111 or ADN 112.* Introduction to historical and contemporary hand processes used by the textile designer. Students will learn a variety of textile techniques utilizing traditional and experimental methods. Emphasis will be on technical exploration and development.

ADN 281 Basic Drawing. *3(0-6) . F. Open only to School of Design Majors and Design Minors* A beginning descriptive drawing experience which teaches students to see, analyze, and transcribe observed subject matters. The transcription incorporates formal drawing issues (line, form, texture) with traditional and contemporary material space exploration.

ADN 292 Special Topics in Design. *1-3. F,S.* Topics of current interest in the School of Design. Used to develop new courses.

ADN 302 Design Studio: History, Culture & Diversity. *6(0-9) . S. Preq: Five studios and HA 202.* Investigations into the historical, cultural, perceptual and aesthetic values and precedents of modern art/design movement. In a studio mode, emphasis is on research, documentation, synthetic and analytic activities.

ADN 311 Basic Visual Laboratories. *3(0-6) . F,S. Preq: Design Majors: DF 102; Non-Design Majors: ADN 111, 112.* Basic activities that relate to the major design areas in the School of Design. Study of visual communication skills in areas of illustration, printmaking, and life drawing. The student elects instructor and area(s) of activity.

ADN 312 Intermediate Photography. *3(2-2) . F,S. Preq: ADN 212.* Continuation of an advanced level of the skills and techniques developed in Basic Photography. Purpose is to develop use of camera as a perceptual tool to increase awareness and sensitivity of visual imagery.

ADN 384 Basic Painting. *3(0-6) . F. Preq: ADN 102; or both ADN 111 and ADF 112.* Introduction to the principles of painting through class projects that expose students to different painting materials and techniques. Students learn to build a stretcher, size and prime a canvas as well as other rigid painting surfaces. Acrylic and oil paint used; projects assigned and open themes.

ADN 386 Basic Sculpture. *3(0-6) . F. Preq: DF 101, ADN 112.* Studio course introducing basic concepts, materials, and processes of sculpture. Instruction incorporates both traditional and contemporary form generation with emphasis on developing formal perception and projection.

ADN 400 Design Studio. *6(0-9) . F,S. Preq: DF 102 or written approval of Department Head and Dean. Course may be used to partially satisfy studio requirement in all undergraduate degree programs in the School of Design.* Studio offering upper-level undergraduates the opportunity to intensively study general design issues (form, color, structure, proportions, scale, etc.).

ADN 402 Design Studio: Practice and Technology. *6(0-9) . S. Preq: Seven studios and ADN 219.* Advanced Design studio emphasizing the exploration of past, current and potential future technologies within Design Department content areas (e.g., painting, sculpture, fibers, jewelry, color and light, etc.). Students are expected to work independently, develop their own problem statements.

ADN 411 . Visual Laboratory II. *3(0-6) . F,S. Preq: DF 102; or both ADN 111 and ADN 112. May be taken for a minimum of 12 credit hours by School of Design students.* Visual communication skills in the areas of life drawing, illustration, painting, print making and sculpture.

ADN 413 Synthetic Drawing. *3(2-3) . Every 3rd Sem. Preq: DF 102; or ADN 111, ADN 112.* Orthographic and axonometric projections, coordinating and perspective systems, and diagramming to facilitate the drawing of shapes and forms conceived by the designer in order to make visually precise simulations of design ideas.

ADN 414 Color and Light. *3(3-0) . F,S. Preq: DF 102.* Physical and perceptual nature of color, color awareness, sensitivity and skills in visual communication with color as a designer's tool.

ADN 418 Contemporary Issues in Art and Design. *3(3-0) . S. Preq: School of Design students only. History of Art I & II or junior standing.* Explore a range of issues about contemporary art and design ideologies. Concentration on selected readings which provide a platform for discussion of various ideas, approaches, perspectives and practices in the contemporary fields of art and design.

ADN 419 Multimedia and Digital Imaging. *3(3-0) . F,S. Preq: DF 102, ADN 219.* Intensive hands-on investigation of the tools, techniques, and processes for the development of interactive multi-media projects. Media teams will emphasize shaping an idea into a well thought-out design that works as an interactive experience.

ADN 428 Art and Design: Theory and Practice. *3(3-0) . F. Preq: 6 Studios. Senior Level, Art and Design.* Conceptual basis for developing a personal philosophy regarding the practice of art and design. Theory based history of diverse cultures and forces of change: political, economic, religious, social, intellectual and philosophical as they affect the fields of art and design.

ADN 454 Geometry for Designers. *3(3-0) . S. Preq: Junior standing.* Geometry and its application to the various fields of design, mathematical and drawing skills required.

ADN 455 Building Workshop. *3(2-2) . Every 3rd Sem. Preq: DF 102 or both ADN 111 and ADN 112.* Process and logic of producing one's own design. Structural behavior, geometry, and materials in the construction of physical form usually at a large scale. Evaluative testing with critical support.

ADN 460 Multimedia and Advanced Digital Imaging Studio. *6(0-9) . F, Sum. Preq: ADN 219.* An intensive study of advanced image-making processes, software, and various computer platforms used in the creation of multimedia. In a studio mode, students will place emphasis on creating interactive programs and finally transfer images to CD Rom and video with audio and special effects.

ADN 470 Fibers and Surface Design Studio. *6(0-9) . F,S. Preq: A grade of C or better in DF 101 or ADN 111 and ADN 112. School of Design students; Minors in Design or permission of instructor.* Practice of widely varying textile techniques with the solving of practical and conceptual design problems. Textile end products are designed and produced at full scale in appropriate materials. Focus includes weaving, knitting, printing and dyeing of fabrics, and a wide variety of fabric construction and embellishment processes. Textile history is an ongoing part of the study. Emphasis on synthesis of techniques and ideas.

ADN 472 Advanced Surface Design. *3(0-6) . F,S. Preq: DF 101, ADN 272* Advanced problems in the design and production of hand-printed and pattern-dyed fabrics. Experimentation with advanced color application techniques. Exploration of pattern and image production on fabric and development of design abilities in textile media. Specific focus changes each semester.

ADN 480 Intermediate Studio. *6(0 9) . F,S. Preq. DF 101 and DF 102; or ADN 111, ADN 112 and ADN 311.* Studio format offering upper level undergraduates the opportunity to intensively study general design issues (form, color, structure, proportions, scale, etc.) through individual study in drawing, painting, sculpture, photography, or printmaking.

ADN 481 Intermediate Drawing. *3(0-6) . S. Preq: ADN 281* An intermediate-level drawing course that further develops the designer's graphic, analytic, observational, and conceptual skills.

ADN 484 Intermediate Painting. *3(0-6) . S. Preq: DF 102; or both ADN 111 and ADN 112.* An intermediate-level painting course that through slide lectures, class projects, and assigned readings exposes students to contemporary painting art movements. Special emphasis given to the formal and interpretative analysis of a painting. Acrylic and oil paint are used; Projects have assigned and open themes.

ADN 486 Intermediate Sculpture. *3(0-6) . S. Preq: ADN 386.* An intermediate-level sculpture course that further develops the designer's analytic, observational, and conceptual skills.

ADN 487 Sculpture: Life Modeling. *3(0-6) . F. Preq: DF 102 or ADN 486.* A studio course with direct observation of nature a primary concern. In-depth study of specific modeling concepts and processes.

ADN 490 Art and Design International Studio. *6(6-0) . F,S,Sum. Preq: Junior standing, School of Design or equivalent program. Approval Study Abroad Office. School of Design or equivalent programs with faculty permission.* Define Art and Design problems and develop design solutions in an international setting. Studio projects related to design, culture, and traditional and contemporary art forms. Focus on artifact making through direct studies. Taught off campus.

ADN 491 Special Seminar in Design. *1 3. F,S.* Seminars on subjects of current interest in design.

ADN 492 Special Topics in Design. *1-3 F,S.* Topics of current interest in Design and Technology. Used to develop new courses.

ADN 494 Internship in Design. *3 6. F S Sum. Preq: Junior standing, 3.0 GPA or better. Maximum of 6 credit hours.* Supervised field experience in design offices, galleries, museums and other organizations.

ADN 495 Independent Study in Design. *1 3 F,S Preq: Junior standing in Design with 3 0 in Design or better Maximum 6 credit hours* Special projects in art and design developed under the direction of a faculty member on a tutorial basis.

ADN 502 Advanced Visual Laboratory. *1 12. F,S. Preq May be taken for a max of 12 credit hrs.* Advanced experimental studies in visual phenomena related to design.

AGRICULTURAL AND EXTENSION EDUCATION

AEE (ED) 206 Introduction to Teaching Agriculture. *3(2-3) F.* Introduction to teaching agricultural education in middle and secondary schools and collaborative efforts for teaching agricultural education to adults as rural community situations dictate. Field experiences include three hours per week of structured observations of classroom teachers, teacher assistant activities, and reflections of the experience.

AEE (ED) 226 Computer Applications and Information Technology in Agricultural & Extension Ed. *3(1-4) . F,S* Use of computers and commercially produced agricultural software; the computer as a management tool; agricultural occupational applications of the computer; a multimedia instructional tool in agricultural classrooms and training situations; use of technology for processing information and imaging; network access; and electronic communications.

AEE (ED) 303 Administration and Supervision of Student Organizations. *3(2-2) Preq: AEE 206 or EOE 207.* Principles and techniques for organizing, administering and supervising student organization activities.

AEE 311 Communication Methods and Media. *3(3-0) . F. Preq. ENG 112* Foundations of agricultural communications. Technologies of agricultural communication and the systematic approach to the development of agricultural communication materials. Development of applied skills in design, production, evaluation, and dissemination of information unique to agricultural sciences and media.

AEE (ED) 322 Experiential Learning in Agriculture. *2(2-0). F.* Planning, organizing, implementing, supervising and evaluating Supervised Agricultural Experience (SAE) programs in agriculture.

AEE 323 Leadership Development in Agriculture. *2(2-0). F.* Leadership development in agricultural and related settings; principles and techniques for developing leadership skills; development of understanding of the dynamic interactions of personal characteristics, technical skills, interpersonal influence, commitment, goals and power necessary for effective leaders; issues and problems facing the leadership of agriculture.

AEE (ED) 327 Conducting Summer Programs in Agricultural Education. *1(0 3) F. Preq: AEE(ED)206; AEE(ED)322; and AEE 323.* Field experience emphasizing summer agricultural education programs. Individualized instruction for students during supervised agricultural experience visits and youth organization activities. Professional development and program improvement activities.

AEE 423 Practicum in Agricultural Extension/Industry. *1-8. S, Sum. Preq: AAE(ED)426, Senior standing and Consent of Instructor. Coreq: AEE (ED) 490.* Participation in professional work experiences in preparation for effective leadership positions in the Cooperative Extension Service or the agribusiness industry.

AEE (EOE) 424 Planning Agricultural Educational Programs. *3(3 0) . S. Preq: AEE(ED) 426. Coreq: AEE(ED) 427 or Consent of Instructor.* Principles of program planning applied to educational programs in agriculture; theory and field experiences in planning, organizing, and evaluating secondary agricultural education programs; development of plans for conducting all aspects of the complete agricultural education program.

AEE (ED) 426 Methods of Teaching Agriculture. *3(2-3) . F. Preq. Jr. standing or Consent of the Instructor.* Discussion and practice in planning and presenting instruction in agriculture in formal and informal settings. Principles and application of approaches to teaching and organizing instruction, motivating students, developing instructional objectives, selecting and using teaching techniques, evaluating instruction, and managing classroom and laboratory instruction.

AEE (ED) 427 Student Teaching in Agriculture. *8(2-15) . S. Preq: AEE (ED) 426; Admission to Professional Semester. Coreq. AEE (ED) 490, AEE (ED) 424.* Skills and techniques in teaching agriculture in a public school setting. Secondary agricultural education program teaching experience under the supervision of university faculty and an experienced agriculture teacher.

AEE 470 Agricultural Communications. *3(3-0) . S. Preq: AEE 311. Senior Standing.* Use of agricultural communication materials. Emphasis on application of principles, materials and processes of B&W and color photography to problems of communication and the development of visual presentation materials for instruction and training.

AEE 478 Extension as Non-Formal Education. *3(3-0) . S. Preq: Advanced undergraduate or PBS.* Extension as a system of non-formal education, how it functions in USA and other countries (with special attention to agricultural extension), historical antecedents and philosophical foundations, mission, organization, methods, problems dealt with; how technology and behavioral sciences are/can be utilized; provides actual experience with extension and with conceptual/theoretical ideas that under gird practice.

AEE (ED) 490 Seminar in Agricultural and Extension Education. *1(1-0) . S, Sum. Admission to Professional Semester.* Analysis of opportunities and challenges facing educational leaders in agriculture.

AEE 492 External Learning Experience in Agricultural and Extension Education. *1-6. F,S,Sum. Preq: Sophomore standing. Not intended for teaching licensure for students in AEE.* Learning experience within an academic framework that utilizes facilities and resources external to the campus. Contact and arrangements with prospective employers initiated by the student and approved by the faculty adviser, prospective employer, and the departmental teaching coordinator prior to the experience.

AEE 493 Special Problems in Agriculture and Extension Education. *1-6. F,S,Sum. Preq: Sophomore Standing. Not intended for teacher licensure for students in AEE.* A learning experience in agriculture and extension education within an academic framework that utilizes departmental campus facilities and resources. Arrangements must be initiated by the student and approved by a faculty adviser and the departmental teaching coordinator.

AEE 495 Special Topics in Agricultural and Extension Education. *1-3. F,S,Sum. Not intended for teacher licensure for students in AEE.* Offered as needed to present material not normally available in regular course offerings or for offerings of new courses on a trial basis.

AEE (ED) 501 Foundations of Agricultural and Extension Education. *3(3-0) . S.* Development and organization of agricultural and extension education in America from colonial times to the present. Emphasis on role of societal and scientific changes, the federal government and philosophy on evolution of agricultural and extension education.

AEE 521 Planning Programs in Agricultural Education. *3(3-0) . F. Preq: Grad. standing or PBS status.* Consideration of the need for planning programs in education; objectives and evaluation of community programs; use of advisory group; organization and use of facilities.

AEE 522 Occupational Experience in Agriculture. *3(3-0) . S. Preq: Grad. standing or PBS status.* A major and critical element in all programs of vocational education is provision for appropriate student learning experiences in a real and simulated employment environment. Due to recent developments in education and agriculture, new and expanded concepts of occupational experience devised. Current research substantiates need and desire of teachers of agriculture for assistance in implementing new concepts. Also designed to develop depth of understanding of theoretical foundations underlying new developments in occupational experiences to stimulate individual growth and creativity in implementing further developments.

AEE 523 Adult Education in Agriculture. *3(3-0) . F. Preq: Grad. standing or PBS status.* Designed to meet needs of leaders in adult education. Opportunity to study some of basic problems and values in working with adult groups. Attention given to problem of fitting educational program for adults into public school program and other educational programs as well as to methods of teaching adults.

AEE 524 Agricultural Occupations. *3(3-0) . F Preq. 12 hrs. professional ed courses.* Theory of education and work related to expanding field of agricultural occupations. Career development in agricultural occupations associated with curriculum development needs. Occupational experience in agriculture in relation to curriculum and placement in agricultural occupations

AEE (ED) 530 Priority Management in Agricultural and Extension Education. *3(3-0). S,Sum.* Examination of theoretical, psychological and empirical bases for strategies and techniques contributing to enhancement of managerial and personal effectiveness of agricultural educators and individuals in related agricultural organizations.

AEE 534 Supervision in Agricultural Education. *3(3-0). S. Preq: AEE "21.* Organization, administration, evaluation and possible improvement of supervisory practice; theory, principles and techniques of effective supervision in agricultural education at different levels.

AEE (ED) 535 Teaching Agriculture in Secondary Schools. *3(3-0). F. Alt. Yrs.(odd).* Application of theoretical models and research on effective teaching in secondary agricultural education programs. teaching strategies, planning required, and instructional management for students with varying backgrounds. Evaluation of student learning and teacher evaluation of instruction.

AEE 595 Special Topics in Agricultural and Extension Education. *1-4. F,S,Sum. Preq: Grad. or PBS status.* Presentation of material not normally available in regular graduate course offerings or for offerings of new 500 level courses on a trial basis.

AEE 601 Seminar. *1(1-0). F. Preq: Grad. or PBS status.* Current topics and issues in agricultural and extension education. Selection and research of topics, presentation of seminars, and leading group discussions.

AEE 610 Special Topics. *F,S,Sum. Preq: Grad. or PBS status.* Presentation of material not normally available in regular graduate course offerings or for offerings of new 500 level courses on a trial basis.

AEE 611 Special Topics in Agricultural Communications. *1-6. F. Preq: Sr. or Grad. standing.* Selected special topics for study in theoretical approaches to communications problems or experimental investigation with instructor guidance.

AEE 620 Special Problems in Agricultural and Extension Education. *1-6. F.* Exploration of topics of special interest not covered by existing courses by individual students under faculty member's directions. Readings and independent study, problems or research not related to a thesis.

AEE (ED) 641 Practicum in Agricultural and Extension Education. *1-6. F.* Examination of theoretical, psychological and empirical bases for strategies and techniques contributing to enhancement of managerial and personal effectiveness of agricultural educators and individuals in related agricultural organizations.

AEE 685 Master's Supervised Teaching. *1-3. F,S,Sum Preq: Master's students* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

AEE 690 Master's Examination. *1 6. F S,Sum. Preq: Master's student* For students in non-thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master s exam.

AEE 693 Master's Supervised Research. *1 9. F,S,Sum. Preq. Master's student* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

AEE 695 Master's Thesis Research. *1 9. F,S,Sum. Preq Master's student* Thesis research

AEE 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq. Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

AEE (ED) 735 Effective Teaching in Agriculture and Life Sciences. *3(3-0). Preq: Grad. standing.* Theory and practice of effective teaching in agricultural and life sciences. Emphasis on course planning, teaching and learning styles, instructional techniques, laboratory instruction, text construction, student evaluation, instructional technology, and faculty roles and responsibilities.

AEE 740 Extension In Developing Countries. *3(3-0). F. Preq: Grad. standing, PBS status or Consent of Instructor.* Rural extension (agriculture, forestry, development, etc.). Strategies for enablement of farm/rural people to better usage of science, technology and other types of knowledge in fulfilling their own aspirations within their cultural context. Examination of practice of rural extension/development in many parts of the world and basic conceptual ideas and processes.

AEE 820 Special Problems in Agricultural and Extension Education. *1-6. F,S,Sum.* Exploration of topics of special interest not covered by existing courses by individual students under faculty member's directions. Readings and independent study, problems or research not related to a thesis.

AEE (ED) 841 Practicum in Agricultural and Extension Education. *1-6. F,S,Sum.* Faculty-supervised practicum in an educational, extension or agricultural industry setting.

AEE 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

AEE 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate faculty.

AEE 895 Doctoral Dissertation Research. *1-9. F,S,Sum. Preq: Doctoral student.* Dissertation research.

AEE 899 Doctoral Dissertation Preparation. *1-3. F S Sum. Preq: Doctoral student.* For students who have completed all credit hours, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

AGRICULTURE AND LIFE SCIENCES

ALS 103 Introductory Topics in Agriculture and Life Sciences. *1(1 0) . F,S. Not open to juniors and seniors.* Introduction to scope and objectives of university education. Emphasis on sciences, particularly as related to agriculture and life sciences. Departmental programs, computers, career opportunities and more.

ALS 110 Agriculture and Life Sciences Scholars Forum. *0(2-0) . F. Preq: Enrollment limited to participants in the Agriculture and Life Sciences Scholars Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

ALS 295 Special Topics in Agriculture and Life Sciences. *F,S,Sum.* Offered as needed to present material not normally available in regular departmental course offerings; or for offerings of new courses on a trial basis.

ALS 398 Agriculture and Life Sciences Honors Seminar. *2(2-0. S. Preq: Enrollment by invitation for sophomores or juniors in CALS with GPA 3.35 or higher.* A seminar/discussion honors course with emphasis on a team approach to scientific research into topics that link science with issues in society; exposure to leadership skills and bioethics; requirement of detailed written or oral reports; career development in the agricultural and life sciences; required participation in on- and off-campus scholarly retreats.

ALS 495 Special Topics in Agriculture and Life Sciences. *F,S,Sum.* Offered as needed to present material not normally available in regular departmental course offerings or for offering of new courses on a trial basis.

ALS 498 Honors Research or Teaching I. *F,S,Sum. Preq: ALS 398 & GPA 3.25 or higher. A maximum of 6 credits for ALS 498 & ALS 499 combined.* Honors research or teaching for students in Agriculture and Life Sciences. First of a two-course sequence. Identification of a project and development of a proposal; literature search, planning, and work initiation.

ALS 499 Honors Research or Teaching II. *F,S,Sum. Preq: ALS 498 & GPA 3.25 or higher. A maximum of 6 credits for ALS 498 and ALS 499 combined.* Honors research or teaching for students in Agriculture and Life Sciences. Completion of work initiated in ALS 498. Analysis of results. Preparation and presentation of written and oral reports.

ANIMAL SCIENCE

ANS 105 Introduction to Companion Animals. *3(3-0) . F,S. Restricted to Class FR and SO.* Introduction to animals that people keep as companions. Variation, behavior, anatomy, physiology, disease, and training of animals as diverse as fish, snakes, mice, rats, birds, cats, and dogs. Special relationships between humans and companion animals in a societal context.

ANS 110 Introduction to Equine Science. *3(3-0) . S. Restricted to Class FR and SO.* History, management, and use of horses and their profound impact on society. Selection, care, and enjoyment of horses with emphasis on genetics, nutrition, reproduction, behavior, and health.

ANS 150 Introduction to Animal Science. *4(3-3) . F,S.* Fundamental principles of animal management; contributions of animals and animal products to humanity; application of science to animal production; issues regarding animal production.

ANS 201 Techniques of Animal Care. *2(0-4) . S. Preq: ANS 150 or ANS 230. Major IAS or SAS, or instructor permission.* A laboratory course in the applied management of beef cattle, dairy cattle, swine and small ruminants with participatory assignments of common techniques utilized in livestock production.

ANS 202 Techniques of Horse Care. *2(0-4) . S. Preq: ANS 150. Major IAS or SAS.* Opportunities to learn applied management skills required in horse production, with emphasis on common techniques utilized in horse production.

ANS 205 Anatomy and Physiology of Domestic Animals. *3(2-2) . F.S. Preq: BIO 125 or BIO 181; ANS 150.* Basic concepts relating mammalian structure and function with emphasis on livestock species. Fundamentals of neuromuscular activity, digestion, absorption as well as regulation of homeostasis relevant to production of milk, wool, and muscle growth efficiency.

ANS 210 Microcomputers in Animal Production. *2(1-2) . F.S.* Use of microcomputers and available software to increase understanding of animal production and management concepts. Word processing, spreadsheet, and presentation programs and effective use of e-mail and information about animals on the Internet.

ANS (HS) 215 Basic Agricultural Genetics. *3(3-0) . F.S. Preq: BIO 125.* Basic principles of inheritance in plants and animals of agricultural significance. Emphasis on transmission genetics and its effects on the usefulness of plants and animals. Introduction to basic principles of plant and animal improvement.

ANS 220 Reproduction and Lactation in Domestic Animals. *4(3-3) . F.S. Preq: ANS 205, BIO 125.* Biological processes in reproduction and lactation with emphasis on domestic animals. Environmental and genetic factors that affect these processes. Identification, evaluation and solutions of problems in these physiological areas.

ANS 230 Nutrition of Domestic Animals. *4(3-3) . F.S. Preq: ANS 150; ANS 205 recommended.* Introduction to nutrition, digestion, and absorption in domestic mammals. Major nutrient classes and their functions in the body, feed classification and chemical analysis, feed processing, and ration formulation to meet nutritional requirements.

ANS (FS, NTR) 301 Introduction to Human Nutrition. *3(3-0) . F.S.Sum. Preq: Sophomore standing. Food science majors may use as a free elective only.* Functions, dietary sources and deficiencies of essential nutrients in humans; a balanced diet; role of nutrients in heart disease, cancer, hypertension, osteoporosis; weight control and eating disorders; vegetarianism; food safety; dietary supplements; government regulation of food supply; food quackery.

ANS 303 Principles of Equine Evaluation. *2(1-3) . S.* Conformation and function, performance, and soundness of the horse. Breed standards, rules, and regulations for evaluation, selection, and performance. Field trips.

ANS (FS, PO) 322 Muscle Foods and Eggs. *3(2-3) . F. Preq: BIO 125* Processing and preserving fresh poultry, red meats, seafood, and eggs. Ante- and post-mortem events as they affect quality, yield, and compositional characteristics of muscle foods. Principles and procedures involved in the production of processed meat items.

ANS (FS) 324 Milk and Dairy Products. *2(2-0) . F. Preq: BIO 125* Composition of milk and dairy products, federal standards, raw milk procurement, cleaning and sanitizing and quality attributes.

ANS 340 Selection of Domestic Animals. *3(2-3) . F Preq: ANS 230. ANS 210.* Modern evaluation and selection procedures for domestic animals; selection goals, estimation of breeding values and performance testing; their impact on genetic changes.

ANS 400 Companion Animal Management. *3(2 3) . S. Preq: ANS 230.* Anatomy, physiology, nutrition, genetics, and health of companion animals including cats, dogs, rabbits, rats, mice, reptiles, amphibians, and fish. Problem solving and enterprise management skills in laboratories.

ANS 402 Beef Cattle Management. *3(2-3) . S. Preq: ANS 150 or ANS 230.* Principles and practices of production, management and marketing of beef cattle. Role of genetics, nutrition, reproduction and animal health.

ANS 403 Swine Management. *3(2 3) . F. Preq: ANS 150 or ANS 230.* Management principles associated with swine production. Emphasis on interactions of health, equipment, nutrition, reproduction and genetics during nursery, finishing, farrowing and breeding phases of production. Waste management practices and alternatives, development of marketing strategies and economic evaluation of management practices.

ANS 404 Dairy Cattle Management. *3(2-3) . S. Preq: ANS 150 or ANS 230.* The management of economic, nutritional, genetic, and physiological factors that influence the operation of a dairy enterprise.

ANS 410 Equine Management. *3(2-2) . S. Preq: ANS 150 or ANS 230* Equine anatomy, physiology, nutrition, genetics and health. Laboratory emphasis on reproductive management, breeding, problem solving, and management skills. Field trips required.

ANS (NTR, PO) 415 Comparative Nutrition. *3(3 0) . F Preq: CH 220 or both 221 and 223.* Principles of nutrition, including the classification of nutrients and the nutrient requirements of and species for health, growth, maintenance and productive functions.

ANS (NTR) 419 Human Nutrition in Health and Disease. *3(3-0) S. Preq. ANS 230, ANS/FS/NTR 301 or FS/NTR 400 or ANS/NTR/PO 415.* Current concepts and physiological bases of the roles of nutrition in the maintenance of health during the different stages in the life cycle and in the prevention and therapy of specific disease states in humans.

ANS (PO) 425 Feed Mill Management and Feed Formulation. *3(2-3) . S. Preq: ANS(NTR,PO) 415 or ANS 230; CH 220 or 221.* Feed mill management, feed ingredient purchasing, inventory, storage, and quality evaluation, computerized feed formulation, feeding programs for poultry and swine, feed mill design, equipment, maintenance, operation, safety, state and federal regulations pertaining to feed manufacture.

ANS 452 Advanced Reproductive Physiology and Biotechnology. *3(3-0) . S,Alt yrs.(odd). Preq: ANS 220.* Comparative approach to examining aspects of reproductive physiology in selected vertebrate species. Detailed examination of current reproductive biotechnologies.

ANS 453 Growth and Development of Domestic Animals. *3(3-0) . F, Alt yrs.(even). Preq: ANS 230 or equivalent; junior standing. Credit will not be given for both ANS 453 and 553.* Introduction to the basic concepts of growth with emphasis on domestic mammals. Growth of the major classes of animal tissues and regulation by endogenous and exogenous factors. Relationship to efficiency of animal production.

ANS 454 Lactation, Milk and Nutrition. *3(2 2) . S. Alt yrs.(even). Preq: ANS 230 or FS/NTR 400; BCH 451 or ZO 421. Credit will not be given for both ANS 454 and 554.* Nutritional properties of milk as a high-quality food with nutritional diversity. Principles of physiology, biochemistry and cell biology in the mammary gland. Procedures of milk production and milk collection for milk quality and nutrition. Human lactation vs. that of domestic animals. Impacts of biotechnology and good safety on dairy production.

ANS 492 External Learning Experience. *1-6. F,S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, and the departmental teaching coordinator prior to the experience.

ANS 493 Special Problems in Animal Science. *1-6. F,S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes departmental campus facilities and resources (Arrangements must be initiated by student and approved by a faculty adviser and the departmental teaching coordinator).

ANS 495 Special Topics in Animal Science. *1-3. F,S,Sum.* Offered as needed to present material not normally available in regular course offerings or for offering of new courses on a trial basis.

ANS 500 Advanced Ruminant Nutrition. *3(3-0) . Sum, Alt. yrs. Preq: ANS 230 or ANS 415.* Advanced concepts in ruminant nutrition for the practicing agricultural professional. Protein, energy, vitamin and mineral nutrition in relationship to the nutritional needs and practical feeding of beef cattle, dairy cattle, sheep and goats. New developments in feeding systems, feed additives and the prevention and treatment of metabolic disorders.

ANS 516 Animal Nutrition Research Methods. *1 4. S. Preq: BCH 451 or NTR(ANS) 415 or NTR(ANS) 419 or FS 400.* Theory and practice of modern research techniques in ruminant and monogastric animal nutrition: NTR(ANS) 516A, nutritive evaluation of feedstuffs; NTR(ANS) 516B, biological evaluation of feeds and diets; NTR(ANS) 516C, blood and tissue analysis; NTR(ANS) 561D, forage and pasture evaluation. Students can register for any combination.

ANS 553 Growth and Development of Domestic Animals. *3(3-0) . F,Alt yrs.(even). Credit will not be given for both ANS 453 and 553.* Introduction to the basic concepts of growth with emphasis on domestic mammals. Growth of the major classes of animal tissues and regulation by endogenous and exogenous factors. Relationship to efficiency of animal production.

ANS (FS, NTR) 554 Lactation, Milk, and Nutrition. *3(2-2) . S, Alt. yrs.(even). Preq: ANS 230 or FS/NTR 400; BCH 451 or ZO 421 Credit will not be given for both ANS 454 and 554.* Nutritional properties of milk as a high-quality food with nutritional diversity. Principles of physiology, biochemistry and cell biology in the mammary gland. Procedures of milk production and milk collection for milk quality and nutrition. Human lactation vs. that of domestic animals. Impacts of biotechnology and food safety on dairy production.

ANS 601 Animal Science Seminar. *1(1-0) . F,S.*

ANS (CBS, PHY, ZO) 602 Seminar in Biology of Reproduction. *2(2-0) . S. Preq: ANS(PHY) 702 or Consent of Instructor.* Current topics in animal reproduction presented by reproductive physiologists from various Research Triangle institutions. Student presentations of research projects or library projects in area of animal reproduction.

ANS 603 Reproductive Physiology Seminar. *1(1-0) . F,S.*

ANS 604 Animal Breeding and Genetics Seminar. *1(1-0) . F,S.*

ANS 610 Topical Problems in Animal Science. *1-6. F,S.* Selection or assignment of special problems in various phases of animal science.

ANS 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ANS 690 Master's Exam. *1-6. F,S,Sum. Preq: Master's student.* For students in non-thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

ANS 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ANS 695 Master's Thesis Research. *1 9. F,S,Sum. Preq: Master's student.* Thesis research.

ANS 699 Master's Thesis Preparation. *1 3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

ANS (PHY) 702 Reproductive Physiology of Mammals. *3(3-0) . S. Preq: ZO 421.* Survey of reproductive strategies among vertebrates; in-depth coverage of mammalian reproductive physiology; gametogenesis, fertilization, embryonic and fetal development, parturition, puberty, neuroendrocrine control mechanisms in male and female mammals.

ANS 706 Mammalian Embryo Manipulation. *4(1-8) . S, Alt. Sum.. Preq: ANS 702* Advanced training and experience in mammalian embryo manipulation; techniques of superovulation and embryo recovery, in vitro culture, parthenogenetic activation, in vitro fertilization, embryo transfer, embryo aggregation and DNA microinjection.

ANS (GN) 708 Genetics of Animal Improvement. *3(3-0) . S. Preq: GN 411, ST 711.* Emphasis on the utilization of basic principles of population and quantitative genetics in animal improvement. Factors affecting genic and genotypic frequencies and methods of estimating genetic and nongenetic variance, heritabilities and breeding values. The roles of mating systems and selection procedures in producing superior genetic populations.

ANS 709 Energy Metabolism. *3(3-0) . Preq: BCH 553.* Relationship of biochemical and physiological events within cell, tissue, organ and system with nutrient needs as sources of energy for productive animal life. Digestion, absorption and metabolism of energy sources. Processes of energy transformations within the body in relation to energetics, biological oxidation, anabolic and catabolic systems, metabolic control, partitioning and efficiency.

ANS 710 Advanced Livestock Management. *3(3-0) . S. Preq: ANS 402 or ANS 403 or ANS 404.* An advanced study of beef cattle, dairy cattle and swine management practices with particular emphasis on input-output relationships and the consequences of alternative management decisions. Problem. (Offered on-campus in even-numbered years.)

ANS (GN) 713 Quantitative Genetics and Breeding. *3(3-0). F. Preq: GN 509, ST 512.* Quantitative and population genetic theory of breeding problems; partitioning of genetic variance, maternal effects, genotype by environment interaction and genetic correlation; selection indexes; design and analysis of selection experiments; marker-assisted selection.

ANS 720 Livestock Production in Warm Climates. *3(3-0) . F. Preq. Consent of Instructor.* Analysis of constraints of warm climates to livestock; interdependence of crop and animal agriculture in farmer decisions; roles of animals in sustainable agriculture and economic development; application of principles through case studies and independent study.

ANS (CBS, NTR, PHY) 764 Comparative Physiology Of the Digestive System. *3(3-0) . F. Preq: Course in general or comparative physiology Coreq: Consent of Instructor.* Discussion of major functions of vertebrate digestive systems and structural and functional adaptations to diet, environment and other characteristics of the animals.

ANS (NTR, PO) 775 Mineral Metabolism. *3(3-0) . F. Preq. ANS(NTR.PO) 415. BCH 451 and ZO 421.* Requirements, function, distribution, absorption, excretion and toxicity of minerals in humans and domestic animals. Interactions between minerals and other factors affecting mineral metabolism or availability. Emphasis on mechanisms associated with mineral functions and the metabolic bases for the development of signs of deficiency.

ANS (PHY) 780 Mammalian Endocrinology. *3(3 0) . S, Alt. Sum. Preq: BCH 451. ZO 421.* Mammalian endocrine system with emphasis on ontogeny and anatomy of key organs; synthesis and action of hormones. Role of hormones in regulation of physiological processes such as metabolism, exocrine function, digestion, ion balance, behavior, lactation, growth and reproduction.

ANS 790 Advanced Special Topics in Animal Science. *F,S.*

ANS 801 Animal Science Seminar. *1(1-0) . F,S.*

ANS (CBS, PHY, ZO) 802 Seminar in Biology of Reproduction. *2(2-0) . S. Preq: ANS(PHY) 702 or Consent of Instructor.* Current topics in animal reproduction presented by reproductive physiologists from various Research Triangle institutions. Student presentations of research projects or library projects in area of animal reproduction.

ANS 803 Reproductive Physiology Seminar. *1(1-0) . F,S.*

ANS 804 Animal Breeding and Genetics Seminar. *1(1-0) . F,S.*

ANS 810 Topical Problems in Animal Science. *1-6. F,S.* Selection or assignment of special problems in various phases of animal science.

ANS 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ANS 890 Doctoral Preliminary Examination. *1-9. F,S,Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

ANS 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ANS 895 Doctoral Dissertation Research. *1-5. F,S,Sum. Preq: Doctoral student.* Dissertation research

ANS 899 Doctoral Dissertation Preparation. *1-3. F,S,Sum. Preq: Doctoral student.* For students who have completed all credit hours, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

ANTHROPOLOGY

ANT 251 Physical Anthropology. *3(3-0) F,S,Sum.* Study of human evolution. Processes of evolution, human variation and race, behavior and morphology of nonhuman primates, and the fossil record. Emphasis on the study of human biosocial adaptation, past and present, and on humans as culture-bearing primates.

ANT 252 Cultural Anthropology. *3(3-0) . F,S,Sum.* Comparative study of contemporary human culture, social institutions and processes that influence behavior. Includes examples from cultural backgrounds and the student's own culture system.

ANT 253 Introduction to Prehistory. *3(3 0) . F,S,Sum.* World-wide survey of origins of human society, technology and culture in Old Stone Age, and origins of agriculture, cities, and civilizations of the Bronze and Iron Age in Europe, Asia, Africa, and pre-Columbian Middle and South America.

ANT 254 Language and Culture. *3(3-0) . F,S,Sum.* Focus among the aspects of human language and between aspects of language and culture. Topics such as: descriptive and comparative linguistics, structuralism, language and thought, sociolinguistics, bilingualism, culture change and linguistic changes.

ANT (SOC) 261 Technology in Society and Culture. *3(3-0) . F,S* Processes of social and cultural change with a focus on role of technological innovation. Cross-cultural emphasis. Workplace changes and societal risks associated with technological innovations. Special attention to the role of scientists and engineers in socio-cultural change. Topical case studies apply course concepts and principles. Core sociological and anthropological concepts, methods, theories.

ANT 310 Native Peoples and Cultures of North America. *3(3-0) . Preq: ANT 252 or HI 365.* Native North American peoples and cultures including Eskimos and Aleuts. Theories of origin and selected prehistoric cultural manifestations. People and cultures at the time of European contact and post-contact cultural change. Contemporary problems and prospects.

ANT 325 Andean South America. *3(3-0) . Preq: ANT 252 or HI 215 or HI 216.* The societies, cultures, politics, economics and ecology of the Andean countries of South America (Peru, Bolivia, Ecuador, Chile, Colombia). Special attention to the development of pre-Columbian Andean Societies.

ANT 330 Peoples and Cultures of Africa. *3(3-0) . S. Preq: Three hours cultural anthropology or HI 275 or HI 276.* African peoples and cultures, especially in sub-Saharan Africa; past and present social patterns of indigenous African populations from a cross-cultural perspective.

ANT 346 Peoples and Cultures of Southeast Asia. *3(3-0) . F. Preq: 3 hours Cultural Anthropology.* Southeast Asian peoples and cultures; past and present social patterns of selected mainland and insular Southeast Asian peoples; culture change; relations between minorities and dominant ethnic groups; development of nationalism.

ANT 373 The Human Fossil Record. *3(3-0) . Preq: Three hours physical anthropology or archaeology.* Analysis of the human fossil record and consideration of alternate theories of human evolution.

ANT (COM, HSS) 392 International and Crosscultural Communications. *3(3-0) S.* Patterns and problems of verbal and non-verbal forms of cross cultural communication. Avoidance and management of cultural conflict arising from awareness of characteristics of cross cultural communication. Impact on communication of differing cultural perspectives.

ANT 412 Applied Anthropology. *3(3-0) . S. Credit cannot be given for both 412 and 512.* History, aims, methods and ethics of applied anthropology. Anthropological practice in government, industry, community development, education, and medicine. Analysis of consequences of development programs for culture change.

ANT 416 Research Methods in Cultural Anthropology. *3(3-0) . F. Alt Yrs. Preq: Six hours ANT.* A systematic overview of cultural anthropological research methods including designing research projects, research techniques, field work methods, and cross-cultural comparison. Reviews relevant ethical questions and anthropologists' reports of their own field work.

ANT 419 Ethnographic Field Methods. *3(2-2) . Sum. Preq: Six hours of cultural anthropology.* Ethnographic research methods as part of a summer field school abroad. Topics: research design, participant observation, field note writing, interviewing, sampling, coding, computers in ethnographic research, analysis and ethics.

ANT 420 Biological Bases for Human Social Behavior. *3(3-0) . Preq: ANT 251 or 3 hrs. biological sciences.* Applicability of sociobiology to the study of the human condition. Nature and uniqueness of human behavior as compared to the social behavior of nonhuman animals.

ANT 432 Anthropology of Tourism: Applied Field Research. *3(2-2) Sum. Preq. Six hours of Anthropology.* Anthropological applications to the study of tourism in an international field setting. Special attention to impact of mass tourism as compared to alternative tourism; environmental and economic impact of tourism; impact of international tourists and tourism on local communities. A guided, field research project included.

ANT (WGS) 444 Cross-Cultural Perspectives on Women. *3(3-0) . S, Alt Yrs. Preq: 3 hours cultural anthropology.* Comparison of women in a variety of societies: western and non-western; hunting and gathering to industrialized. Cross-cultural perspective on the similarity and diversity of women's statuses and roles. Effect of gender on social position.

ANT 460 Urban Anthropology. *3(3-0) . F, Alt Yrs. Preq: ANT 252.* Anthropological study of cities. Examination of cross-cultural patterns of behavior in urban areas and adaptive strategies that urban dwellers employ. Introduction to major theoretical and methodological approaches relevant to an understanding of contemporary urbanization.

ANT 495 Special Topics in Anthropology. *3(3-0) F,S,Sum.* Detailed investigation of a topic in anthropology. Topic and mode of study determined by faculty member(s).

ANT 498 Independent Study in Anthropology. *1-6. F,S,Sum. Preq: Six hours of ANT.* Independent study of a topic in anthropology. Topic and mode of study determined by faculty member(s) and student(s).

ANT 508 Culture and Personality. *3(3-0) . Preq: ANT 252 or 6 hrs. in cultural anthropology.* Interplay between cultural norms and enculturation process. From cross-cultural perspective, an examination of process of transmission and learning of cultural norms, as well as effect of culture change on individual. Historical development of the field as well as contemporary trends in both theoretical and applied contexts.

ANT 511 Anthropological Theory. *3(3-0) . Preq: ANT 252 or 6 hrs. in cultural anthropology.* Approach to theory from both historical and contemporary point of view. Emphasis upon key anthropological concept of culture and its significance for understanding man and his works.

ANT 512 Applied Anthropology. *3(3-0) . Preq: ANT 252 or Consent of Instructor* A review of historical development of applied anthropology and study of anthropology as applied in government, industry, community development, education and medicine. Analysis of processes of cultural change in terms of application of anthropological techniques to programs of developmental change.

ANT 516 Qualitative Research Methods. *3(3-0) F, Alt. yrs.(even). Preq. Graduate Standing. Credit will not be given for both ANT 416 and 516.* Systematic overview of qualitative research methods including theoretical perspectives, research techniques, research design and data management. Reviews relevant ethical questions and social science presentation of research findings.

ANT 544 Cross-Cultural Perspective on Women. *3(3-0) . S, Alt.Yrs.(odd). Preq: 3 hours Cultural Anthropology or Graduate Standing. Credit will not be offered for both ANT 444 and ANT 544.* Comparison of women in a variety of societies: western and non-western; hunting and gathering to industrialized. Cross-cultural perspectives on the similarity and diversity of women's statuses and roles. Effect of gender on social position.

ANT 560 Urban Anthropology. *3(3 0) . F, Alt. Yrs (odd). Preq: ANT 252 or Graduate Standing. Credit will not be given for both ANT 460 and ANT 560.* Anthropological study of cities. Examination of cross-cultural patterns of behavior in urban areas and adaptive strategies that urban dwellers employ. Major theoretical and methodological approaches relevant to an understanding of contemporary urbanization.

ANT 610 Special Topics in Anthropology. *1-6.* Provision for in-depth investigation of some particular topic in anthropology. Reflection of current student needs and interests through variations in course content and mode of study. Determination of topics by faculty member(s) and student.

ANT 810 Special Topics in Anthropology. *1-6. F,S.* Provision for in-depth investigation of some particular topic in anthropology. Reflection of current student needs and interests through variations in course content and mode of study. Determination of topics by faculty member(s) and student.

ARCHITECTURE

ARC 140 Experiencing Architecture. *3(3-0) . F.* Contemporary and historic houses, public buildings and cities illustrate the practical and aesthetic aspects of architecture. The basic elements of architectural form, design process, and architectural criticism.

ARC 141 History of Design I. *3(3-0) . F.* Western design from prehistory to Imperial Rome through examples of architecture and construction, landscape and urban planning, pure and applied three- and two-dimensional artifacts in their cultural setting. Students draw and/or construct selected historical design solutions.

ARC 142 History of Design II. *3(3-0) . S.* Western design from the early Christian to the Modern Age through examples of architecture and construction, landscape and urban planning, pure and applied three- and two-dimensional artifacts in their cultural setting. Students draw and/or construct selected historical design solutions.

ARC 201 Architectural Design: Environment. *6(0-9) . S. Preq: DF 102, ARC 141 and ARC 142. Coreq: ARC 211.* Investigation of the relationships between environment and built form. Solar orientation, topography, vegetation, and constructed context in relationship to user needs as parameters for justifying design proposals. Particular emphasis on architectural conventions of communication.

ARC 202 Architectural Design: Form. *6(0-9) . S. Preq: ARC 201, ARC 261. Coreq: ARC 252.* Investigation of relationships between idea and form. Composition and precedent as parameters for generating, developing, and justifying architectural form. Particular emphasis on electronic media in drawing and modeling.

ARC 211 Natural Systems and Architecture. *3(3-0) . F. Preq: DF 102.* Restricted to students in BEDA Program. Relationship between natural and architectural systems. Exploration of the implications of natural forces - sun, wind and daylight- on architecture. Energy-conscious architectural design and site planning strategies to fulfill thermal comfort requirements of people in designed environments.

ARC 232 Structures and Materials. *3(2-2) . S.* Construction materials related to structural applications. Theory of structures and introduction to quantitative analysis. Implications for design. Historical examples and current practices. Laboratory and field trips required.

ARC 252 Architectural Design Methods. *3(3-0) . S. Preq: DF 102.* A comprehensive survey of methods for conceiving, developing, justifying, and evaluating architectural form from historical, cultural, social, technical and aesthetic perspectives.

ARC 253 Architectural Communication. *3(2-2) F,S. Preq: DF 102 or Graduate standing in Architecture.* Basic graphic communication skills in architecture. Emphasis on the use of drawing as a path to better design and on the communication of architectural ideas.

ARC 261 The Discipline of Architecture. *3(3-0) . F.* The modern architecture profession in the U.S. Emphasis on historical events and intellectual, technological, and esthetic developments here and abroad which have shaped today's profession. Concepts of professionalism and ethics, legal and institutional foundations, and case studies of professional roles in architecture.

ARC 289 Architectural Travel Study I. *3(3-0) . F,S,Sum. Preq: ARC 141 and ARC 142. Departmental Approval.* The study of cities, architectural sites, buildings, building complexes, and architectural elements conducted independently by students as part of a planned travel-study tour. Includes advance research and approval of proposed study topic and itinerary. Students will document study through sketches, analytical notations, and a summary paper.

ARC 292 Special Topics in Architecture. *1-3. F,S,Sum. Preq: Consent of Instructor.* Topics of current interest in Architecture. Normally used to develop new courses.

ARC 302 Architectural Design: Technology. *6(0-9) . S. Preq: ARC 202, ARC 232, Architecture majors. Coreq: ARC 332.* An investigation of technical systems of buildings - structure, environmental control/energy, materials, enclosure, and circulation, their fabrication and assembly and their capacity to affect form and tectonic expression as fundamental elements of the design process. Particular emphasis on physical models.

ARC 331 Architectural Structures I. *3(2-2) . F. Preq: ARC 232.* Structural design process. Combined role of imposed loads and architectural function in shaping the form of the building. Interaction of elements in structural systems containing beams, columns, trusses, space frames, slabs, arches, vaults, domes, cables, cable networks, fabrics and diaphrams. Case studies emphasized.

ARC 332 Architectural Structures II. *3(2-2) . S. Preq: ARC 331.* Structural systems explored through case studies and design projects. Emphasis on interaction of structural elements. Tracing of loads in structural systems. Sizing of tensile elements, columns, trusses, and flexural elements. Design and sizing of joints.

ARC 400 Architectural Design. *6(0-9) . F, Sum. Preq: DF 102.* Studies in architectural design. Projects of many types and scales employed to investigate issues in architecture. Emphasis on independent exploration of design values and their implications.

ARC 402 Architectural Design: Integration. *6(0-9) . S. Preq: ARC 302, ARC 432, ARC 441. Coreq: ARC 414 Bachelor of Environmental Design in Architecture majors only.* The execution of a project in sufficient depth to understand the opportunities and discipline resulting from the inclusion of building technologies, the elaboration of interior space, and the development, representation, and communication of details at a large scale.

ARC 403 Architectural Design Fundamentals: Environment. *6(0-12) . F. Coreq: ARC 211. M. Arch Track 3 Students only.* An introductory architectural design studio for M. Arch, Track 3 students investigating the relationship between environment and built form. Solar orientation, climate, topography, vegetation, and constructed context in relationship to user needs as parameters for design proposals. Particular emphasis on design fundamentals and conventions of architectural communication.

ARC 404 Architectural Design Fundamentals: Form. *6(0 12) . S. Preq: ARC 403, ARC 252. Coreq: ARC 261. M. Arch Track 3 Students only.* An introductory architectural design studio for M. Arch. Track 3 students investigating relationships between idea and form. Composition and precedent as parameters for generating, developing, and justifying architectural form. Particular emphasis on electronic media in drawing and modeling.

ARC 405 Architectural Design Fundamentals: Technology. *6(0-12) . S. Preq: ARC 404. Coreg: ARC 331. M. Arch Track 3 Students only.* An introductory architectural design studio for M. Arch. Track 3 students in which the technical systems of building - structure, environmental control/energy, materials, enclosure, and circulation; their fabrication and assembly; and their capacity to affect form and tectonic expression - are explored as fundamental elements of the design process. Particular emphasis on physical models.

ARC 406 Architectural Design Fundamentals: Integration. *6(0-12) . S. Preq ARC 405. Coreq: ARC 332, ARC 414, ARC 441. M. Arch Track 3 Students only.* An introductory architectural design studio for M. Arch. Track 3 students involving the execution of a project in sufficient depth to understand the opportunities and discipline resulting from the inclusion of building technologies, the elaboration of interior space, and the development, representation, and communication of details at a large scale.

ARC 414 Environmental Control Systems. *3(3-0) . S. Preq: ARC 211, Junior standing.* Studies in light, heat, moisture, air motion, and sound in architectural environments. Mechanical, electrical and/or electronic equipment for illumination, heating, cooling, ventilation, vertical transportation and communication in buildings. Water and waste, fire protection and safety, and acoustic systems in architecture.

ARC 432 Architectural Construction Systems. *3(2-3) . F. Preq: ARC 232.* Building construction systems related to architectural design. Historical and current building practices. Implications for design and systems selection. Case studies. Field trips are required.

ARC 441 History of Contemporary Architecture. *3(3-0) . F. Preq: Junior standing or ARC 141 or 142.* A survey and critical examination of modern architecture from its origins in 19th-century philosophy and technology to the most recent developments in world architecture.

ARC 442 History of NC Architecture. *3(3-0) . S. Preq; ARC 141,142, Jr. Standing in SOD.* Survey of NC Architecture from 17th-century settlement to World War II. Coverage of a wide range of building types and development patterns.

ARC 445 Aesthetics and Design. *3(3-0) S. Preq: ARC 141 or 142.* An examination of the identity, nature, and function of aesthetic experience, cognition and action as related to the design disciplines and reflected in designed artifacts.

ARC 490 Architecture International Studio. *6(6-0) . F S,Sum. Preq: ARC 202* Exploration of architectural problems and development of design solutions in an international setting. Studio projects focused on current conditions found in the host culture, profession, and community.

ARC 492 Special Topics in Architecture. *1-3. F,S,Sum.* Topics of current interest in Architecture. Normally used to develop new courses.

ARC 495 Independent Study in Architecture. *1-3. F S,Sum Preq: 3 0 Junior standing in architecture GPA or better; and approval of department head* Special projects in architecture developed under the direction of a faculty member on a tutorial basis.

ARC 501 Professional Architecture Studio I. *6(0 12) . Preq. BEDA degree or equivalent and Consent of Instructor* Design studio investigations aimed at the development of an understanding of the major issues confronting the contemporary architect and at the expanding of problem solving abilities in architectural design.

ARC 502 Professional Architecture Studio II. *6(0-12) . Preq ARC 501 and Consent of Instructor.* Design investigation aimed at the development of an understanding of the major issues confronting the contemporary architect and at the expanding of problem solving abilities in architectural design. This is an individualized, final project studio.

ARC 503 Advanced Architectural Design (Series). *6(0-12) F,S. Preq: Grad standing.* Advanced studies in architectural design. Projects concerning various aspects of building design, urban design and community design in comprehensive and integrative manner.

ARC 531 The Chair as an Architectural Artifact. *3(2-2) . Preq: 4 semesters of DX studio.* Survey of modern chair design emphasizing issues of contemporaneous architectural developments. Exploration of alternative designs through sketches, models and class reviews. Refinement and construction of final design.

ARC 543 Analysis of Precedent. *3(0-3) . S. Preq: Grad. standing* Investigation of architectural elements, relationships and ordering ideas through comparative graphic analysis of buildings designed by architects. Emphasis on buildings as physical artifacts.

ARC 544 Architectural Conservation. *3(3-0) . S. Preq: Advanced undergrad. in SOD or Grad. standing* Examination of the many dimensions of architectural conservation and/or preservation as significant aspect of architectural practice. Exploration of historical evolution, regulatory and economic factors, technology and pertinent design issues as foundations for individual case studies by class members of selected adaptive use, rehabilitation and restoration projects.

ARC 546 Theory of Building Types. *3(3-0) . F. Preq: Two ARC studios.* Theoretical implications and practical applications of typology in architecture. Analysis and documentation of selected building types in their historical evolution. Graphic identification of type characteristics.

ARC 551 Design Methods and Programming. *3(3-0) . F. Preq: Grad. standing or Consent of Instructor.* An intensive study of a part of the design process involving the social and behavioral needs of the users through disciplined methods of data collection, analysis, organization, communication and evaluation. Emphasis upon the role of programming in the environmental design field and variety of applications used in the profession.

ARC 561 The Practice of Architecture. *3(3-0) . F,S.* A lecture course examination of the practice of architecture through a lecture course, with emphasis upon both normative and emerging procedures in the private architectural firm. Special attention upon the role and function of the practicing architect, legal and regulatory conditions, the nature of professional services, office management and project management processes.

ARC 570 Anatomy of the City. *3(3-0) . F.* A morphological investigation of cities throughout urban history, with emphasis on formal principles of spatial organization. Part one: examination of the descriptive properties of cities in terms of interdisciplinary concepts and principles. Part two: examination of the organizational characteristics of urban space.

ARC 571 Urban House. *3(3 0) . S. Graduate standing or permission of instructor.* This course is intended to reveal the interrelationships between the form of housing and the characteristics of cities. Reference is made to the physical, technological, social and economic factors which influence housing design, as well as to historic and cultural developments.

ARC 573 Environmental Perception. *3(3 0) . S,Alt Yrs Preq: Grad. standing or Consent of Instructor.* An intensive review of the design research literature with emphasis upon people's interaction with the physical environment. Exploration of various techniques for measuring human response to the environment to permit student development and analysis of their own research projects.

ARC 574 Place and Place Making. *3(3-0) F. Preq: Graduate standing or Consent of Instructor.* Examination of the definitions, concepts and emergent research findings useful in explaining the human sense of place through seminar-lecture course. Particular emphasis upon those physical aspects and relationships influencing this sense of place and affording some designer control.

ARC 575 Participatory Design in Architecture. *3(3-0) . S,Alt. Yrs. Preq: Graduate standing or Consent of Instructor.* The theories and methods pertaining to the participatory design process. A probe of the nature of advocacy design and examination of successful projects in the U. S. and abroad defining a social role for architects.

ARC (LAR) 576 Community Design. *3(3-0) . F. Preq: Graduate Standing. For Master's student in School of Design or Department of City & Regional Planning (UNC-Chapel Hill). Consent of instructor required for non-design or non-planning students..* Processes through which citizens shape and manage built environment. Strategic planning, visioning process, community action, and mediation will be discussed and illustrated with case study examples from architecture, landscape architecture and planning. Analysis and assessment from case studies of participation techniques such as charrette, study circles, and visual appraisal.

ARC (LAR) 577 Sustainable Communities. *3(1.5-1.5) . S. Preq: Graduate Standing. For master's students in the School of Design or Department of City & Regional Planning (UNC-Chapel Hill). Permission of instructor required for non-design or non-planning students..* Historical precedents of sustainable communities. Examination of the Garden City, the New Towns Movement, and the New Urbanism. Comparison of sustainable communities to urban visions of Wright, Corbusier, Soleri and others. Virtual cities and digital communities.

ARC 581 Project Preparation Seminar. *3(3-0) . F,S.* Quantitative and qualitative conditions, considerations and determinants as preparation for architectural design. Emphasis on research methods, data collection and interpretation, theoretical discourse, site analysis, programming and architectural precedent. Required enrollment in B.Arch.

ARC 589 Architectural Travel Study II. *3(0-9) . F,S,Sum.* Independent study while traveling. Submission of sketchbook/journal and paper upon return. Research on topic of concentration and approval of itinerary in advance required. Graphic documentation and critical evaluation of buildings and urban spaces. Required of all participants in Dept. of Architecture Foreign Exchange and Summer Abroad Programs. Restricted to departmental approval.

ARC 590 Special Topics in Architecture. *2-3. F,S. Preq: Grad. standing or Consent of Instructor.* Topics of current interest by faculty in the Department of Architecture. Subjects under this number normally to test and develop new courses.

ARC 598 Final Project Studio In Architecture. *6(0-12) . F.S. Preq: 18 hrs. of ARC 503 and ARC 697.* Final project for graduate students supervised by members of their graduate advisory committee.

ARC 630 Independent Study. *1-6. F,S,Sum. Preq: Grad. standing.* Development of special problems and projects in various aspects of architecture under the direction of architecture faculty member on tutorial basis.

ARC 676 Special Seminar in Architecture. *1-3. F,S. Preq: Grad. standing.* Presentation of seminars on subjects of current interest in design by persons not part of the regular faculty.

ARC 697 Final Project Research in Architecture. *1-6. Preq: Grad. standing.* Investigation of selected problems and projects in architecture of particular interest to graduate students under the direction of a faculty member on a tutorial basis. Credits and content vary to meet the scope of the project proposal.

AGRICULTURAL AND RESOURCE ECONOMICS

ARE 201 Introduction to Agricultural & Resource Economics. *3(3-0) . F,S. Preq: MA 111. Credit will not be given for both EC 205 and either EC 201 or ARE 201.* Introduction to economic principles of marginal benefits and costs with application to consumer and producer decisions. Functions of market exchange systems in determining prices and quantities and creation of wealth. Property rights and opportunities for exchange. Role of government in dealing with agricultural and resource problems. Macroeconomic analysis including inflation, unemployment, money and banking system.

ARE 210 Consumer Economics. *3(3-0) . S.* Role of the consumer in the modern economy and application of economic concepts to consumer markets and decisions. Economic analysis of home buying and home finance, credit, life, health, and property insurance, investments, retirement planning, and information collection. Relationship of the macroeconomy to consumer decisions.

ARE (EC) 301 Intermediate Microeconomics. *3(3-0) . F,S,Sum. Preq: MA 121 or 131; ARE 201 or EC 201. Credit not allowed for both EC(ARE) 301 and EC(ARE) 401.* Functioning of the market economy: role of prices in determining the allocation of resources; the functioning of the firm in the economy; forces governing the production and consumption of economic goods.

ARE 303 Farm Management. *3(2-2) . F,S. Preq: ARE 201 or EC 201.* Analytical and planning techniques for making business decisions centered around farm business applications. Economic principles and management concepts such as budgeting, accounting, finance credit, investment analysis, business organization, risk,and taxes as related to practical problems of operating a farm business.

ARE 304 Agribusiness Management. *3(3-0) . S. Preq: ARE 201 or EC 201.* Management decision-making by food, fiber, horticulture, and forestry firms. Emphasis on current agribusiness topics such as information utilization, strategic planning, organization structures, competitor intelligence, pricing, leadership, crisis management, ethics, and human resource management. Business communications, agribusiness case studies, and a computerized management simulation game.

ARE 306 Agricultural Law. *3(3-0) . F,S. Preq: ARE 201 or EC 201. Credit for both ARE 306 and BUS 307 is not allowed.* Legal principles of practical importance in an agricultural setting: the court system; tort, contract and real and personal property law; legal aspects of organizing an agribusiness; environmental and labor regulations affecting agriculture; income and estate taxation of agriculture.

ARE 309 Environmental Law & Economic Policy. *3(3-0) F Preq: ARE 201 or EC 201.* Current federal and state environmental laws and regulations and their common law foundations. Relationship of the law and its regulatory mechanisms to economic policy issues: externalities, pollution taxes, incentives, permit trading, and cost-benefit analysis. Major environmental topics including water and wetlands, solid and hazardous wastes, pesticides, clean air, endangered species and nuisance actions. Overview of the legal system.

ARE 311 Agricultural Markets. *3(3-0) . F,S Preq. ARE 201 or EC 201* Agricultural marketing system and economic forces affecting its structure and efficiency. Public policy issues affecting agricultural markets. Emphasis on the analysis of current sources of agricultural market information. Marketing and storage problems over time; futures markets and the management of risk; transportation and international trade; government agricultural programs.

ARE 312 Agribusiness Marketing. *3(3-0) . S. Preq: ARE 201 or EC 201.* Application of marketing and economic principles to decision making in contemporary agribusiness firms. Marketing strategies, marketing research and information, segmentation and targeting, marketing mix, and market plans within food, fiber, natural resource, and production input industries. Professional selling skills and knowledge. Off-campus field experience and visiting lecturers from the agribusiness industry.

ARE 321 Agricultural Financial Management. *3(3-0) F. Preq: ARE 201 or EC 201.* Fundamental concepts for financial management decision in agricultural farm businesses. Emphasis on financial statement analysis of profitability, efficiency, liquidity, repayment capacity, risk, leverage, growth. Capital budgeting, investment decisions, farmland bid price determination, farm real estate appraisal. Financial markets and credit institutions serving agriculture, lending policies, loan analysis, interest rate determination. Financial structure, performance, condition of farm sector.

ARE (EC) 336 Introduction to Resource and Environmental Economics. *3(3-0) . S. Preq: ARE 201 or EC 201.* Application of basic economic tools to understand and evaluate environmental/resource policies. Concepts such as property rights, non-market goods, allocation over time, externalities, and public goods. Current policy issues such as global climate change, evaluating natural resource damages from oil spills, reducing the costs of regulations, protecting estuaries, and dealing with non-point source pollution.

ARE (EC) 401 Economic Analysis for Non-Majors. *3(3-0) . F,S. Preq: ARE 201 or EC 201. Not open to undergraduates majoring in the Department of Agricultural and Resource Economics or the College of Management. Credit not allowed for both ARE(EC) 301 and 401.* Intermediate economic theory of firm, household, and market behavior. Demand, production and cost theory, market equilibrium under competitive and non-competitive conditions, and problems of economic efficiency.

ARE 403 Economics of Consumer Decisions. *3(3-0) . Alt Yrs. Preq: ARE 201 or EC 201. Not open to undergraduates majoring in the Department of Agricultural and Resource Economics or the College of Management. Credit not allowed for both ARE 210 and ARE 403.* Application of economic theory of the consumer to lifetime personal resource allocation decisions intended for non-major graduate students at the master's level. Emphasis on dynamic considerations in consumption and saving, replacement of consumer durables, and evaluation of consumer protection policies.

ARE 423 Futures and Options Markets. *3(2-2) . S. Preq: ARE(EC) 301 and ARE 311 or BUS 320.* Operation and business uses of futures and options markets. Emphasis on market institutions, arbitrage price relationships, risk analysis, hedging theory and practice, portfolio evaluation and market regulation. Similarities among commodity, bond and stock index futures emphasized.

ARE 433 U.S. Agricultural Policy. *3(3-0) . S. Preq: ARE(EC) 301 or ARE(EC) 401.* Government economic policies and programs affecting agricultural inputs and farm products. Analysis of the rationale, objectives, and major types of agricultural programs and their effects on resource allocation and income distribution within agriculture and between agriculture and the rest of the economy.

ARE (EC) 436 Environmental Economics. *3(3-0) . S. Preq: ARE(EC) 301.* Usefulness of economics in understanding pollution, congestion, conservation and other environmental problems. Relevant economic tools such as pricing schemes, abatement cost curves, damage functions and benefit cost analysis. Pollution taxes, regulations, marketable permits and subsidies considered in designing alterations in the incentive system. Current public policy alternatives in the context of non-market decision making.

ARE 490 Career Seminar in Agriculture & Resource Economics. *1(1-0) F Preq: Junior Standing* Planning and preparing for career choices. Resume writing, networking, interviewing, personality characteristics, and job searching. Visits with employer representatives. Employer expectations and career opportunities. Researching firms and employment opportunities. Oral and written presentations.

ARE 492 External Learning Experience. *1-6 F.S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

ARE 493 Special Problems/Research Exploration. *1-6. F.S. Preq: ARE Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes campus facilities and resources. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

ARE 495 Special Topics in Agricultural and Resource Economics. *1-6. Preq: Consent of the Department.* Presentation of material not normally available in regular course offerings or offering of new courses on a trial basis.

AEROSPACE STUDIES

AS 121 The Foundation of the United States Air Force I. *1(1-0) . F.* Part I of a survey course designed to introduce students to the United States Air Force and provide an overview of the basic characteristics, missions, and organization of the Air Force.

AS 122 The Foundations of the United States Air Force II. *1(1-0) . S.* Part II of a survey course designed to introduce students to the United States Air Force and provide an overview of the basic characteristics, missions, and organization of the Air Force.

AS 221 The Evolution of USAF Air and Space Power I. *1(1-0) . F.* Part I of a course featuring topics on Air Force heritage and leaders; introduction to air and space power through examination of competencies and functions; and continued application of communication skills. Its purpose is to instill an appreciation of the development and employment of air power and to motivate students to transition from AFROTC cadet to Air Force RO TC officer candidate.

AS 222 The Evolution of USAF Air and Space Power II. *1(1-0) . S* Part II of a course featuring topics on Air Force heritage and leaders; introduction to air and space power through examination of competencies and functions; and continued application of communication skills. Its purpose is to instill an appreciation of the development and employ ment of air power and to motivate students to transition from AFROTC cade to Air Force ROTC officer candidate.

AS 321 Air Force Leadership Studies I. *3(3-0) . F. Preq: Departmental Approval Required.* Part I of a course that teaches cadets advanced skills and knowledge in management and leadership. Special emphasis is place on enhancing leadership skills. Cadets have an opportunity to try out these leadership and management techniques in a supervised environment as juniors and seniors.

AS 322 Air Force Leadership Studies II. *3(3 0) . S. Preq: Departmental Approval Required.* Part II of a course that teaches cadets advanced skills and knowledge in management and leadership. Special emphasis is placed on enhancing leadership skills. Cadets have an opportunity to try out these leadership and management techniques in a supervised environment as juniors and seniors.

AS 421 National Security Affairs/Preparation for Active Duty I. *3(3-0) F Prereq: Department approval required.* Part I of a course designed for college seniors and that gives them the foundation to understand their role as military officers in American society. It is an overview of the complex social and political issues facing the military profession and requires a measure of sophistication commensurate with the senior college level.

AS 422 National Security Affairs/Preparation for Active Duty II. *3(3-0) S. Preq. Departmental Approval Required.* Part II of a course designed for college seniors and that gives them the foundation to understand their role as military officers in American society. It is an overview of the complex social and political issues facing the military profession and requires a measure of sophistication commensurate with the senior college level.

AS 495 Special Topics in Aerospace Studies. *2(2-0) . F,S. Preq: Consent of Instructor.* Offered as needed to treat new or special subject matter relating to the Department of the Air Force.

BIOLOGICAL AND AGRICULTURAL ENGINEERING

BAE 101 Introduction to Biological Engineering and Computing. *3(2-2) . F. Preq: MA 141.* Introduction to Biological Engineering, areas of concentration, and example engineering problems from each. Departmental and campus-wide computing facilities.

BAE 121 Computer Applications in Agriculture and Life Sciences. *3(1-4) . F,S.* Operation of computers and applications to agricultural and environmental systems. Hands-on experience with following software: word processing, electronic spreadsheet, database management, equation solver, presentation graphics and on-line information systems. Individual term project in agricultural and environmental systems.

BAE 201 Shop Processes and Management. *3(2-3) . F,S.* Safety practices, materials, equipment, processes, procedures, and management techniques related to operation and maintenance of a mechanized agricultural enterprise or agriculture-related industry. Theory and practice through basic shop operations and procedures.

BAE 202 Introduction to Biological and Agricultural Engineering Methods. *3(1-4) . S. Preq: BAE 101, GC 120.* Basic design and problem solving methodology for Biological Engineering. Visualization skills, computer-aided 3-D solid modeling of parts, 3-D assembly of solid part geometries, computation of mass properties, 2-D engineering drawings, engineering design process, safety, tools, and fabrication processes and design, and hands-on shop fabrication of semester project.

BAE 311 Agricultural Machinery and Power Units. *4(3 3) . S. Preq: CH 101, CH 102 and PY 211 or PY 131.* Agricultural machinery principles, energy requirements, operation, calibration and environmental considerations. Diesel engine principles and their application to engine power, efficiencies and systems. Power trains and hydraulic systems. Application of basic machinery and power principles to mechanical needs in environmental systems.

BAE 315 Properties of Biological Engineering Materials. *3(2 2) S. Preq: PY 208, BAE 235, BIO 125. Coreq. MAE 308 or CE 382 and MAE 314 or CE 313.* Physical properties of biological and non-biological engineering materials, their uniqueness and variability within systems. Relationships between plant, animal, and human tissues, property measurement, and evaluation of dimensional, mechanical, rheological, thermal, electrical, and optical properties.

BAE (SSC) 323 Water Management. *3(2-2) F Preq. Junior standing* Water management principles applied to small watersheds. Hydrologic cycle; runoff; erosion control; soil-water-plant relationships; surface and subsurface drainage: surface, sprinkler, and microirrigation; vegetative waterways and open channel flow; impoundments; wetlands; water quality and supply; water rights. Emphasis on concepts, quantification, and systems approach.

BAE (SSC) 324 Elementary Surveying. *1(0 3) F. Preq: Junior standing* Theory and practice of plane surveying to include measuring distances as well as record keeping, differential leveling, profile leveling, topographic mapping, stadia surveying, and the use of these tools in agricultural applications.

BAE 332 Animal Facilities and Environmental Management. *4(3-3) . S. Preq: PY 211 or PY 131.* Environmental relationships, design methods, materials and construction procedures as they relate to agricultural animal production facilities. Problem situations integrating structural design, environmental control, and waste handling.

BAE 333 Processing Agricultural Products. *4(3 3) . S. Preq: PY 212.* Application of the principles of fluid flow, heat transfer, refrigeration, psychrometrics, and materials handling to the processing of agricultural products. Pump sizing, heat exchanger selection, refrigeration analyses, fan sizing, crop drying, and selection of materials handling equipment.

BAE 335 Medical Sciences for Engineers. *3(2-2) . F. Preq: CH 101; BAE 235 or BIO 125 or BIO 181/183. Engineering Majors.* Survey of basic human anatomy and physiology with examples of biomedical engineering applications. Computer-based laboratory exercises. Term paper on a selected disease or disorder and biomedical engineering applications for its diagnosis or treatment.

BAE 343 Agricultural Electrification. *3(3-0) . F. Coreq: PY 212.* Practical and efficient use of electrical energy for agricultural and home application. Energy conservation, electric rates, farm and house wiring, circuit design, single-phase and three-phase distribution systems, electric motors, lighting, space and water heating, electric controls, safety and protective devices.

BAE 344 Circuits and Controls. *1(0-3) . F. Coreq: PY 212; BAE 343 or ECE 211.* Applied laboratory covering energy conservation, farm and home wiring, circuit design, single-phase and three-phase distribution systems, electric motors, lighting, heating, electric controls, safety and protective devices, and home water systems.

BAE 361 Analytical Methods in Engineering Design. *3(2 2) . S. Preq: BAE 101, CE 213, MA 341. Coreq: MAE 314.* Engineering problem solving through studies of topics in engineering design. Kinematic analysis of linkages, analysis and design/selection of machine structures and power transmission components, including vibration modeling and control in lumped mass mechanical and biomechanical systems.

BAE 401 Bioinstrumentation. *3(2-3) . F. Preq: ECE 331, MA 341. Credit will not be given for both BAE 401 and BAE 501.* Concepts of instrumentation for making, measuring and controlling biological systems. Transducers and control circuits utilized in biological and agricultural engineering work. Electronic models used to demonstrate concepts of errors, accuracy and precision, linearity and other instrumentation characteristics. Laboratories provide hands-on experience for reinforcing lecture concepts.

BAE 402 Transport Phenomena. *3(2-2) . F. Preq: MA 341.* Theory and application of heat and mass transfer in biological, food, and agricultural systems. Topics include fluid flow, conduction, convection, radiation, psychrometrics, and refrigeration.

BAE 422 Introduction to Food Process Engineering. *3(2-0) . S. Preq: BAE 402; MAE 308 or CE 382. MAE 301 OR CHE 315* Introductory principles and practices of handling and preserving food products. Coverage includes the design and analysis of handling systems for discrete and continuous flow material handling systems, the selection and specification of automatic controls, food preservation principles and considerations relevant to the design of food handling systems, and the principles and practices of drying and storing grain.

BAE 432 Agricultural and Environmental Safety and Health. *3(3-0) . F. Preq: Junior standing and 6 hrs CALS Group A, B or C Electives.* Safety and health issues for agricultural and environmental occupations. Hazard recognition, injury and illness prevention, regulations, and safety and health management strategies for agricultural production, chemical handling, and waste management. Environmental factors which affect human health and safety.

BAE 442 Systems Approach to Agricultural and Environmental Issues. *3(3-0) . S. Preq: ENG 331 or ENG 332 or ENG 333; Senior Standing.* Systems approach to complex agricultural and environmental issues and problematic situations including people's views. Multiple stages of soft systems approach: open inquiry into and description of issues, conceptual modeling, feasibility and implementation of changes. Individual project using systems approach to a complex issue in agriculture or the environment.

BAE 451 Engineering Design I. *2(0-4) . F. Preq: 12 hours BAE courses 300 level or above and within 36 credit hours of completing the degree.* Design concepts of engineering problems; objectives, specifications, prior art and analysis. Projects from agricultural, biomedical, bioprocessing and environmental engineering.

BAE 452 Engineering Design II. *4(1-6) . S. Preq: BAE 451.* Continuation of BAE 451; design development, engineering documentation, prototype/model construction, engineering tests, field tests, re-design, and reports.

BAE 462 Machinery Design and Applications. *3(2-3) . S. Preq: BAE 361.* Machinery design for effective use of energy and labor in agricultural production. Engine cycles, power transmission, hydraulics, traction, combined stresses, finite element analysis, computer-aided-engineering, and engineering economics. Machinery design of agricultural field equipment and other agricultural machinery systems.

BAE 465 Biomedical Engineering Applications. *3(3-0) . F. Preq: MA 341 and BAE 235 or BIO 125 or BIO 183. Coreq: ECE 331.* Application of engineering concepts to biomedical problems involving the cardiovascular, pulmonary, nervous, and musculoskeletal systems. Other areas covered: biosensors, computers and medical instrumentation, nuclear medicine, diagnostic ultrasound, medical imaging, and moral and ethical aspects of advances in biomedical engineering.

BAE 471 Land Resources Environmental Engineering. *3(2-2) . F. Preq: SSC 200. Coreq: CE 382 or MAE 308.* Hydrology and erosion principles. Designing structures and selecting practices to control land runoff, erosion, sediment pollution and flooding.

BAE 472 Irrigation and Drainage. *3(3-0) . S. Preq: SSC 200, BAE 471. Credit will not be given for both BAE 472 and BAE 572.* Design, management and evaluation of irrigation and drainage systems; concepts and processes of system design.

BAE 473 Introduction to Surface/Water Quality Modeling. *3(3-0) . S. Preq: BAE 471 and SSC 200. Credit will not be given for both BAE 473 and BAE 573.* Concepts in basic hydrologic, erosion and chemical transport used in modeling. Evaluation of typical hydrologic water quality models on watershed systems. Project examples using state-of-the-art models.

BAE 481 Structures & Environment. *3(2 3) . S. Preq. BAE 402; CE 313 or MAE 314.* Principles of environmental control and structural analysis are combined with biological principles for the design of structures. Topics include structural analysis, load estimation, material selection, fasteners, physiological reactions of animals and plants to their environment, applications of heat transfer and psychrometrics in calculating ventilation requirements, heating or cooling loads.

BAE 485 Bioelectricity. *3(3-0) . S. Preq: MA 341; BAE 401 or equivalent instrumentation course. Senior or Graduate standing, Credit not given for both BAE 485 and BAE 585.* Quantitative analysis of excitable membranes and their signals, including plasma membrane characteristics, origin of electrical membrane potentials, action potentials, voltage clamp experiments, the Hodgkin-Huxley quations, propagation, subthreshold stimuli, extracellular fields, membrane biophysics, and electrophysiology of the heart. Design and development of an electrocardiogram analysis system.

BAE 492 External Learning Experience. *1-6. F,S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

BAE 493 Special Problems in Biological and Agricultural Engineering. *1-6. F,S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes campus facilities and resources. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

BAE 495 Special Topics in Biological and Agricultural Engineering. *1-3. F,S,Sum. Preq: Consent of Instructor.* Offered as needed for presenting material not normally available in regular BAE departmental courses or for new BAE courses on a trial basis.

BAE 501 Instrumentation and Control For Biological Systems. *3(2-3) . F. Preq: ECE 211, MA 242, MA 341. Credit for both BAE 401 and BAE 501 is not allowed.* Basic concepts of instrumentation for monitoring and control of biological systems. Study of transducers and control circuits utilized in biological and agricultural engineering work. Demonstration of concepts of errors, accuracy and precision, linearity and other instrument characteristics by electronic models. Provision of hands-on experience for reinforcing lecture concepts in laboratories.

BAE (CBS) 522 Mechanics of Biological Materials. *3(2-2) Alt F Preq. BS 125. MA 242, PY 205* Structure and composition of biological materials, both animal and plant, as related to the ability of the materials to withstand mechanical loading. Emphasis on measurement of mechanical properties and the development and understanding of models of biological material mechanical behavior.

BAE 572 Irrigation and Drainage. *3(3-0) Alt S Preq. BAE 471 SSC 200 or Consent of Instructor* Design, management and evaluation of irrigation and drainage systems; concepts and processes of system design.

BAE (SSC) 573 Hydrologic and Water Quality Modeling. *3(2-2) . S, Alt. yrs Preq: BAE 471, SSC 200 or Consent of Instructor.* Concepts in basic hydrologic, erosion and chemical transport used in modeling. Evaluation of typical hydrologic water quality models on watershed systems. Usage of state-of-the-art models in project examples.

BAE 578 Agricultural Waste Management. *3(2-3) F Preq. Grad. or advanced undergrad. standing.* Principles of managing, handling, treating and applying agricultural and organic industrial and municipal waste materials. Waste characterization of systems and technology, land application, waste management plans, permits, biochemical/biological processes, anaerobic digestion, irrigation, and water quality. Emphasis on problem solving and development of waste management.

BAE 585 Bioelectricity. *3(3-0) . S. Preq: MA 341, BAE 401 or equivalent instrumentation course. Senior or Graduate standing; Credit not given for both BAE 485 and BAE 585.* Quantitative analysis of excitable membranes and their signals, including plasma membrane characteristics, origin of electrical membrane potentials, action potentials, voltage clamp experiments, the Hodgkin-Huxley equations, propagation, subthreshold stimuli, extracellular fields, membrane biophysics, and electrophysiology of the heart. Design and development of an electrocardiogram analysis system.

BAE 590 Special Problems. *Preq: Sr or grad standing in Biological and Agricultural Engineering.* Selection of a subject by each student on which to do research and write a technical report on the results. The individual may choose a subject pertaining to his or her particular interest in any area of study in biological and agricultural engineering.

BAE 601 Seminar. *1(1-0) F,S. Preq: Grad. standing in BAE.* Elaboration of subject areas, techniques and methods peculiar to professional interest through presentations of personal and published works; opportunity for students to present and critically defend ideas, concepts and inferences. Discussions to point up analytical solutions and analogies between problems in biological and agricultural engineering and other technologies, and to present relationship of biological and agricultural engineering to socio-economic enterprise.

BAE 610 Special Topics. *1-4. Preq: Grad standing.* A study of topics in the special fields of interest of graduate students under the direction of the graduate faculty.

BAE 620 Special Problems. *Preq: Sr. or grad. standing in Biological and Agricultural Engineering.* Selection of a subject by each student on which to do research and write a technical report on the results. The individual may choose a subject pertaining to his or her particular interest in any area of study in biological and agricultural engineering.

BAE 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

BAE 690 Master's Examination. *1-6 F,S,Sum. Preq Master's student* For students in non-thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

BAE 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

BAE 695 Master's Thesis Research. *1 9. F,S. Preq: Master's student.* Thesis research.

BAE 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

BAE 752 Instrumentation for Agricultural Research and Processing. *2(1-3) . F. Preq: ECE 331, MA 301.* Theory and application of primary sensing elements and transducers. Generalized performance characteristics and the use of standards. Use of specialized measurement systems for agricultural research and processing including an introduction to correlation and power spectral density measurements.

BAE (SSC) 771 Theory of Drainage–Saturated Flow. *3(3-0) . F,Alt. Yrs. Preq: MA 301.* Discussion of physical concepts and properties of fluids and porous media in relation to soil-water movement. Derivation and discussion of the fundamental laws and equations governing saturated flow in porous media. Analysis of mathematical solutions of steady-state and transient flow equations to determine their applicability to drainage problems. Consideration of analogs and models of particular drainage problems.

BAE (SSC) 774 Theory of Drainage--Unsaturated Flow. *3(3-0) . S,Alt. Yrs. Preq: BAE 871 or equivalent.* Involvement of forces and utilization of theories in unsaturated flow of porous media in relation to soil-water movement. Development and solution of steady-state and transient unsaturated flow equations for horizontal and vertical moisture movement. Application of solutions to present day laboratory and field technology. Consideration of molecular diffusion and hydrodynamic dispersion considered in light of current tracing techniques.

BAE (SSC) 780 Transport and Fate of Chemicals in Soils and Natural Waters. *3(3-0) . Preq. SSC 511, SSC 722 or equivalent.* Ecological and environmental significance of movement of chemicals from agricultural and forested land to water and/or the atmosphere. Movement, deposition and chemical and biological transformations of chemicals. Emphasis on saprolite and the vadose zone. Transport to ground water and/or laterally toward surface water. Design of course for advanced graduate students.

BAE (FS) 785 Food Rheology. *3(2-3) . F, Alt. yrs. Preq: FS 231 or MAE 314.* Principles and methods for measuring rheological properties. Theories of elastic, viscous, viscoelastic and viscoplastic behavior and relationships to food texture and commodity damage during harvest, handling and processing. Influence of time, composition and processing on rheological properties.

BAE 790 Special Topics.

BAE 801 Seminar. *1(1-0) . F,S. Preq: Grad. standing in BAE.* Elaboration of subject areas, techniques and methods peculiar to professional interest through presentations of personal and published works; opportunity for students to present and critically defend ideas, concepts and inferences. Discussions to point up analytical solutions and analogies between problems in biological and agricultural engineering and other technologies, and to present relationship of biological and agricultural engineering to socio-economic enterprise.

BAE 810 Special Topics. *1-4.* A study of topics in the special fields of interest of graduate students under the direction of the graduate faculty.

BAE 820 Special Problems. *Preq: Sr. or grad. standing in Biological and Agricultural Engineering.* Selection of a subject by each student on which to do research and write a technical report on the results. The individual may choose a subject pertaining to his or her particular interest in any area of study in biological and agricultural engineering.

BAE 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

BAE 890 Doctoral Preliminary Examination. *1-9. F,S,Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

BAE 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

BAE 895 Doctoral Dissertation Research. *1 9. F,S,Sum. Preq: Doctoral student.* Dissertation research

BAE 899 Doctoral Dissertation Preparation. *1 3. F,S,Sum. Preq: Doctoral student.* For students who have completed all credit hours, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertation.

BIOCHEMISTRY

BCH 150 Introductory Biochemical Concepts. *2(2-0) . S. Preq: Enrollment limited to freshmen and sophomores in BCH. Coreq: CH 101.* An introduction to concepts and perspectives in biochemistry, designed to provide students with an overview of biology at the molecular level.

BCH 451 Principles of Biochemistry. *4(4-0) . F,S,Sum. Preq: CH 223.* Introduction to the fundamental principles of biochemistry. Emphasis on biochemical structures, properties, functions and interactions, including enzyme kinetics and central pathways of metabolism.

BCH 452 Introductory Biochemistry Laboratory. *2(1-3) . F,S. Coreq: BCH 451.* Laboratory experience to complement BCH 451. Basic skills in the use of volumetric equipment, spectrophotometers, chromatography, and electrophoresis. Manipulation and assay of small quantities of biological materials, and analysis of laboratory data.

BCH 453 Metabolism and Molecular Biology. *3(3-0) . F,S. Preq: BCH 451. Credit is not allowed for both BCH 453 and BCH 553.* Metabolic relationships including nitrogen and lipid metabolism, photosynthesis, molecular biology, and methodologies of recombinant DNA research.

BCH 454 Advanced Biochemistry Laboratory. *4(1-8) . F. Preq: BCH 452. Coreq: BCH 453.* Techniques in molecular biology and protein purification. Cloning and expression of a eukaryotic gene in bacteria followed by purification of the eukaryotic gene product. Microanalysis of DNA, RNA and protein.

BCH 492 External Learning Experience. *1-6. F,S. Preq. Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and academic dean prior to the experience.

BCH 493 Special Problems in Biochemistry. *1 6. F S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes campus facilities and resources. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

BCH 495 Special Topics in Biochemistry. *1 5. F,S,Sum. Preq: Junior Standing.* Offered as needed to present materials not normally available in regular BCH departmental courses or for new BCH courses on a trial basis.

BCH 552 Experimental Biochemistry. *3(1-6) . F Preq: BCH 452,BCH 553* An advanced laboratory to give students practical experiences in purification and quantitative characterization of enzymes and nucleic acids. Studies with carbohydrates and membrane lipids. Credit may be applied toward biotechnology minor.

BCH 553 Metabolism and Molecular Biology. *3(3-0) . F,S. Preq: BCH 451. Credit in both BCH 453 and BCH 553 is not allowed.* Metabolic relationships including nitrogen and lipid metabolism, photosynthesis, molecular biology and methodologies of recombinant DNA research.

BCH 601 Macromolecular Structure. *1(1-0) . F. Preq: BCH 453 or BCH 553; a course in physical chemistry highly recommended.* Introduction to the current understanding and methods used for the study of structures, thermodynamics and conformational dynamics of proteins, nucleic acids and membranes.

BCH 610 Special Topics. *1-3. F,S,Sum. Preq: BCH 451 or equivalent.* The study of topics of special interest by small groups of students instructed by members of the faculty.

BCH 615 Special Topics in Biochemistry. *F,S,Sum. Preq: Grad. standing in BCH.* Critical study of special problems and selected topics of current interest in biochemistry and related fields.

BCH 660 Free Radicals in Toxicology. *1(1-0) . Preq: BCH 451 and TOX 710.* Introduction to the field of free radicals and their role in toxicology and health; chemical and physical properties of partially reduced oxygen intermediates and the natural biological defense mechanisms

BCH 670 Laboratory Rotations. *1(1-0) . F,S,Sum. Preq: BCH 451 or equivalent; Consent of Instructor.* Performance of highly directed research by biochemistry students in one or more laboratories of student's choice prior to beginning thesis research. Each laboratory experience lasts 5 weeks and given 1 hr. of credit. No more than 4 credits earned in BCH 692.

BCH 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

BCH 690 Master's Examination. *1-6. F,S,Sum. Preq: Master's student.* For students in non-thesis master's programs who have completed all other requirement of the degree except preparing for and taking the final master's exam.

BCH 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

BCH 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research.

BCH 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

BCH 701 Macromolecular Structure. *3(3-0) . F. Preq: BCH 453 or BCH 553; a course in physical chemistry highly recommended.* Introduction to the current understanding and methods used for the study of structures, thermodynamics and conformational dynamics of proteins, nucleic acids and membranes.

BCH 703 Macromolecular Synthesis and Regulation. *3(3-0) . F. Preq: BCH 453 or BCH 553.* Biochemistry of DNA replication, transcription, RNA processing and translation. Development of key concepts, techniques and applications relating to mechanisms and regulation of these processes by analysis of primary literature.

BCH 705 Molecular Biology of the Cell. *3(3-0) . S. Preq: BCH 701 or BCH 703.* Regulation of cellular processes, membrane structure and function, signal transduction, protein trafficking/sorting, secretion, photosynthesis and nitrogen fixation.

BCH 751 Biophysical Chemistry. *3(3-0) . F,Alt. Yrs. Preq: BCH 451 or equivalent; one sem. of physical chemistry.* Fundamental and practical aspects of biological macromolecular structure, thermodynamics, hydrodynamics, kinetics and spectroscopy with emphasis on mechanisms in functionally important structural transformations.

BCH (GN) 761 Advanced Molecular Biology of the Cell. *3(3-0) . S,Alt. Yrs. Preq: BCH 703 and 705.* An advanced treatment involving integrated approaches to biological problems at the molecular level, encompassing biochemistry, cell biology and molecular genetics. Broad, multidisciplinary approaches to solving research problems in biology and the critical study of primary scientific literature, the development of a research proposal, oral presentations and class discussions.

BCH 763 Biochemistry of Hormone Action. *3(3-0) . S,Alt. Yrs . Preq: BCH 705 or GN 757.* Study of well-defined models of steroid and protein hormone action via lectures, assigned readings and discussions. Students add breadth to the course and depth to their own understanding by searching the literature and writing or lecturing about a particular hormone of their own choosing.

BCH (GN) 768 Nucleic Acids: Structure and Function. *3(3-0) . S. Alt.yrs. Preq: BCH 701 and 703.* Study of well-defined models of steroid and protein hormone action via lectures, assigned readings and discussions. Students add breadth to the course and depth to their own understanding by searching the literature and writing or lecturing about a particular hormone of their own choosing.

BCH 801 Seminar in Biochemistry. *1(1-0) . F,S.*

BCH 810 Special Topics. *1-3. F,S,Sum. Preq: BCH 451 or equivalent.* The study of topics of special interest by small groups of students instructed by members of the faculty.

BCH 815 Advanced Special Topics. *F,S,Sum. Preq: Grad. standing in BCH.* Critical study of special problems and selected topics of current interest in biochemistry and related fields.

BCH 860 Free Radicals in Toxicology. *1(1-0) . Preq: BCH 451 and TOX 710.* Introduction to the field of free radicals and their role in toxicology and health; chemical and physical properties of partially reduced oxygen intermediates and the natural biological defense mechanisms.

BCH 870 Laboratory Rotations. *1(1-0) . F,S,Sum. Preq: BCH 451 or equivalent; Consent of Instructor.* Performance of highly directed research by biochemistry students in one or more laboratories of student's choice prior to beginning thesis research. Each laboratory experience lasts 5 weeks and given 1 hr. of credit. No more than 4 credits earned in BCH 692.

BCH 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

BCH 890 Doctoral Preliminary Examination. *1-9. F,S,Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

BCH 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

BCH 895 Doctoral Dissertation Research. *1-9. F,S,Sum. Preq: Doctoral student.* Dissertation research

BCH 899 Doctoral Dissertation Preparation. *1-3. F,S,Sum. Preq: Doctoral student.* For students who have completed all credit hours, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

BIOLOGICAL SCIENCES

BIO 105 Biology in the Modern World. *3(3-0) . F,S,Sum. For non-science students. Students may not receive credit for both BIO 105 and BIO 125.* Principles and concepts of biology including cellular structure and function, metabolism and energy transformation, homeostasis, reproduction, heredity, diversity of life, ecology, evolution and animal behavior. Emphasis on human affairs and human examples.

BIO 106 Biology in the Modern World Laboratory. *1(0-2) . F,S,Sum. Coreq: BIO 105. For non-science students. Students may not receive credit for both BIO 106 and BIO 125, BIO 181 or BIO 183.* Laboratory experience in biological principles to complement BIO 105.

BIO 125 General Biology. *4(3-3) . F,S,Sum. Students may not receive credit for both BIO 125 and BIO 105.* Basic principles and concepts of biology, including the structure and function of cells and organisms, development, heredity, evolution, and ecology.

BIO 181 Introductory Biology I. *4(3-3) . F,S. Students may not receive credit for both BIO 181 and either BIO 105 or BIO 125.* Emphasis on interactions of organisms with their environment, evolutionary change, genetic bases of adaptive traits and of regulation and control, and on critical thinking, problem solving, and effective communication.

BIO 183 Introductory Biology II. *4(3-3) . F,S. Preq: BIO 181 or BIO 125.* Emphasis on adaptive strategies in meeting common challenges in diverse environments, role of natural selection in evolution of life forms, and on critical thinking, problem solving, experimental design, and effective communication.

BIO 490 Senior Seminar in Biological Sciences. *1(0-1) . F,S. Preq: BIO 125 or BIO 105, plus six additional credits in life sciences courses.* Student seminars on selected biological topics of historical or contemporary significance. Discussions of the influences of biological concepts, research methods, and research findings on society.

BIO 491 Seminar on Professional Development in Biological Sciences. *1(1-0) . F.* Planning and analyzing strategies for professional development in the biological sciences utilizing discussion, guest lecturers, and field trips to nearby research laboratories and industrial plants. Intended primarily for juniors and seniors in any biological discipline.

BIO 492 External Learning Experience. *1-6 F,S. Preq: Sophomore standing.* Learning experience in agriculture and life sciences within an academic framework with facilities and resources external to the campus. Contact and arrangements with prospective supervisors by the student. Prior approval by faculty advisor, prospective supervisor, and departmental teaching coordinator.

BIO 493 Special Problems in Biological Sciences. *1-6 F,S. Preq. Sophomore standing.* Learning experience in agriculture and life sciences within an academic framework with campus facilities and resources. Contact and arrangements with prospective supervisors by the student. Prior approval by faculty advisor, prospective supervisor, and department teaching coordinator.

BIO 495 Special Topics in Biology. *1-6 F,S,Sum* Individualized study, under faculty supervision, of biological topics, and developmental course on a trial basis.

BIO 510 Advanced Biology for Secondary Teachers. *6(4-6) Sum. Preq: Two years of college biology.* Comprehensive review of important principles and concepts of biology for secondary teachers preparing to teach advanced placement biology. Emphasis on contemporary topics in biology; extensive laboratory and field work.

BIOTECHNOLOGY

BIT 810 Core Technologies in Molecular and Cellular Biology. *4(4-0) . Sum. Preq: Consent of Instructor.* Intensive four-week course in basic technologies of recombinant DNA procedures, isolation and identification of nucleic acids and proteins.

BIT 815 Advanced Special Topics. *3-6. Sum. Preq: BIT 810.* Intensive three-week or six-week courses in advanced technologies such as DNA sequencing, downstream processing, immunological techniques, construction of c-DNA libraries, mammalian embryo manipulation, plant transformation, bioreactor design, cloning in gram positive bacteria, electron microscopy or techniques in yeast molecular biology.

BIOMATHEMATICS

BMA 567 Modeling of Biological Systems. *4(3-2) . Alt. yrs. Preq: MA 131.* An introduction to quantitative modeling in biology. Use of Forrester diagrams, probabilistic and deterministic description of dynamic processes, development of model equations, simulation methods and criteria for model evaluation. Examination of current literature dealing with application of models and simulation in biology. Individual and class modeling projects.

BMA (MA) 573 Mathematical & Experimental Modeling of Physical Processes I. *3(3-0) . F. Preq: MA 341, MA 405, knowledge of high-level programg. lang.* In-depth treatment of case studies in application of mathematics to problems currently under investigation in industrial and governmental laboratories. Background information for each case study; development of mathematical models; analytical and computational methods appropriate to models; model validation using experimental data collected during field trips to laboratories. Problems in biology & electromagnetism.

BMA (MA) 574 Mathematical & Experimental Modeling of Physical Processes II. *3(3-0) . S. Preq: MA 341, MA 405, knowledge of high-level programg. lang.* In-depth treatment of case studies in the application of mathematics to problems currently under investigation in industrial and governmental laboratories. Background information for each case study; development of mathematical models; analytical and computational methods appropriate to the models; model validation using experimental data collected during field trips to the laboratories. Case studies involve problems in mechanics, thermodynamics, and hydrodynamics.

BMA 610 Special Topics. *1-3 F,S,Sum. Preq: Consent of Instructor.* Directed readings, problem sets, written and oral reports as dictated by need and interest of student, e.g., cellular, molecular and physiological modeling; new >00-level courses during the developmental phase.

BMA 685 Master's Supervised Teaching. *1 3. F S Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

BMA 690 Master's Examination. *1-6 F,S. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

BMA 693 Master's Supervised Research. *1-9. F,S. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

BMA 695 Master's Thesis Research. *1 9. F,S Preq. Master's student.* Thesis research.

BMA 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

BMA (OR, ST) 722 Decision Analytic Modeling. *4(3-2) . F, Alt. yrs. Preq: MA 421 or ST 421 plus ST 511 or ST 516.* Analysis of decision problems involving risk and uncertainty. Modeling decision process; Bayesian probability analysis, use of information, and subjective probability; utility theory and multi-attribute utility assessment; dynamics of interacting with decision makers and subject matter specialists; decision trees, influence diagrams and other tools to assist in modeling decision problems. Laboratory develops skill in implementing methodology.

BMA (MA, ST) 771 Biomathematics I. *3(3-0) . F. Preq: Advanced calculus, reasonable background in biology or Consent of Instructor.* Role of theory construction and model building in development of experimental science. Historical development of mathematical theories and models for growth of one-species populations (logistic and off-shoots), including considerations of age distributions (matrix models, Leslie and Lopez; continuous theory, renewal equation). Some of the more elementary theories on the growth of organisms (von Bertalanffy and others; allometric theories; cultures grown in a chemostat). Mathematical theories of two and more species systems (predator-prey, competition, symbosis; leading up to present-day research) and discussion of some similar models for chemical kinetics. Much emphasis on scrutiny of biological concepts as well as of mathematical structure of models in order to uncover both weak and strong points of models discussed. Mathematical treatment of differential equations in models stressing qualitative and graphical aspects, as well as certain aspects of discretization. Difference equation models.

BMA (MA, ST) 772 Biomathematics II. *3(3-0) . S. Preq: BMA 771, elementary probability theory.* Continuation of topics of BMA 771. Some more advanced mathematical techniques concerning nonlinear differential equations of types encountered in BMA 771: several concepts of stability, asymptotic directions, Liapunov functions; different time-scales. Comparison of deterministic and stochastic models for several biological problems including birth and death processes. Discussion of various other applications of mathematics to biology, some recent research.

BMA (MA, OR, ST) 773 Stochastic Modeling. *3(3-3) . S,Alt. Yrs.. Preq: BMA 772 or ST (MA) 746.* Survey of modeling approaches and analysis methods for data from continuous state random processes. Emphasis on differential and difference equations with noisy input. Doob-Meyer decomposition of process into its signal and noise components. Examples from biological and physical sciences, and engineering. Student project.

BMA (MA, OR) 774 Partial Differential Equation Modeling in Biology. *3(3-0) . S. Preq: BMA 771 or MA/OR 731; BMA 772 or MA 401 or MA 501.* Modeling with and analysis of partial differential equations as applied to real problems in biology. Review of diffusion and conservation laws. Waves and pattern formation. Chemotaxis and other forms of cell and organism movement. Introduction to solid and fluid mechanics/dynamics. Introductory numerical methods. Scaling. Perturbations. Asymptotics, Cartesian, polar and spherical geometries. Case studies.

BMA 801 Seminar. *1(1-0) . F,S. Preq: Grad. standing.* Graduate students in biomathematics are expected to attend through most of their residence period.

BMA 815 Advanced Special Topics. *1-3. F,S,Sum. Preq: Consent of Instructor.* Directed readings, problem sets, written and oral reports as dictated by need and interest of student; new 600-level courses during the development phase (currently includes courses in stochastic modeling and biophysical theory).

BMA 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

BMA 890 Doctoral Preliminary Exam. *1-9. F,S,Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

BMA 893 Doctoral Supervised Research. *1 9. F,S,Sum. Preq: Doctoral student* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

BMA 895 Doctoral Dissertation Research. *1-9. F,S,Sum. Preq: Doctoral student.* Dissertation research

BMA 899 Doctoral Dissertation Preparation. *1-3. F,S,Sum. Preq: Doctoral student.* For students who have completed all credit hours, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

BOTANY

BO 101 Perspectives on Botany. *1(1-0) . F.* Orientation to modern botany, including discussions of historical background, relation to other sciences, the nature of modern subdisciplines, professionalism and ethics, local resources of personnel and facilities, educational opportunities, and career possibilities.

BO 102 Introduction to Research. *1(1-0) . S. Preq: BO 101* Overview of research resources available to students. Methods of access to current information in chosen area of specialty. Interact with several faculty about research opportunities, develop a research proposal.

BO 200 Plant Life. *4(3-3) . F,S,Sum. Credit cannot be given for both BO 200 and BO 250.* An introduction to the structure, processes, and reproduction of higher plants, including the diversity of the plant kingdom and principles of inheritance, ecology, and evolution.

BO 213 Plants and Civilization. *3(3-0) . S. Preq: BIO 125, BIO 105 or BO 200.* Economic social, political, religious, and medical roles of plants and plant products in human civilization. Foods, beverages, drugs, fibers, oils, latexes, religious symbols and elements.

BO 220 Local Flora. *3(2-2) . S. Preq: BIO 125 or BO 200.* Structural terminology of vascular plants, field identification of plant species using popularized field guides, description of plant community types and their soil and topographic features.

BO 222 Kingdom of Fungi. *3(3-0) . S. Preq: BIO 125 or BIO 105 or BO 200.* Survey of fungal kingdom. Economical, historical and practical aspects of fungi and their impact on humankind. Mushrooms, molds, mycorrhizae, maladies, and mutualisms. Term paper of students' choice.

BO 250 Plant Biology. *4(3-3) . F Preq: BIO 181 and BIO 183 or BIO 125 Students may not receive credit for both BO 200 and BO 250.* An introduction for Life Science majors to the ecology, structure, function, processes, reproduction and evolution of higher plants.

BO 277 Space Biology. *3(3-0) . F. Preq: BIO 125 or BIO 105 or BO 200 or ZO 150 or BIO 183 or BAE(BIO) 235.* Overview of the biology of plants, animals and humans in the space environment, including gravitational biology, aerospace medicine, search for extraterrestrial life, terraforming and life support.

BO 295 Special Topics in Botany. *1-4. F,S,Sum Preq: Consent of Instructor.* Trial offerings of new or experimental courses in Botany at the early undergraduate level.

BO 360 Introduction to Ecology. *3(3 0) . S,Sum. Preq: A 100-level biology course* The science of ecology, including factors which control distribution and population dynamics of organisms, structure and function of biological communities, and energy flow and nutrient cycling in ecosystems; contrasts among the major biomes; and, principles governing ecological responses to global climatic and other environmental changes.

BO 365 Ecology Laboratory. *1(0-3) . S,Sum. Coreq: BO 360.* Laboratory coordinated with BO 360 lecture, illustrates basic principles of environmental measurement, data analysis, limiting factors, adaptation, biogeography, succession, populations, communities, ecosystems, and competition and predation by means of field trips and laboratory experiments.

BO 400 Plant Diversity. *4(3-2) . F. Preq: BIO 125 or BO 200.* Survey of the vegetative and reproductive diversity of the plant kingdom. Emphasis on evolutionary trends, adaptive strategies, and bases for assumed phylogenetic relationships of fossil as well as living forms.

BO 403 Systematic Botany. *4(2-4) . Preq: BIO 125 or 105 or BO 200.* Systematic survey of vascular plants, emphasizing terminology, family characteristics, field identification, general evolutionary relationships, and mechanisms of plant speciation.

BO 405 Wetland Flora. *3(2-3) . F. Preq: BO 200 or BO 250 or BO 403 or FOR 212.* Plant morphological terminology and identifications of wetland plants; discussion of wetland flora, plant communities, functions and values of North Carolina wetland types; several one-day weekend field trips required.

BO 413 Introductory Plant Anatomy. *4(3-3) . S. Preq: BO 200.* Organelles, cells, tissue systems, and organs of flowering plants and selected gymnosperms. Microscope use on fresh, cryostat, and prepared plant sections. Histochemistry of plant cells and tissues.

BO (ZO) 414 Cell Biology *3(3-0) . F. Preq: Preqs: CH 223, PY 212, ZO 160, or 250.* The chemical and physical bases of cellular structure and function with emphasis on methods and interpretations.

BO 421 Plant Physiology. *4(3-3) . F,S. Preq: Preqs: BIO 125, BIO 105 or BO 200; one year of college chemistry.* Physiology of higher plants with emphasis on structure-function relationships, water and solute relationships, metabolism, photosynthesis, and nutrition. Plant growth and development as influenced by plant growth regulators and environmental factors.

BO 480 Introduction to Plant Biotechnology. *3(3-0) . F,S. Preq: CH 221; BO 421 or GN 411 or BCH 421.* Introduction to molecular techniques in the plant sciences, gene identification and isolation, plant tissue culture and transformation, and methods for working with single and multiple locus traits. Discussions of the role and potential of plant genetic engineering to solve problems facing agriculture.

BO 492 External Learning Experience. *1-6. F,S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

BO 493 Special Problems in Botany. *1-6. F,S. Preq: Sophomore standing.* A learning experience within an academic framework that utilizes campus facilities and resources. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

BO 495 Special Topics in Botany. *1-6. F,S,Sum. Preq: Preq: 8 hrs. of Botany courses.* Individualized study, under faculty supervision, of botanical topics in the student's area of interest and not covered in existing courses. Development of a new course on a trial basis.

BO (MB, PP) 501 Fungi and their Interaction with Plants. *3(3-0) . F. Preq: PP 315 or equivalent.* Biology, physiology and molecular interactions between plant pathogenic fungi and their host plants. Basic introduction to fungal biology and evolutionary relationships, fungal development and life cycles, and genetic variability in fungi. In-depth coverage of fungal pathogenesis mechanisms, physiology of diseased plants, physiology, genetics, and molecular biology of plant defense reactions, and genetic engineering of plants for disease resistance.

BO 544 Plant Geography. *3(3-0) . S,Even yr. Preq: BO 403, BO (ZO) 360, GN 411 or equivalents.* Descriptive and interpretive plant geography, synthesizing data from fields of ecology, genetics, geography, paleobotany and taxonomy. Survey of present distribution of major vegetation types throughout world, a discussion of history and development of present pattern of vegetation, and discussion of principles and theories of plant geography.

BO 565 Plant Community Ecology. *4(3-3) . F. Preq: BO 360 or ZO 260 or equivalent.* Consideration of structure and function of terrestrial vascular plant communities, with emphasis on both classical and recent research. Measurement and description of community properties, classification, ordination, vegetation pattern in relation to environment, ecological succession and a survey of vegetation of North America.

BO (MB, PP) 575 Introduction to Mycology. *4(3 3) . F, Alt. Yr(even). Preq: BS 125 or BIO 181 & 183 or BO 200 or PP 315 or PP 318.* A survey of the fungal kingdom in context of phyla and classes. Systematics, ecology, biology and utilization. Illustrative material, cultural techniques in laboratories. Collection and paper required.

BO 595 Special Topics Botany.

BO 601 Botany Seminar. *1(1-0) . F,S.*

BO 620 Special Problems in Botany. *Credits Arranged.* Directed research in some phase of botany other than a thesis problem, but designed to provide experience and training in research.

BO 624 Topical Problems. *1-3. F,S. Preq: Consent of Instructor.* Discussions and readings on problems of current interest in fields of ecology, anatomy and morphology, taxonomy, plant physiology and cell biology. May be repeated with a change in topic for a maximum of six credits.

BO 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

BO 690 Master's Examination. *1-6. F,S,Sum. Preq: Master's student.* For students in non-thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

BO 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

BO 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research

BO 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

BO 710 Plant Anatomy. *4(2-6) . F. Preq: BO 200.* Study of plant cells, ultrastructure, cell types, tissues, organs and patterns of growth and differentiation.

BO 712 Plant Morphogenesis. *4(3-3) . F. Preq: Six hrs. of botany equivalent to BO 400 and BO 421.* Review and synthesis of factors involved in development of plant form. Demonstration of levels of control from the molecular to whole organism by tissue culture experiments.

BO (CS, HS) 718 Biological Control of Weeds. *1(1-0) . F Preq: CS 414 or equivalent.* Concepts and methods in use of biological agents for control of weeds. Primary emphasis on weed biocontrol with insects and plant pathogens. Taught third 5 weeks of semester.

BO 721 Advanced Mycology. *4(2-6) . F. Alt. yrs. Preq. PP 7~5 or Consent of Instructor.* In-depth treatment of major groups of fungi. Aspects of taxonomy, nomenclature, developmental morphology, genetics, host-parasite relations, physiology and ecology. Determination of cardinal characteristics of selected fungi representing major groups. Required field observations and collecting.

BO 722 Advanced Morphology and Phylogeny of Seed Plants. *4(3-3) F.Odd yrs Preq BO 403.* Comprehensive survey of morphology and evolution of angiosperms and gymnosperms. Special emphasis upon vegetative and reproductive morphology of fossil and living forms and their presumed evolutionary relationships.

BO (GN, MB, PP) 730 Fungal Genetics and Physiology. *3(2 3) . S. Alt. yrs. Preq: BCH 451, BO 575, GN 411 or PP 501* Basic concepts of genetics and physiology of fungi, with emphasis on saprophytic and plant pathogenic mycelial fungi. Current literature on evolution, cell structure, growth and development, gene expression, metabolism, sexual and asexual reproduction and incompatibility systems. Laboratory exercises on mutant isolation, sexual and parasexual analysis, genetic transformation, and RFLP and isozyme analysis.

BO 731 Water Relations of Plants. *3(3-0) . S,Alt. Yrs. Preq: BO 751 or equivalent.* Physiological water relations of plants with emphasis on theoretical principles and quantitative description.

BO 733 Plant Growth and Development. *3(3-0) . S. Preq: BO(ZO) 414 or BO 421, organic chemistry.* Advanced course in plant physiology covering plant growth, development, differentiation, senescence and biological control mechanisms.

BO 745 Paleobotany. *4(3-3) . S,Odd yrs. Preq: BO 400, 403, 413, 544 or equivalent.* Morphologic, taxonomic, geologic and evolutionary relationships of fossil plants; emphasis on vascular plants; discussions of taphonomy, biogeography and palynology. Required field trips.

BO 751 Advanced Plant Physiology I. *3(3-0) . F. Preq: BO 421 or equivalent.* Cellular mechanisms and regulatory features related to plant respiration, photosynthesis, sulfur metabolism, nitrogen fixation and metabolism, and signal transduction. One of two courses covering field of plant physiology.

BO 752 Advanced Plant Physiology II. *3(3-0) . S Preq: BO 421 or equivalent and biochemistry.* Water and solute relations, influence of environmental cues and plant growth regulators on growth, development, reproduction and senescence, and aspects of stress physiology. One of two courses covering field of plant physiology.

BO 754 Laboratory in Advanced Plant Physiology II. *1(0-3) . S. Preq BO ~52* Laboratory to accompany BO 752 Advanced Plant Physiology II.

BO (ZO) 760 Principles of Ecology. *4(3-3) . F. Preq: Three semesters of college-level biology courses.* Consideration of principles of ecology at graduate level. Development of each of major subject areas of ecology in sufficient depth to provide factual and philosophical framework for understanding of ecology.

BO 761 Physiological Ecology. *4(3 3) . S,Odd yrs. Preq: BO 421 and BO (ZO) 760 or equivalent.* Plant community approached from a physiological standpoint. Emphasis upon individual in community and its response to its immediate environment on short- and long-term bases.

BO 762 Applied Coastal Ecology. *3(3-0) . S,Alt. Yrs. Preq: BO 360 or BO(ZO) 760.* Environmental factors, vegetative communities and man's influence on ecology of Coastal Plain of North Carolina. Emphasis on coastal fringe (Outer Banks) and the problems involved in Coastal one Management. Course field- and problem-oriented and designed primarily for graduate students in environmentally oriented programs. Two field trips mandatory.

BO (ZO) 770 Advanced Topics in Ecology I. *3(3-0) . S. Preq: BO(ZO)760.* Development of subject matter in major fields of ecology through seminars and lectures and principles illustrated by laboratory exercises and field trips. Microenvironment, population biology, community ecology, ecosystems and nutrient cycling.

BO (MB) 774 Phycology. *3(1-4) . S,Odd Yrs. Preq: BIO 125 or BO 200.* Introduction to taxonomy, morphology, reproduction and ecological importance of organisms which may be included in the algae. Attention to local freshwater flow and physiology of selected species in relation to algal blooms, water quality and nutrient loading in aquatic habitats.

BO (MB) 775 The Fungi. *3(3-0) . F. Preq: BO 200 or equivalent* Overview of the fungi within framework of a survey of major classes.

BO (MB) 776 The Fungi - Lab. *1(0-3) . F. Coreq: BO ~75.* Illustrative material of fungal assemblages discussed in BO 775.

BO 780 Plant Molecular Biology. *3(3-0) . F Preq: BCH 451, GN 411.* Molecular analysis of plant growth and development. Molecular techniques and their application to understanding control of gene expression in plants.

BO 795 Special Topics Botany. *F S*

BO 801 Seminar. *1(1-0) . F,S.*

BO 820 Special Problems. *Credits Arranged.* Directed research in some phase of botany other than a thesis problem, but designed to provide experience and training in research.

BO 824 Topical Problems. *1-3. F,S. Preq: Consent of Instructor.* Discussions and readings on problems of current interest in fields of ecology, anatomy and morphology, taxonomy, plant physiology and cell biology. May be repeated with a change in topic for a maximum of six credits.

BO 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

BO 890 Doctoral Preliminary Examination. *1-9. F,S,Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

BO 893 Doctoral Supervised Research. *1 9. F,S,Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

BO 895 Doctoral Dissertation Research. *1-9. F,S,Sum. Preq: Doctoral student.* Dissertation research

BO 899 Doctoral Dissertation Preparation. *1-3. F,S,Sum. Preq: Doctoral student.* For students who have completed all credit hours, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

BUSINESS MANAGEMENT

BUS 100 Introduction to College of Management. *1(1-0) . F,S.* College of Management requirements and expectations, career paths in business, and services available in the College and University. Recognition of the relationships among various functional areas of business education. Examination of fundamental educational issues and vocational strategies.

BUS 201 Introduction to Business Processes. *3(3-0) . F,S.* Cross-functional treatment of major activities of business, such as product design, distribution, production, and marketing. Description of specific tasks, via lectures and case studies, in support of major business activities. Interactions among various functional areas of business.

BUS 225 Personal Finance. *3(3-0) . F,S.* Economic and financial strategies used to accumulate, manage and protect personal assets. Emphasizing income generation, expense reduction, investment selection, and wealth creation to meet future needs and goals. Topics include investing (mutual funds, stocks, etc.), annuities, deferred savings, insurance, retirement planning, estate planning, and real estate finance.

BUS 295 Special Topics in Business Management. *1-6 Preq: Convent of Instructor* Experimental course development. Special topics in Business Management at the introductory level.

BUS 300 Business Career Planning. *1(1-0) F.* Integration of work values, career interests, and skills and corporate environments and career fields related to business management. Development of proactive plans and skills to enhance marketability for placement into professional career paths in business. Minimal fee assessed to cover cost of career tests administered during course.

BUS 305 Legal and Regulatory Environment. *3(3-0) . F,S,Sum.* Introduction to contract, tort, property, and agency law, the judicial system, common law, statutory law, and constitutional law. Review and discussion of the major statutes affecting business including antitrust, securities, employment, labor, environmental, international, and product safety laws.

BUS 307 Business Law I. *3(3-0) . F,S. Preq: Sophomore standing. Credit for both ARE 306 and BUS 307 is not allowed.* The main principles of law affecting the conduct of trade. Main areas of interest: introduction to law, constitutional law, criminal law, tort law, agency, real and personal property, and especially contract law including the Uniform Commercial Code.

BUS 320 Financial Management. *3(3-0) . F,S,Sum. Preq: EC 201 or ARE 201 and ACC 220 or 280.* Financial decision making by businesses, including capital structure and dividend decisions, capital budgeting and working capital management. Basic financial concepts such as risk and return measurement, portfolio theory and the Capital Asset Pricing Model.

BUS 330 Human Resource Management. *3(3-0) . F,S. Preq: Sophomore standing.* The systematic principles for managing the human resource component of organizations. Topics include: environmental influences on planning, recruitment, and selection; managing workforce diversity; developing effectiveness and enhancing productivity; compensation, benefits, and security; and strengthening employee-management relations.

BUS 335 Organizational Behavior. *3(3-0) . S. Preq: 9 hrs. of social science or 6 hours of social science plus BUS 201.* Survey of contemporary managerial applications for managing people in modern organizations. Topics include: motivation, group dynamics, team development, ethics, communications, organizational politics, leadership, power, organizational development, organizational design and structure. Current managerial issues include total quality management and technology management.

BUS (CSC) 340 Information Systems Management. *3(3-0) . F,S. Preq: M 200 or Equivalent.* Fundamentals of information systems development and use in organizational setting. Primary topics: information systems (IS), concepts, hardware, software, telecommunications, database management. IS development, applications and management in various business processes, global issues, security and ethical challenges.

BUS 346 International Business. *3(3-0) . S. Preq: EC 201.* Principles and conduct of international business. Environment of international trade and finance relevant to international business. Competitive advantages of multinational firms. International management issues in marketing, accounting, taxation, financial management and control, technology transfer, export-import management, and organizational form. Case studies and discussions.

BUS (ST) 350 Economics and Business Statistics. *3(3-0) . F,S.Sum Preq: MA 114. EC 201 or ARE 201.* Introduction to statistics applied to management, accounting, and economic problems. Emphasis on statistical estimation, inference, simple and multiple regression, and analysis of variance. Use of computers to apply statistical methods to problems encountered in management and economics.

BUS 360 Marketing Methods. *3(3-0) F,S. Preq. Sophomore standing* Examination of decisions affecting marketing of goods and services in consumer, industrial and international markets. Emphasis on the role of marketing in a managerial context. Areas studied include: the activities of marketing research, identification of marketing opportunities, and the development of marketing mix strategies including the decisions concerning pricing, distribution, promotion and product design.

BUS 370 Operations Management. *3(3-0) . F,S,Sum Preq. BUS (ST) 350.* Concepts in planning, controlling, and managing the operations function of manufacturing and service firms. Topics include operations strategy, process choice decisions, forecasting, production planning and control, and trends in operations management. Common tools for informed decision-making in these areas.

BUS (PRT) 406 Sports Law. *3(3-0) . F. Preq. Junior standing.* Fundamental principles of law, especially tort and contract law, applied to sports situations. Analysis of liability of sports personnel in various roles including participant, coach, promoter, trainer, and official. Analysis of common law court decisions in sports contexts as well as key state and federal statutory legislation such as civil rights and antitrust.

BUS 407 Business Law II. *3(3-0) . F,S. Preq: BUS 305 or BUS 307.* The main principles of law affecting the conduct of trades and industry, including corporations, partnerships, government regulation of business, sales, negotiable instruments, and secured transactions.

BUS 420 Financial Management of Corporations. *3(3-0) F,S. Preq: BUS 320, BUS(ST) 350.* Advanced theory and practice of corporate financial management. Techniques for evaluating alternative investment, financing, capital structure, and dividend policy decisions. International aspects of corporate financial management. Use of personal computers in applying financial management theory to common financial problems.

BUS 422 Investments and Portfolio Management. *3(3-0) . F,S. Preq: BUS(ST) 350 or ST 311, and BUS 320.* Analysis of the investment process, dichotomized into security analysis and portfolio management. Background information on financial assets, securities markets, and risk-return concepts. Analysis of valuation theory and techniques, modern portfolio theory and portfolio performance.

BUS 425 Advanced Personal Financial Management. *3(3-0) . S. Preq: BUS 320.* Detailed economic, financial and legal analysis of risk management, retirement planning, nontraditional investments, estate planning. Strong emphasis on professional financial planning for those interested in personal finance as a career. Directly applicable for needs of small business.

BUS 426 International Financial Management. *3(3-0) . F. Preq: BUS 320, BUS 350. Credit for both BUS 426 and EC 449 not allowed.* Foreign exchange markets and their implications for direct and portfolio investment abroad. International capital markets. Multinational company exchange rate exposure measurement and management. Techniques and instruments of financing international trade and investment. Multinational capital budgeting and capital cost measurement. Techniques of international cash management.

BUS 432 Industrial Relations. *3(3-0) . F,S. Preq. EC 201, BUS 330.* The role of collective bargaining in the labor market. Determinants of the pattern of union membership today and its growth rate. The objectives and tactics of both labor and management within public policy guidelines. Analysis of the impact of unions on job security, productivity, and compensation.

BUS 434 Compensation Systems. *3(3-0) . F,S. Preq: BUS 330.* Compensation philosophy, strategy, and policy. Earnings, individual and group incentive plans, voluntary and mandated benefits. Legal, regulatory, economic, and strategic issues affecting compensation and benefits. Strategies for developing the structure and level of compensation to enhance organizational performance.

BUS 435 Managerial Effectiveness. *3(3-0) F,S. Preq: BUS 333* Development of management skills for organizational settings. History and evolution of management principles, functions of management, decision making, goal setting, time and stress management, team building, conflict management, power and politics, leadership practices, interpersonal communications, organizational innovation, and change management.

BUS 436 Training, Development and Performance Management. *3(3-0) . S. Preq: BUS 330* Training, development and performance management functions in organizations. Needs assessment, legal issues, training program design, learning, training methods, transfer of training, effectiveness and utility of training programs, executive development, criteria development for performance appraisal, validation, instrumentation, sources, accuracy, and feedback.

BUS 455 Quantitative Methods for Management. *3(3-0) . F,S,Sum. Preq: EC 201 or ARE 201, and BUS(ST) 350.* Formulation and use of quantative techniques for analyzing management problems. Linear programming, decision making under uncertainty and forecasting methods applied to problems in operations management, marketing, finance, human resource management, accounting, other areas. Use of computer software.

BUS 462 Marketing Research. *3(3-0) . F,S. Preq: BUS 360 and BUS(ST) 350.* The use, collection, organization and analysis of information pertinent to marketing decisions. Use of qualitative and quantitative data in the solution of specific marketing problems.

BUS 464 International Marketing. *3(3-0) . F,S. Preq: BUS 360.* Analysis of concepts, issues, and methods involved in marketing of products across national boundaries. Emphasis on distinctive opportunities and constraints in the international environment, international marketing strategies, and international marketing management techniques.

BUS 465 Advertising and Promotion Management. *3(3-0) . F,S. Preq. BUS 360.* Development of advertising theory and exploration of advertising practice. Topics include: advertising and marketing; planning, management and budgeting; strategy development and execution; media strategy and research; advertising research; economics, social and legal issues; promotion strategy; campaign development and presentation.

BUS 466 Personal Selling. *3(3 0) . F,S,Sum. Preq: BUS 360.* Careers and professionalism in business-to-business marketing. Buying behavior, selling process, and relationship marketing. Sales and self management.

BUS 469 National Student Advertising Competition. *4(4-0) . F. Preq: BUS 360 and permission of instructor required.* A year-long case study in advertising campaign development. Activities include marketing research, marketing planning, media planning, budgeting, creative strategy development, creative execution for national companies and final presentation to advertising professionals.

BUS 472 Operations Planning and Control Systems. *3(3-0) . F. Preq: BUS 370.* Design and management of operations planning and control systems for manufacturing and service firms. Forecasting, capacity management, production and work force scheduling, project management, just-in-time and time-based competition, the impact of information technologies on planning and control systems.

BUS 473 Supply Chain Management. *3(3-0) . S. Preq. BUS 370.* Purchasing, materials management, and logistics. Purchasing systems, supplier-based strategies, price-cost management, value analysis. Inventory strategies, quantity and quality decisions, materials planning. Logistics strategies for services and manufacturing.

BUS 475 Operations Strategy. *3(3-0) . S. Preq. BUS 370* Proper configuration of operational processes, systems, infrastructures, and measures. Design of operations for internal consistency and consistency with market expectations. Relationship to other business functions in support of overall business strategy.

BUS 480 Business Policy and Strategy. *3(3-0) . F,S. Preq. BUS 305 320, 360; BUS(ST) 350.* Comprehensive analysis of administrative policy-making from the point of view of the general manager. Integration of perspectives from marketing, finance, and other functional areas of management. Use of case analyses and written reports to develop decision making skills.

BUS (TAM) 482 Textile Marketing Management. *3(2-2) . F,S. Preq: BUS 360, EC(ARE) 301, TAM 382. Coreq: TAM 380.* The development and state of the art of current textile marketing management theory and practice are covered in classroom sessions. Management lab sessions include experiential, marketing games, and role-playing exercises. Current industry practice and government relations are stressed.

BUS 483 Entrepreneurship. *3(3-0) . F,S. Preq: Junior Standing.* Elements and application of the entrepreneurial process. Entrepreneurship, business planning, entrepreneurial opportunities and strategies, structuring and financing a venture, managing growth and risk, and intrapreneurship. Development of business plan.

BUS 485 Management Development Seminar. *3(3-0) . F. Preq. EC 201 or ARE 201. This course may not be used for credit toward a business management minor for any graduate degree.* Emphasis on developing insight into individual management potential and providing guidance and planning for a management career in industry, government services, or as an entrepreneur.

BUS 495 Special Topics in Business Management. *1-6. Preq: Consent of Instructor* Presentation of material not normally available in regular course offerings, or offering of new courses on a trial basis.

BUS 498 Independent Study in Business Management. *1 6. F,S,Sum. Preq Consent of department.* Detailed investigation of topics of particular interest to advanced undergraduates under faculty direction on a tutorial basis. Credits and content determined by faculty member in consultation with Department Head.

BUS 500 Strategic Management. *3(3-0) . F. Preq: Graduate Standing.* Theory and practice of business, global, and corporate strategy for high technology firms and firms in industries affected by advancements in information technology. Alignment of technologically intensive organizations' strategies and structures with their macro and industry environments.

BUS 501 Legal and Regulatory Environment in Management. *3(3-0) F,S Preq Grad. standing* Major laws and regulations affecting business, including product liability, antidiscrimination, securities, antitrust, environmental and consumer protection. Philosophy of law, ethics, common law precedents, exposure to criminal, tort, agency and basic contract law. Intellectual property laws, international law applications.

BUS 504 Technology, Competition and the Law. *3(3-0) . S. Preq: Grad standing* Intellectual property law, including patent, copyright, trade secrets and trademark law. Impact on management decision making. International differences in intellectual property law and moves toward harmonization. Relationship to torts, contracts and antitrust.

BUS 520 Managerial Finance. *3(3-0) . F, S. Preq: ACC 580 BUS 500, ECG 507, ST 513.* Investment and financing decisions by businesses with emphasis on technology-driven organizations in rapidly changing environments. Cash as the basis of asset valuation. Time value of money. Capital budgeting decisions under certainty and uncertainty. Capital market theory. Cost of capital. Capital structure theory and dividend policy. Cash management. Options and managerial implications. Derivatives and risk management.

BUS 522 Portfolio and Capital Market Theory. *3(3-0) F Preq: BUS 520* Theory and practice of investment decision making for individual and institutional investors. Survey of investment opportunities and security markets. Theory of portfolio choice and asset pricing. Valuation of stocks, bonds and options. Fixed income portfolio management, market efficiency and evaluation of portfolio performance.

BUS 524 Financial Markets and Institutions. *2(2-0) . S. Preq BUS 520* Survey of financial markets, financial institutions and financial instruments. Determination of interest rates. Money and capital market instruments, derivatives and their markets. International financial instruments and their markets. Determination of exchange rates. Commercial banks and banking industry. Non-bank financial intermediaries. The Federal Reserve and monetary policy. Contemporary problems in financial markets and payments system.

BUS 527 Risk Management. *2(2-0) . F. Preq. BUS 520 and 522* Risk management to maximize value of firm. Management of financial risk with emphasis on recognition of financial price risk and tools of risk management from business firm's perspective. Analysis of derivatives and their uses in risk management.

BUS 528 Short-Term Capital Management. *2(2-0) . S. Preq: BUS 520* Coverage of payments and cash management systems. Analysis of liquidity and short-term credit needs. Credit policy and management of accounts payable and accruals. Advances in inventory management.

BUS 529 New Firm Financing. *2(2-0) . F. Preq: BUS 520.* Survey of financial management problems at firms from initial formation to initial public offering. Financial components of business plan, design of financial information and control systems, sources of funds for small firms, financing rapid growth, firm valuation for initial public offerings, going public transactions.

BUS 530 Managing People in the High Tech Environment. *3(3-0) . S. Preq: BUS 500.* Management of people in organizations. Processes of staffing, motivating, and managing within cultures of technology-intensive organizations. Leadership. Diagnosis of organizational culture. Conflict management and negotiations. Innovation and change management.

BUS 532 Strategic Human Resource Management. *2(2-0) . F,S. Preq: BUS 530.* Design and implementation of competitive human resource management systems. Impact of environmental trends. Job/work design. Performance management. Employee relations. Human resource planning and staffing. Training and development. Compensation and incentive systems.

BUS 533 Leadership In Management. *3(3-0) . F,S. Preq: BUS 530.* Leadership of individuals, groups, and organizations. Motivation, conflict and negotiation, empowerment. Group dynamics and team building. General systems theory, sociotechnical systems, advanced organizational development topics.

BUS 541 Information Technology and Management. *2(2-0) . F,S. Preq: BUS 500.* Contemporary information technology and its application to management. Technology and application trends, tools for determining information requirements, systems analysis and design, and economic analysis.

BUS 542 Networking and Productivity. *2(2-0) . S. Preq: BUS 541.* Overview of networks and telecommunications and their application to management. Architecture of internet. Electronic marketing and commerce. Legal and security issues.

BUS 545 Management Support Systems. *2(2-0) . S. Preq: BUS 541.* Design, development and use of management support systems. Managerial issues surrounding decision support systems, group support systems, executive information systems, geographic information systems and expert systems. Conceptual foundations and applications.

BUS 546 Analysis and Design of Management Support Systems. *2(2-0) . S. Preq: BUS 545.* Concepts and methodologies for analysis and design of management support systems. Systems development methodologies, requirements analysis, project scope, project management, human interface issues and elements of system design. User-oriented approach.

BUS 547 Management Support Systems Project. *2(2-0) . S. Preq: BUS 546.* System development strategies and methodologies. Construction of management support system. Prototyping orientation to systems development. User-oriented issues concerning project scope, value and design.

BUS 549 Managerial Issues in Information Systems. *2(2-0) . S. Preq: BUS 541.* Managerial implications of decisions about information technology. Assessment of strategic and competitive use of information technology. Critical success factors. Frameworks for effective organizational/technology relationships.

BUS 560 Marketing Management and Strategy. *3(3-0) . F, S. Preq: BUS 500, ECG 507.* Market segmentation, targeting, and positioning. Channels of distribution, promotion strategy, product development strategy, and pricing strategy. Relationship marketing and marketing strategy. Applications in high-tech environments.

BUS 562 Research Methods in Marketing. *3(3-0) . S. Preq: BUS(ST) 350, BUS 500.* A systematic approach to structure, implementation and analysis of marketing research for decision making. Models of consumer demand and firm behavior analyzed in a marketing context.

BUS 565 Product Design and Development. *4(4-0) . F. Preq: Grad. standing.* Total product realization process, including customer needs analysis, product design and engineering, manufacturability assessment and marketing plan development. Definition of relevant market, design and engineering principles, financial considerations and manufacturing aspects of product development process. Application and integration of business, design and engineering methodologies, concepts and tools on actual product design and development project.

BUS 570 Production and Operations Management. *3(3-0) . F, S. Preq: ACC 580, ECG 507 BUS 500, ST 513.* Design and management of organizational operation, including both service and manufacturing. Analysis of strategies, process design, planning and control, operations organizational structures, work design, scheduling, materials management, and advanced operations techniques using a variety of managerial and quantitative models.

BUS 572 Operations Planning and Control. *3(3-0) . F. Preq: BUS 570.* Design and management of operations planning and control systems for manufacturing firms. Capacity management, master production scheduling, production activity control. Just-in-time and time-based competition concepts. Multi-week simulation of decision making in manufacturing environment.

BUS 573 Supply Chain Management. *3(3-0) . S. Preq: BUS 570.* Purchasing, materials management and logistics. Purchasing systems, supplier base strategies, price-cost management, value analysis. Inventory strategies, quantity and quality decisions, materials planning. Logistics strategies for services and manufacturing.

BUS 574 Management of Technology. *2(2-0) . F,S. Preq: Grad. standing.* Development of technology policy and strategy. Management and implementation of new technologies. Technology sourcing, technology forecasting and life cycles, economic and financial analysis of technology. Innovation process and impact on organizations.

BUS (MAT) 576 Technology Evaluation and Commercialization Concepts. *3(3-0) S. Preq: Grad. standing.* Commercialization potential of new technologies, products and processes. Marketing, organizational, financial, operational and manufacturing issues. Strategic assessment and planning. Innovation management. Entrepreneurial transfer mechanisms including spinoffs, licensing and high-technology start-ups. Practical application with project and team management skills development.

BUS (MAT) 577 Technology Evaluation and Strategy. *3(3-0) . F. Preq: BUS 576.* Theoretical and practical team-based application of systematic evaluation techniques for assessing commercial potential of technologies, products and processes. Prioritization and selection based on technology strategy.

BUS (MAT) 578 High Technology Entrepreneurship. *3(3 0) . Every yr. Preq: BUS 577.* Development of strategies to commercialize technology based on prioritized assessments. Investigation of various commercialization approaches. Business plan development. Practical application of technology management skills to actual cases with commercial potential.

BUS 579 Operations Strategy. *3(3 0 . S. Preq: BUS 570.* Concepts, models and formulation of operations strategy for both manufacturing and service environments. Analysis and development of links between operations and other functions and environmental areas. Application through case analysis and course project.

BUS (TTM) 585 Market Research In Textiles. *3(3-0 . S. Preq· TAM (EB) 482.* A study and analysis of quantitative methods employed in market research in the textile industry. Function of market research and its proper orientation to management and decision making.

BUS 590 Special Topics in Business Management. *1-6. F,S,Sum. Preq: Consent of Instructor.* Presentation of material not normally available in regular courses offerings or offering of new courses on a trial basis.

BUS 630 Independent Study in Business Management. *1-6. F,S,Sum. Preq: Consent of Instructor.* Detailed investigation of topics of particular interest to graduate students under faculty direction on a tutorial basis. Determination of credits and content by faculty member in consultation with department head.

COMPARATIVE BIOMEDICAL SCIENCES

CBS (BAE) 522 Mechanics of Biological Materials. *3(2-2). F, Alt. Yrs. Preq: BIO 125, MA 242, PY 205.* Structure and composition of biological materials, both animal and plant, as related to the ability of the materials to withstand mechanical loading. Emphasis on measurement of mechanical properties and the development and understanding of models of biological material mechanical behavior.

CBS 595 Special Topics.

CBS (ANS, PHY, ZO) 602 Seminar In Biology of Reproduction. *2(2-0) S. Preq· ANS(PHY) 702 or Consent of Instructor.* Current topics in animal reproduction presented by reproductive physiologists from various Research Triangle institutions. Student presentations of research projects or library projects in area of animal reproduction.

CBS 610 Special Topics in Veterinary Medical Sciences. *1 3. F,S,Sum Preq. Sr. or grad. standing.* Designed to present new or special subject matter within the scope of pathology, veterinary microbiology, morphology or pharmacology. The studies may include independent investigations, seminars and/or formal lectures.

CBS 620 Special Problems. *F,S*

CBS 662 Professional Conduct in Biomedical Research. *1(1-0. S.* Plagiarism, authorship, fraud, safety, sexual harassment, IACUC, consulting agreements, serving as an expert witness, contacting elected officials, working with press, human subjects committee, and related topics.

CBS 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq. Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

CBS 693 Master's Supervised Research. *1-9. F,S,Sum. Preq· Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

CBS 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research

CBS 699 Master's Thesis Preparation. *1-5. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

CBS 730 Veterinary Histology. *3(2-4. F, Alt. yrs. Preq: BCH 451 and Consent of Instructor.* The structure of cells, tissues and organs of domestic animals using light microscopy.

CBS 731 Applied Veterinary Anatomy I. *4(2-8) . F, Alt. yrs. Preq: DVM or equivalent and Consent of Instructor.* Graduate veterinarian provided with detailed anatomic information relevant to surgical and medical problems in domestic carnivores. Designed for graduate veterinarians in pursuit of advanced training in areas of anatomy, physiology, surgery, radiology and pathology.

CBS 732 Electron Microscopy in Veterinary Medicine. *4(2-4. S. Preq: Consent of Instructor.* An introduction to ultramicrotomy, tissue processing for electron microscopy, theory and utilization of transmission electron microscope and scanning electron microscope, darkroom techniques and an introduction to various specialized techniques for preparation of samples for veterinary diagnostic and research electron microscopy.

CBS 740 Research Animal Care and Use. *3(2-3). S, Alt. yrs.* Principles of selection, care and use of animals in laboratory teaching and investigation presented. Topics including ethics of animal experimentation, selection of animal models, biology and care of laboratory animals, techniques of administration of substances and obtaining of specimens, producing surgical alterations and common laboratory animal health problems.

CBS 742 Advanced Systemic Histopathology. *2(1-3). S, Alt. Yrs. Preq: Grad. students holding DVM or equivalent degree and Consent of Instructor.* Histopathologic changes associated with diseases of various organ systems. Emphasis on pathogenesis and morphologic changes associated with selected diseases.

CBS 743 Toxicologic Pathology I. *3(2 2) . F, Alt. yrs. Preq: Those holding DVM or equivalent degree or Consent of Instructor.* A review of principles and practices of toxicologic pathology and a survey of common spontaneous and chemically induced lesions by organ systems with emphasis on recognition and interpretation.

CBS 750 Veterinary Medical Virology I. *2(2 0). S. Preq: Veterinary Medical Virology I.* Discussion of basic principles of animal virology and the relationship of viruses to diseases in domestic animals.

CBS 751 Pathogenic Bacteriology and Mycology. *3(2-2) F Preq: MB 411, grad. standing and Consent of Instructor* Lecture covering pathogenic bacteria and fungi important in medicine. Lectures supplemented by laboratory exercises providing students the opportunity to learn basic characteristics of these microorganisms and how they are isolated, cultivated and identified.

CBS 752 Diagnostic Bacteriology and Mycology. *3(1-8) . F S. Preq: Grad standing, VMM 814 or CBS 551 and Consent of Instructor* Presentation of principles of specimen collection, selection and use of media, culture processing and identification of bacteria and fungi important in animal disease.

CBS 753 Veterinary Immunology. *2(2-0) . S. Preq: MB 501 and grad. standing.* Basic and clinical immunology. Discussion of role of the immune system in disease prevention, inflammation and autoimmune diseases.

CBS 754 Principles of Analytical Epidemiology. *3(2-4) . F, Alt. yrs. Preq: Grad. standing or Consent of Instructor.* Principles of epidemiology related to investigation of disease involving agent-host-environment concepts. Stress on epidemiological techniques and experimental design. Main focus on descriptive, analytical and experimental epidemiology pertinent to disease etiology and prevention.

CBS (IMM) 755 Immunoparasitology. *2(2-0) . S, Alt. yrs. Preq: MB 751.* Helminth and protozoal parasite immune evasion and immunomodulation; consequences of parasite-induced immunopathogenesis; learning from failed attempts to develop protective vaccines against protozoa and helminths.

CBS (IMM, MB, PHY, PO) 756 Immunogenetics. *3(2-2) . F Alt. yrs. Preq: MB 501 or MB 751 or Consent of Instructor.* Basic concepts of the immune system. Genetic basis of the immune response including immunoglobulin genetics, major histocompatibility complexes and their role in the immune response, the molecular basis of the immune system and effector mechanisms.

CBS 762 Principles of Pharmacology. *3(3-0) . S.* The action of drugs in animals and man including basic principles of drug disposition, pharmacokinetics, drug resistance, and signal transduction. Modification of physiological processes by drugs influencing nervous, renal, cardiovascular, and endocrine systems and the antimicrobic and antineoplastics agents.

CBS (ANS, NTR, PHY) 764 Comparative Physiology of the Digestive System. *3(3-0) F. Preq: Course in general or comparative physiology.* Discussion of major functions of vertebrate digestive systems and structural and functional adaptations to diet, environment and other characteristics of the animals.

CBS 770 Cell Biology. *3(3-0) . F. Preq: BCH 451, BIO 125, CH 223 or equivalent or Consent of Instructor.* Advanced cell and organelle structure and function and recent advances in molecular biology. Emphasis on current literature and application of research procedures.

CBS 771 Veterinary Medical Virology II. *3(3-0) . F, Alt. yrs. Preq: VMM 824 or VMS 550 or Consent of Instructor.* Principles of animal viral pathogenesis and host-response to viral infection. The biology of selected viral groups including oncogenic viruses and persistent viral infection.

CBS 773 Advanced Developmental Biology. *2(2-0) . F,S. Preq: CBS 570 or Consent of Instructor.* In-depth coverage of current concepts and new research technologies in developmental biology. Biochemical aspects of germ cell maturation and early development, molecular and genetic regulation of morphogenesis, cellular interaction for organogenesis, hormones and growth factors mediated cellular differentiation and growth, molecular basis of neoplasia apopotises and gene therapy.

CBS 774 Epidemiology of Infectious Diseases of International Importance. *3(2-4) . F, Alt. yrs. Preq: Consent of Instructor.* Discussion of infectious diseases and epidemiological principles. Stress on selected enteric, zoonotic, nosocomial diseases of worldwide importance. Consideration of population dynamic techniques related to host-vector-agent.

CBS 780 Veterinary Production Epidemiology. *2(2-0) . S. Preq. VMM 844 or equivalent, basic statistics or Consent of Instructor.* Examination of tools, limits, advantages and disadvantages specific to veterinary epidemiology and its execution. Assessment of means of disease prevention and outbreak investigation; mathematical simulation and economics; plus monitoring and evaluation of disease control programs; use of a multiple-species orientation. Application of the above epidemiologic techniques and their roles in assisting producers, practitioners and regulators.

CBS 782 Marine Mammal Medicine. *2(2-0) . F. Preq: Grad. standing or enrollment in DVM curriculum or approval of instructor.* Discussion of disease issues in free ranging and captive cetaceans, pinnipeds and marine mustelids with emphasis on species found in North American waters. Examination of anatomic, physiologic and behavioral basis of health and population managementand assessment of diagnostic and therapeutic approaches to disease in these species.

CBS (IMM, MB) 783 Advanced Immunology. *3(3-0) . F, Alt. yrs. Preq: CBS 553 or VMM 815 or MB 551 or equivalent or Consent of Instructor.* The ontogeny and phylogeny of self and non-self recognition. Emphasis on basic mechanisms evolved during the evolution of the species. Specialty areas such as immunology of reproduction and genetic regulation of the immune response.

CBS 785 Advanced Pharmacology. *2(2-0) S, Alt. yrs. Preq: CBS 560 or equivalent and Consent of Instructor.* In-depth study of current topics in pharmacology. Subjects including but not limited to: the actions of drugs on ion permeability, prostaglandins, receptors, pharmacologically active peptides, toxicity of heavy metals and anti-fertility drugs.

CBS 787 Pharmacokinetics. *3(3-0) F, Alt. yrs . Preq: CBS 560 or equivalent, working knowledge of calculus and Consent of Instructor.* Mathematical models to describe disposition of drugs and toxic chemicals in the animal body. Areas including classic compartmental and nonlinear models as well as physiological approaches. Discussion of application of these techniques to toxicologic studies.

CBS 790 Special Topics in Clinical Pathology. *F,S,Sum. Preq: DMV or equivalent degree and Consent of Instructor.* New, fundamental and in-depth understanding of selected topics in clinical pathology (blood coagulation, acid-base balance, hematology, cytology, and clinical chemistry). A new topic selected each semester. Students read pertinent current journal articles and references and lead weekly discussion sessions. Stress upon clinical application of this information.

CBS 795 Special Topics.

CBS (ANS, PHY, ZO) 802 Seminar in Biology of Reproduction. *2(2-0) . S. Preq: ANS(PHY) 702 or Consent of Instructor.* Current topics in animal reproduction presented by reproductive physiologists from various Research Triangle institutions. Student presentations of research projects or library projects in area of animal reproduction.

CBS 803 Seminar in Surgical Pathology. *1(1-0) F,S,Sum. Preq: Those holding the DVM or equivalent degree and Consent of Instructor.* Description and interpretation of microscopic changes in tissues from diseased domestic and laboratory animals. Students attend and participate in a one-hour weekly seminar where microscopic lesions described, interpreted and discussed.

CBS 804 Seminar in Necropsy Pathology. *1(1-0) F,S,Sum. Preq: Those holding the DVM or equivalent degree and Consent of Instructor.* Description and interpretation of gross changes in tissues from diseased domestic animals. Students attend daily (M-F) 15-to 30-minute review of necropsy lesions presented by a member of the graduate staff.

CBS 805 Seminar in Pharmacology. *1(1-0) . S. Preq: Grad. standing and Consent of Instructor.* Presentations and discussions of pharmacological topics of current interest and importance are made.

CBS 806 Seminar in Cell Biology. *1(1-0) . F,S. Preq: Grad. standing and Consent of Instructor.* Presentation and discussions of ongoing research and current topics in cell biology.

CBS (IMM) 807 Seminar in veterinary Microbiology/Immunology. *1(1-0) . F,S.* Presentation of ongoing research and current topics in microbiology.

CBS 810 Special Topics. *1-3. F,S Sum. Preq. Sr. or grad standing* Designed to present new or special subject matter within the scope of pathology, veterinary microbiology, morphology or pharmacology. The studies may include independent investigations, seminars and/or formal lectures.

CBS 812 Special Topics Pathology. *1-4 F,S. Preq: Those holding DVM degree and Consent of Instructor.* Specific topics of study assigned in various laboratories involved in veterinary microbiology investigation. Students conduct in-dept studies of assigned problem areas.

CBS 813 Special Topics Laboratory Pharmology. *1-3. F,S,Sum. Preq: Grad. standing and Consent of Instructor.* Involvement in practical participation in the normal research activities of different laboratories working in pharmacological research. Students pursue a semi-independent project.

CBS (IMM) 816 Advanced Topics in Immunology and Biotechnology. *1(1-0) . F,S,Sum. Preq: CBS 553, MB 751 or Consent of Instructor.* A study of selected topics of current interest in immunology/biotechnology. A new topic selected each semester to keep the advanced graduate students up to date on the most recent developments in these fields.

CBS 817 Advanced Topics in Zoological Medicine I. *2(2-0) . F. Preq: Grad. standing or enrollment in DVM curriculum or Consent of Instructor.* Selected topics of current interest in clinical zoological medicine focused on marine mammals, fish, reptiles, amphibians, waterfowl, ratites, raptors and medical issues in free-ranging wildlife. Review of current clinical and basic science literature, student-lead discussion sessions and participation in faculty-lead discussions.

CBS 818 Advanced Topics in Zoological Medicine II. *1(1-0) . S. Preq: Grad. standing or enrollment in DVM curriculum or Consent of Instructor.* Selected topics of current interest in clinical zoological medicine focused on North American hooved stock, African hooved stock, primates and issues in immunology, infectious disease, reproductive physiology and endocrinology. Review of current clinical and basic science literature, student-led discussion sessions and participation in faculty-led discussions.

CBS 820 Special Problems. *F,S.*

CBS 860 Instrumentation in Pharmacological Research. *2(1-4) . F. Preq: BCH 452B or CH 315 and grad standing or Consent of Instructor.* Theory and applications of modern scientific instrumentation to analysis of tissues, body fluids and drugs in pharmacological research. Discussion of appropriate aspects of the pharmacological use of spectroscopy, microscopy, chromatography, electrophoresis, radioisotope usage and centrifugation.

CBS 861 Bacterial Pathogenic Mechanisms. *2(2-0) . S, Alt. yrs Preq: CBS 552 or VMM 814.* Discussion of principles of pathogenesis and host-response in bacterial infections of animals.

CBS 885 Doctoral Supervised Teaching. *1 3. F,S,Sum Preq. Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

CBS 890 Doctoral Preliminary Examination. *1-9. F,S,Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

CBS 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

CBS 895 Doctoral Dissertation Research. *1-9. F,S,Sum. Preq: Doctoral student.* Dissertation research.

CBS 899 Doctoral Dissertation Preparation. *1-5. F,S,Sum. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

CIVIL ENGINEERING

CE 200 Civil Engineering, Measurements, and Surveys. *3(2-3) . S. Preq: CSC 112 or 114. Coreq: ST 370.* Plane surveying, topographical surveying, horizontal and vertical curves, topographic surveys, construction surveys, earthwork, route surveying. Use of computers to adjust measured quantities, to calculate coordinates and areas, and to locate points for design grades and planned roadways. Mathematical topics for surveying and construction including probability, error and precision; matrix operations; allocation theory; linear programming; network analysis; and constraint based optimization.

CE 201 Civil Engineering Measurements and Surveys. *2(1-3) . F,S. Preq: CSC 112 or 114; GC 101 or 120. Coreq. ST 370. Credit will not be given for both CE 200 and CE 201.* Plane surveying, topographical surveying, horizontal and vertical curves, topographic surveys, construction surveys, earthwork, route surveying. Use of computers to adjust measured quantities, to calculate coordinates and areas, and to locate points for design grades and planned roadways.

CE 203 Global Positioning and Geographical Information Systems Applications. *1(1-0) . F. Preq: GC 120. Coreq: ST 370. CE, CEM, ENE, or BE majors only.* Applications of global positioning systems and geographical information systems to civil engineering projects. Brief coverage of the fundamental concepts of the systems. Selection of hardware and software appropriate for applications. Relevant analysis tools and databases.

CE 213 Introduction to Mechanics. *3(3-0) . F,S,Sum. Preq: PY 205. Coreq: MA 242. Not for CE department majors.* Study of the state of rest or motion of bodies subjected to the action of forces. Properties of force systems, free body diagrams, concepts of equilibrium, kinematics of particles, Newton's laws, conservational principles of energy of momentum in mechanics, mechanical vibrations.

CE 214 Engineering Mechanics-Statics. *3(3-0) . F,S,Sum. Preq: PY 205. Coreq: MA 242.* Basic force concepts and equilibrium analysis; distributed forces; centroids; moments of inertia; application to structural elements.

CE 215 Engineering Mechanics-Dynamics. *3(3-0) . F,S,Sum. Preq: Grade of C or better in CE 214, MA 242.* Kinematics and kinetics of particles; mass flow; vibrations; plane kinematics and kinetics of rigid bodies; selected topics from three-dimensional rigid body dynamics, and orbital motion.

CE 260 Construction Engineering Systems. *1(1-0) S Coreq: ST 370. Credit will not be given for both CE 200 and CE 260.* Introduction to optimization principles and techniques for Construction Engineers. Topics include simultaneous equations, matrix math operations, transitional probabilities and markov chains, use and application of Linear Programming techniques including allocation theory and the simplex algorithm. Duality and sensitivity analysis. The transportation problem and overviews of non-deterministic and non-linear problems. Simulation techniques.

CE 280 Principles of Environmental Engineering. *3(3-0) . F. Preq: Matriculation into ENE, MA 241, C or better in CH 201. Coreq: BIO 125.* Emphasis on types of pollutants and their fate and effect in the environment. Environmental chemistry and microbiology; ecology; water quality in lakes, streams, subsurface environments, and other natural systems; public health issues and hazardous waste management.

CE 305 Traffic Engineering. *3(3-3) . F,S. Preq: CE 215 and ST 370.* Integrated approach to planning, design, and operation of transportation systems with an emphasis on highway and street systems. Roadway design, traffic operations and performance, and control systems.

CE 313 Mechanics of Solids. *3(3-0) . F,S,Sum. Preq: Grade of C or better in CE 214, MA 242.* Elementary analysis of deformable solids subjected to force systems. Concepts of stress and strain; one, two and three-dimensional stress-strain relationships for the linear elastic solid. Statically determinate and indeterminate axial force, torsion and bending members. Stress transformations, pressure vessels, combined loadings. Introduction to column buckling.

CE 324 Structural Behavior Measurement. *1(0-3) . F,S. Preq. CE 313. Coreq. CE 215* Theory and application of strain, displacement, and acceleration measurements. Verification of structural theories. Error Analysis. Bending of determinant and indeterminate beams, twisting of circular tubes, buckling of columns, and vibration of shear buildings.

CE 325 Structural Analysis. *3(3-0) . F,S,Sum. Preq: CSC 112 or 114; CE 313.* Analysis of internal forces and deformations in statically determinate trusses, beams and frames. Indeterminate structural analysis of trusses, beams and frames by force and displacement methods.

CE 327 Reinforced Concrete Design. *3(3-0) . F,S,Sum. Preq: CE 313 and CE 332.* Behavior, strength, and design of reinforced concrete members subjected to moment, shear, and axial forces. Introduction to the design of reinforced concrete structures.

CE 332 Materials of Construction. *3(2-3) . F,S. Preq: MAT 200 CSC 112 or 114; Junior standing in CE.* Manufacture and properties of mineral and bituminous cements and mineral aggregates. Mechanical properties and durability of portland cement concrete, bituminous mixtures, masonry units, timber products, and miscellaneous construction materials. Materials testing.

CE 342 Engineering Behavior of Soils and Foundations. *4(3-2) . F,S,Sum Preq CE 313. Coreq: CE 332.* Description, identification, and engineering classification of soils. The basic principles and mechanics of flow of water through soils, deformation and strength of soils, and the processes of consolidation and compaction. Effective stress concepts, stress and settlement analyses, and evaluation of shear strength. Methods of analysis and geotechnical engineering design concepts.

CE 367 Mechanical and Electrical Systems in Buildings. *3(3-0) S Preq PY 208. Junior standing in CE, CEC, CM, or ENE* Introduction to mechanical and electrical systems in building construction. Includes HVAC, lighting and electrical systems, focusing on design concepts, equipment application and design of the construction process for modern building systems.

CE 374 Environmental Engineering Laboratory. *2(1 4) . F. Preq: Junior Standing in ENE, C or better in CE 280, CH 220 or CH 221* Experimental techniques for the analysis of water and wastewater quality parameters; interpretation of the status of the environment based on measurements such as acidity, alkalinity, solids, DO, BOD, COD, plate counts and volatile organics.

CE 375 Civil Engineering Systems. *3(3 0) . F,S. Preq: CSC 112 or 114 Coreq: MA 341 or MA 305.* A broad perspective, systematic approach to civil planning, analysis, evaluation and design for large scale projects in construction, structures, transportation, water resources and other civil engineering areas.

CE 381 Hydraulics Systems Measurements Lab. *1(0-3) . F,S,Sum. Coreq: CE 382.* Introduction to experimental techniques for the analysis of hydraulic systems; measurement of viscosity, fluid pressures, velocity distributions, flow rates; investigations into the friction, momentum transfer, and turbulence on fluid flow.

CE 382 Hydraulics. *3(3-0) . F,S. Preq: CE 215, Junior standing in CE, CEC CM, ENE, or BE. Coreq: MA 341, MA 305, or ST 370.* Fluid properties; mass, energy and momentum conservation laws; dimensional analysis and modeling; laminar and turbulent flows; surface and form resistance; flow in pipes and open channels; elementary hydrodynamics; fluid measurements; characteristics of hydraulic machines.

CE 383 Hydrology and Urban Water Systems. *3(3-0) . F,S. Preq: C or better in CE 382. For students in CE, ENE, and CEM; others on space available basis.* Study of engineering hydrology and design of elements of urban stormwater systems. Commonly encountered applications in urban stormwater management, flood control and groundwater engineering. Familiarization with effects of watershed development on quantity and quality of streamflow.

CE 384 Introduction to Environmental Engineering. *3(3-0) . F,S. Preq: CE 382 and CE major or CHE 311.* Overview of environmental engineering and manner in which environment is affected by human activity. Physical, chemical, and biological processes for water and wastewater treatment. Municipal solid waste and hazardous waste management, air pollution, environmental chemistry and microbiology.

CE 400 Transportation Engineering Project. *3(1-4) . S. Preq: CE 305.* Integrated team approach to design of major transportation engineering projects. Professional topics in transportation engineering practice.

CE 401 Transportation Systems Engineering. *3(3-0) . F,S. Preq: CE 305.* Multi-modal transportation systems; railroads, airports, highways, and other modes. Planning, analysis, and design. Fundamental concepts; supply, demand, flows, impacts, and network optimization.

CE 413 Principles of Pavement Design. *3(3-0) . S. Preq: CE 332, 342.* Basic principles of analysis, design and performance of highway and airport pavements with critical evaluation of current design and maintenance strategies.

CE 420 Structural Engineering Project. *3(2-2) . F,S. Preq: CE 327,426.* Planning, analysis and design of complete structural systems composed of steel and reinforced concrete. Professional topics in structural engineering practice.

CE 425 Introduction to Matrix Structural Analysis. *3(3-0) . F. Preq: CE 325.* Review basic concepts related to displacement method of analysis; develop matrix equations for the solution for 2-D beam and frame structures by formulating elements of the structural stiffness matrix directly, and by assembling member stiffness matrices; approximate methods of analysis.

CE 426 Structural Steel Design. *3(3-0) . F,S,Sum. Preq: CE 325.* Design and behavior of structural steel members and their connections subjected to moment, shear, and axial forces. Introduction to the design of steel structures.

CE (MEA) 435 Engineering Geology. *3(3-0) . S. Preq: MEA 101 and Junior Standing in colleges of Agriculture and Life Sciences, Engineering, Forest Resources Physical and Mathematical Sciences or Textiles.* Application of both geology and geotechnical engineering to engineering projects. Illustrations of relevant materials properties and techniques utilized in describing subsurface conditions.

CE 440 Geotechnical Engineering Project. *3(1-4) . F. Preq: CE 342, CE 375.* Integrated team approach to design of building foundations involving site selection, analysis and design of shallow and deep foundations, establishment of performance criteria, economic analysis, identification of potential construction problems and matters regarding professional practice and ethics.

CE 443 Seepage, Earth Embankments and Retaining Structures. *3(3-0) . F,S. Preq: CE 342.* Review of shear strength concepts; ground water hydraulics; slope stability; lateral earth pressure problems; placement of fills.

CE (MEA) 456 Air Quality. *3(3-0) . F. Preq: CE 384, ST 370 or CE 280 and CE 382.* Introduction to air quality engineering and meteorology. Air quality management, air quality meteorology, atmospheric emissions and dispersion modeling, and control technology principles.

CE 463 Construction Estimating, Planning, and Control. *3(2-2) . F. Preq: CSC 112 or 114; Junior standing in CE.* Overview of the construction industry; life cycle of construction projects, work breakdown structure, activity cost and time estimation, computerized planning and scheduling methods, resource leveling, time-cost tradeoff; computerized cost estimating, bidding and negotiation strategies; and cost/schedule control systems.

CE 464 Legal Aspects of Contracting. *3(3-0) . F. Preq: Senior standing in CE, or CEC or CEM.* Legal aspects of contract documents, drawings and specifications; owner-engineer-constructor relationships and responsibilities; bids and contract performance, Labor laws; governmental administrative and regulatory agencies; torts; business organizations; ethics and professionalism.

CE 465 Construction Equipment and Methods. *3(3-0) . S. Preq: CE 332 and CSC 112 or 114.* Study of construction operations as dynamic production processes. Utilization of equipment and other resources to achieve highest levels of productivity, safety, and quality. Covers a wide range of traditional and state-of-the-art construction methods.

CE 466 Building Construction Engineering. *3(2-2) . F. Coreq: CE 327.* Construction processes for buildings and other structures including codes and standards, structural and architectural components and systems, form work and bracing design, erection and assembly methods.

CE 469 Construction Engineering Project. *3(1-6) . F,S. Preq: CE 463. Last semester in CEM Coreq: CE 464.* Capstone course involving integrated team approach in the design of the construction process, utilizing computerized tools for cost estimation, planning, scheduling, process design, and management of two construction projects. Each student also selects an individual project. Lecture topics include: ethics, professionalism, marketing, bid presentations, business planning, finance, and other appropriate topics by guest speakers from industry.

CE 470 Physical Processes of Environmental Engineering. *3(3-0) . S. Preq: CE 280, CHE 225 and C or better in CE 382. Coreq: CE 381, and MAE 301 or CHE 315.* The fundamentals of physical processes of mass, momentum and energy transfer in fluid systems as applied to environmental engineering. Examples drawn from wastewater treatment, air pollution, surface and groundwater pollution, and solid and hazardous waste.

CE 476 Air Pollution Control. *3(3 0) . F. Preq: CHE 315 or MAE 301. CE 375, CHE 225. Coreq: ST 370 or CHE 450. Credit for both CE 476 and CE 576 will not be given.* Introduction to air pollution control fundamentals and design. Fundamentals include the physics, chemistry and thermodynamics of pollutant formation, prevention and control. Design will include gas treatment, process modification, and feedstock modification. Pollutants to be addressed include sulfur dioxide, nitrogen oxides, particulate matter, volatile organic compounds, hydrocarbons, and air toxics.

CE 477 Principles of Solid Waste Engineering. *3(3-0) . S. Preq: CE 374 or CE 384, Senior Standing.* Solid waste management including generation, storage, transportation, processing, land disposal and regulation. Processing alternatives including incineration and composting. Integration of policy alternatives with evaluation of engineering decisions.

CE 480 Water Resources Engineering Project. *3(1-4) . S. Preq: CE 375 and C or better in CE 382 and CE 383.* Engineering design of selected projects in water resources engineering involving interactions with other scientific and engineering disciplines. Discussion of ethical conduct and professional engineering practice. Projects will include site work, storm drainage, water supply, water transmission and water-quality issues.

CE 481 Environmental Engineering Project. *3(1-4) . S. Preq. CE 375, 383, CE 484. Coreq: Two of: CE 476, CE 477, CE 488.* Engineering design of selected projects in environmental engineering involving interactions with other scientific and engineering disciplines. Discussion of ethical conduct and professional engineering practice.

CE 484 Water Supply and Waste Water Systems. *3(3-0) . F. Preq: CE 374 and CE 382 or CHE 312* Elements of the design of water supply and wastewater disposal systems.

CE 487 Introduction to Coastal and Ocean Engineering. *3(3 0) . S. Preq: Senior standing and CE 382.* Introduction to the analysis of civil engineering projects in the ocean and along the coastline. Basic wave mechanics, tides, and ocean dynamics as applied to the understanding of coastal erosion control and other marine problems. An optional two-day field trip to the North Carolina Outer Banks at a nominal student expense is a regular feature of the course.

CE 488 Water Resources Engineering. *3(3 0) . S. Preq: CE 375. Coreq. CE 383.* Extension of the concepts of fluid mechanics and hydraulics to applications in water supply, water transmission, water distribution networks and open channels to include water-supply reservoirs, pump and pipe selection, determinate and indeterminate pipe networks, and analysis of open channels with appurtenances.

CE 497 Current Topics in Civil Engineering. *1-4. F,S,Sum. Preq: Permission of Instructor.* Presentation of material not normally available in regular course offerings or offering of new courses on a trial basis. Credits and content determined by faculty member in consultation with the Department Head.

CE 498 Special Problems in Civil Engineering. *1-4. F,S. Preq: Sr standing.* Directed reading in the literature of civil engineering, introduction to research methodology, seminar discussion dealing with special civil engineering topics of current interest.

CE 501 Transportation Systems Engineering. *3(3 0) . F Preq. CE 305 Credit for both CE 401 and CE 501 is not allowed.* Planning and analysis of multi-modal transportation systems including railroads, airports, highways and other modes. Supply, demand, flows, impacts and network optimization. Completion of term papers and projects for students taking course for graduate credit.

CE 502 Traffic Operations. *3(3-0) . F. Alt. yrs. Preq: CE 305.* Highway capacity; traffic control systems; intelligent vehicle/highway systems; and other advanced topics.

CE 503 Highway Design. *3(3-0) S Alt. yrs.(odd). Preq. CE 305.* Corridor selection; highway alignment; design of roadsides, intersections and interchanges.

CE 504 Airport Planning and Design. *3(3-0) . F, Alt. yrs.(even). Preq. CE 305* Analysis, planning and design of air transportation facilities.

CE 505 Advanced Airport Systems Design. *3(3-0) . S, Alt. Yrs.(odd). Preq: CE 504.* Planning, design and operation of components of the U. S. air transportation system with special emphasis on forecasting and analysis techniques used at major airports.

CE 509 Highway Safety. *3(3-0) . S, Alt. Yrs.(even). Preq: CE 305 Coreq: ST 370 or equivalent.* Methods to reduce collisions and injuries on highways. Identifying promising locations, choosing appropriate countermeasures, and evaluating past projects. Understanding the institutional context and establishing appropriate highway design standards.

CE 521 Structural Models. *3(3-0) . F Preq: CE 425 or 426.* Dimensional analysis and structural similitude, indirect and direct models, model materials and experimental techniques, individual project in structural model analysis.

CE 522 Theory and Design of Prestressed Concrete. *3(3-0) . F. Preq: CE 327.* Principles and concepts of design in prestressed concrete including elastic and ultimate strength analyses for flexure, shear, torsion, bond and deflection. Principles of concordancy and linear transformation for indeterminate prestressed structures. Application of pre-stressing to tanks and shells.

CE 523 Theory and Behavior of Steel Structures. *3(3-0) . S. Preq. CE 426.* Theory and behavior of steel structures leading to the development of design requirements contained in current specifications; flexural, torsional and flexural-torsional buckling of columns; plastic analysis of beams and frames; lateral-torsional buckling of beams; stability and strength of flat plates; beam-columns.

CE 524 Analysis and Design of Masonry Structures. *3(3-0) . S. Alt. Yrs. Preq. CE 327* Theory and design of masonry arches, culverts, dams, foundations and masonry walls subjected to lateral loads.

CE (WPS) 528 Structural Design in Wood. *3(3-0) . S. Preq. CE 325.* Behavior, strength and design of wood structural members subjected to moment, shear and axial forces. Design of connections and introduction to design of wood structural systems.

CE 537 Computer Methods and Applications. *3(3-0) . F. Preq: CE 375.* Computational approaches to support civil planning, analysis, evaluation and design. Applications to various areas of civil engineering, including construction, structures, transportation and water resources.

CE 538 Information Technology and Modeling. *3(3-0) . F,S. Preq: CE 375.* Computing research and advanced technologies of interest to civil engineers. Issues in the design and development of engineering software systems and engineering modeling of structures, assemblies, processes and phenomena. Additional topics from thermost predominant and recent developments and advances in civil engineering computing.

CE 548 Engineering Properties of Soils I. *3(2-3) . F. Preq: CE 342.* Significant soil properties in earthwork engineering, including soil elasticity and soil mineralogy, hydraulic conductivity, stress-strain relations and shear strength, compressibility and compaction. Laboratory work including plasticity, triaxial compression, permeability, consolidation and compaction tests.

CE 549 Soil and Site Improvement. *3(3-0) . S. Preq: CE 342.* Principles and design methodologies for techniques related to densification, including dynamic compaction, vibro-compaction and compaction grouting; drainage, including wick drains, horizontal drains and dewatering; physical and chemical modification, including admixtures, chemical and cement grouting, soil mixing, jet grouting and soil freezing; and use of inclusions, including stone columns, soil nailing, and meta and geosynthetic reinforcement.

CE 561 Construction Project Management. *3(3-0) . Every 3rd semester. Preq: CE 463.* Construction project management and control using network based tools, time-money analysis and other quantitative and qualitative techniques. Planning and scheduling, critical path, lead-lag, resource allocation, uncertainty, cash flow and payment scheduling, change orders, project acceleration, coordination and communication, record keeping. Emphasis on computer-based techniques.

CE 564 Legal Aspects of Contracting. *3(3-0) . F. Preq: Grad. standing. Credit for both CE 464 and CE 564 is not allowed.* Legal aspects of contract documents, drawings and specifications; owner-engineer-constructor relationship and responsibilities; bids and contract performance; labor laws; governmental administrative and regulatory agencies; torts; business organizations; ethics and professionalism; analysis of current topics and issues. Investigation of recent statute and case implications.

CE 571 Theory of Water and Waste Treatment. *3(3-0) . S. Preq: CE 574.* Basic physical and chemical processes underlying water and waste treatment, including mass transfer, equilibria, kinetics and flow through porous media.

CE 572 Design of Water and Wastewater Facilities. *3(3-0) . S. Preq: CE 571.* Theory and design of water and wastewater treatment plants.

CE 574 Chemistry and Microbiology for Engineers I. *3(3-0) . F. Preq: CE 384.* Fundamental aspects of inorganic chemistry, biochemistry and microbiology presented and related to problems of surface and groundwater pollution, refuse decomposition and water and wastewater treatment. Buffering, alkalinity, solubility, oxidation reduction, microbial diversity and ecology, and energy conservation and growth requirements in bacteria.

CE 576 Engineering Principles of Air Pollution Control. *3(3-0) . F Preq: CE 375; CE 470 CHE 315 or MAE 301; or equivalent courses. Coreq: ST 511 or ST 515 or equivalent course. Credit for both CE 476 and CE 576 is not allowed.* Introduction to air pollution control fundamentals and design. Fundamentals including physics, chemistry and thermodynamics of pollutant formation, prevention and control. Design including gas treatment and process and feedstock modification. Addressed pollutants including sulfur dioxide, nitrogen oxides, particulate matter, volatile organic compounds, hydrocarbons and air toxins. Investigation of current research.

CE 577 Engineering Principles of Solid Waste Management. *3(3-0) . F. Preq: CE 384* Solid waste management including generation, storage, transportation, processing, land disposal and regulation. Processing alternatives including incineration and composting. Integration of policy alternatives with evaluation of engineering decisions. Investigation of current research.

CE 580 Flow in Open Channels. *3(3-0) . F. Preq: CE 382* Theory and applications of flow in open channels, including dimensional analysis, momentum-energy principle, gradually varied flow, high-velocity flow, energy dissipaters, spillways, waves, channel transitions and model studies.

CE 583 Engineering Aspects of Coastal Processes. *3(3-0) S. Preq: CE 382 or equivalent.* Coastal environment, engineering aspects of mechanics of sediment movement, littoral drift, beach profiles, beach stability, meteorological effects, tidal inlets, inlet stability, shoaling, deltas, beach nourishment, mixing processes, pollution of coastal waters, interaction between shore processes and man-made structures, case studies.

CE 584 Hydraulics of Ground Water. *3(3 0) . F. Preq: CE 382.* Introduction to ground water hydraulics and hydrology. Hydrologic cycle, basic ground water hydraulics, numerical solution of governing equations, ground water hydrology of North Carolina, well design and construction, flow net development, and ground water contamination sources.

CE 586 Engineering Hydrology. *3(3-0) . S. Preq. CE 383.* Hydrologic principles underlying procedures for surface water modeling; applications of common hydrologic models to actual watersheds

CE 588 Water Resources Engineering. *3(3 0) . F. Preq: CE 382.* Extension of concepts of fluid mechanics and hydraulics to applications in water supply, water transmission, water distribution networks and open channels to include water-supply reservoirs, pump and pipe selection, determinate and indeterminate pipe networks, and analysis of open channels with appurtenances.

CE 590 Special Topics in Civil Engineering. *1-3. F,S.* New or special course on recent developments in some phase of civil engineering. Specific topics and prerequisites identified for each section and varied from term to term.

CE 591 Special Topics in Civil Engineering Computing. *1-3. F,S.* New or special course on recent developments in some phase of civil engineering. Specific topics and prerequisites identified for each section and varied from term to term.

CE 592 Special Topics in Construction Engineering. *1-3. F,S.* New or special course on recent developments in some phase of civil engineering. Specific topics and prerequisites identified for each section and varied from term to term.

CE 593 Special Topics in Geotechnical Engineering. *1-3. F,S.* New or special course on recent developments in some phase of civil engineering. Specific topics and prerequisites identified for each section and varied from term to term.

CE 594 Special Topics in Structures and Mechanics. *1-3. F,S.* New or special course on recent developments in some phase of civil engineering. Specific topics and prerequisites identified for each section and varied from term to term.

CE 595 Special Topics in Transportation Engineering. *1-3. F,S.* New or special course on recent developments in some phase of civil engineering. Specific topics and prerequisites identified for each section and varied from term to term.

CE 596 Special Topics in Water Resource and Environmental Engineering. *1 3 F,S.* New or special course on recent developments in some phase of civil engineering. Specific topics and prerequisites identified for each section and varied from term to term.

CE 601 Civil Engineering Seminar. *1(1-0) . F,S Preq: CE 502* Discussions and reports of subjects in civil engineering and allied fields.

CE 602 Seminar in Civil Engineering Computing. *1(1-0) F S.* Discussions and reports of subjects in civil engineering and allied fields.

CE 603 Construction Engineering Seminar. *1(1 0) . F,S.* Discussions and reports of subjects in civil engineering and allied fields.

CE 604 Geotechnical Engineering Seminar. *1(1-0) . F,S.* Discussions and reports of subjects in civil engineering and allied fields.

CE 605 Structures and Mechanics Seminar. *1(1 0) F S.* Discussions and reports of subjects in civil engineering and allied fields.

CE 606 Transportation Engineering Seminar. *1(1-0) . F,S.* Discussions and reports of subjects in civil engineering and allied fields.

CE 607 Water Resource and Environmental Engineering Seminar. *1(1-0) . F,S.* Discussions and reports of subjects in civil engineering and allied fields.

CE 635 Advanced Reading in Civil Engineering. *1-3 F,S. Preq: Grad. standing.* Directed reading of advanced topics in some phase of civil engineering.

CE 675 Civil Engineering Projects. *1-6. F,S Sum.* Research- or design-oriented independent study and investigation of a specific civil engineering topic, culminating in final written report.

CE 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's student* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

CE 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

CE 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research.

CE 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

CE 701 Urban Transportation Planning. *3(3-0) S, Alt. Yrs.(odd). Preq: CE 501* Planning and design of urban transportation systems as related to comprehensive urban planning; principles of land use planning, urban thoroughfare planning and regional planning

CE 702 Traffic Flow Theory. *3(3-0) . F, Alt. Yrs.(odd). Preq: CE 502. Coreq: ST 370 or equivalent.* Stream flow, shock wave, queuing, and other macroscopic theories;car following, gap acceptance, and other microscopic theories; distributions of traffic stream parameters; building traffic simulation models.

CE 705 Intelligent Transportation Systems. *3(3-0) . F, Alt. Yrs. (even). Preq: CE 501 and CE 502.* Intelligent Transportation Systems (ITS) planning and human factor elements; application of monitoring, communications and information dissemination technologies to transportation systems; advanced traffic management for freeway and arterial systems; traveler information and public transportation systems; automated vehicle and highway systems. ITS evaluation methods and models.

CE 706 Advanced Traffic Control. *3(3-0) . S. Alt Yrs.(even). Preq: CE 502* Advanced signalized traffic control methods at intersections, arterials and networks. Applications of mathematical optimization techniques to signal timing and coordination. Use of traffic simulation and optimization models for signal evaluation and design. Roundabout analysis and design.

CE 714 Stress Waves. *3(3-0) . F, Alt. Yrs. Preq: MA 301; CE 313 or PY 411 or MA 401 or MEA 351.* Theory of stress waves in solids. Origins and nature of longitudinal transverse and surface waves originating at an impact site or from other transient disturbances. Determination of stresses, particle velocities, wave velocities. Wave interaction with other waves and with boundaries and dissimilar materials. Modern instrumentation and seismic refraction exploration.

CE 715 Advanced Strength of Materials. *3(3-0) . F. Preq: CE 313 or MAE 314.* Stresses and strains at a point; rosette analysis; strength theories, stress concentration and fatigue, torsion and unsymmetrical bending of open and closed sections; inelastic, composite and curved beams; energy methods; shear deflections.

CE 717 Theory of Plates and Shells. *3(3-0) . F. Preq: CE 713 or CE 715.* Small and large deflection theories of thin plates; membrane analysis of shells. Discussion and illustration of various methods of analysis by problems of practical interest.

CE 718 Plasticity and Limit Analysis. *3(3-0) . S, Alt. Yrs. Preq: CE 713 or 715.* Stress-strain rate relationships and theorems of limit analysis and shakedown in plastic solids. Application to collapse load calculations in arches, rings, plates and axisymmetric shells. Introduction to slip-linc field theory of plane plastic flow and to dynamic limit analysis.

CE 719 Finite Deformation of Materials I. *3(3-0) . F, Alt. Yrs. Preq: CE 713, MA 512.* Application of principles of classical continuum mechanics to study of large deformation of solid materials. Finite strain geometry and kinematics, work-conjugate stress and stress-rate measures, rotating reference frames, local balance laws and jump conditions. Constitutive equations of nonlinearly elastic and inelastic behavior, general theorems for rate-type boundary value problems, conditions for bifurcation of solution.

CE 720 Matrix and Finite Element Structural Analysis I. *3(3-0) . F. Preq: CE 425* Development of stiffness method of analysis using bar and bean elements; solution of symmetric-banded simultaneous equations; displacement and shape functions for bar and beam elements; introduction to finite element method using constant strain triangle and 4- and 8-node isoparametric elements. Development of computer programs at each stage.

CE 721 Matrix and Finite Element Structural Analysis. *3(3-0) . S. Preq: CE 720.* Advanced topics in matrix structural analysis and finite element method. Introductory review of the method, isoparametric quadrilateral element and three-dimensional elements. Energy methods and convergence criteria. Higher order elements. Isoparametric beam and plant elements, shear locking. Isoparametric curved beam and shell elements. Axisymmetric elements, Fourier series load and displacement representation. Analysis of systems with geometric and material nonlinearities.

CE 722 Structural Dynamics. *3(3-0) . S. Preq: CE 425.* Analysis of single and multi-degree-of-freedom structures subjected to various types of excitations and initial conditions. Computational aspects of dynamic analysis. Introduction to approximate methods of analysis.

CE 723 Advanced Structural Dynamics. *3(3-0) . F, Alt. Yrs. Preq: CE 722.* Finite element formulation of equations of motion; advanced analysis techniques for discrete parameter systems; investigation of damping; analysis of continuous systems; applications to civil engineering structures.

CE 724 Probabilistic Methods of Structural Engineering. *3(3 0) . F, Alt. Yrs. Preq: MA 421.* Application of probability theory and stochastic processes to study safety of structures. Fundamentals of probability theory and stochastic processes; probabilistic modelings of structural loadings, material properties and risk. Reliability analysis of structures; reliability-based design criteria. Random vibration of simple structures; safety analysis of structures under dynamic loads.

CE 725 Earthquake Structural Engineering. *3(3-0) S. Preq: CE 722.* Effects of earthquakes on structures and of design of structures to resist earthquake motions; earthquake mechanisms and ground motions; response of structures to earthquake motions; behavior of materials, structural elements and assemblages subjected to earthquakes; principles of earthquake-resistant design practice; soil-structure interaction; and special topics.

CE 726 Advanced Theory of Concrete Structures. *3(3-0) . S. Preq. CE 522.* Inelastic theory of structural concrete members under flexure, axial load, combined flexure and axial compression, shear and torsion. Yield line theory of slabs. Limit analysis of beams and frames of reinforced and prestressed concrete.

CE 737 Computer-Aided Engineering Systems. *3(3-0) . S. Preq. CE 537 or 538.* Design and implementation issues for building real-world computer-aided engineering systems. Engineering data modeling; data definition, query and manipulation methodologies; application program interfaces; problem-oriented languages and software supervisors; and knowledge-based systems to support engineering design and decision making.

CE 741 Advanced Soil Mechanics. *3(3-0) . F. Preq: Grad. standing.* Theories of soil mechanics; failure conditions; mechanical interaction between solids and water, and problems in elasticity and plasticity pertaining to earthwork engineering.

CE 742 Advanced Soil Mechanics. *3(3-0) . F. Preq: Grad. standing.* Theories of soil mechanics; failure conditions; mechanical interaction between solids and water, and problems in elasticity and plasticity pertaining to earthwork engineering.

CE 744 Foundation Engineering. *3(3-0) . S. Preq: CE 342.* Subsoil investigations; excavations; design of sheeting and bracing systems; control of water; footing, grillage and pile foundations; caisson and cofferdam methods of construction.

CE 746 Dynamics of Soils and Foundations. *3(3-0) . S, Alt. Yrs. Preq: CE 742.* Application of vibration and wave propagation theories to soil media; review of existing experimental data and empirical procedures for analysis of foundation vibrations, prediction of soil responses to impulse loads, dynamic properties of soils and methods for their determination, design procedures for foundation subjected to dynamic forces.

CE 751 Theory of Concrete Mixtures. *3(3-0) . F. Preq: CE 332* In-depth study of theory of portland cement concrete mixtures including types and properties of portland special cements; chemical reactions; brief examination of history of mixture design; detailed study of current design methods; properties of fresh and hardened concretes; strength-age-curing relationships; durability; admixtures; special concretes; production and quality control.

CE 753 Asphalt and Bituminous Materials. *3(2-3) . S Preq CE 332* In depth study of properties of asphalts and tars for use in waterproofing and bituminous materials and theories of design of bituminous mixtures for construction and paving uses including types and properties of asphalt cements, cutbacks, emulsions, blown asphalts and tars; brief examination of historical developments; detailed study of properties and design of bituminous mixtures; and current research. Laboratory work: standard tests on asphalts, tars and road oils; design, manufacture and testing of trial batches; and current research techniques.

CE 755 Highway Pavement Design. *3(3 0) F Preq: CE 342.* Theoretical analysis and design of highway pavements with critical evaluation of current design practices. Pavement materials characterization; stresses and strains in pavements; traffic consideration; pavement performance models; and actual thickness design of pavements using different methodologies.

CE 757 Pavement Management Systems. *3(3-0) . S. Alt. Yrs. Preq: CE 755.* Fundamental concepts in process of pavement management at both network level and project level. Distress identification and evaluation; concepts and methods for rehabilitation and maintenance techniques; nondestructive testing of pavements; performance prediction models; and principles of prioritization/optimization.

CE 759 Inelastic Behavior of Construction Materials. *3(3-0) . S, Alt. Yrs. Preq. CE 713 & 715 or CE 721.* Application of principles of linear and nonlinear viscoelasticity, fracture mechanics and damage mechanics to modeling inelastic behavior of construction materials. Mechanical analog of time-dependent response: linear and nonlinear elastic-viscoelastic correspondence principles; time-temperature superposition; stress intensity factor; energy release rate; J-integral; and continuum damage mechanics.

CE 761 Design of Temporary Structures. *3(3-0) . S, Alt. yrs. Preq: CE 522 or CE 744 or CE 766 or equivalent.* Computer-based analysis of temporary structures in construction and their design, safety and control. Emphasis on concrete formwork, falsework, earth support, cofferdams, underpinning, lifting and rigging.

CE 762 Construction Productivity. *3(3 0) . F or S. Preq: CE 463 or equivalent.* Methods of collecting, assembling and analyzing construction productivity data in order to increase construction productivity. Applications of methods improvement techniques such as time-lapse photography, flow charts, process charts and time standards to improvement of construction productivity. Safety and human factors in construction and their relation to construction productivity.

CE 763 Materials Management in Construction. *3(3-0) . Every 3rd sem. Preq: CE 463, CE 465.* Fundamental concepts and methods; construction specific models for integrated materials management; computer usage; vendor analysis and "best-buy;" materials requirement planning and control; management of material waste; automated materials tracking; materials handling; study of current issues; development of practical solution to a real-world problem.

CE 765 Construction Equipment Systems. *3(3-0) . S, Alt. yrs. Preq: CE 761 or 762 or equivalent.* Analysis of heavy construction processes as systems in order to optimize the selection and employment of construction equipment. Considerations in system design, cost and productivity estimation, operational procedures, safety and maintenance. Computer applications utilizing analytical and simulation techniques.

CE 766 Building Construction Systems. *3(3-0) . F or S. Preq: CE 466 or CE 327 or grad. standing in ARC.* Construction engineering of conventional and industrialized building systems. Emphasis in areas of structural systems utilizing cast-in-place concrete, precast concrete, prestressed concrete, structural steel, cold-formed steel, masonry, timber, composite and mixed materials. Mechanisms for resisting and transmitting loads, detailing, fabrication, transportation, erection, stability, shoring, quality control and integration of service systems.

CE 769 Automation and Robotics in Civil Engineering. *3(3-0) . Every 3rd sem. Preq: CE 763 or equivalent.* Concepts of automation in design, planning, construction and maintenance of civil structures. Design office automation as a tool to create a computer-integrated engineering system. Intelligent process planning to link design with fabrication and construction. Critical robot technologies. Pattern recognition and architectures for adaptive control.

CE 771 Advanced Water and Waste Treatment: Principles and Design. *3(3-0) . S. Alt. odd yrs. Preq: CE 571.* Theory and design of physiochemical processes including adsorption, ion exchange, membrane treatment and gas transfer processes.

CE 773 Hazardous Waste Management and Treatment. *3(3-0) . F. Preq: CE 571 or CE 572.* New concepts and regulations as well as emerging technologies and practices applicable to characterizing, managing, recovering, reusing, treating and disposing industrial hazardous wastes.

CE 774 Chemistry and Microbiology for Engineers II. *3(3-0) S Coreq CE 574* Microbiological and chemical principles, including applications of energetics, stoichiometry, genetics, biodegradation mechanisms, kinetics models, and applied microbial ecology.

CE 775 Modeling and Analysis of Environmental Systems. *3(3-0) . F. Preq: CE 375 and CE 382 or equivalent.* Movement and fate of pollutant discharges. Development and application of analytical solutions and numerical models. Role of these models in planning and management. Mathematical programming models. Alternative management strategies: direct regulation, charges and transferable discharge permits. Multiple objectives: cost, equity and certainty of outcome.

CE 776 Advanced Water Management Systems. *3(3-0) . S, Alt. Yrs. Preq: CE 375, CE 775.* Application of systems analysis methods to design, analysis and management of water resources and environmental engineering.

CE 781 Behavior and Analysis of Ocean Structures. *3(3-0) . S, Alt. Yrs. Preq: CE 722.* Introduction to linear and random water waves, analysis of wave forces on small bodies, analysis of wave forces on large bodies, response of offshore structures to waves and earthquake loadings, mooring dynamics.

CE 782 Coastal Hydrodynamics. *3(3-0) . F. Preq: CE 382 or equivalent.* Surface gravity waves, solitary waves, longwaves, impulsively generated waves, flow in inlets and estuaries, storm surge, wave refraction and diffraction, harbor oscillations.

CE 783 Design of Coastal Facilities. *3(3-0) . F. Preq: CE 782 and CE 783.* Types and functions of coastal structures, computation of wave forces on coastal structures, wave uprush, shore protection against waves and storms, planning and design of navigation channels, port development, harbor design, dredging technology, planning and design of offshore platforms, technology of disposal of wastes and heated discharge, consideration of environmental effects of waste disposal.

CE 784 Ground Water Contaminant Transport. *3(3-0) . S. Preq: CE 574 and 584.* Introduction to movement and attenuation of contaminants in the subsurface. Common contaminant sources; advection and dispersion; numerical modeling of contaminant transport; chemical and biological processes in the subsurface; and ground water restoration technology.

CE 785 Urban Stormwater Management. *3(3-0) . F. Preq: CE 383.* Storm water management in urban areas emphasizing quantitative problems in flooding, sedimentation and water quality. Review and extension of design concepts involving channels and impoundments. Survey of hydrographic formation techniques and examination of common hydrologic models. Case studies of urbanizing watersheds.

CE 790 Advanced Topics in Civil Engineering. *1 3 F,S.* New or special course on advanced developments in some phase of civil engineering. Specific topics and prerequisites identified for each section and varied from term to term.

CE 791 Advanced Topics in Civil Engineering Computing. *1-3 F,S.*

CE 792 Advanced Topics in Construction Engineering. *1-3. F S.*

CE 793 Advanced Topics in Geotechnical Engineering. *1-3. F,S.*

CE 794 Advanced Topics in Structures and Mechanics. *1 3. F,S.*

CE 795 Advanced Topics in Transportation Engineering. *1 3. F,S.*

CE 796 Advanced Topics in Water Resource and Environmental Engineering. *1-3 F,S.*

CE 801 Advanced Civil Engineering Seminar. *1(1-0) F,S.* Discussions and reports of subjects in civil engineering and allied fields.

CE 802 Advanced Civil Engineering Computer Seminar. *1(1-0) . F.S.*

CE 803 Advanced Construction Engineering Seminar. *1(1-0) F,S.*

CE 804 Advanced Geotechnical Engineering Seminar. *1(1-0) . F.S.*

CE 805 Advanced Structures and Mechanics Seminar. *1(1-0) . F,S.*

CE 806 Advanced Transportation Engineering Seminar. *1(1-0) . F.S.*

CE 807 Advanced Water Resource and Environmental Engineering Seminar. *1(1-0) F,S.*

CE 839 Advanced Reading in Civil Engineering. *1-3. F,S,Sum. Preq: Grad. standing.* Directed reading of advanced topics in some phase of civil engineering.

CE 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

CE 890 Doctoral Preliminary Examination. *1-9. F,S,Sum. Preq: Doctoral student.* For studentsd who are preparing for and taking written and/or oral preliminary exams.

CE 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

CE 895 Doctoral Dissertation Research. *1-9. F,S,Sum. Preq: Doctoral student.* Dissertation research.

CE 899 Doctoral Thesis Preparation. *1 3 F,S,Sum. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

COLLEGE OF FOREST RESOURCES

CFR 110 Forest Resources Scholars Forum. *0(2-0) F,S Enrollment limited to participants in the Scholars Program.*

CFR 111 Forest Resources Scholars Forum. *0(2 0) . F,S* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

CFR 134 Computers in Natural Resources. *1(0-3) . F,S. Freshmen and first semester transfer students only.* Forestry, wood science, recreation, and natural resource computer applications and exercises using word processing, spreadsheets, and database management programs. Introduction to microcomputer operating systems, specific application packages, and BASIC computer language.

CFR 210 Forest Resources Scholars Forum. *0(2 0) . F,S Enrollment limited to participants in the Scholars Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

CFR 211 Forest Resources Scholars Forum. *0(2-0) . F,S. Enrollment limited to participants in the Scholars Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

CFR 490 Senior Honors Seminar. *2(2-0) . S. Preq: 4 credit hours of Independent Study.* Oral presentations of the results of the senior honors projects. Additional special seminars and group discussions to enrich and broaden student perspectives.

CHEMISTRY

CH 100 Chemistry and Society. *4(4-0) . F,S,Sum. Credit is not allowed for CH 100 if student has prior credit for CH 101.* Awareness and understanding of chemistry in everyday life for the non-science student. Non-mathematical treatment of essential fundamental concepts. Emphasis on practical applications of chemistry to consumer affairs, energy, medicine, food, sports, and pollution.

CH 101 Chemistry - A Molecular Science. *3(3-1) . F,S,Sum. Preq: One Year of High School chemistry or completion of CH 111 with grade of C- or better; and eligibility for MA 107. Coreq: CH 102.* A fundamental study of molecular bonding, structure, and reactivity. Principles of atomic structure, ionic and covalent bonding, reaction energetics, intermolecular forces, precipitation reactions, acid/base reactions, oxidation/reduction processes, and introductions to organic and inorganic chemistry.

CH 102 General Chemistry Laboratory. *1(0-3) . F,S,Sum. Coreq: CH 101.* Laboratory experience to accompany CH 101. Introduction to basic laboratory equipment and skills. Emphasis on gravimetric and volumetric techniques.

CH 106 Computer Applications in Chemistry I. *1(0-3) . F. Preq: CH major. Coreq: CH 101.* A supplement to CH 102 laboratory, for chemistry majors. An introduction to the use of computers in chemistry for data analysis, graphical data display, report preparation, and bibliographic searching.

CH 108 Computer Applications in Chemistry II. *1(0-3) . S. Preq: CH 106, CH major. Coreq: CH 201.* A supplement to CH 202 laboratory, for chemistry majors. The use of computers in mathematical modeling of chemical concepts; applications of computer graphics to structure drawing, molecular modeling, and scientific illustration.

CH 111 Preparatory Chemistry. *3(3-0) . F,S. Credit for CH 111 is not allowed if a student has prior credit in CH 101 Credit for CH 111 does not count towards graduation for students in curricula that require CH 101.* Preparation for CH101. Review of main topics from high school emphasizing nomenclature, vocabulary, the periodic table and problem solving. Emphasis on mathematical skills, data handling, reaction types, stoichiometry and solutions.

CH 201 Chemistry - A Quantitative Science. *3(3 0) . F S Sum. Preq: CH 101 with grade C- or better and eligibility for MA 121 or higher. Coreq: CH 202.* Detailed quantitative aspects of solutions, solution stoichiometry, thermodynamics, chemical equilibrium, acid-base equilibria, solubility equilibria, electrochemistry, chemical kinetics,and nuclear chemistry.

CH 202 Quantitative Chemistry Laboratory. *1(0 3) . F,S,Sum. Preq: CH 101, CH 102. Coreq: CH 201.* Laboratory experience to complement CH 201. Experimental exploration of thermodynamic, kinetic,and electrochemical behavior.

CH 211 Analytical Chemistry I. *3(3-0) . S. Preq: CH 108. Coreq. CH 212 and PY 208. Credit not allowed for both CH 211 and CH 315.* Methods of quantitative analysis based on solution chemistry, potentiometry, coulometry, chromatography, and molecular absorption and fluorescence spectroscopy. Statistics of measurement precision.

CH 212 Analytical Chemistry Laboratory I. *1(0-3) . S. Coreq: CH 211.* Laboratory experiments in volumetric analysis, ion selective electrodes, potentiometry, molecular absorption and fluorescence spectroscopy, acid/base chemistry, and computer applications. Precision, accuracy, and statistical analysis emphasized.

CH 220 Introductory Organic Chemistry. *4(3-3) . F,S,Sum. Preq: CH 201. Credit is not allowed for both CH 220 and CH 221.* A one-semester course in the fundamental principles of organic chemistry. Preparation, reactions, and physical properties of alkanes, cycloalkanes, alcohols, alkyl halides, aromatic compounds, aldehydes, ketones, organic acids, acid derivatives, and amines.

CH 221 Organic Chemistry I. *4(3-3) . F,S,Sum. Preq: CH 101. Credit is not allowed for both CH 220 and CH 221.* First half of two-semester sequence in the fundamentals of modern organic chemistry. Structure and bonding, stereochemistry, reactivity and synthesis of carbon compounds. Detailed coverage of aliphatic hydrocarbons, alcohols, ethers, and alkyl halides. Introduction to spectral techniques.

CH 223 Organic Chemistry II. *4(3-3) . F,S,Sum. Preq: CH 221.* Second half of a two-semester sequence in modern organic chemistry. Continuation of mechanistic approach to reactions and synthesis of organic compounds. Detailed coverage of carbonyl compounds (aldehydes, ketones, acids), aromatic chemistry and amines. Spectral techniques employed throughout.

CH 295 Special Problems in Chemistry. *1-3. F,S,Sum. Preq: Consent of Department.* Special topics in chemistry at the early undergraduate level. Trial offerings of new or experimental courses in chemistry.

CH 315 Quantitative Analysis. *4(3-3) . F,S,Sum. Preq: CH 201. Credit is not allowed for both CH 211 and CH 315.* Fundamental principles and modern techniques of chemical analyses: spectrochemical, electrochemical, volumetric and chromatographic methods of analysis, modern chemical instrumentation, and interpretation of data.

CH (MEA) 323 Earth System Chemistry. *3(3-0) . S. Preq: CH 201. Coreq: BIO 125 or any MEA course.* Chemistry of the earth with an emphasis on the interactions of the biosphere, geosphere and atmosphere. The origin and chemical evolution of the solar system, chemical cycles in the environment, and the impact of man on biogeochemical processes.

CH 331 Introductory Physical Chemistry. *4(3-1) . F,S,Sum. Preq: CH 201/202; MA 241 or 242, PY 205 or PY 211.* Fundamental physiochemical principles including chemical thermodynamics, physical and chemical equilibrium, electrochemistry and reaction kinetics. For students requiring only a single semester of physical chemistry.

CH 401 Systematic Inorganic Chemistry I. *3(3-0) . F,S,Sum. Preq: CH 201.* Descriptive chemistry of the elements with particular attention to their reactions in aqueous solution. Emphasis on the chemistry of the main group elements and the periodicity of their chemical properties. Introduction to transition element and coordination chemistry. Major paper required.

CH 402 Inorganic Chemistry Laboratory. *1(0-3) . F,S. Preq: CH 401.* A laboratory program to accompany CH 401, for B.S. chemistry majors. Synthetic techniques including inert atmosphere, electrolysis, high-temperature, and ion-exchange illustrated by application to main-group and transition metal complexes and to other main-group compounds.

CH 403 Systematic Inorganic Chemistry II. *3(3-0) . F,S. Preq: CH 401, CH 431* Development and application of theoretical principles to the structure and energies of inorganic substances. Particular attention to the chemistry of coordination compounds of the transition elements. Special applications to bioinorganic chemistry,organometallic chemistry, and inorganic solid state chemistry.

CH 415 Analytical Chemistry II. *3(3-0) . F. Preq: CH 211 or CH 315 or TC 412. Coreq: CH 416, CH 433.* Methods of quantitative analysis based on electronic instrumentation. Signal processing and electronics, spectroscopy (atomic, x-ray fluorescence, infrared/Raman, surface), voltammetry, chromatography (gas, liquid), mass spectrometry as well as chemical transducers and statistical methods of data handling.

CH 416 Analytical Chemistry Laboratory. *1(0-3) F. Coreq: CH 415* Experiments in spectroscopy, electrochemistry, chromatography and electronics; computer applications to experimental design and data smoothing.

CH 428 Qualitative Organic Analysis. *3(1-6) . F,S. Preq: CH 223.* Introduction to organic chemistry research techniques and to the systematic identification and separation of organic compounds. Application of both physical and chemical procedures. Experimental and research techniques including infrared and nuclear magnetic spectroscopy, chemical classification tests, and the preparation of derivatives.

CH 431 Physical Chemistry I. *3(3-1) . F,S,Sum. Preq: CH 201, MA 242, PY 203 or 208. Coreq: MA 341.* An intensive study of physical chemical principles including states of matter, classical thermodynamics, physical and chemical equilibria, and electrochemistry.

CH 433 Physical Chemistry II. *3(3-1) . F,S,Sum. Preq: CH 431, MA 341. Credit may not be claimed for both CH 433 and CH 437.* An intensive study of physical chemical principles including molecular spectroscopy, statistical thermodynamics, reaction kinetics, kinetic theory, and transport properties.

CH 434 Physical Chemistry Laboratory. *3(1-4) . F,S Preq: CH 211 or CH 315 or TC412 ; CH 431 Coreq: CH 433.* A project-oriented course to acquaint students with modern physical chemistry laboratory techniques. Experiments in chemical thermodynamics, kinetics, molecular structure and spectra.

CH 435 Introduction to Quantum Chemistry. *3(3-0) . F. Preq: CH 431* An introduction to the basic principles of quantum theory and its application to atomic and molecular structure and spectroscopy.

CH 437 Physical Chemistry for Engineers. *4(4-0) . F,S. Preq: PY 208, CHE 315 MA 341 Credit may not be claimed for both CH 433 and CH 437".* Selected physiochemical principles including quantum theory, spectroscopy, statistical thermodynamics, and rates of chemical reactions.

CH (TC) 461 Introduction to Fiber-Forming Polymers. *4(3 3) . F. Preq. CH 223* Formation and properties of fiber forming polymers. Step growth and chain growth polymerization. Survey of formation techniques for man-made fibers. Relationship between chemical structure and physical properties of natural and man-made fibers.

CH (MEA) 473 Principles of Chemical Oceanography. *3(3-0) F. Preq. CH 201/202. MEA 200* Chemical processes that control the composition of the oceans including discussions of chemical equilibria, biological cycling of nutrients, tracers of ocean circulation, minor and trace element distributions, and the chemical history of the marine environment.

CH 491 Honors Chemistry. *1-4. F,S. Preq: CH 223 Admission to Honors Program.* Independent study and research projects in chemistry.

CH 499 Undergraduate Research in Chemistry. *1-3. F,S,Sum Preq: Two years of chemistry and departmental approval.* Independent investigation of a research problem under the supervision of a chemistry faculty member.

CH 601 Seminar. *1(1-0) . F,S. Preq: Grad. standing in CH* Review and discussion of scientific articles, progress reports on research and special problems of interest to chemists.

CH 610 Special Topics in Chemistry. *1-3. F,S. Preq: Consent of Instructor.* Detailed study of a particular problem or technique pertaining to chemistry.

CH 615 Chemical Separation. *F. Preq: CH 415, CH 416. Coreq: CH 610 OR 810.* Basic principles of methods in chemical separation including gas chromatography, liquid chromatography, etc. Theory, instrumentation and applications of various chromatographic and electrophoretic techniques.

CH 677 Advanced Chemistry Projects. *1-3. F,S,Sum. Preq: Grad. standing in CH.* Independent literature study of a current subject in chemistry. Required written critical review paper of selected subject.

CH 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

CH 690 Master's Examination. *1-6. F,S,Sum. Preq: Master's student.* For students in non-thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

CH 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

CH 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research.

CH 699 Master's Thesis Preparation. *1-3. F,S. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

CH 701 Advanced Inorganic Chemistry I. *3(3-0) . F. Preq: CH 433.* Major emphasis on complexes of transition metals (3d, 4d and 5d). Structure, stability, synthesis and reaction mechanisms of these complexes. Consideration of organometallic compounds and of species containing metal-metal bonds.

CH 703 Advanced Inorganic Chemistry II. *3(3-0) . S. Preq: CH 701.* A continuation of CH 701 dealing with use of photochemical reactions as applied to inorganic complexes, metal cluster complexes and organometallic systems. Other topics treated at length: solid-state chemistry and bioinorganic chemistry. Discussion of structure, synthesis, energetics, reactions and applications. Discussion of other topics of current research interest in inorganic chemistry.

CH 705 Physical Methods in Inorganic Chemistry. *3(3 0) . S. Preq: Grad. standing and CH 701 or Consent of Instructor.* Use of group, molecular orbital and ligand field theories for spectroscopy and bonding; measurement methodology and the significance of experimental parameters, including electronic, photoluminescence, photoelectron, vibrational spectroscopies, magnetic susceptibility, Mossbauer, esr, nmr, nqr and x-ray structure determinations.

CH (MAT) 707 Chemical Concepts in Materials Science and Engineering. *3(3-0) F. Preq: Consent of Instructor.* Structure, symmetry and chemical bonding; spectroscopic methods and their utilization in trace analysis and pollution control; phase equilibria, crystal growth and materials purification; vapor phase equilibria and kinetics of chemical reactions andtransport; electrochemical thermodynamics and kinetics with applications to batteries, solar cells, electrorefinement, plating and corrosion processes.

CH 711 Advanced Analytical Chemistry I. *3(3-0) . S. Preq: CH 433; CH 415.* First semester of two-semester integrated sequence covering advanced methods for extraction and interpretation of chemical information from electronic/optical signals in chemical analysis. Digital and analog electronics, signal acquisition and processing, chemometrics, and instrumentation.

CH 713 Advanced Analytical Chemistry II. *2(2-0) . S. Preq: CH 711.* Second semester of two-semester integrated sequence covering advanced methods for extracting and interpreting chemical information from electronic/optical signals in chemical analysis. Digital and analog electronics, signal acquisition and processing, chemometrics, and instrumentation.

CH 714 Electronics and Instrumentation Laboratory. *1(0-3) . S. Preq: CH 711. Coreq: CH 713.* Laboratory course covering operation and application of analog and digital electronics in context of chemical instrumentation. Circuit elements, integrated circuits, microprocessors and computers, data acquisition systems, and signal processing.

CH 715 Chemical Instrumentation. *3(3-0) . S. Preq: CH 431. Coreq: CH 211.* Basic electronic components and circuits, the response of laboratory instruments, design and modification of typical electronic control and measurement systems. Emphasis on utilization of transducers and control elements in chemical research.

CH 717 Physical Methods of Elemental Trace Analysis. *3(3-0) . F. Preq: CH 315 or 331 or Consent of Instructor.* Principles and applications of currently used methods of trace analysis. For students with little or no experience in trace analysis but with strong interest in or need for analytical data at trace level. Pulse polarography, potentiometry, UV-Vis spectrophotometry, atomic absorption, emission spectrometry, fluorescence, neutron activation analysis and spark source mass spectrometry.

CH 718 Trace Analysis Laboratory. *2(0-6) . F. Coreq: CH 717 or Consent of Instructor.* Trace element content of samples determined by variety of instrumental techniques including UV-Vis spectrophotometry, fluorescence, emission spectrometry, atomic absorption, pulse polarography and neutron activation analysis.

CH 721 Advanced Organic Chemistry I. *3(3-0) . F. Preq: CH 223, 433 or 435.* Structure stereochemistry and reactions of various classes of hydrocarbons. Molecular orbital treatment of bonding and reactivity of alkenes, conformational interpretation of cycloaklene and cycloaklene reactivity and application of optical isomerism to study of reaction mechanisms.

CH 723 Advanced Organic Chemistry II. *3(3-0) . S. Preq: CH 721.* Introduction to acid-base theory and mechanistic organic chemistry as applied to synthetically useful organic reactions.

CH 725 Physical Methods iIn Organic Chemistry. *3(3-0) . S. Preq: CH 223 and 433 or 435.* Application of physical methods to the solution of structural problems in organic chemistry. Spectral methods including infrared, ultraviolet, nuclear magnetic resonance, mass spectrometry, electron paramagnetic resonance, X-ray and electron diffraction and optical rotatory dispersion.

CH 727 Mass Spectometry. *3(3-0) . F, Alt. Yrs. Preq: CH 223* Interpretation of mass spectra emphasizing characterization of organic molecules. Instrumentation topics: types of mass analyzers such as magnetic sector, quadrupole and time-of-flight; hybrid instruments such as GC/MS, LC/MS and MS/MS; and ionization methods including EI, CI, laser desorption and fast atom bombardment. Applications: quantitation, environmental analysis, and peptide and DNA sequencing.

CH 730 Advanced Physical Chemistry. *3(3 0) . F Preq: Grad standing or Consent of Instructor.* Survey of chemical thermodynamics and kinetics, with emphasis on reactions in liquid phase. Problem solving an important part of course. Designed for review and expansion on materials usually covered in a one-year undergraduate physical chemistry course.

CH 731 Chemical Thermodynamics I. *3(3-0) . F. Preq: CH 433, MA 301.* Extension of elementary principles to treatment of ideal and real gases, ideal solutions, electrolytic solutions, galvanic cells, surface systems and irreversible processes. Introduction to statistical thermodynamics and estimation of thermodynamic functions from spectroscopic data.

CH 733 Chemical Kinetics. *3(3-0) . S, Alt. Yrs. Preq: CH 433, MA 301.* Intensive survey of basic principles of chemical kinetics with emphasis on experimental and mathematical techniques, elements of the kinetic theory and theory of the transition state. Applications to gas reactions, reactions in solution and mechanism studies.

CH 736 Chemical Spectroscopy. *3(3 0) . S, Alt. Yrs. Preq: CH 435.* Introduction to rotational, vibrational and electronic molecular spectroscopy from a quantum mechanical viewpoint. Emphasis on the elucidation of structure, bonding and excited state properties of organic and inorganic molecules.

CH 737 Quantum Chemistry. *3(3 0) . S. Preq: MA 301, CH 435 or PY 407.* Elements of wave mechanics applied to stationary energy states and time-dependent phenomena. Applications of quantum theory to chemistry, particularly chemical bonds.

CH 739 Colloid Chemistry. *3(2-3) . S, Alt. Yrs Preq: CH 220, 315 or 331, or Consent of Instructor.* Theories, basic principles and fundamental concepts including preparation and behavior of sols, gels, emulsions, foams and aerosols and topics in areas of adsorption, Donnan equilibrium dialysis and small-particle dynamics. Laboratory includes independent project studies in specialized areas.

CH 741 Analytical Spectroscopy. *3(3-0) . S, Alt. Yrs. Preq: CH 431 or 433.* Presentation of quantitative laws of spectroscopic analysis and discussion of deviations. Discussion of experimental methods for spectroscopic observation.

CH 743 Electrochemistry. *3(3-0) . S Alt. Yrs Preq: CH 431 or CH 433.* Thermodynamics and kinetics of electrode reactions presented as well as experimental methods for studying them. Particular emphasis on measurement of standard potential and establishing number of electrons transferred. Applications of electrochemistry in production/storage of energy and in chemical analysis.

CH 745 Chemical Separation. *3(3 0) . F Preq. CH 412, CH 416. Coreq: CH 610 or 810* Basic principles of methods in chemical separation including gas chromatography, liquid chromatography, etc. Theory, instrumentation and applications of various chromatographic and electrophoretic techniques.

CH 755 Organic Reaction Mechanisms. *3(3-0) . S. Preq. CH 723, CH 433* Effects of structure and substituents on direction and rates of organic reactions.

CH 757 Chemistry of Metal-Organic Compounds. *3(3 0) . F Alt Yrs Preq. CH 721.* Preparation, properties and reactions of compounds containing carbon-metal bond with brief description of their uses.

CH 759 Natural Products. *3(3-0) . F. Preq CH 723 and CH 725.* Illustrative studies of structure determination, synthesis and biosynthesis of natural substances. Stress upon modern physical methods and fundamental chemical concepts. Examples from such classes as alkaloids, terpenes, steroids and antibiotics.

CH (FPS, MAT, TC) 762 Physical Chemistry of High Polymers-Bulk Properties. *3(3-0) F, Preq: CH 220 or TC 203, CH 431.* Molecular weight description; states of aggregation and their interconversion; rubbery, glassy and crystalline states; rubber elasticity; diffusion properties.

CH (FPS, MAT, TC) 772 Physical Chemistry of High Polymers--Solution Properties. *3(3 0) . S, Alt. yrs. Preq: CH 433, TC (CH, MAT) 762.* Thermodynamics of polymer solutions; phase equilibria; determination of molecular weight.

CH 795 Special Topics in Chemistry. *F,S.*

CH 801 Seminar. *1(1-0) . F,S. Preq: Grad. standing in CH.* Review and discussion of scientific articles, progress reports on research and special problems of interest to chemists.

CH 810 Special Topics in Chemistry. *1-3. F,S. Preq: Consent of Instructor.* Detailed study of a particular problem or technique pertaining to chemistry.

CH 815 Advanced Topics in Chemistry. *1-3. F,S. Preq: Consent of Instructor.* Critical study in one of branches of chemistry.

CH 877 Advanced Chemistry Projects. *1-3. F,S,Sum. Preq: Grad. standing in CH. 1-3.* Independent literature study of a current subject in chemistry. Required written critical review paper of selected subject.

CH 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning but the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

CH 890 Doctoral Preliminary Examination. *1-9. F,S,Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

CH 893 Doctoral Supervised Research. *1-9. F,S,Sum Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

CH 895 Doctoral Dissertation Research. *1-9. F,S,Sum. Preq: Doctoral student.* Dissertation research.

CH 899 Doctoral Dissertation Preparation. *1-3. F,S,Sum. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

CHEMICAL ENGINEERING

CHE 205 Chemical Process Principles. *4(3-2) . F,S. Preq: Grade of C or better in MA 241, PY 205, CH 201.* Engineering methods of treating material balances, stoichiometry, phase equilibrium calculations, thermophysics, thermochemistry and the first law of thermodynamics. Introduction to computers and Fortran programming computer language for solving problems related to chemical engineering calculations.

CHE 225 Chemical Process Systems. *3(3-0) . F,S,Sum. Preq: C or better in both CHE 205 and MA 242.* Introduction to methods of measurement of process variables and instrumental measurement methods. Dynamic process system behavior and computer simulation of steady state and dynamic processes. Introduction of equilibrium-stage process and graphical and analytical design methods.

CHE 311 Transport Processes I. *3(3-0) . F,S. Preq: C or better in both CHE 225 and MA 341.* Fundamental aspects of momentum and heat transfer, and the use of these fundamentals in solving problems in transport operations.

CHE 312 Transport Processes II. *3(3-0) . F,S. Preq: C or better in CHE 311.* Fundamental aspects of mass transfer and the use of these basic principles in solving problems in transport operations.

CHE 315 Chemical Process Thermodynamics. *3(3-0) . F,S. Preq: C or better in CHE 225.* Laws of thermodynamics and their application to chemical engineering problems, both in theory and in practice. Criteria of equilibrium in physical and chemical changes. Behavior of real fluids, including mixtures.

CHE 316 Thermodynamics of Chemical and Phase Equilibria. *3(3-0) . F,S. Preq: C or better in CHE 315.* Systematic study of chemical reaction equilibria and phase equilibria. Use of fugacity, activity and chemical potential concepts for predicting the effect of such variables as temperature, pressure on equilibrium compositions. Methods for measuring and estimating thermodynamic properties important to equilibrium calculation in real systems.

CHE 330 Chemical Engineering Lab I. *3(1-4) . F,S,Sum. Preq: CHE 311. Coreq: ENG 331.* Laboratory experiments in unit operations of heat transfer and fluid flow. Laboratory safety, technical report writing, statistics, experimental design, error analysis and instrumentation.

CHE 331 Chemical Engineering Lab II. *2(0-4) . F,S,Sum. Preq: CHE 312, CHE 330.* Laboratory experiments in mass transfer and reaction kinetics. Experimental planning, technical report writing and oral presentations are emphasized.

CHE 425 Process System Analysis and Control. *3(3-0) . S. Preq: CHE 312. Credit cannot be received for both CHE 425 and CHE 525 .* Dynamic analysis and continuous control of chemical engineering processes. Process modeling; stability analysis, design and selection of control schemes. Solution of differential equations using Laplace transform techniques.

CHE 446 Design and Analysis of Chemical Reactors. *3(3-0) . F. Preq: CHE 316. Coreq: CHE 312 Credit cannot be received for both CHE 446 and CHE 546..* Characterization and measurement of the rates of homogeneous and heterogeneous reactions. Design and analysis of chemical reactors.

CHE 450 Chemical Engineering Design I. *3(3-0) . F. Preq: CHE 312.* Applications of cost accounting, cost estimation for new equipment, manufacturing cost and measures of profitability. Use of computer simulation design and cost programs. Procedures for sizing unit operations commonly encountered in the chemical process industry. Heuristics for selection of separation processes and heat exchanger network synthesis.

CHE 451 Chemical Engineering Design II. *3(2-0) S. Preq: CHE 450, CHE 446.* Chemical process design and optimization. The interplay of economic and technical factors in process development, site selection, project design, and production management. Comprehensive design problems.

CHE 460 Chemical Processing of Electronic Materials. *3(3-0) . Preq: CHE 312 and CHE 446 or Consent of Instructor. Credit for both CHE 460 and CHE 560 is not allowed.* Plasma and thermal inorganic chemical processes in semiconductor device fabrication. Thin films and electronic devices. Kinetics and chemical transport in electronic materials synthesis, modification and etching. Plasma physics and chemistry, reactors and process diagnostics.

CHE 461 Polymer Sciences and Technology. *3(3-0) . F. Preq: CH 223, CHE 316.* Concepts and techniques for polymerization of macromolecules. Structure, properties, and applications of commercially important polymers.

CHE 465 Diffusion in Polymers. *3(3-0) . S. Preq: CHE 461/543. Credit will not be given for both CHE 465 and CHE 565.* The theory of small molecule transport in polymers; application of membrane transport processes in the chemical, polymer, textile, coatings and natural fibers industries.

CHE 467 Polymer Rheology. *3(3-0) . S. Preq: CHE 311 or equivalent.* Theoretical principles and experimental techniques associated with flow and deformation of polymer systems. Systems include: meffs and solutions, suspension, gels, emulsions, and thixotropic materials.

CHE 469 Polymers, Surfactants, and Colloidal Materials. *3(3-0) . S. Preq: CHE 316, CH 223. Credit will not be given for CHE 469 and CHE 769.* Relationships between molecular structure and bulk properties of nonmetallic materials applied to commercial products and chemical engineering processes. Applications of surface and colloidal chemistry and polymer science to product development and process improvement.

CHE 475 Advances in Pollution Prevention: Environmental Management for the Future. *3(3-0) . S. Preq: PY 208, MA 341.* Design of industrial processes which minimize or eliminate wastes. Regulations and the corporate organization of current pollution prevention efforts. Current pollution prevention research. Product life cycle analysis and the application to design of more efficient processes.

CHE (NE) 485 Management of Hazardous Chemical and Radioactive Wastes. *1(1-0) . F. Junior Standing. Credit will not be given for both NE 485 and 585.* Seminar series designed to provide an introduction to the management of both hazardous chemical and radioactive wastes. Topics include: hazardous waste treatment and disposal, pollution prevention, radioactive waste management, Superfund policy, state and federal regulations and risk assessment.

CHE 497 Chemical Engineering Projects I. *3(0 12) . F,S Sum Preq: Senior standing.* Introduction to chemical engineering research through experimental, theoretical and literature studies. Oral and written presentation of reports.

CHE 498 Chemical Engineering Projects II. *1-3. F,S,Sum. Preq: Senior standing* Projects in research, design or development in various areas of chemical engineering

CHE 525 Process System Analysis and Control. *3(3-0) . S. Preq: CHE 312. Credit for both CHE 425 and CHE 525 is not allowed.* Dynamic analysis and continuous control of chemical engineering processes. Process modeling; stability analysis, design and selection of control schemes. Solution of differential equations using Laplace transform techniques.

CHE (OR) 527 Optimization of Engineering Processes. *3(3-0) . Alt. Yrs Preq: CHE 451.* Formulation and solution of process optimization problems, with emphasis on nonlinear programming techniques. Computer implementation of optimization algorithms, on-line optimization, simulation methods and structuring of process models to increase computational efficiency.

CHE 543 Polymer Science and Technology. *3(3-0) . Alt. Yrs. Preq: CHE 223, CHE 316.* Concepts and techniques for polymerization of macromolecules. Structure, properties, and applications of commercially important polymers.

CHE 546 Design and Analysis of Chemical Reactors. *3(3 0) . F. Preq: CHE 316. Credit for both CHE 446 and CHE 546 is not allowed.* Characterization and measurement of rates of homogeneous and heterogeneous reactions. Design and analysis of chemical reactors.

CHE 551 Biochemical Engineering. *3(3-0) . S. Preq: CHE 312, 446.* Enzyme and microbial kinetics and reactor designs for processes involving enzymes and single and mixed cultures. Samples drawn from full range of applications: food processing, single cell proteins, tissue culture and vaccines, monoclonal antibodies, recombinant DNA and hybridomas, artificial organs, biological waste treatment and environmental processes.

CHE 560 Chemical Processing of Electronic Materials. *3(3-0) . S. Preq: CHE 312 and CHE 446 or Consent of Instructor. Credit for both CHE 460 and CHE 560 is not allowed.* Plasma and thermal inorganic chemical processes in semiconductor device fabrication. Thin films and electronic devices. Kinetics and chemical transport in electronic materials synthesis, modification and etching. Plasma physics and chemistry, reactors and process diagnostics.

CHE 565 Diffusion in Polymers. *3(3-0) . S. Alt Yrs (even). Preq: CHE 461 or 543.* Theory of small molecule transport in polymers; application of membrane transport processes in chemical, polymer, textile, coatings and natural fibers industries.

CHE 575 Advances in Pollution Prevention: Environmental Management. *3(3-0). S. Preq: PY 208, MA 341. Credit will not be given for CHE 475 and CHE 575.* Design of industrial processes which minimize or eliminate wastes. Regulations and the corporate organization of current pollution prevention efforts. Current pollution prevention research. Product life cycle analysis and the application to design of more efficient processes.

CHE (NE) 585 Management of Hazardous Chemical and Radioactive Wastes. *1(1-0) . F. Credit for both CHE 485 and CHE(NE) 585 is not allowed.* Seminar series to provide introduction to management of both hazardous chemical and radioactive wastes. Hazardous waste treatment and disposal, pollution prevention, radioactive waste management, Superfund policy, state and federal regulations and risk assessment.

CHE 596 Special Topics in Chemical Engineering. *1-3 F.S.*

CHE 597 Chemical Engineering Projects. *1-3. F.S. Preq: Grad. standing.* Independent study of some phase of chemical engineering or related field.

CHE 601 Seminar. *1(1-0) . F.S.* Weekly seminars on topics of current interest given by resident faculty members, graduate students and visiting lecturers.

CHE 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

CHE 690 Master's Examination. *1-6. F.S,Sum. Preq. Master's student.* For students in non-thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

CHE 693 Master's Supervised Reasearch. *1-9 F,S Sum. Preq: Master's student* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

CHE 695 Master's Thesis Research. *1-9. F,S. Preq: Master's student.* Thesis research.

CHE 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

CHE 711 Chemical Engineering Process Modeling. *3(3-0) . F. Preq: CHE 311, CHE 312, MA 301.* Applications of methods of mathematical analysis to formulation and solution of problems in transport phenomena, process dynamics and chemical reaction engineering.

CHE 713 Thermodynamics I. *3(3-0) . F. Preq: CHE 315, 316.* In-depth coverage of chemical engineering thermodynamics principles. Application of non-ideal fluid-phase chemical potentials to problems in phase and chemical reaction equilibria. Relations of molecular structure and intermolecular forces to macroscopic thermodynamic properties.

CHE 714 Thermodynamics II. *3(3-0) . Alt. Yrs. Preq: CHE 713.* Topics in chemical engineering thermodynamics. Perturbation theories, critical phenomena, multicomponent phase equilibria, supercritical extraction, irreversible thermodynamics and thermodynamics of macromolecules are representative topics.

CHE 715 Transport Phenomena. *3(3-0) . F. Preq: CHE 311.* A theoretical unified study of transport of momentum, energy and matter. Introduction to diffusional operations including coupled heat and mass transfer in light of the theory.

CHE 716 Transport Phenomena II. *3(3-0) . S. Preq: CHE 715.* Applications of principles introduced in CHE 515. Applications include multiphase flow and sedimentation, non-Newtonian and porous media flows, transport through membranes and in electrochemical systems, and thermal instabilities.

CHE 717 Chemical Reaction Engineering. *3(3 0) . S. Preq: CHE 446.* Rates and mechanisms of homogeneous and heterogeneous reactions. Design, analysis and scale-up of batch and continuous chemical reactors.

CHE 718 Advanced Chemical Reaction Engineering. *3(3-0) . Alt. Yrs. Preq: CHE 717* Topics relating to design, analysis and operation of homogeneous and heterogeneous chemical reactors.

CHE 719 Electrochemical Systems Analysis. *3(3-0) S. Alt Yrs. Preq: CHE 715, 717 or Convent of Instructor* Electrochemical thermodynamics, electrochemical kinetics and catalysis, coupled charge and material transport in an electric field and electrophoretic effects. Design and analysis of electrochemical reactors. Survey of electrochemical industry.

CHE 721 Separation Processes. *3(3-0) . S. Preq: CHE 312.* Theory and practice of staged multicomponent mass transfer operations and continuous rate processes. Problems unique to specific operations such as extractive and azeotropic distillation.

CHE 752 Separation Processes for Biological Materials. *3(3-0) . Alt. Yrs. Preq: CHE 721 or CHE 551 or Consent of Instructor.* Definition and engineering analysis of major bioseparation techniques useful in product isolation and purification. Solid-liquid separation, crystallization, filtration, extraction, chromatography, membrane processes, distillation, drying, combined operations and process economics.

CHE 760 Photochemical Engineering: Fundamentals and Applications. *3(3-0) . Alt. Yrs. Preq: Grad. standing in engineering or physical or life sciences.* Fundamentals and applications of photochemical processing: photoexcitation and deexcitation kinetics, illumination sources, radiation fields and photoreactor configurations, and engineering kinetics. Design applications include air pollution photochemical models, grafting and curing of polymers, microlithography, water treatment processes, photography and imaging processes.

CHE (MAT) 761 Polymer Blends and Alloys. *3(3-0) . F, Alt. Yr(odd). Preq: CHE 316 or MAT 301.* Thermodynamics, morphological, characteristics and properties of multiphase polymer systems composed of homopolymers or copolymers. Interfacial characteristics and modification of multicomponent polymer blends through emulsification and reactive blending. Measurement and uses of specific chemical interactions to control phase equilibria. Microphase ordering in block copolymers, and emerging technolgies employing these nanostructured materials. Conformational properties and dynamics of macromolecules constrained near an interface.

CHE (FPS, TC) 769 Polymers, Surfractants and Collodial Materials. *3(3-0) . Alt. yrs. Preq: CHE 316, CH 223.* Relationships between molecular structure and bulk properties of nonmetallic materials applied to commercial products and chemical engineering processes. Applications of surface and colloid chemistry and polymer science to product development and process improvement.

CHE (FPS, TC) 779 Diffusion in Polymers. *2(2-0) . Alt. yrs. Preq: CHE 769 or Consent of Instructor.* Theory of small molecule transport in polymers; applications of membrane transport processes in chemical, polymer, textile, coatings and natural fiber industries.

CHE 796 Special Topics in Chemical Engineering. *1-3. F,S. Preq: Grad. standing.* Directed reading of chemical engineering literature, introduction to research methodology, and lectures and seminar discussion on topics which vary from term to term.

CHE 797 Chemical Engineering Projects. *1-3 F,S. Preq: Grad. standing.* Independent study of some phase of chemical engineering or related field.

CHE 798 Advanced Chemical Engineering Projects. *1 3. F,S,Sum Preq: Grad. standing in CHE.* Independent study of some phase of chemical engineering or related field.

CHE 801 Seminar. *1(1-0) . F,S.* Weekly seminars on topics of current interest given by resident faculty members, graduate students and visiting lecturers.

CHE 885 Doctoral Supervised Teaching. *1-3 F,S,Sum. Preq: Doctoral student* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

CHE 890 Doctoral Preliminary Examination. *1-9. F,S,Sum Preq: Doctoral student* For students who are preparing for and taking written and/or oral preliminary exams.

CHE 893 Doctoral Supervised Research. *1-9 F,S,Sum Preq: Doctoral student* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

CHE 895 Doctoral Dissertation Research. *1-9 F,S,Sum Preq: Doctoral student* Dissertation research.

CHE 899 Doctoral Dissertation Preparation. *1 3 F,S,Sum Preq: Doctoral student* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

COMPARATIVE LITERATURE

CL 495 Special Topics in Comparative Literature. *3(3-0)* Detailed investigation of a topic in comparative literature. Topic and mode of study determined by faculty member(s) in consultation with Comparative Literature Committee and heads of departments of English and Foreign Languages.

COMMUNICATION

COM 103 Introduction to the Theater. *3(3-0) F,S,Sum* Artistic, technical, historical, and literary areas of theater, including acting, directing, design, stagecraft, lighting, costuming, makeup, and criticism.

COM 110 Public Speaking. *3(3-0) . F,S,Sum.* Research skills, topic selection, speech organization, skills in speech delivery. Listening for analysis and evaluation of in class speech presentation.

COM 112 Interpersonal Communication. *3(3-0) . F,S,Sum.* Interpersonal communication competence: self-concept, self-disclosure, active listening, verbal and nonverbal communication, and conflict management.

COM 146 Business and Professional Communication. *3(3-0) . F,S. Communication majors may not count COM 146 in the major.* The nature of communication theory and practice in business and professional settings. Development of individual, dyadic, group and organizational communication proficiencies. Supervisory/subordinate and peer communication, active listening, group communication, and presentational speaking.

COM 201 Introduction to Persuasion Theory. *3(3-0) . F,S,Sum.* Impacts of persuasive communication on attitudes and behavior. Uses humanistic and social scientific theories to explain the persuasive process.

COM 202 Small Group Communication. *3(3-0) . F,S.* Theory and practice of effective communication in small groups, including: stages of group development, role emergence, leadership functions, decision making strategies, conflict management, and the significance of power.

COM 203 Theory and Practice of Acting. *3(3-0) . F,S,Sum.* Basic contemporary theories on acting, with practical application through classroom exercises. Role analysis, adaptation of voice and body to performance demands, and role development through various rehearsal activities.

COM 204 Writing for the Electronic Media. *3(3-0) . F,S,Sum.* Theory and practice of writing for radio, television, and film. Students create scripts, treatments, and storyboards. Areas of study include news, documentary, instructional, corporate, promotional, and dramatic approaches to scriptwriting.

COM 211 Argumentation and Advocacy. *3(3-0) F,S.* Process of influencing opinion through the use of logical arguments. Emphasis on analytical reasoning, evidence, and refutation. In-class argumentation.

COM 212 Interracial Communication. *3(3-0) . F. Preq: Consent of Instructor* Human communication in interracial contexts, with special emphasis on African-American and white American communication. Self awareness and self disclosure of racial attitudes and behaviors. Individual and group exercises and presentations.

COM 213 Oral Interpretation of Literature. *3(3 0) . F.S.* Selection, preparation, and oral performance of literature for specific audiences of adults and children.

COM 214 Introduction to Audio Production. *3(1-4) . F,S,Sum. Preq: COM 204 Preference is given to Communication majors.* Basic principles of audio production, including studio operation, performing, writing, and producing.

COM 215 Introduction to Communication Disorders. *3(3-0) . F,S.* Normal speech/language development including the anatomical and physiological bases for reception and expression of oral language. Developmental and acquired speech/language problems and basic treatment principles applied to communication disorders.

COM 223 Stagecraft. *3(3-0) . F,S.* Fundamentals of scenery design, set construction, and related technical activities. Practical applications with use of design media and shop facilities. Required production participation in University Theater presentations.

COM 224 Introduction to Television Production. *3(1-4) . F,S. Preq: COM 204. Enrollment preference is given to Communication majors.* Basic techniques of television studio production, including producing, writing, and directing.

COM 226 Introduction to Public Relations. *3(3-0) . F,S,Sum.* Public relations as a communication function of organizations. Public relations process, principles, history, and practice. Analysis of environmental, organizational, communication, and audience influences on public relations practice; career opportunities.

COM 230 Introduction to Communication Theory. *3(3-0) . F,S. Admission to Communication Major.* Micro- and macro-analytic theories used in the study of human communication: perspectives and assumptions of major theories; utility and application of major theories; contexts, cultures, and media.

COM 233 Introduction to Stage Lighting. *3(2-2) . F.* Fundamentals and uses of stage lighting equipment and stage lighting design. Practical application of design media and shop facilities. Participation in production activity for University Theater presentations.

COM 234 Analysis of Entertainment Media. *3(3-0) . F.* History and impact of media entertainment programming. Central focus on television but film, radio, print, and computer-based multimedia included. Evolution of contemporary entertainments and skills in criticism and analysis.

COM 240 Communication Inquiry. *3(3-0) . F,S. Preq: COM 230. Admission to Communication Major.* Qualitative and quantitative methods of inquiry in communication: types of questions; strategies for answering questions; nature of evidence; advantages and disadvantages of different methods; reference tolls in the field; and channels of distribution for research-based information.

COM 243 African-American Theater. *3(3 0) . S.* African-American dramaturgy and its impact on the American theater; plays from the nineteenth century to the present.

COM 244 Introduction to Film Production. *3(2-2) . F.* Principles of production and editing techniques for 8mm and 16mm film including film stocks, cinematography, camera and lens operation, editing and splicing, the laboratory, scripting, and the film business. Students will script, shoot, and edit short films.

COM 250 Communication and Technology. *3(3-0) F,S. Preq: COM 240 Admission to Communication Major.* Examination of past and current intersections of technology, culture, and communication. Implications for future intersections. Impact of technology and communication policy. Methods of message evaluation. Exposure to technology applications in the discipline. Basic technology skills for the competent communicator. Practical experience in interactive communication technology.

COM 284 Introduction to Mass Communication. *3(3-0) . F.* Development, structure, and functions of radio, television, film, books, newspapers, magazines and other mass media in the United States. Fundamentals of news, mass entertainment, advertising, public relations and mass communication research.

COM 293 Theater Practicum. *1-6. F,S,Sum* Practical experience in one or more of the various areas of artistic and technical theater through active participation in Thompson Theater's play production program.

COM 298 Special Projects in Communication. *1-3. F,S.* A special projects course to be utilized for guided research or experimental classes at the sophomore level, topic determined by instructor.

COM 301 Presentational Speaking. *3(3-0) . F,S. Preq: COM 110 or COM 146.* Design, organization and delivery of oral presentations for policy determination, policy implementation, and sales.

COM 302 Managing Meetings. *3(3-0) . F.* Rules and customs of meetings in committees, assemblies and organizations; meeting management and group leadership; parliamentary motions and strategies.

COM 303 Stage Directing. *3(3 0) . S.* Basic theory of directing and its application to theatrical production. Play reading, evaluation, casting procedure, staff organization, and rehearsal planning and practices. Laboratory productions of short plays.

COM 312 Patterns of Miscommunication. *3(3 0) . F,S.* Miscommunication patterns originating from fallacious semantic assumptions held by communicators. Suggestions for preventing miscommunication.

COM 314 Advanced Audio Production. *3(1-4) S. Preq: COM 214.* Advanced multichannel techniques for audio production. Studio acoustics, audio signal processing, and advanced microphone techniques, writing, and performing.

COM 315 Phonetics. *3(3 0) . S.* Articulatory and acoustic phonetics; application of the International Phonetic Alphabet with vocal and ear training.

COM 316 Communication Techniques for Public Relations. *3(3-0) . F,S. Preq: COM 226.* Communication processes and procedures of public relations programs. Media techniques, preparation of materials, channels of distribution.

COM (ENG) 321 Survey of Rhetorical Theory. *3(3-0) F. Preq. COM 201 or permission of instructor.* Principles of rhetorical theory from its classical origins through the modern period to the present time. Key concepts and theories that provide a critical understanding of the processes of persuasive symbol use.

COM 322 Nonverbal Communication. *3(3 0) . F,S. Preq: COM 112.* Theory and research in nonverbal communication, including: environment; space; physical appearance, movement; eyes and facial expressions; and vocal cues. Nonverbal communication in personal, workplace and cross-cultural setting.

COM 323 Introduction to Scenic Design. *3(2-2) . S. Alt Yrs Preq COM 103 or 223.* Aesthetics, elements, and principles of scenic design. Theories and applications to the physical stage in relation to the script. Practical applications with the use of design media in University Theater productions.

COM 324 Advanced Television Production. *3(1-4) S. Preq. COM 224.* Television program production utilizing advanced production techniques. Emphasis on refinement of writing, producing, and directing skills through work in TV studio on production of sophisticated program formats.

COM 325 Anatomy and Physiology of Speech. *3(3-0) . F.* Anatomy and physiology of the speech mechanism including the muscular, skeletal, and nervous system structures involved in respiration, phonation, and articulation.

COM 326 Public Relations Applications. *3(3-0) F,S. Preq: COM 226.* Management of the public relations function in organizations and public relations counseling; communication theory and nature of materials emanating from public relations departments and counseling firms, practical analysis and development of public relations publicity and campaigns.

COM 332 Relational Communication. *3(3-0) F,S. Preq. COM 112.* Communication patterns in the development and deterioration of interpersonal relationships. Functional and dysfunctional communication behaviors in family relationships.

COM 333 Advanced Acting. *3(3 0) S. Alt Yrs Preq. COM 203 or demonstrated competence in acting.* Advanced methods in role preparation through exercises in concentration, imagination, sensory and emotional recall, and other Stanislavskian techniques. Analyses and critiques of plays and in-class performances.

COM 334 Analysis of Information Media. *3(3-0) . S. Preq: COM 234 or junior standing.* History and impact of informational and persuasive telemediated messages. Credibility and motivation in local and national news media, persuasion in political campaigns and social movements, art artifice in commercials, the infusion of entertainment elements into informational programs.

COM 335 Language Development. *3(3-0) F, Alt. Yrs.* Syntactic, semantic, morphologic, and pragmatic development from birth through adolescence. The influence of cognitive and social development on language development. First language acquisition versus second language learning.

COM 342 Interviewing. *3(3-0) . F,S Preq: Junior standing.* Theory and practice of effective communication skills applied in various types of professional interviews. In-class interviewing.

COM 345 Child Language Disorders. *3(3-0) . S. Preq: COM 335.* Basic principles, methods and procedures for assessment and intervention of child language disorders. Dialectical differences. Research methodology. Computer applications.

COM 354 Portable Video Production. *3(2-2) . F,S,Sum. Preq: COM 204.* Principles of producing, directing, and editing techniques for video. Students will script, storyboard, shoot and edit short video projects.

COM (WGS) 362 Male/Female Communication. *3(3-0) . F,S. Preq: Junior Standing; COM 112.* Effects of gender on the interpersonal communication process. Explanations of gender differences, communication about women and men via language and via media, and interpersonal communication

COM (ENG) 364 History of Film to 1940. *3(3-0) . F. Preq: Junior standing.* Technological developments and aesthetic movements that shaped cinema production and direction from the beginning of the industry to 1940. Evolution in camera movement, editing, sound storyline, and the documentary. Rise to prominence of the Hollywood studio systems and the contributions of foreign filmmakers.

COM (ENG) 374 History of Film from 1940. *3(3-0) . S. Preq: Junior standing.* Technological developments and aesthetic movements that have shaped cinema production and direction from 1940 to the present. Evolution in camera movement, editing, sound, storyline, and the documentary. Post-war decline and re-emergence of the Hollywood film industry and the contributions of foreign filmmakers.

COM 375 Articulation and Phonological Development and Disorders. *3(3-0) . F Preq: COM 215.* Normal acquisition of articulation and phonology. Basic principles and methods of assessment, diagnosis, and treatment of articulation and phonological disorders. Dialectal differences. Phonological transcription. Computer applications.

COM 385 Speech Science. *3(2-2) . S. Preq: COM 215 and COM 325.* Acoustic properties of speech sounds and the dynamics of speech sound production. Initial experience with basic clinical instrumentation used to measure respiratory, phonatory, and articulatory movements and the acoustic events that result from these movements. Lab assignments using basic instrumentation and computer software are completed outside of class.

COM (ANT, HSS) 392 International and Crosscultural Communication. *3(3-0) . S.* Patterns and problems of verbal and non-verbal forms of crosscultural communication. Avoidance and management of cultural conflict arising from awareness of characteristics and crosscultural communication. Impact on communication of differing cultural perspectives.

COM 403 Touring Theatre. *3(1 4). S. Preq. Audition required.* A touring performance experience consisting of text analysis, characterization, role development, and performance of scripts.

COM (ENG) 411 Rhetorical Criticism. *3(3-0) . S.* Rhetorical analysis of public speeches, social movements, political campaigns, popular music, advertising, and religious communication. Neo-Aristotelian criticism, movement studies, genre criticism, dramatistic analysis, content analysis, fantasy theme analysis.

COM 415 Diagnostic Procedures in Speech Pathology. *3(3-0) . S. Preq: COM 215 plus six (6) additional credits in communication disorders courses.* Principles and practices of assessment. Models and procedures used in diagnosing a wide variety of communication disorders in children and adults. Critical analysis and diagnosis of voice, fluency, hearing, articulation and phonological language, and neuropathic disorders. Diagnostic report writing.

COM 421 Communication Law. *3(3 0) . F. Preq: Junior standing.* Explores the historical, philosophical, and legal foundations of communication rights and responsibilities. Philosophies and regulations affecting sources, messages, channels, receivers, and situations provide the central focus of the course.

COM 431 Communication in Political Campaigns. *3(3-0) . F, Alt. Yrs. Preq: COM 110.* Roles of analysis and criticism of oral communication in political campaigns; analysis of special political communication situations; ghostwriting, news conferences, negative advertising.

COM 441 Ethical Issues in Communication. *3(3-0) . S. Preq: COM 110, 112.* Critical analysis of ethical problems in interpersonal and public communication practices.

COM 444 Television Writing Seminar. *3(3 0) . F. Preq: COM 204.* Development of advanced skills in writing for television in such formats as news, documentary, commercials and public service announcements, drama and non-broadcast video. Discussions with working professionals.

COM 445 Neurolinguistic Development and Disorders. *3(3-0) . F,S. Preq: COM 335.* Neuroanatomy and physiology basic to the diagnosis and treatment of children and adults with neurolinguistic disorders related to traumatic brain injury, aphasia and neurological disease. Survey of etiology and symptomatology. Training in the nature, characteristics, associated problems, and clinical management of patients with brain damage.

COM 446 Problems in Public Relations. *3(3-0) . F,S* This class is a problem solving course where students learn to apply public relations in social science theories to real world public relations challenges. It is designed to link other practical and theoretical course work and to provide a bridge to implementing actual public relations campaigns in COM 326 and in internships. Although the instructor will conduct lectures and exercises on the theoretical course content, the focus of the course is on applying theory to case studies.

COM 454 Portable Video Practicum. *3(0-6) S. Preq: COM 354.* Hands-on experience in small video-systems production. Students produce instructional videotapes. Provides practical experience in all phases of the production process, including pre-production organization, and critical analysis of the final product.

COM 455 Clinical Observation in Speech-Language Pathology. *3(3-0) F,S. Preq: COM 215.* Observation of a variety of therapy techniques and clinical procedures used in the treatment of speech-language-hearing-impaired individuals in the NC State Speech Clinic and other local sites.

COM 456 Organizational Communication. *3(3 0) . F,S,Sum.* Role of human communication in organizations, the assumptions inherent in management philosophies about effective communication, and an investigation of the relationships among communication, job satisfaction, productivity, development, and employee motivation.

COM 462 Cross-Cultural Communication. *3(3-0) . F. Preq: COM 112; 3 additional COM credits.* Communication across cultural boundaries with emphasis on comparative analysis of communication strategies and tactics as well as overall communication systems of various cultures: problems, barriers, patterns of communication.

COM 465 Advanced Clinical Practicum in Speech-Language Pathology. *3(3-0) . F,S. Preq: COM 455.* Initial experience for students to assess and treat individuals with speech, language, and hearing problems and to write clinical reports.

COM 474 Video in Business and Industry. *3(3-0) . S. Preq: COM 224 or COM 354.* Planning and controlling the use of video for training, employee communication, public relations, and other purposes in organizations. Applications, organizational variables, and technologies.

COM 486 Communication Research Methods. *3(3-0) F,S. Preq: 12 credit hours of COM courses.* Design and implementation of communication research methods, including experimental and survey research procedures. Use of computer software for statistical analysis.

COM 496 Communication Internship. *3(3-0) . F,S. Preq: Jr. standing in Communication; permission of Department Communication majors only.* Directed work experience for Communication majors with supervision from the work site and the University.

COM 498 Advanced Topic in Communication. *1-3. F,S. Preq: Nine hours of communication courses; Junior Standing* Advanced study of contemporary theories, methods, practices, processes, or issues related to the field of communication. Topic varies.

COM 499 Advanced Independent Study in Communication. *1 3. F,S. Preq Nine credits in Communication courses. Must be Junior or Senior majoring in Communication. Must have permission of department to enroll May enroll only twice* Special projects in communication developed under the direction of a faculty member on a tutorial basis.

COM 514 History of Rhetoric. *3(3 0) . S* Contemporary rhetorical theory and its development from classical rhetoric; emphasis on differences between oral and written communication and the relevance of traditional theory to purposes and constraints of writing. Special attention to current issues: revival of invention, argumentation and truth, contributions of research in composition.

COM (ENG) 516 Rhetorical Criticism: Theory and Practice. *3(3-0) . F Preq: COM 321 or 411 or ENG 514 or 518.* Development, achievements, limitation of major critical methods in the 20th century, including neo-Aristotelian, generic, metaphoric, dramatistic, feminist, social-movement, fantasy-theme and postmodern approaches. Criticism of political discourse, institutional discourse, discourses of law, medicine, religion, education, science, the media. Relations between rhetorical and literary criticism and other forms of cultural analysis.

COM 556 Seminar In Organizational Communication. *3(3-0) . S. Preq: Advanced undergrad. or grad. standing.* Theoretic and applied approaches for studying communication perspectives of organizational behavior. Topics relate communication with organizational theories, research methods, leadership, power, attraction, conflict and theory development.

COM 561 Human Communication Theory. *3(3-0) . F,S. Preq: PBS or graduate standing.* The role of theory in study of human communication. General social scientific theories as well as context-based theories including interpersonal, public, group, organizational and mass communication contexts.

COM 566 Seminar in Crisis Communication. *3(3-0) . S, Alt. Yrs.* Working within theoretical perspectives of communication, conflict management and organizational designs, a theoretical understanding for crisis communication, including thorough guidelines for strategic communication planning for, managing and evaluating crises.

COM 598 Special Topics in Communication. *1-3. F,S,Sum.* Detailed investigation of a special topic in communication. No more than 6 hrs. may be used as credit toward graduation with master's degree.

COM 630 Independent Study in Communication. *1-3. F,S. Preq: Grad. standing.* Special projects course to be utilized for guided research at graduate level. Topic determined by instructor. No more than 6 hrs. may be used as credit toward graduation with master's degree.

COM 685 Master's Supervised Teaching. *1-3 F,S,Sum. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

CROP SCIENCE

CS 200 Introduction to Turfgrass Management. *4(3-2) F. Preq: BIO 125, BO 200, or CS 213.* Turfgrass selection, establishment, maintenance, and pest management in lawns, golf courses, athletic fields, and roadside care; Emphasis on understanding the impact of the environment on management practices and turfgrass performance. Field trips in laboratory.

CS 213 Crops: Adaptation & Production. *4(3-2) . F,S. Preq: BIO 125 or BO 200.* Fundamental structure and reproductive features of crops. Their adaptation and importance in global agriculture. Practices and inputs needed for economic production of a quality product and interaction of these factors within the constraints of climate, soils, and topography in maintaining a quality environment.

CS 312 Grassland Management for Natural Resources Conservation. *3(2-2) . F. Preq: BIO 125, CS 213, SSC 200.* Basic principles and practices of production and utilization of pasture and forage crops; impact on developing sustainable systems for livestock feed, soil and water conservation; use of computers to assist in whole farm planning and information retrieval.

CS 400 Turf Cultural Systems. *3(3-0) . F Preq: CS 200, BO 200 SSC 200.* Topics include: golf course design considerations, fertilizer characteristics and application techniques, irrigation programming, construction of high use turfgrass areas, calibration of spreaders and sprayers, aerification, pesticide fate and development of effective management systems.

CS 411 Crop Ecology. *3(3-0) . F. Preq: BO 421.* Ecology and production of major agronomic crops of economic importance. Impact of key environmental stress factors on production processes and management strategies. Environmental issues pertaining to sustainable cropping systems. Manipulation of canopy climate and rooting environment for enhanced crop performance in the context of global climate change. Ecological analysis of abiotic - and biotic-derived crop disorders.

CS 413 Plant Breeding. *2(2-0) . S. Preq: GN 411 or ANS 215.* Discussion of reproductive systems of higher plants; the genetic basis for plant improvement and the selection, evaluation, and utilization of crop varieties.

CS 414 Weed Science. *4(3-2) . F. Preq: CH 220.* History, current status and fundamentals of weed biology and cultural, biological, and chemical weed control; properties and uses of herbicides; weed identification; proper use of herbicide application equipment; current weed management practices incrops and non-cropland situations.

CS 415 Agronomic Pest Management Systems. *3(3-0) . S. Preq: CS 213, CS 200, CS 414.* History, principles, and application of techniques for managing agricultural pests. Theory and practice of integrating pest control tactics to manage pests and minimize environmental impacts. Topics include pest sampling techniques, economic thresholds, biological control, efficient pesticide use, crop/pest modeling, animal pest management and IPM economics.

CS (SSC) 462 Soil-Crop Management Systems. *3(2-3) . S. Preq: CS 213, CS 414, SSC 342, SSC 452, senior standing.* Unites principles of soil science and crop science with those of allied areas into realistic agronomic applications; practical studies in planning and evaluation of soil and crop management systems.

CS (SSC) 490 Senior Seminar in Crop Science and Soil Science. *1(1-0) . S. Preq: Senior in Agronomy.* Review and discussion of current topics in crop science, soil science, agronomy and natural resource management. Preparation and presentation of scientific information in written and oral format.

CS 492 External Learning Experience. *1-6. F,S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

CS 493 Special Problems in Crop Science. *1-6. F,S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes campus facilities and resources. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer the departmental teaching coordinator and the academic dean prior to the experience.

CS 495 Special Topics in Crop Science. *1-3. F,S,Sum.* Offered as needed to present materials not normally available in regular course offerings or for offering of new courses on a trial basis.

CS (HS, PP) 502 Plant Disease: Methods and Diagnosis. *2(0-6) . F. Preq: PP 315.* Introduction to the basic principles of disease causality in plants and the methodology for the study and diagnosis of plant diseases caused by fungi. Identification of plant-pathogenic fungi. Research project, disease profiles and field trips are required.

CS (FOR, SSC) 577 Conservation and Sustainable Development I. *3(3-0) . F.* Agronomic, ecological and economic concepts of sustainability, with emphasis on application in developing countries; forest, soil and wildlife resources; models in conservation biology; historical, cultural and sociological perspectives; policy analysis. Offered as part of the program of Center for World Environment and Sustainable Development.

CS 601 Seminar. *1(1-0) . F,S Preq: Grad. standing. Maximum of two credits allowed toward master's degree; however, additional credits toward doctorate allowed.* Review and discussion of scientific articles, progress reports in research and special problems of interest to agronomists.

CS 620 Special Problems. *F,S,Sum. Credits Arranged* Special problems in various phases of crop science. Problems may be selected or will be assigned. Emphasis on review of recent and current research.

CS 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

CS 690 Master's Examination. *1-6. F,S. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

CS 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

CS 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research.

CS 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

CS 711 Tobacco Technology. *3(3-0) . S, Alt. Yrs. Preq: BO 421 or equivalent.* Special problems concerned with the tobacco crop. Latest research problems and findings dealing with this important cash crop.

CS 713 Physiological Aspects of Crop Production. *3(3-0) . S, Alt. Yrs. Preq: BO 421.* Emphasis upon pertinent physiological processes associated with crops and crop management such as plant growth, maturation, respiration and photoperiodism. Relationship of environment to maximum crop yields.

CS (HS) 715 Weed Science Research Techniques. *1(0-2) F Preq: CS 414 or equivalent* Bioassay techniques for detection of herbicide residues in soils, chemical analytical (GLC, HPLC) techniques for identifying herbicide residues in soils and plants, procedures for studying adsorption and leaching in soils, procedures for measuring herbicide interference of photosynthesis and use of 14C-labeled herbicides for following uptake, transport and metabolism of herbicides in plants.

CS (HS) 716 Weed Biology. *1(0-1) . F. Preq: CS 414.* Weed seed development and dispersal, seed dormancy, oil seed bank, seedling development, growth analysis, reproduction, community structure, population dynamics, species interactions, environmental effects on interactions and influence of man. Taught first 5 weeks of semester.

CS (HS) 717 Weed Management Systems. *1(0-1) F Preq: CS 414 or equivalent.* Weed management systems including integration of cultural, biological, mechanical and chemical methods for vegetables, fruits, ornamentals, turf, small grains, corn, tobacco, cotton, peanuts, aquatic and non-cropland settings. Taught second 5 weeks of semester.

CS (BO, HS) 718 Biological Control of Weeds. *1(1-0) . F. Preq: CS 414 or equivalent* Concepts and methods in use of biological agents for control of weeds. Primary emphasis on weed biocontrol with insects and plant pathogens. Taught third 5 weeks of semester.

CS (GN) 719 Origin and Evolution of Cultivated Plants. *1(0-1) F, Even Yrs. Preq: CS(GN,HS)741.* Review of concepts of speciation and classification; origin and variation in plants; theories related to agricultural origins: variation patterns of cultivated species; evolution under domestication; utilization of wild and unadapted germplasm in plant breeding.

CS (GN, HS) 720 Molecular Biology in Plant Breeding. *3(3-0) S, Alt. Even Yrs. Preq: CS(GN,HS) 741, GN 701, GN 702, GN 703.* Theory and principles of molecular biology applied to plant breeding. Experimental approaches to induce genetic change, cytoplasmic recombination, haploid utilization and potentials of molecular techniques for solving breeding problems.

CS (HS, SSC, TOX) 725 Pesticide Chemistry. *1(1-0) . S. Preq: CH 201 and 221.* Chemical properties of pesticides including hydration and solvation, ionization, volatilization, lipophilicity, molecular structure and size, and reactivity and classification according to chemical description, mode of action or ionizability. Taughtduring the first 5 weeks of semester. Drop date is last day of 3rd week of the minicourse.

CS (HS, SSC, TOX) 727 Pesticide Behavior and Fate in the Environment. *2(2-0) S. Preq: CS(HS,SSC,TOX) 725,SSC 200.* Sorption/desorption, soil reactivity, movement, volatilization, bioavailability, degradation and stability of pesticides in the environment. Taught during the last 10 weeks of semester. Drop date is last day of 3rd week of the minicourse.

CS (HS) 729 Herbicide Behavior in Plants. *2(2-0) . S. Preq: BO 751 and BO 752 and CS(HS,SSC) 725.* Chemical, physiological and biochemical actions of herbicides in plants including uptake, translocation, metabolism and mechanism of action.

CS (GN, HS) 741 Plant Breeding Methods. *3(3-0) . F. Preq: ST 711.* Advanced study of methods of plant breeding as related to principles and concepts of inheritance.

CS (GN, HS) 745 Quantitative Genetics in Plant Breeding. *1(1-0) . S. Alt. Yrs. Preq: CS(GN, HS) 741, ST 712, course in quantitative genetics recommended.* Theory and principles of plant quantitative genetics. Experimental approaches of relationships between type and source of genetic variability, concepts of inbreeding, estimations of genetic variance and selection theory.

CS (GN, HS) 746 Breeding Methods. *2(2-0) . S, Alt. Yrs. Preq: CS (GN, HS) 741, ST 535.* Theory and principles of plant breeding methodology including population improvement, selection procedures, genotypic evaluation, cultivar development and breeding strategies.

CS (GN, HS, PP) 748 Breeding for Pest Resistance. *2(2-0) . F, Alt. Yrs. Preq: CS(GN, HS) 741, PP 315, ST 512.* Theory and principles of breeding for pest resistance. Experimental approaches for examining genetics of host-parasite interactions, expression and stability of pest resistance and breeding strategies for developing pest-resistant cultivars.

CS 801 Seminar. *1(1-0) . F.S. Preq: Grad. standing. Maximum of two credits allowed toward master's degree; however, additional credits toward doctorate allowed.* Review and discussion of scientific articles, progress reports in research and special problems of interest to agronomists.

CS 820 Special Problems. *F,S,Sum. Credits Arranged.* Special problems in various phases of crop science. Problems may be selected or will be assigned. Emphasis on review of recent and current research.

CS (GN, HS) 860 Plant Breeding Laboratory. *1(1-0) . S, Alt. Odd Yrs. Preq: CS(GN,HS)741.* Visitation of plant breeding projects in the Depts. of CS and HS at NC State, along with commercial seed companies. Discussion and viewing of breeding objectives, methods and equipment and teaching and practice of hybridization methods.

CS (GN, HS) 861 Plant Breeding Laboratory. *1(1-0) . F, Alt. Odd Yrs. Preq: CS(GN,HS)741.* Visitation of plant breeding projects in the Depts. of CS and HS at NC State, along with commercial seed companies. Discussion and viewing of breeding objectives, methods and equipment and teaching and practice of hybridization methods.

CS 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

CS 890 Doctoral Preliminary Examination. *1-9. F,S,Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/oral preliminary exams.

CS 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

CS 895 Doctoral Dissertation Research. *1-9. F,S,Sum. Preq: Doctoral student.* Dissertation research.

CS 899 Doctoral Dissertation Preparation. *1-3. F,S,Sum. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

COMPUTER SCIENCE

CSC 100 Computer Literacy. *2(2-0) . Credit for CSC 100 is not allowed if student has prior credit in another computer science course or computer related course. Offered only through Independent study by Extension.* Survey of computer hardware and software systems, how programs are created, how computers are used in organizations, and the effects of the computer society. Four written assignments and a final exam..

CSC 112 Introduction to Computing-FORTRAN. *3(2-3) . F,S. Preq: E 115, MA 141.* Problem solving through writing FORTRAN programs. Particular elements include: careful development of FORTRAN programs from specifications; documentation and style; appropriate use of control structures, data types and subprograms; abstractions and verification; engineering applications.

CSC 114 Introduction to Computing-C++. *3(2-3) F,S,Sum. Preq: E 115 or PMS 100. Coreq: MA 121 or 131 or 141* An introductory course in computing in C++. Emphasis on algorithm development and problem solving. Particular elements include: careful and methodical development of C++ programs from specifications; documentation and style; appropriate use of control structures, data types and subprograms; data abstraction and verification; numeric and nonnumeric applications; introduction to object-oriented programming and design.

CSC 116 Introduction to Computing - Java. *3(2-3) . F,S. Preq: E 115 Coreq: MA 121 or 131 or 141.* An introductory course in computing in Java. Emphasis on algorithm development and problem solving. Careful and methodical development of Java applications and applets from specifications; documentation and style; appropriate use of control structures; classes and methods; data types and data abstraction; object-oriented programming and design; graphical user interface design.

CSC 200 Introduction to Computers and their Uses. *3(2-2) . F,S,Sum. May not be used by CSC major as a restricted elective.* Survey of basic principles of computer hardware, communications, operating systems, micro-computer issues, security, impact on society, system development, and use in organizations. Hands-on use of software, including operating system commands, word processing, spreadsheets, and database managers. Demonstration and application of current end-user applications.

CSC 214 Programming Concepts. *3(3-0) . F,S,Sum. Preq: CSC 114 with a grade of C- or better.* Software design in a high-level language: abstract data types, modular programming, management of large programs. Dynamic memory management: linked lists, pointers, allocation and deallocation. Alternate programming paradigms: recursive list processing, object-oriented programming.

CSC 216 Programming Concepts - Java. *3(3 0) . F,S. Preq: C or better in CSC 112, 114 or 116. Coreq: CSC 222.* The second course in computing, intended for majors. Emphasis is placed on interpretation of inductive definitions (functions and data types); testing strategies; specification and implementation of finite-state machine; encapsulation; polymorphism; inheritance; class invariants; and resource management

CSC 224 Applied Discrete Mathematics. *3(3-0) . F,S. Preq: CSC 114 and MA (121 or 131 or 141).* Formal logic. Methods of proof including induction. Introduction to grammars and finite state machines. Recurrence relations and asymptotic behavior of functions. Sets and counting. Boolean expressions and logic networks. Graphs and relations.

CSC 226 Discrete Mathematics for Computer Scientists. *3(3 0) . F,S. Preq: CSC 116 and MA 141. CSC,CSU,CPE,CPU majors only.* Propositional logic and the predicate calculus. Logic gates and circuits. Methods of proof. Elementary set theory. Mathematical induction. Recursive definitions and algorithms. Solving recurrences. The analysis of algorithms and asymptotic growth of functions. Elementary combinatorics. Introduction to graph theory. Ordered sets, including posets and equivalence relations. Introdcution to formal languages and automata.

CSC 234 Computer Organization and Assembly Language. *3(3 0) . F,S,Sum. Preq: CSC 214 with a grade of C- or better.* Number systems, von Neuman machines, instruction sets and machine code, data representation, assemblers and assembly language programming, compilers, external and internal processor organization, memory, I O organization and devices. Detailed study of a contemporary processor architecture.

CSC 236 Computer Organization and Assembly Language for Computer Scientists. *3(3 0) . F,S. Preq: CSC 216 with grade of C- or better CSC majors only.* Computer architecture topics required by professional software developers, including binary and hexadecimal numbers, hardware component organization, machine instruction sets, assembler language programming, linking assembler language with high-level languages, program testing, computer hardware design issues, computer software design issues, and trends in current computer design.

CSC 244 Concepts and Facilities of Operating Systems. *3(3-0) . F,S. Preq: CSC 234.* The history and evolution of operating systems, concepts of process management, memory addressing and allocation, files and protection, deadlocks and distributed systems.

CSC 246 Concepts and Facilities of Operating Systems for Computer Scientists. *3(3-0) . F,S. Preq: CSC 236. CSC,CPE majors only.* Fundamental concepts of computer operating systems for computer scientists, including memory management, file systems, process management, distributed systems, deadlocks, and basic security and system accounting.

CSC 251 Web Page Development. *1(1-0) . S. Preq: E 115 or equivalent knowledge of EOS/Unity system.* Syntax and semantics of HTML (HyperText Markup Language). Students will learn necessary skills to develop web pages on their EOS/Unity account. In addition to mechanics, design aspects and bandwidth conservancy are covered. Several pages will be created including a final project.

CSC 254 Visual C ++. *1(1-0) . F. Preq: CSC 214.* Programming in Windows 95/NT using the Visual C++ compiler and tools. The focus is on using the Microsoft Foundation Classes (MFC), understanding the Win32 API, and modern operating systems concepts.

CSC 255 String Processing Languages. *1(1-0) . Preq: CSC 112 or CSC 114 or CSC 200.* Syntax and semantics of a string manipulation language, currently SNOBOL 4. Application of the language to programming problems in non-numeric areas. Discussion of other string processing languages such as PERL.

CSC 256 Assembly Language Programming. *2(2-0) . F,S. Preq: CSC 112 or 114.* IBM s/370 Assembly Language. Basic concepts: base register usage, looping, address modification, input/output using system macros, subroutines, interrupt handling, use-defined macros, and system control functions.

CSC 257 Introduction to Java. *1(1-0) . F. Preq: CSC 214.* Introduction to the Java programming language. Object-oriented techniques and language syntax. Java class libraries including strings, graphical interfaces, events, exceptions, arguments, threads, file i/o, and networking.

CSC 258 Programming Language-C. *2(2-0) . Preq: CSC 244.* Systems implementation language C. History and current applications; syntax and semantics of C; paradigms of C that set it apart from other high-level languages; C programming environment.

CSC 295 Special Topics in Computer Science. *1-3.* Special topics in CSC at the early undergraduate level.

CSC 302 Introduction to Numerical Methods. *3(3-0) . F,S. Preq: CSC 110 or CSC 112 or CSC 114 and MA 305. CSC major or 2.7 GPA.* Numerical computations with digital computers; floating point arithmetic and implications of round-off error. Algorithms and computer techniques for the numerical solution of problems in: function evaluation; zeros of functions; interpolation; numerical differentiation and integration; linear systems of equations; curve fitting; solutions of non-linear equations; numerical solutions of ordinary differential equations.

CSC 312 Computer Organization and Logic. *4(3-3) . F,S. Preq: CSC 234, CSC 224.* Combinational logic circuits and their relation to Boolean algebra. Functional properties of combinational and sequential components and their realizations in integrated circuit forms. Organization of digital computer components; processors, controlunits, memories, switches, and peripherals. Architecture of computer systems. Computer arithmetic. Microprogrammed control. Interrupt mechanisms. Laboratory exercises involve logical, functional, and electrical properties of components from gates tomicroprocessors.

CSC 314 Data Structures. *3(3-0) . F,S,Sum. Preq: CSC 214 and CSC 224 with a grade of C or better.* A survey of fundamental abstract data types along with efficient implementations for each. Emphasizes asymptotic running time as a measure of program performance. Lists, stacks, queues, sparse arrays, binary trees, heaps, balanced search trees, and hash tables. Illustrative applications such as graph, text-processing, or geometric algorithms.

CSC 316 Data Structures for Computer Scientists. *3(3-0) . F,S. Preq: CSC 216 and CSC 226 with a grade of C- or better. CSC,CPE majors only.* Abstract data types; abstract and implementation-level views of data types. Linear and branching data structures, including stacks, queues, trees, heaps, hash tables, graphs, and others at discretion of instructor. Best, worst, and average case asymptotic time and space complexity as a means of formal analysis of iterative and recursive algorithms.

CSC 326 Software Engineering. *3(3-0) . F,S. Preq: CSC 314 or 316.* Application of product engineering methods to software: quality assurance, project management, requirements analysis, specifications, design, development, testing, production and maintenance.

CSC 333 Automata, Grammars, and Computability. *3(3-0) . F,S. Preq: CSC 224. CSC major or 2.7 GPA.* Study of three classical formal models of computation--finite state machines, context-free grammars, and Turing machines--and the corresponding families of formal languages. Power and limitations of each model. Parsing. Non-determinism. The Halting Problem and undecidability. The classes P and NP, and NP-completeness.

CSC (BUS) 340 Information System Management. *3(3-0) . F,S. Preq: M 200 or equivalent.* Fundamentals of information systems development and use in organizational setting. Information systems (IS), concepts, hardware, software, telecommunications, database management. IS development, applications and management in telecommunications,database management, various business processes, global issues, security and ethical challenges.

CSC 379 Ethics in Computing. *1(1-0) S .Preq: Junior standing . CSC major or 2.7 minimum GPA .* Discussion of the concern for the way in which computers pose new ethical questions or pose new versions of standard moral problems and dilemmas. Study of ethical concepts to guide the computer professional. Computer professional codes of ethics. Use of case studies to relate to ethical theory. Ethical and legal use of software. Conflicts of interest.

CSC 401 Data and Computer Communications Networks. *3(3-0) . F. Preq: MA 314 or ST 371, CSC 244. Credits are not allowed for both CSC 401 and ECE 460.* Basic concepts of data communication networking and computer communications architectures, including packet switching, local area networks, OSI (Open System Interconnection Architectures), TCP IP, X.25 X.75, and SNA (System Network Architecture).

CSC 402 Network Projects. *3(3-0) . Preq: CSC 401, CSC 312. No auditing.* Under the supervision of faculty members, students engage in projects that may include communication architecture implementation, networking technology assessment, network performance evaluation, and network administration. Comprehensive written and oral project report required.

CSC 411 Introduction to Artificial Intelligence. *3(3-0) . S. Preq: CSC 224 or LOG 201.* Overview and definitions of Artificial Intelligence (AI). Search, including depth-first and breadth-first techniques with backtracking. Knowledge representation with emphasis on logical methods, Horn databases, resolution, quantification, unification, skolemization and control issues; non-monotonic reasoning; frames; semantic nets. AI systems, including planning, learning, natural language and expert systems. An AI programming language may be taught at the instructor's discretion.

CSC (MA) 416 Introduction to Combinatorics. *3(3-0) . S. Alt. Yrs. Preq: MA 242 or CSC (MA) 224, and proficiency in a programming language.* Basic principles of counting: addition and multiplication principles, generating functions, recursive methods, inclusion-exclusion, pigeonhole principle; basic concepts of graph theory: graphs, digraphs, connectedness, trees; additional topics from: Polya theory of counting, Ramsey theory; combinatorial optimization - matching and covering, minimum spanning trees, minimum distance, maximum flow; sieves; mobius inversion; partitions; Gaussian numbers and q-analogues; bijections and involutions; partially ordered sets.

CSC 417 Theory of Programming Languages. *3(3-0) . F,S. Preq: CSC 314.* Theory of programming languages with emphasis on programming language semantics and implementation issues. Formal models of syntax and semantics. Static versus dynamic scoping. Parameter passing mechanisms. Garbage collection. Programming in alternate paradigms such as applicative, functional, logic, and object-oriented programming languages.

CSC 423 Information Resources Management. *3(3-0) . Preq: CSC/BUS 340. May not be used as a CSC restricted elective.* Information Resources Management as a process that encompasses strategic planning, the implementation of new technology, dramatic changes to both the corporate Management Information Services and traditional information systems architecture, and the emerging role of end user computing to enable a business enterprise to operate effectively.

CSC (MA) 427 Introduction to Numerical Analysis I. *3(3-0) . Preq: MA 301 and programming language proficiency. May not be used as a CSC restricted elective.* Theory and practice of computational procedures including approximation of functions by interpolating polynomials, numerical differentiation and integration, and solution of ordinary differential equations including both initial value and boundary value problems. Computer applications and techniques.

CSC (MA) 428 Introduction to Numerical Analysis II. *3(3-0) . F,S. Preq: MA 405 and programming language proficiency; MA (CSC) 427 is not a prerequisite. May not be used as a CSC restricted elective.* Computational procedures including direct and iterative solution of linear and nonlinear equations, matrices and eigenvalue calculations, function approximation by least squares, smoothing functions, and minimax approximations.

CSC 431 File Organization and Processing. *3(3-0) . F,S. Preq: CSC 314.* Hardware characteristics of storage devices. Basic file organizations including sequential, direct, and indexed sequential; hashing and collision resolution; perfect hashing; signatures; bloom filters; sorting and other bit level structures. Tree structures including binary search trees, B-trees, and tries. Dynamic hashing techniques. Structures including grid files. Applying file structures to practical problems.

CSC 432 Database Management System Projects. *3(3-0) . F. Preq: CSC 431.* Introduction to database concepts. Database design. Data models: entity-relationship and relational. Data manipulation languages including SQL. Data dictionaries. Query processing. Concurrency. Software development environments using a database system. Expert, object-oriented, multi-media, and distributed database systems. Database system architecture. Project assigned to develop prototype application using a commercial database.

CSC 440 Database Management Systems. *3(3 0) . F. Preq: CSC 316. CSC Majors only.* Introduction to database concepts. This course examines the logical organization of databases: the entity-relationship model; the relational data model and its languages. Functional dependencies and normal forms. Design, implementation, and optimization of query languages; security and integrity, concurrency control, transaction processing, and distributed database systems.

CSC (IE) 441 Introduction to Simulation. *3(3-0) . F,S. Preq: MA 242, ST 372, programming proficiency.* Discrete-event stochastic simulation for the modeling and analysis of systems. Programming of simulation models in a simulation language. Input data analysis, variance reduction techniques, validation and verification, and analysis of simulation output. Random number generators and random variate generation.

CSC 451 Operating Systems. *3(3-0) . F,S. Preq: CSC 244, CSC 314* Design and implementation of operating system internals. Structure of an operating system kernel, process synchronization primitives, interrupt handlers, and device drivers. Details of the run-time environment supporting high level languages for concurrent programming. Programming required.

CSC 452 Operating Systems Projects. *3(1-4) . F,S. Preq: CSC 451. Coreq: ENG 331. This course qualifies as project course required of CSC majors.* Definition, design, and implementation of a significant operating system project from such areas as single or multi-user file systems, process management, virtual memory, time-sharing, distributed systems. Substantial programming, written and oral reports required.

CSC 454 Human-Computer Interaction. *3(3-0) . S. Preq: CSC 314* A survey of concepts and techniques for user interface design and human computer interaction. Emphasizes user-centered design, interface development techniques, and usability evaluation.

CSC 456 Computer Architecture and Multiprocessors. *3(3-0) . S. Preq: CSC 234 and CSC 314.* Major components of digital computers and the organization of these components into systems. Begins with single processor systems and extends to parallel systems for multiprocessing. Topics include computer organization, instruction set design, cache memory, pipelined processors, and multiprocessors. Recent developments in PC and desktop architectures are also studied.

CSC (ECE) 460 Digital Systems Interfacing. *3(3-0) . F,S. Preq: A grade of C or better in either ECE 206 or CSC 312.* Concepts of microcomputer system architecture and applications to fundamental computer hardware. Theoretical and practical aspects of interfacing and a variety of microprocessor peripheral chips with specific microprocessor/microcomputer systems from both hardware and software points of view.

CSC 461 Computer Graphics. *3(3-0) . F. Preq: MA 305 and CSC 314 and knowledge of C or C++.* Principles of computer graphics with emphasis on two-dimensional and aspects of three-dimensional raster graphics. Topics include: graphics hardware devices, lines and polygons, clipping lines and polygons to windows, graphical user interface, vectors, projections, transformations, polygon fill. Programming projects in C or C++.

CSC 462 Computer Graphics Projects. *3(3 0) . S. Preq: CSC 461 Coreq MA 305. This course qualifies as project course required of CSC majors* Principles of computer graphics with emphasis on three-dimensional graphics. Topics include: free-form curves and surfaces, hidden lines and surfaces, local and global illumination models, chromatic and achromatic light, aliasing and antialiasing, animation, image manipulation, and solid modeling. Programming project required. Major written and oral technical reports required.

CSC 467 Multimedia Technology. *3(3-0) . S. Preq: CSC 244 Coreq: CSC 312.* Methods of creating, recording, compressing, parsing, editing and playing back on a computer the following media: sound, music, voice, graphics, images, video, and motion. Introduction to basic principles: signal processing, information theory, real-time scheduling. Also includes discussion of standards, programming tools and languages, storage and I/O devices, networking support, legal issues, user interfaces, and applications. Includes significant hands-on experience.

CSC 471 Software Process and Development Tools. *3(3-0) . F Preq: CSC 244 CSC 314.* A study of project software management, development and computer-based software engineering tools. Topics include: team-work, software standards and processes, personal software process, computer-based software engineering (CASE) tools (e.g., CASEtools for classical and object-oriented software specification, analysis, design, verification, validation, testing, and maintenance.)

CSC 472 Software Engineering Project. *3(3-0) . S. Preq: CSC 471. Coreq: ENG 321. Audits not allowed.* Development of software system following software engineering practices: requirement analysis, design, inspection, testing, documentation, configuration control, work and time management. Students are divided into teams to develop a single class project together and get experience in real-world software development.

CSC 489 Fundamentals of Computer Science. *3(3-0) . F. Preq: Higher level computer language. Not available to majors in Computer Science.* Provides the background for graduate students who do not have an undergraduate degree in computer science to take selective, graduate-level computer science courses. Computer organization from both hardware and software viewpoints is discussed. Includes computer system organization, digital logic, microprogramming, conventional machine language, operating systems, assembly language, advanced computer architectures, and data structures.

CSC 492 Senior Design Project. *3(3-0) . F,S. Preq: CSC 310. CSC majors only.* Application of software engineering principles and basic science to the total development of a software system. Consideration of the software system design process, including feasibility study, preliminary design detail, and cost effectiveness. Development and evaluation of a prototype accomplished through design team activity. Comprehensive written and oral project report is required.

CSC 495 Special Topics in Computer Science. *1-6 F,S,Sum. Preq: Consent of Instructor* Used for the following types of study: readings in the literature of computer science, introductory research projects, major computer programming projects, seminars, or new course development. Work may be done in any CSC area such as software, hardware utilization, programming languages, numerical methods or telecommunications.

CSC 499 Independent Research in Computer Science. *1-6. F,S,Sum. Preq: Consent of Department.* Independent investigation of a research problem under faculty supervision.

CSC 501 Operating Systems Principles. *3(3-0) F S Preq: CSC 244, CSC 314 and MA 421.* Fundamental issues related to the design of operating systems. Process scheduling and coordination, deadlock, memory management and elements of distributed systems.

CSC 505 Design and Analysis of Algorithms. *3(3-0) . F,S. Preq: CSC 314 and CSC 224.* Algorithm design techniques: use of data structures, divide and conquer, dynamic programming, greedy techniques, local and global search. Complexity and analysis of algorithms: asymptotic analysis, worst case and average case, recurrences, lower bounds, NP-completeness. Algorithms for classical problems including sorting, searching and graph problems (connectivity, shortest paths, minimum spanning trees).

CSC (ECE) 506 Architecture of Parallel Computers. *3(3 0) . F. Preq: CSC 312 or CSC 456 or ECE 206.* Need for parallel computers and their potential performance. Taxonomy of parallel computer architecture. Arithmetic pipeline design and vector processes. Single and multi-stage interconnection networks, massively parallel computing with array machines shared memory and distributed memory multi-processor computers. Memory system, design issues, applications/ algorithms for parallel computers.

CSC (ECE) 510 Software Engineering. *3(3-0) . F. Preq: CSC 314 and CSC 224.* An introduction to software life cycle models; size estimation; cost and schedule estimation; project management; risk management; formal technical reviews; analysis, design, coding and testing methods; configuration management and change control; and software reliability estimation. Emphasis on large development projects. An individual project required following good software engineering practices throughout the semester.

CSC 512 Compiler Construction. *3(3-0) . S. Preq: CSC 314 and 333.* Theory and practice of compiler writing. Lexical analysis, table driven LL(1), LR(1) and LALR(1) parsers, code generation, flow analysis, run-time storage organization and optimization. Writing a compiler using software tools a significant part of course.

CSC 513 Electronic Commerce Technology. *3(3-0) . F. Preq: CSC 501. No Audits.* Exploration of technological issues and challenges underlying electronic commerce. Distributed systems; network infrastructures; security, trust, and payment solutions; transaction and database systems; and presentation issues. Project required.

CSC (ECE) 517 Object-Oriented Languages and Systems. *3(3-0) . F. Preq. CSC 417* Object-oriented languages and systems built with object-oriented software components. Systems concepts, including inheritance, dynamic binding, type systems and genericity; implementation in specific languages, e.g., Smalltalk, C++ and Eiffel. Object-oriented programming environments and object-oriented databases. Project required.

CSC 520 Artificial Intelligence I. *3(3-0) F,S. Preq: CSC 316 and either CSC 224 or LOG 201 or LOG 335 or background in symbolic logic.* Introduction to and overview of artificial intelligence. Study of AI programming language such as LISP or PROLOG. Elements of AI problem-solving technique. State spaces and search techniques. Logic, theorem proving and associative databases. Introduction to knowledge representation, expert systems and selected topics including natural language processing, vision and robotics.

CSC 523 Computational Linguistics. *3(3-0) . F. Preq: Consent of Instructor.* Overview of natural language processing including applications in textural analysis and machine translation. Overview of current theories of language with emphasis on syntax. Lexical and syntactic processing including parsing with context-free grammars, top-down and bottom-up parsing, deterministic and non- deterministic parsing. Chart parsers, Recursive Transition Networks and Augmented Transition Networks.

CSC (MA) 530 Computational Methods for Molecular Biology. *3(3-0) . F.Alt yr(odd). Preq: CSC 314. Coreq: CSC 505.* Computer algorithms supporting genomic research: DNA sequence comparison and assembly, hybridization mapping, phylogenetic reconstruction, genome rearrangement, protein folding and threading.

CSC 541 Advanced Data Structures. *3(3-0) . F. Preq: CSC 314.* Complex and specialized data structures relevant to design and development of effective and efficient software. Hardware characteristics of storage media. Primary file organizations. Hashing functions and collision resolution techniques. Low level and bit level structures including signatures, superimposed coding, disjoint coding and Bloom filters. Tree and related structures including AVL trees, B*trees, tries and dynamic hashing techniques.

CSC (IE) 546 Management Decision and Control Systems. *3(2 2) F. Preq. CSC 423 or BUS 541 or equivalent.* Planning, design, and development and implementation of comprehensive computer-based information systems to support management decisions. Formal information systems principles; information requirements analysis; knowledge acquisition techniques; information modeling. Information resource management for quality operational control and decision support; system evaluation, process improvement and cost effectiveness.

CSC 550 Computer Graphics. *3(3 0) . F. Preq MA 405 and CSC 314 and knowledge of C or C++* Principles of three-dimensional raster graphics. Hardware devices, object representation, graphical user interfaces, transformations, curves and surfaces, hidden line and surface removal, illumination models, color systems, and animation. Required programming projects using C or C++

CSC 554 Human-Computer Interaction. *3(3-0) . F. Preq. CSC 314* Basic theory and concepts of human-computer interaction. Human and computational aspects. Cognitive engineering. Practical HCI skills. Significant historical case studies. Current technology and future directions in user interface development.

CSC (IE) 556 Voice Input/Output Communication Systems. *3(3-0) . F Preq: IE 307 or CSC 312.* Introduction to physical, linguistic and computational principles underlying speech synthesis and speech recognition. Human factors of speech I O. Advantages and disadvantages of implementing voice applications. Hands-on use of voice I O equipment through class projects. Case studies of current applications of speech I/O technology.

CSC 557 Multimedia Technology. *3(3-0) . F. Preq: CSC 244, CSC 314, and MA 242.* Technologies (particularly operating systems, network protocols, and programming tolls) supporting sound, music, images, voice, video, and graphics on computer. Physical and perceptual qualities of each media type, as well as recoding, signal processing, combining, synthesizing, creation, and media playback. Important compression methods and standards, including JPEG and MPEG. Real-time scheduling techniques, and real-time communication for distributed multimedia.

CSC (MA, OR) 565 Graph Theory. *3(3-0) . F, Alt. Even Yrs. Preq: CSC 224 or MA 351.*. Basic concepts of graph theory, including: paths and connectivity, Euler tours and Hamilton cycles, matchings and independence, graph coloring, planarity, directed graphs and network flows, vector spaces associated with a graph, and applications with emphasis on organizing problems for computer solution.

CSC (ECE) 570 Computer Networks. *3(3-0) . F,S. Preq: CSC 312 or ECE 206.* Detailed description and related performance issues of OSI layers two and three for wide-area networks, well-known standards for metropolitan area networks such as FDII and DQDB, and basic random access mechanisms for local area networks

CSC (ECE) 571 Telecommunications Systems Engineering. *3(3-0) . F,S. Preq. ECE 471 and ECE 402; ST 361 or ST 422.* Systems aspects of telecommunications system design and analysis. Interrelationships of component subsystems affecting behavior of whole system. Statistical definitions of system requirements and system performance. Economics of telecommunications systems and regulated environment. Case studies.

CSC (ECE) 572 Introduction to Computer Communications. *3(3-0) . F,S. Preq: CSC 312 or ECE 206.* Computer communications including local area networks (LANs), metropolitan area networks (MANs), wide area networks (WANs), standard organizations, open system architecture (OSI), IBM's system network architecture (SNA), network performance and topological optimization.

CSC (ECE) 573 Internet Protocols. *3(3-0) . F. Preq: CSC/ECE 570.* Principles and issues underlying provision of wide area connectivity through interconnection of autonomous networks. Internet architecture and protocols today and likely evolution in future. Case studies of particular protocols to demonstrate how fundamental principles applied in practice. Selected examples of networked clinet/server applications to motivate the functional requirements of internet working. Project required.

CSC (ECE) 576 High Speed Networks. *3(3-0) . S. Preq: CSC/ECE 570.* Topics related to high-speed networks such as: frame relay, high-speed LANs and MANs, the asynchronous transfer mode (ATM) architecture, adaptation layers, switch architectures, preventive and reactive congestion control schemes, schemes for connectionless services over ATM, transmission schemes and signaling.

CSC (ECE, OR) 579 Introduction to Computer Performance Modeling. *Preq: CSC 312 or ECE 206 and MA 421. 3(3-0) . F. Coreq: CSC 701.* Workload characterization, collection and analysis of performance data, instrumentation, tuning, analytic models including queuing network models and operational analysis, economic considerations.

CSC (MA) 580 Numerical Analysis I. *3(3-0) . F,S. Preq: MA 405; MA 425 or MA 711; high-level computer language.* For students in engineering, physical and mathematical sciences. Algorithm behavior and applicability. Effect of round off errors, systems of linear equations and direct methods, least squares via Givens and Householder transformations, stationary and Krylov iterative methods, the conjugate gradient and GMRES methods, convergence of GMRES, eigenvalue problems, systems of nonlinear equations, Newton's method.

CSC 591 Special Topics in Computer Science. *1-6. F,S. Preq: B average in technical subjects and Consent of Instructor.* Topics of current interest in computer science not covered in existing courses.

CSC 630 Master's Independent Study. *F,S,Sum. Preq: Consent of Instructor.* Individual investigation of topics under the direction of member(s) of the graduate faculty.

CSC 685 Master's Supervised Teaching. *1-3. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

CSC 690 Master's Examination. *1-6. F,S,Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

CSC 693 Master's Supervised Research. *1-9 F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

CSC 695 Master's Thesis Research. *1-6. F,S. Preq: Master's student.* Thesis research.

CSC 699 Master's Thesis Preparation. *1 3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

CSC 707 Automata, Languages and Computability Theory. *3(3-0) . S. Preq: CSC 224 required, CSC 333 recommended.* Formal models of language and computation; finite automata and regular languages, pushdown automata and context-free languages, Turing machines. Relative power of models, Chomsky hierarchy. Inherent complexity of problems: undecidability, computational complexity, intractable problems.

CSC 714 Real Time Computer Systems. *3(3-0) . S, Alt. Yrs. Preq: CSC 451 or CSC 501 programming required in C* Design and implementation of computer systems required to provide specific response times. Structure of a real-time kernel, fixed and dynamic priority scheduling algorithms, rate monotonic scheduling theory, priority inheritance protocols, real-time benchmarks, case study of a real-time kernel.

CSC 715 Concurrent Software Systems. *3(3 0) . S. Preq. CSC 501.* Concepts, techniques and tools for development of concurrent (parallel or distributed) software systems. Specification of concurrency, design of concurrent software systems, concurrent languages and validation of concurrent programs.

CSC 720 Artificial Intelligence II. *3(3-0) . S Preq: CSC 520* A second course in artificial intelligence emphasizing advanced concepts of AI including logic programming, automatic programming, natural language understanding, visual perception by machine, learning and inference, intelligent computer-aided instruction, knowledge representation, robotics and other topics to be chosen by instructor. Students asked to write programs in AI programming language such as LISP and PROLOG.

CSC 723 Computational Semantics. *3(3-0) . S. Preq: CSC 523 and CSC 224.* Examination of how to represent meaning in natural language to a computer. Logical systems for representing meaning. Other systems for representing meaning such as conceptual dependencies. Generating natural language output from databases representing knowledge. Reading of advanced material in such areas as natural language dialogue processing.

CSC 725 Intelligent Multimedia Systems. *3(3-0) . S. Alt. Yrs(even). Preq: CSC 520 or consent of instructor.* Principles and issues underlying intelligent multimedia technologies. Animated intelligent agents, intelligent behavior planning, affective reasoning, gesture and locomotion planning, mixed-initiative multi-modal dialogue control, and natural language generation. Intelligent multimedia presentation planning. Intelligent 3D virtual cinematography. Interactive narrative planning with animated intelligent agents. Selected examples of applications in knowledge-based learning environments, intelligent training systems, interactive entertainment.

CSC 742 Database Management Systems. *3(3-0) . S. Preq: CSC 431 or 541.* Database concepts. Database design. Data models: entity-relationship and relational. Data manipulation languages including SQL. Data Dictionaries. Query processing. Concurrency. Software development environments using a database system. Expert, object-oriented, multimedia and distributed database systems. Database systems architecture. Use of a commercial database management system.

CSC (ECE) 748 Parallel Processing. *3(3-0) . S. Preq: CSC(ECE) 506.* Concepts of parallelism, data-flow, program flow, partitioning and scheduling, performance metrics and scaleability, vector processing, Superscalar and VLIW, SIMD and MIMD machines, recent parallel machines, such as T3D, DASH, Tera KSR1, SP/1 and SP2, parallel models and program development

CSC (IE) 756 Advances in Voice Input/Output Communications Systems. *3(2-3) S. Preq: CSC 556.* Selected topics from current literature in voice input/output research, technology and applications. Execution of a significant experiment or project by each student.

CSC (IE, OR) 762 Computer Simulation Techniques. *3(3 0) . F.* Basic discrete event simulation methodology: random number generators, simulation designs, validation, analysis of simulation output. Applications to various areas of scientific modeling. Simulation language such as SLAM and GPSS. Computer assignments and projects.

CSC (ECE) 776 Performance Evaluation of Computer Networks. *3(3 0) S. Preq: CSC(ECE) 570 and CSC(ECE) 579.* Performance modeling of random access networks. Synthesis and analysis of local area networks, metropolitan area networks and packet radio networks. Routing and flow control in computer networks.

CSC (ECE) 777 Telecommunications Network Design. *3(3-0) S Preq: CSC(ECE) 570.* Analytic modeling and topological design of telecommunications networks, including centralized polling networks, packet switched networks, T1 networks, concentrator location problems, routing strategies, teletraffic engineering and network reliability.

CSC (ECE) 779 Advanced Computer Performance Modeling. *3(3-0) . S, Alt. Yrs . Preq: CSC(ECE) 579 or OR(IE) 761.* In-depth study of computer performance modeling techniques such as exact and approximate analysis of queuing networks and direct and iterative numerical solutions of queuing systems.

CSC (MA) 780 Numerical Analysis II. *3(3-0) F,S. Preq: MA 580.* Approximation and interpolation, Fast Fourier Transform, numerical differentiation and integration, numerical solution of initial value problems for ordinary differential equations.

CSC (MA) 783 Parallel Algorithms and Scientific Computation. *3(3-0) S Preq: MA 580.* Multiprocessing and supercomputer architectures including Alliant FX/8, IBM 3090 VF-600, CRAY XMP-48, Intel iPCS and BBN Butterfly. The implementation of standard numerical linear algebra algorithms on vector and multiprocessing computers. Portability of codes from one computer to another. Typical applications to science and engineering.

CSC 791 Advanced Topics in Computer Science. *1-6. F.S. Preq: Consent of Instructor.* Advanced topics of current interest in computer science not covered by existing courses.

CSC 830 Doctoral Independent Study. *1-3. F,S,Sum. Preq: Consent of Instructor.* Individual investigation of advanced topics under the direction of member(s) of the graduate faculty.

CSC 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

CSC 890 Doctoral Preliminary Exam. *1-9. F,S,Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

CSC 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

CSC 895 Doctoral Dissertation Research. *1-9. F S,Sum. Preq. Doctoral student.* Dissertation research

CSC 899 Doctoral Dissertation Preparation. *1 3. F,S,Sum. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

PHYSICAL EDUCATION – DANCE

DAN (PE) 264 Ballet. *1(0-2) . F,S.* Beginning level ballet technique course. Fundamental ballet concepts and vocabulary introduced through barre and center exercises and combinations.

DAN 272 Dance Composition. *1(0-2) . F,S. Preq: PE 264 or PE 274.* Creative problem-solving using the components of movement composition. Development of movement vocabulary through structured improvisation. Development of a thematic phrase. Manipulation of the thematic phrase through various choreographic devices.Structure of the developed materials.

DAN (PE) 274 Modern Dance I. *1(0-2) . F,S.* Introduction of movement and dance concepts and techniques through theory and analysis, improvisation and composition, structured dance exercises combinations.

DAN (PE) 275 Modern Dance II. *1(0-2) . F,S. Preq: PE/DAN 274 (or permission of instructor).* Continuation of Modern Dance I. Emphasis on design of body in space, movement qualities and musicality through structured technical exercises and combinations.

DAN 295 Problems of Dance Performance. *2(0 4) . F,S. Preq: Audition.* Practical performing experience in a company setting. Rehearsal, performance and production of concert dance.

DAN 498 Independent Study in Dance. *F S,Sum. Preq: DAN 272, Dan 295 Dance Program approval required.* Independent study in special choreographic or performance proejcts approved by and done under the direction of the Dance Program.

DESIGN - GRADUATE

DDN 771 Design as Cognitive Artifact. *3(3-0) . F,S. Coreq: DDN 830 or 831. For PhD in Design student only; non-majors by permission only.* Relationship between theories of human cognition and design. Analysis and critique of design objects as cognitive artifacts and extension, transformation, or diminishing of human thought by their form and content. A critical examination of cognitive, linguistic and social science theories shaping design.

DDN 772 Design as Cultural Artifact. *3(3-0) . F,S. Coreq: DDN 830 or 831. For PhD in Design student only; non-majors by permission only.* Recent theories in various disciplines concerning a cultural understanding of graphic design. Theories of mass and popular culture, critiques of creativity and authorial intentionality, influences of interpretive criticism, theories of consumption and issues of cultural representation. Emphasis on adaptation of these theories to an understanding of the cultural significance of graphic design. Non-majors by permission only.

DDN 773 New Information Environments. *3(3-0) . F,S. Coreq: DDN 830 or 831. For PhD in Design students only; non-majors by permission only.* Changing role of design in new information environments. Implications of new technology on social construction of meaning, impact of electronic media on culture and cognition, and differences in designing artifacts and designing interactions.

DDN 776 Community Design. *3(3-0) . F. Preq: Graduate Standing. For Doctoral students in the Community & Environmental Design concentration..* Processes through which citizens shape and manage built environment. Strategic planning, visioning process, community action, and mediation will be discussed and illustrated with case study examples from architecture, landscape architecture and planning. Analysis and assessment from case studies of participation techniques such as charrette, study circles and visual appraisal.

DDN 777 Sustainable Communities. *3(1.50-1.50) . S. Preq: Graduate Standing. For doctoral students.* Historical precedents of sustainable communities. Examination of the Garden City, the New Towns Movement, and the New Urbanism. Comparison of sustainable communities to urban visions of Wright, Corbusier, Soleri and others. Virtual cities and digital communities.

DDN 778 Ecological Design. *3(2-1) . F. Preq: Graduate Standing. Doctoral students in the Community & Environmental Design concentration..* An integrative approach to human and natural systems. Ecological scale, function, spatial structure and human-ecosystem interaction through case studies at a variety of scales. Ecological concepts linked to design and planning principles.

DDN 779 Human Use of the Urban Landscape. *3(0 3) . F. Preq: Graduate Standing. For Doctoral students in the Community & Environmental Design conentration.* Techniques for documenting and analyzing user needs at cite planning scale. Methods of integrating user needs into design programming in design and redesign projects. Community participation methods. Examples of best practice in design of user-intensive settings in residential, health, education and recreation. Principles of Universal Design. Fieldwork-oriented.

DDN 795 Special Topics. *3(3-0) . F,S.*

DDN 809 Dissertation Colloquium. *3(3-0) . F,S. Preq: Doctoral student.*

DDN 830 Information Design. *6(0-12) . F,S. Coreq: DDN 771, 772, or 773.* Directed study in information design with a focus on the cognitive, cultural or technological implications of visual communication design. Students design visual research studies in response to questions arising from co-requisite study in Information Design seminars.

DDN 831 Information Design. *6(0-12) . F,S. Coreq: DDN 771, 772, or 773.* Directed study in information design with a focus on the cognitive, cultural or technological implications of visual communication design. Students design visual research studies in response to questions arising from co-requisite study in Information Design seminars.

DDN 890 Doctoral Preliminary Examination. *1-9. F,S. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

DDN 893 Doctoral Supervised Research. *1-9. F,S. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

DDN 895 Doctoral Dissertation Research. *1-9. F,S. Preq: Doctoral student.* Dissertation research.

DDN 899 Doctoral Dissertation Preparation. *1-3. F,S. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

DESIGN FUNDAMENTALS

DF 101 Design Fundamentals Studio I. *6(0-11) . F. School of Design students only.* Introduction to the design disciplines and departments of the School of Design. A studio course examining the techniques and attitudes for dealing with identification, solution and evaluation of problems arising from the design of physical artifactsin the natural and built environment. The design studio process includes the acquisition of languages and skills appropriate to design studies.

DF 102 Design Fundamentals Studio II. *6(2-11) S Preq DF 101* Second course--design disciplines and departments of the School of Design. Examines the techniques and attitudes for dealing with identification, solution, and evaluation of problems arising from the design of physical artifacts in natural and built environments. Acquisition of languages and skills appropriate to design studies.

ENGINEERING

E 100 Introduction to College of Engineering. *0(1-0) . F.* Orientation to the University and introduction to the College of Engineering and the engineering profession. General academic requirements and special educational opportunities, the history of engineering and computer science, professionalism and ethics.

E 110 Engineering Scholars Forum. *0(2-0) . F,S. Preq: Enrollment limited to participants in the Engineering Scholars Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

E 111 Engineering Scholars Forum. *0(2-0) . F,S. Preq: Enrollment limited to participants in the Engineering Scholars Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

E 115 Introduction to Computing Environments. *1(0-2) . F,S,Sum.* Fundamentals of the EOS System. Software and services available on the system. Network hardware configuration, on-line help and communication, file and directory manipulation. Software applications such as E-mail, publishing packages, spreadsheets, mathematical packages, CAD packages.

E 123 Engineering 1-2-3: Product and Processing Engineering. *2(0-3) . F,S.* Introduction to product and process (1) usage, (2) assembly, and (3) engineering calculations and design through the case study approach. Working in teams of two, students explore bar code scanners and inventory systems, compact disc audio and CD-ROM information storage and retrieval, photocopier and FAX devices, optical fiber communications and probes, video camera and video cassette recorder, and water purification technologies.

E 144 Academic and Professional Preparation for Engineering I. *1(1-0) . F.* Assist new freshmen engineering students in the transition from high school to the collegiate environment. Cover critical-thinking; problem solving techniques; academic skills and time management.

E 145 Academic and Professional Preparation for Engineering II. *1(1 0) . S.* Engineering as a field of study and profession. Career and professional development, goal setting, decision making and effective communication strategies.

E 210 Engineering Scholars Forum. *0(2-0) . F,S. Preq: Enrollment limited to participants in the Engineering Scholars Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

E 211 Engineering Scholars Forum. *0(2-0) . F,S. Preq: Enrollment limited to participants in the Engineering Scholars Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

E 432 Patents, Trademarks and Copyrights. *3(3-0) . S. Preq: Jr. standing.* Patent, trademark and copyright problems that arise in engineering, scientific and industrial pursuits. Includes the rights and remedies available to individual inventors and authors as well as companies. Patent Office procedures and practices.

E 490 Fundamentals of Engineering(FE) Exam Preparation. *1(2-0) . F,S. Engineering Seniors and PBS students only. Credit may not be counted toward graduation.* Preparation for graduating seniors in engineering to take the Fundamentals of Engineering (FE) Examination. Information on how to register for the FE exam, exam strategy, and a review of selected science and engineering topics through active learning exercises directed at working sample examination problems.

E 497 Engineering Research Projects. *1-3. F,S,Sum. Preq: Jr Standing in College of Engineering; Restricted to participants in Engineering Scholars Program and Engineering Research Center Scholars.* Projects in research, design or development in engineering or computer science.

E (MA, OR) 531 Dynamic Systems and Multivariable Control I. *3(3-0) . F. Preq: MA 341, MA 405.* Introduction to modeling, analysis and control of linear discrete-time and continuous-time dynamical systems. State space representations and transfer methods. Controllability and observability Realization. Applications to biological, chemical, economic, electrical, mechanical and sociological systems.

E (MA, OR) 731 Dynamic Systems and Multivariable Control II. *3(3-0) . S. Alt. yrs. Preq: OR(E,MA) 531.* Stability of equilibrium points for nonlinear systems. Liapunov functions. Unconstrained and constrained optimal control problems. Pontryagin's maximum principle and dynamic programming. Computation with gradient methods and Newton methods. Multidisciplinary applications.

ADULT AND COMMUNITY COLLEGE EDUCATION

EAC 602 Seminar In Adult and Community College Education. *1-3. F,S. Preq: Grad. standing.* Identification and scientific analysis of major issues and problems relevant to adult education. Course credit through active student participation in a formal seminar and scientific appraisal and solution of a selected problem. Student acquisition of a broad perspective of issues confronting adult educators and experiences in scientific analysis and solution of specific issues.

EAC 624 Topical Problems in Adult and Community College Education. *F,S,Sum. Preq: Grad. standing or PBS status. Credits Arranged.* Study and scientific analysis of problems in adult education and preparation of a scholarly research type of paper.

EAC 641 Practicum In Health Occupations. *3(3-0) . Even Alt. Yrs. Preq: 21 hrs of grad. work. For credentialed health professionals.* Design of a practicum in teaching or administrative context appropriate to individual's particular discipline and area of function based upon participants' professional objectives. Design of program by student in cooperation with preceptor and course instructor.

EAC 651 Internship in Adult and Community College Education. *3-9. F,S,Sum. Preq: Nine hrs. in graduate level courses and Consent of Instructor.* Utilization of the participant-observer role with required participation in selected educational situations. Emphasis upon observational skills' development, the recording of relevant observations through written journals, analysis of experiences identifying critical incidents and projection of events and consequences. Student development and selection of possible alternative courses of action in various situations and evaluation of the consequences of the selected course of action.

EAC 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

EAC 692 Research Projects in Education. *1-3. F,S,Sum. Preq: Consent of Instructor; EAC 732 or equivalent.* A project or problem in research in education for graduate students, supervised by members of graduate faculty. Choice of research on basis of individual students' interests and not to be part of thesis or dissertation research.

EAC 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

EAC 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research.

EAC 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

EAC 700 Community College and Two-Year Postsecondary Education. *3(3-0) . F,S. Preq: Grad. standing or PBS status.* Comprehensive community colleges and technical institutes and the state systems of which they are part: underlying concepts, design of educational needs to be serve, role in meeting these needs, historical development, issues in establishment and operation of state systems and individual institutions, unresolved issues and emerging trends.

EAC 701 Administrative Concepts and Theories Applied to Adult and Community College Education. *3(3-0) . S. Preq: EAC 787 or a comparable course(s) on organizational theory.* For persons interested in building more consistent philosophy of educational administration, extension and strengthening of understanding of administrative concepts and processes, improved comprehension of theoretical and research foundations upon which administrative processes predicated, and increased ability for application of administrative concepts, theories and principles to management of complex education system.

EAC 703 The Programming Process in Adult and Community College Education. *3(3-0) . F,S. Preq: Grad. standing.* Principles and processes in programming, including basic theories and support of concepts in programming process. Attention to general programming framework, organizational needs and program roles of both professional and lay leaders.

EAC 704 Leadership in Higher and Community College Education. *3(3-0) . S.* Issues and concepts of leadership development and practice in two- and four-year colleges and universities; interpretation and communication of institutional values and understanding of organizational processes. Attention to role of organizational culture in management improvement and institutional performance in higher education institutions.

EAC 705 Group Process in Adult and Community College Education. *3(3 0) . Sum.* Application of research and theory in small group behavior to administration and teaching in adult and community college education settings. Opportunities for participant experience of various aspects of group behavior and practice of group leadership skills applicable to various group situations.

EAC 706 The College and University Presidency. *3(3-0) . S, Alt. Even Yrs. Preq: EAC 700 or EAC 716.* Promotion of understanding of many facets of the college and university presidency. Investigation and analysis of college and university from the perspective of students's own careers and from the literature on the presidency. The president as institutional leader.

EAC 707 The Politics of Higher Education. *3(3-0) Preq: Grad. standing or Management Development Certificate Program and six sem. hrs. of 500-level course work.* Differing and changing perceptions of role of higher education in American society; politics of competition for priority of attention and resources; organizational alternatives in its control; relevant elements in structure and processes of government. References to other societies.

EAC 708 Continuing Education for the Professions. *3(3-0) Sum. Preq: EAC 703 739.* Theoretical and research literature related to continuing education for the professions. Examination of role of educator in providing and managing continuing professional education.

EAC 710 Adult Education: History, Philosophy, Contemporary Nature. *3(3-0) F,S. Preq. Advanced undergrad., Consent of Instructor.* Historical and philosophical foundations of adult education from ancient times to present, with attention to key figures, issues, institutions, movements and programs, including consideration of relationship between adult education's historical development and prevailing intellectual, social, economic and political conditions. Consideration of adult education's contemporary nature, present-day schools of thought on its objectives and trends.

EAC 716 History of Higher Education in the United States. *3(3-0) S, Alt. Yrs.. Preq: Six hrs. of grad. ED courses and Consent of Instructor.* History of higher education from colonial period to the present. Emphasis on influence of philosophic, political, social and economic forces upon function and structure of higher education.

EAC 717 Current Issues in Higher Education. *3(3-0) . F, Alt. Yrs.. Preq: Grad. standing or PBS status.* Examination of important social, political and economic issues affecting present and future operation of colleges and universities in America.

EAC 720 Use of Secondary Survey Data in Adult and Higher Education. *3(3-0) . F. Preq: Graduate standing and one introductory-level statistics course.* Examination and evaluation of secondary survey data to address research and policy issues in adult and higher education.

EAC 732 Health Care Delivery Systems and Environments. *3(3-0) . Sum. Preq: Grad. standing.* Organization of health care delivery system, services and recourses. Focus on major social, economic, political and professional factors contributing to shaping the system and influencing change. Analysis of organizations and environments in regard to demand for health personnel and the implications for health occupations education.

EAC 735 Curriculum and Instruction in the Health Professions. *3(3-0) . S, Even Alt. Yrs.. Preq: Advanced undergrad. or grad. standing.* Elements of curriculum design and theoretical considerations for development of curricula in health occupations. Identification, analysis and evaluation of instructional strategies appropriate for clinical and classroom teaching.

EAC 736 Issues and Trends in Education for the Health Professions. *3(3-0) . S, Alt. Yrs. Preq: Grad. standing* An analysis of educational and social factors influencing change in health professions education. Problems of student selection and program articulation, and implications for health occupations education and health services of recent legislation impacting health care.

EAC 737 The Extension and Public Service Function in Higher Education. *3(3-0) S. Preq: EAC 710.* Examination of background, history, philosophy and contemporary nature of extension and public service function of institutions of higher education in U.S. Emphasis on adult education role of public and private universities and colleges. Specific focus on: general extension, industrial extension, engineering extension, cooperative extension and continuing education.

EAC 738 Instructional Strategies in Adult and Community College Education. *3(3-0) . F. Preq: Grad. standing or PBS status.* Forms of instruction appropriate for the teaching of adults. Special emphasis upon methods for maximum involvement of the adult learner. Relevant concepts, theories and principles for selection, utilization and evaluation of instructional strategies with focus on integration of theory into practice. Development of student proficiency in use of applicable teaching techniques for adult and community college education through participation in classroom exercises.

EAC 739 Educational Gerontology. *3(3-0) . F. Preq: Six hrs in ED, SOC or PSY.* Broad overview of factors relevant to education of older adults. Various sociological, physiological, psychological and economic aspects of aging and their educational implications. Attention to necessary knowledge and skills for development of educational programs for aging population.

EAC 743 Adulthood and Learning: The Later Years. *3(3-0) . S. Preq: EAC 739 or Consent of Instructor.* Occurrence of basic sensory, attitudinal, intellectual and emotional changes in individuals during process of growing old and the implications of these changes for development, implementation and evaluation of educational programs for and with older adults.

EAC 745 Death and Dying: A Lifespan Issue. *3(3-0) . Sum. Preq: Grad. standing or PBS status.* Examination of issues associated with dying process, death itself and bereavement. Perceptions and responses to these issues at various stages of the lifespan. Implications for students' fields of practice.

EAC 749 Finance in Adult and Community College Education. *3(3-0) . S. Preq: EAC 700; grad. standing.* Examination of theory, research, practices and issues in development and management of financial resources of adult and community college enterprise.

EAC 750 The Environment for Learning in Adult and Community College Education. *3(3-0) . S. Preq: EAC 700 and grad. standing or PBS status.* Planning and management of the physical environment for effective adult learning. Applicability of concepts and theories of learning and teaching environment to need analysis, planning, resource development, cooperation with professional designers, and construction, operations, conservation and maintenance of educational facilities, equipment and grounds.

EAC 759 The Adult Learner. *3(3-0) . F,S. Preq: Six hrs. in ED.* Requisite involvement and undergirding of principles in adult education programs including theories and concepts. Emphasis on interrelationship of nature of adult learning, the nature of the subject matter and setting for learning occurrence. Applicability of relevant principles and pertinent research findings to adult learning.

EAC 765 Current Issues in Adult Education. *3(3-0) . S. Preq: 15 Semester hours of graduate credit in the Department of Adult and Community College Education, including 3 semester hours of either quantative or qualitative research methods .* Analysis of social, political, economic, and ethical issues influencing effective practice of adult education. Participant formulation and analysis of problems, issues, and challenges relevant to their practice and advanced graduate study.

EAC 767 Education of Special Adult Populations. *3(3-0) . S,Sum.* Analysis and development of adult education responses to needs and characteristics of special adult populations such as nonliterate, unemployed, handicapped and older adults.

EAC 778 Law and Higher Education. *3(3-0) . S, Alt. Yrs.. Preq: Six hrs. grad. credit.* Constitutional, statutory and case law in relationship to higher education. Emphasis on faculty, student and staff rights and tort liability.

EAC 779 Concepts and Principles of Evaluation Applied to Non-Formal Adult Education Program. *3(3-0) . S. Preq: EAC 703 or Consent of Instructor.* Introduction to evaluation of non-formal adult educational programs; course topics include purposes of evaluation, alternative concepts and techniques, stake holders and their concerns, specification of evidence, selection of standards for making judgments, gathering and analysis of data, use and dissemination of results and handling problems in evaluation.

EAC 780 Designing Instructional Systems in Training and Development. *3(3-0) . F.* Introduction to instructional design models including needs assessment, systematic training design and development techniques and proactive strategies for evaluating training programs. Instructional design issues of work-based training, learner characteristics and effects of technology on instructional design, implementation and evaluation processes.

EAC 781 Advanced Instructional Design in Training and Development. *3(3-0) . S, Alt. yrs.(odd). Preq: EAC 784 or EAC 788.* In-depth analysis of instructional systems design (ISD) theory and practice using professional competency models. Organizational training requirements, development of performance objectives and measures, design of instructional materials, and address of evaluation issues in training programs in business and industry. Research and development of instructional design projects relating to ISD process and model.

EAC 782 Organization and Operation of Training and Development Programs. *3(3-0) . F,S.* Overview of occupational education practice in business and industrial settings. Presentation of roles common to training and development specialists, including managerial concerns related to organization, operation and financial training and development programs.

EAC 783 Needs Assessment and Task Analysis in Training and Development. *3(3-0) . S. Preq: EAC 780 and EAC 782.* Current needs assessment and task analysis methods and techniques used in business and industrial settings. Development of comprehensive needs assessment plans for diagnosing and documenting human performance deficiencies/improvement opportunities through training programs in business settings.

EAC 784 Evaluating Training Transfer and Effectiveness. *3(3-0) . F. Preq: EAC 783.* Philosophy, strategies, and procedures for evaluating effectiveness of training programs. Development of multi-level evaluation plan for use with training program to study outcomes and process of training from perception to organizational impact. Design of evaluation methods and instruments, data collection, analysis, and interpretation for each level of evaluation emphasizing transfer of training.

EAC 785 Qualitative Research in Adult and Community College Education. *3(3-0) F Preq: Grad. standing.* Design of qualitative studies, conduct of field work including open-ended interviews and participant observation, analysis of data and understanding of theoretical and philosophical background of this research approach.

EAC 786 Methods and Techniques of Training and Development. *3(3-0) . F,S.* Methods and techniques common to model occupational education programs in business and industrial settings. Focus on design and evaluation of effective learning programs and instructional methodologies.

EAC 787 Organizational Concepts and Theories Applied to Adult and Community College Education. *3(3-0) . F. Preq: EAC 703, PS 502, SOC 728.* For present and potential administrators interested in increase of their understanding of organization as a basis for administration of effective adult and community college education programs.

EAC 788 Integrating Technology into Training Program. *3(3-0) S Preq. EAC 780, EAC 782.* Appropriate technologies for design and delivery of effective training programs. Performance-based training models for distance and individualized learning through audio, video, computer-based, and multimedia technologies. Planning devisions for selecting/developing appropriate technologies to support specific training outcomes, adult learner characteristics, and organizational training resources.

EAC 789 Marketing for Education and Training Programs. *3(3-0) S. Alt yrs.(even).* Strategic marketing in education and training. Identifying and understanding targeted organization and audience for education or training program. Design of basic marketing strategy for education or training program incorporating elements of marketing mix and formulating marketing plan to guide implementation of strategy.

EAC 790 Advanced Qualitative Research Methods. *3(3-0) . F. Preq: EAC 783* Advanced guidance for students designing or preparing for qualitative study. Emphasis on developing deeper understanding of theoretical issues informing qualitative research, including assessing validity of data and justifying design. Student development of a research proposal.

EAC 795 Topical Problems in Adult and Community College Education.

EAC 802 Seminar in Adult and Community College Education. *1-3 F S. Preq: Grad. standing.* Identification and scientific analysis of major issues and problems relevant to adult education. Course credit through active student participation in a formal seminar and scientific appraisal and solution of a selected problem. Student acquisition of a broad perspective of issues confronting adult educators and experiences in scientific analysis and solution of specific issues.

EAC 803 Research Seminar in Adult and Higher Education. *3(3-0) . F,S. Preq: 6 semester hours of course work in research methodology/analysis.* Examination and application of frameworks, processes and compositional approaches in developing research proposals focusing on problems in adult education and higher education.

EAC 824 Topical Problems in Adult and Community College Education. *F,S,Sum. Preq: Grad. standing or PBS status. Credits Arranged.* Study and scientific analysis of problems in adult education and preparation of a scholarly research type of paper.

EAC 841 Practicum in Health Occupations. *3(3-0) . Even Alt. Yrs. Preq: 21 hrs of grad. work. For credentialed health professionals.* Design of a practicum in teaching or administrative context appropriate to individual's particular discipline and area of function based upon participants' professional objectives. Design of program by student in cooperation with preceptor and course instructor.

EAC 851 Internship in Adult and Community College Education. *3-9. F,S,Sum. Preq: Nine hrs. in graduate level courses and Consent of Instructor.* Utilization of the participant-observer role with required participation in selected educational situations. Emphasis upon observational skills' development, the recording of relevant observations through written journals, analysis of experiences identifying critical incidents and projection of events and consequences. Student development and selection of possible alternative courses of action in various situations and evaluation of the consequences of the selected course of action.

EAC 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

EAC 890 Doctoral Preliminary Exam. *1-9. F,S,Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

EAC 892 Doctoral Research Project. *1-3. F,S,Sum. Preq: Consent of Instructor; EAC 732 or equivalent.* A project or problem in research in education for graduate students, supervised by members of graduate faculty. Choice of research on basis of individual students' interests and not to be part of thesis or dissertation research.

EAC 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

EAC 895 Doctoral Dissertation Research. *1-9. F,S,Sum. Preq: Doctoral student.* Dissertation research.

EAC 899 Doctoral Dissertation Preparation. *1-3. F,S,Sum. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

ECONOMICS

EC 201 Principles of Microeconomics. *3(3-0) . F,S,Sum. Credit will not be given for both EC 201 and either ARE 201 or EC 205.* Scarcity, production possibilities, and opportunity cost. Supply and demand analysis, free markets, the price system, and government policy. Microeconomic analysis of business decisions in competitive and noncompetitive markets. Labor markets, capital, and natural resource markets, and externalities. Market breakdown, income redistribution, and role of government. Free trade, tariffs, and gains from international trade.

EC 202 Principles of Macroeconomics. *3(3-0) . F,S,Sum. Preq: EC 201 or ARE 201. Credit will not be given for both EC 202 and EC 205.* Aggregate economic analysis emphasizing current public policy issues. Determinants of level and rate of growth of total output. Causes of unemployment and business cycles, inflation, and exchange rate fluctuations. Effects of monetary policy (money supply) and fiscal policy (government spending, taxes, deficits) on these problems. Trade surpluses/deficits and impact of international events and policies on national economies.

EC 205 Fundamentals of Economics. *3(3-0) . F,S,Sum. Credit will not be given for both EC 205 and either EC 201 or ARE 201. Credit will not be given for both EC 205 and EC 202.* Fundamental ideas in economics: scarcity, substitution, opportunity cost, marginal analysis, gross domestic product, real and nominal magnitudes. Supply and demand analysis. Microeconomic analysis of pricing in competitive and noncompetitive markets. Macroeconomic analysis of production, employment, the price level, and inflation. Monetary and fiscal policy and the stabilization of the economy. Comparative advantage and international trade.

EC (ARE) 301 Intermediate Microeconomics. *3(3-0) . F,S,Sum. Preq: MA 121 or 131; EC 201 or ARE 201. Credit not allowed for both EC(ARE) 301 and 401.* Functioning of the market economy, role of prices in determining the allocation of resources, the functioning of the firm in the economy, forces governing the production and consumption of economic goods.

EC 302 Intermediate Macroeconomics. *3(3-0) . F,S,Sum. Preq: EC 201 or ARE 201; MA 121 or MA 131.* Applied, analytical course in aggregate economics: business cycles, stabilization policy, inflation, costs of disinflation, international trade, and economic growth. Interaction of consumers and businesses with government economic policies; unemployment, interest rates, and output growth. Impacts of government deficits, trade deficits, and monetary policies.

EC 303 Markets and Governments. *3(3-0) . F,S,Sum. Preq: EC 201 or EC 205 or ARE 201.* Social benefits of markets and the price system. Market failures and the rationale for government intervention in the economy. Government spending and taxing. Government failures. Applications to policies concerning the environment, labor markets, health care, antitrust, and economic growth.

EC 304 Introduction to Financial Markets and Institutions. *3(3-0) . F,S,Sum. Preq: EC 201 or ARE 201. Credit will not be given for both EC 304 and EC 404.* Financial assets, markets and institutions. Stock and bond markets. Measurement and determination of rates of return on financial assets. Banks and other financial intermediaries including their management and regulation. Roles of the Federal Reserve System and monetary policy in determining interest rates, economic activity and foreign exchange rates.

EC 310 Managerial Economics. *3(3-0) . Preq: EC 201 or ARE 201.* Microeconomic principles applied to decision-making in the firm. Present value analysis. The relationship between accounting and economic concepts of cost. Criteria and procedures for decision-making under uncertainty. Economic allocation by markets and the price system. Sources of market power and competitive advantage. Applications to product pricing and advertising.

EC (ARE) 336 Introduction to Resource and Environmental Economics. *3(3-0) S. Preq: ARE 201 or EC 201.* Application of basic economic tools to understand and evaluate environmental/resource policies. Concepts such as property rights, non-market goods, allocation over time, externalities, and public goods. Current policy issues such as global climate change, evaluating natural resource damages from oil spills, reducing the costs of regulations, protecting estuaries, and dealing with non-point source pollution.

EC 348 Introduction to International Economics. *3(3-0) . F,S,Sum. Preq: EC 201 or ARE 201.* Application of basic economic analysis to international economic events and policies. Gains from trade, impacts of trade restrictions, international systems of payments, global capital markets, and balancing international with domestic macroeconomic policies. Current policy issues such as economic integration (customs unions and free trade areas), a common European currency, and the role of international trade in economic growth and development.

EC 372 Evolution of American Business. *3(3-0) . F,S. Preq: EC 201 or ARE 201.* Historical development of modern business enterprise from the Colonial Era through World War II. Emphasis on the transformation of business practices in response to technological change, evolution of capital markets, growth of international trade, changes in distribution techniques, entrepreneurship, and the influence of government regulation.

EC 375 Comparative Economic Systems. *3(3-0) . F,S. Preq: EC 201 or ARE 201.* Comparative Economic Systems contrasts market-type economies with other types of economic systems, particularly collectivist or planned economies in order to analyze their relative economic efficiency. The collapse of the Soviet economy will be analyzed as well as the attempts to convert the newly established republics into market economies.

EC (ARE) 401 Economic Analysis for Nonmajors. *3(3-0) . F,S. Preq: EC 201 or ARE 201. Not open to undergraduates majoring in the College of Management or Department of Agriculture and Resource Economics. Credit not allowed for both EC(ARE) 301 and EC(ARE) 401.* Intermediate economic theory of firm, household and market behavior. Demand, production and cost theory, market equilibrium under competitive and non-competitive conditions, and problems of economic efficiency. (EC (ARE) 401 is primarily for graduate students desiring an economics minor at the master's level. Students completing intermediate microeconomics and calculus should elect ECG 501, Price Theory, instead.)

EC 404 Money, Financial Markets, and the Economy. *3(3-0). F,S.Sum. Preq: EC 302.* Roles of money, credit, and financial institutions in a market economy. Allocation of credit, the determination of interest rates and security prices, and the activities of the Federal Reserve System. Pricing models.

EC 410 Public Finance. *3(3-0) . F,S. Preq: EC(ARE) 301.* A micro-economic analysis of the rationale for public expenditure and taxation. Externalities, pollution and public policy, income redistribution and public welfare, public goods, collective choice and political institutions, public budgeting techniques and cost-benefit analysis, taxation and tax policy, state-local finance and fiscal federalism.

EC 413 Competition, Monopoly and Public Policy. *3(3-0) . S. Preq: EC(ARE) 301.* Current theories of industrial organization with specific reference to such topics as cartels, industrial concentration, vertical integration, franchise contracts, ownership and control of firms, multipart and discriminatory pricing, and tie-in sales. Economic aspects of antitrust law and government regulation of industry.

EC 431 Labor Economics. *3(3-0) . F,S. Preq: EC(ARE) 301.* An economic approach to the labor market and its problems including unemployment and the determination of wages, hours and working conditions under various labor market structures. The economic effects of trade unions. Introduction to human capital theory.

EC 435 Urban Economics. *3(3-0) . Preq: EC(ARE) 301.* Application of land use and location theory to urban structure and centralized economic activity. Analysis of trends in urbanization and suburbanization. Urban poverty, housing, transportation, pollution and local public finance.

EC (ARE) 436 Environmental Economics. *3(3 0) . S. Preq: EC(ARE) 301* Usefulness of economics in understanding pollution, congestion, conservation and other environmental problems. Relevant economic tools such as pricing schemes, abatement cost curves, damage functions and benefit cost analysis. Pollution taxes, regulations, marketable permits and subsidies considered in designing alterations, in the incentive system. Current public policy alternatives in the context of non-market decision-making.

EC 437 Health Economics. *3(3-0) . F,S. Preq: EC(ARE) 301 or EC(ARE) 401.* Application of micro-economic tools to the analysis of public and private policy issues concerning health care financing and delivery in the United States.

EC 442 Evolution of Economic Ideas. *3(3-0) . F,S. Preq: EC(ARE) 301.* General development of economic ideas from ancient times through the post-Keynesian period. Emphasis on the classical school and developments thereafter. The evolution of economic ideas in the context of the changes in technology and the increasing complexity of economic activity.

EC 448 International Trade. *3(3-0) . F,S. Preq: EC(ARE) 301.* Determinants of commodity composition of trade and analysis of tariffs, quotas, and transport costs. Treatment of international investment including multinational corporations. Analysis of the effects of tariffs and quotas. Relationship between international trade and economic growth.

EC 449 International Finance. *3(3-0). Preq: EC(ARE)301.* Study of international markets and their effects on firms, investors and national economics. Topics include: futures and options in foreign exchange, management of foreign exchange risk, exchange rate determination, and macroeconomic policy in an open economy.

EC 451 Introduction to Econometrics. *3(3-0) . F. Preq: EC(ARE) 301, EC 302, BUS(ST) 350.* The measurement, specification, estimation and interpretation of functional relationships through single equation least-square techniques. Applications of simple and multiple regression, curvilinear regression and various transformations to demand, cost, production, consumption and investment relationships.

EC 470 The Japanese Economy. *3(3-0) . S. Preq: EC(ARE) 301.* Growth and development of the Japanese economy. Issues arising from Japan's integration with the world economy. Analysis of contemporary Japanese economic institutions and business practices. Economics of Japanese government policies.

EC 471 Evolution of the American Economy. *3(3-0) . S. Preq. EC(ARE) 301.* Relationship of modern economic development to the history of America. Analysis of contemporary problems and issues with reference to their origins in the historical growth of the economy.

EC 472 The Rise of Industrialism. *3(3-0) . F,S. Preq: EC (ARE) 301.* Historical development of the modern industrial economy from origins in medieval and early modern Europe. The industrial revolution in England and its diffusion throughout the western world and beyond.

EC 480 Introduction to Economic Research. *3(3-0) . S. Preq: EC 301, M 200, ST/BUS 350.* Finding economic data. Critically analyzing newspaper and journal articles using economic reasoning. Developing, writing, and presenting economic analysis.

EC 490 Research Seminar in Economics. *3(3-0) . F,S. Preq: EC (ARE) 301, EC 302, ST(BUS) 350.* The final course for students completing the undergraduate programs in economics. Students study a selected economic issue, make classroom presentations related to the seminar topic, and write research papers.

EC 495 Special Topics in Economics. *1-6. Preq: Consent of the Department.* Examination of special topics in economics not normally treated in other courses, or offering of new courses on a trial basis.

EC 498 Independent Study in Economics. *1-6. F,S,Sum. Preq: Consent of Department.* Detailed investigation of topics of particular interest to advanced undergraduates under faculty direction on a tutorial basis. Credits and content determined by faculty member in consultation with Associate Department Head.

ECONOMICS - GRADUATE

ECG (PRT) 503 Economics of Recreation. *3(3-0) . F. Preq: EC 301 or 401.* Principal emphasis on identity and importance of economic information for planning. Examination of market mechanism and government as they affect and interact to affect allocation of resources to recreation, distribution of recreation services and behavior of recreationists. Other topics including demand analysis, economics of planning, cost/benefit analysis, secondary economic impacts, public decision making, externalities, public finance and supply considerations in urban and rural recreation situations.

ECG 504 Monetary and Financial Macroeconomics. *3(3-0) . S, Alt. Yrs. Preq: ECG 703.* Financial and monetary determinants of national income and employment and levels of wages, the interest rate and inflation. Emphasis on money supply and banking system. Special topics include banking regulation, budgetary deficits and dynamics of money stock determination.

ECG 505 Applied Microeconomic Analysis. *3(3-0) . F,S. Preq: EC 202 or 301.* Applied course in microeconomics. Behavior of producers and consumers in a market economy. Price and output determination in competitive and noncompetitive markets. Decision making under uncertainty and imperfect information.

ECG 506 Applied Macroeconomic Analysis. *3(3-0) . F,S,Sum. Preq: ECG 505.* Applied course in aggregate economics. Analysis of aggregate economic fluctuations and stabilization policy; inflation and disinflation; the Federal budget and international balance of trade; and economic growth. Capital markets, monetary and fiscal policy, banking system, foreign exchange markets and their effects on business conditions. Development of standard macroeconomic model in context of specific applications.

ECG 507 Economics for Managers. *3(3-0) . F. Preq: EC 202. Not open to students pursuing major or minor in Economics.* Survey of microeconomic concepts applied to managerial decisions. Competition. Market power. The firm, production, and cost. Pricing practices. Economics of information and innovation.

ECG 508 Macroeconomics and the Business Environment. *2(2-0) . F S. Preq: ECG 507* Applications of aggregate economics to issues of management decisions. Basic macroeconomic analysis; fiscal and monetary policy issues; international dimensions of trade; capital markets and financial intermediation.

ECG 512 Law and Economics. *3(3-0) . F, Alt. Yrs. Preq: EC(ARE) 301 or EC(ARE) 401.* Economic analysis of sources and effects of law, including common law, statutory law and regulation. Property rights and contracts, liability rules, crime and punishment, statutory enactment, bureaucratic behavior and institutional reform.

ECG 515 Environmental and Resource Policy. *3(3-0) . F, Alt. Yrs.. Preq: EC(ARE) 301 or 401.* Application of price theory and benefit-cost analysis to public decisions related to resources and environment. Emphasis on evaluation of water supply and recreation investments, water quality management alternatives, public-sector pricing, common property resources and optimum management of forest and energy resources.

ECG 521 Markets and Trade. *3(3-0) . F. Preq: EC(ARE) 301 or 401.* Emphasis upon space, form and time dimensions of market price and the location and produce combination decisions of firms. Consideration of way in which non-price factors and public policy choices influence firm behavior and the efficiency of marketing systems. Emphasis upon application of these models to agricultural, industrial and public service questions, including relationships between resource availability and spatial arrangement of economic activity.

ECG 523 Planning Farm and Area Adjustments. *3(2-2) . S, Alt. Yrs.. Preq: EC(ARE) 301, ARE 303 or EC(ARE) 401.* Application of economic principles to production problems on typical farms in the state; methods and techniques of economic analysis of the farm business; application of research findings to production decisions; development of area agricultural programs.

ECG 532 Economics of Trade Unions. *3(3-0) . Preq: EC 301 or 401.* Examination of growth of trade union movement in US. Primary consideration given to impact of unions on economy through their influence on wages, prices, employment and resource allocation. Relationship between government and unions, changing compensation mix and recent growth in public employee unionism.

ECG 533 Economics of World Food and Agricultural Policy. *3(3-0) F Preq EC(ARE) 301 or 401.* Economic analysis of causes and effects of agricultural policies commonly applied in developed, developing and planned economies. Emphasis on economic models of policy analysis. Examination of impact of commodity, farm input international trade, consumer and general economic policies on agriculture and the whole economy. Effects of policy on income distribution and econonic development.

ECG 537 Health Economics. *3(3 0) F. Preq: EC(ARE) 401 or ECG "00.* Microeconomic analysis of public and private policy issues concerning health care financing and delivery in United States including: choice under conditions of asymmetric information; health insurance; performance of physician, hospital, long-term care and pharmaceutical markets.

ECG 540 Economic Development. *3(3-0) . Alt. Yrs.. Preq: EC(ARE) 301 or 401.* Examination of problems encountered in promoting regional and national economic development. Consideration given to structural changes required for raising standards of living. Some basic principles of economics applied to suggest ways of achieving development goals. Planning strategies, policies and external assistance.

ECG 551 Agricultural Production Economics. *3(3-0) . S. Preq: MA 131 and EC(ARE) 301 or 401.* Economic analysis of agricultural production including: production functions, cost functions, programming and decision-making principles. Applications of these principles to farm and regional resources allocation, and to distribution of income to and within agriculture.

ECG 555 Managerial Economics. *3(3-0) . S. Preq: EC 301 or 401.* Applications of economic theory to study of selected business practices in realms of finance, marketing and management decision making. Capital budgeting, financial structure, government regulation of industry, pricing strategies, tie-in sales, contractual arrangements between manufacturers and retailers, comparisons of managerial behavior in nonprofit or government enterprise to for-profit firms.

ECG (ST) 561 Intermediate Econometrics. *3(3-0) . S. Preq: ST 514.* Formalization of economic hypotheses into testable relationships and application of appropriate statistical techniques. Major attention to procedures applicable for single equation stochastic models expressing microeconomic and macroeconomic relationships. Statistical considerations relevant in working with time series and cross sectional data in economic investigations. Survey of simultaneous equation models and the available estimation techniques.

ECG 562 Topics in Applied Econometrics. *3(3-0) . F. Preq: ECG(ST) 561.* Application of advanced econometric techniques to selected issues in economics. Practice in presenting econometrics results in professional fashion, in written or oral form.

ECG 570 Analysis Of American Economic History. *3(3-0) . F, Alt. Yrs. Preq: Grad. standing or PBS status.* Stress upon application of economic analysis to formulation and testing of hypotheses concerning economic growth and development in historical context. Problems selected for analysis primarily from American economic history.

ECG 590 Special Economics Topics. *1-6. F,S,Sum. Preq: Consent of Instructor.* Examination of current problems on a lecture-discussion basis. Course content varies as changing conditions require new approaches to deal with emerging problems.

ECG 630 Independent Study. *F,S.*

ECG 685 Master's Supervised Teaching. *1-3. F,S. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ECG 690 Master's Examination. *1-6. F,S,Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

ECG 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research.

ECG 699 Master's Thesis Preparation. *1-3. F,S,Sum Preq· Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

ECG 700 Price Theory. *3(3-0) . F. Preq: MA 131 and EC(ARE)301.* Intensive analysis of determination of prices and of market behavior, including demand, cost andproduction, pricing under competitive conditions and pricing under monopoly and other imperfectly competitive conditions.

ECG 701 Advanced Price Theory. *3(3-0) . S. Preq: ECG 700,MA 231.* Theory of consumer behavior. Derivation of individual and market demand curves. Consumer surplus. Derivation of firm and market supply curves. Equilibrium and price determination in a market economy. Consideration of alternative market structures.

ECG 702 Prices, Value and Welfare. *3(3-0) . S. Preq: ECG 701.* Production and duality theory. Demand for and supply of factors of production. Theories of capital and interest. Welfare economics topics, including externalities, compensation, public goods and the social welfare function. General equilibrium.

ECG 703 Income and Employment Theory. *3(3-0) . F,S,Sum. Preq: EC(ARE) 301,EC 302,BUS(ST)350,MA 131.* Determinants of national income, employment, wages, the interest rate and inflation. Emphasis on real (as opposed to monetary) determinants of these variables and on microfoundations of modern macroeconomics. Discussion of monetary and fiscal policy and stochastic elements in income determinations.

ECG 704 Advanced Income and Employment Theory. *3(3-0) . F. Preq: ECG 703.* Analysis of forces determining level of income and employment; a review of some of theories of economic fluctuations; and a critical examination of a selected macroeconomic system.

ECG 705 Monetary Economics. *3(3-0) . S. Preq: ECG 704.* Consideration of money market and portfolio management, cost of capital, effects of monetary phenomena on investment and accumulation of wealth with emphasis throughout on problems arising from uncertainty; general equilibrium theory of money, interest, prices and output.

ECG 706 Industrial Organization and Control. *3(3-0) . F. Preq: ECG 700.* Survey of microeconomic literature on industrial organization: internal structure of the firm, number and sizes of firms in an industry, pricing and output behavior of firms. Public policy, including antitrust laws, patent and copyright laws, and government regulation of industry.

ECG 707 Topics in Industrial Organization. *3(3 0) . S. Preq: ECG 700.* Advanced study of selected topics such as oligopoly theory, empirical models of industry, principal-agent contracts, economic theories of firm organization, antitrust issues, economic theories of regulation and economics of property rights.

ECG 708 History of Economic Thought. *3(3-0) . Sum. Alt. Yrs.. Preq: ECG 700 and 703 or equivalent.* Systematic analysis of development and cumulation of economic thought, designed in part to provide sharper focus and more adequate perspective for understanding of contemporary economics.

ECG 710 Theory of Public Finance. *3(3-0) . F, Alt. Yrs.. Preq: ECG 700.* Application of microeconomic theory and welfare economics to public sector. Externalities and public policy, theory of public goods, collective choice, program budgeting and cost-benefit analysis, theory of taxation and its application to tax policy, public debt and fiscal federalism.

ECG 715 Environmental and Resource Economics. *3(3-0) . F. Preq: ECG 700.* Theoretical tools and empirical techniques necessary for understanding of resource and environmental economics, developed in both static and dynamic framework. Discussions of causes of environmental problems, possible policies and approaches to nonmarket valuation. Analysis of resource use over time using control theory for both renewable and exhaustible resources.

ECG 716 Topics in Environmental and Resource Economics. *3(3-0) S Preq: ECG 715.* Advanced study of selected topics in environmental and resource economics. Topics vary with interests of instructor and students.

ECG 730 Labor Economics. *3(3-0) . F. Preq: ECG 700 and one of the following: ECG(ST) 561, ST 422, ST 512, ST 708.* Application of microeconomic theory and econometric methods to labor market behavior in both static and dynamic contexts. Labor demand analysis, labor force participation, hours of work, household production, human capital, distribution of earnings, information and search, and mobility.

ECG 731 Policy and Research Issues in Labor Economics. *3(3-0) . S. Preq: ECG 700 and one of the following: ECG(ST) 561, ST 422, ST 512, ST 708 policy-related issues in labor economics, including trade union behavior,.* Survey of current literature on policy-related issues in labor economics, including trade union behavior, unemployment, macroeconomic aspects of labor market adjustment, discrimination, regulation of wages and benefits and public-sector labor markets. Examples from labor markets in U. S. and developing countries. Recent research developments in labor economics; topics vary according to interests and needs of students.

ECG 740 Advanced Economic Development. *3(3-0) . F, Alt. Yrs. Preq: ECG 700, 540.* Analysis of factors determining growth of poorer countries and regions of countries. Consideration of issues having arisen in current theoretical and empirical bases for policy decisions. The latter elements include the quantitative foundations for planned and programmed development. Evaluation of applications of alternative planning methods.

ECG 741 Agricultural Production and Supply. *3(3-0) F. Preq: ECG 700.* Advanced study in logic of, and empirical inquiry into, producer behavior and choice among combinations of factors and kinds and qualities of output; aggregative consequences of individuals' and firms' decisions in terms of product supply and factordemand; factor markets and income distribution; and general interdependency among economic variables.

ECG 742 Consumption, Demand and Market Interdependency. *3(3-0) . S. Preq: ECG 700.* Analysis of behavior of individual households and of consumers in aggregate with respect to consumption of agricultural products; impact of these decisions on demand for agricultural resources, competition among agricultural regions and for markets;and interdependence between agriculture and other sectors of the economy.

ECG 748 Theory of International Trade. *3(3-0) . F. Preq: ECG 700, 703.* Consideration of specialized body of economic theory dealing with international movement of goods, services, capital and payments. A theoretically oriented consideration of policy.

ECG 749 Monetary Aspects of International Trade. *3(3-0) S Preq ECG 703.* Macroeconomic problems of an open economy including balance of payments adjustment mechanism, alternative exchange rate systems, external effects of monetary and fiscal policy, optimum currency areas and international monetary reform.

ECG 750 Economic Decision Theory. *3(3-0) . S. Alt Yrs Preq: ECG 700.* General theories of choice. Structure of decision problems, role of information: formulation of objectives. Current research problems.

ECG (ST) 751 Econometrics. *3(3-0) . F. Preq: ECG 701 ST 421, ST 422.* Role and uses of statistical inference in economic research; problem of spanning gap from an economic model to its statistical counterpart; measurement problems and their solutions arising from statistical model and nature of the data; limitations and interpretation of results of economic measurement from statistical techniques.

ECG (ST) 752 Topics in Econometrics. *3(3-0) . S Preq: ECG(ST) 751* Survey of current literature on estimation and inference in simultaneous stochastic equations systems. Techniques for combining cross section and time series data including covariance, error correlated and error component models. Lag models and inference in dynamic systems. Production functions, productivity measurement and hypotheses about economic growth. Complete and incomplete prior information in regression analysis. Nonlinear estimation in economic models.

ECG 765 Mathematical Methods for Economics. *3(3-0) S. Preq. MA 231 or equivalent, introductory course in linear algebra.* Linear algebra and matrices, optimization with equality and inequality constraints, comparative statistics, differential and difference equations, intertemporal optimization. Economic applications to utility and profit maximization, national income determination, economic growth, business cycles.

ECG 784 Advanced Macroeconomics. *3(3-0) . F, Alt. Yrs. Preq ECG 704* Advanced study of macro-economics. Emphasis on business cycles and behavior of real variables. Real, incomplete information and disequilibrium theories of the business cycle; rational expectations; contract theory and indexation; investment; and effects of government expenditure, taxes and debt.

ECG 785 Monetary Theory. *3(3-0) . S, Alt. Yrs. Preq: ECG 701, 702, 704, 705.* Advanced study of micro- and macroeconomic theories of role of money in the economy. Primary emphasis on money demand and monetary growth models. Specific areas explored include: traditional and recent developments in both asset and transactions theory and rational expectations and optimal policy. Discussion of empirical record included for most topics.

ECG 790 Avanced Special Topics. *F,S.*

ECG 830 Independent Study. *F,S.*

ECG 885 Doctoral Supervised Teaching. *1-3. F,S. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ECG 890 Doctoral Preliminary Examination. *1-9. F,S. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

ECG 895 Doctoral Dissertation Research. *1-9. F,S,Sum. Preq: Doctoral student.* Dissertation research.

ECG 899 Doctoral Dissertation Preparation. *1-3. F,S,Sum. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

COUNSELOR EDUCATION

ECD 101 University Orientation I. *1(1-0) . F. Open to University Transition Program (UTP) students only.* An orientation to academic requirements of the various colleges and departments at the University, a review of study skills and time management, advising procedures and decision-making skills, designed to assist students to develop a knowledge of major requirements and requisite comprehension and skills to succeed in college.

ECD 102 University Orientation II. *1(1-0) . S. Open to University Transition Program (UTP) students only.* A continuation of ECD 101, the course emphasizes the further development of study skills, time management and methods for the selection of a major field of study.

ECD 220 College Student Development and Peer Counseling. *2(2-0) . F,S. Preq: Sophomore standing. Priority will be given to resident advisors and students active in student organizations or volunteer programs.* Developmental issues of young adulthood with opportunity for the acquisition of paraprofessional counseling skills and crisis intervention skills. Major consideration is given to self-awareness and values clarification through utilization of personality inventories and self-assessment instruments.

ECD 221 Career Planning and Personal Development. *3(3-0) . F,S.* Knowledge, attitudes, self-understanding, and skills needed to enhance career planning and foster personal development. Study of self-understanding, self-talk, goal setting, the environment, and decision making as ways to adapt more effectively to the challenges of life.

ECD 223 Orientation Counselor Training. *2(2-0) . S. Preq: Selection as an Orientation Counselor. Consent of Department.* For new student orientation counselors. Relevant research, student development theory, and shared professional experiences are presented. Class discussion, small group activities, simulations, and journal writing employed. Individual projects andan out-of-class team building experience are required.

ECD 296 Special Topics in Education: Counselor Education. *1-3. F,S,Sum.* Individual or group study of special topics in professional education. The topic and mode of study are determined by the faculty member after discussion with the student.

ECD 510 Introduction to Counseling. *3(3-0) . S. Preq: Six hrs. in ED or PSY.* Introduction to counseling with a focus on three settings: schools, college and community agencies. Exploration of issues of theory, practice and research with regard to children, adolescents, college students and adults. Personal and professional exploration encouraged through use of psychological tests.

ECD 524 Career Counseling and Development. *3(3-0) . S, Sum. Preq: Six hrs. of ED or PSY.* Knowledge and skills needed to: (a) provide professional career counseling to individuals and (b) design, implement and evaluate career development programs for particular groups. Theories of career development and decision making; career guidance programs in educational, agency and industrial setting; career information sources and delivery systems; and assessment in career counseling.

ECD 525 Cross Cultural Counseling. *3(3-0) . S,Sum. Preq: Six hours of Educ or Psych.* Theory and practice of counseling culturally different clients. Client populations include African Americans, Asian-Americans, American Indians and Hispanics. Cultural assumptions, cultural values, counselor credibility, prejudice and racism in context of counseling.

ECD 530 Theories and Techniques of Counseling. *4(3-2) . F,S,Sum. Preq: Six hrs. of ED or PSY.* Theory, philosophy with techniques of counseling. Behavioral approaches, psychoanalytic approaches, client-centered counseling, existential counseling and relationship models, and their relation to counseling. Presentation of techniques related to each theory. Basic counseling skills taught in laboratory setting, including attending, listening and challenging.

ECD 533 Guidance and Counseling in the Secondary Schools. *4(3-1) . F. Preq: Grad. Standing.* Examination of (1) theoretical framework for roles and functions of secondary school counselors, (2) primary and secondary prevention strategies and (3) evaluation and administration procedures, to develop and implement model programs for secondary schools.

ECD 534 Guidance and Counseling in Elementary and Middle Schools. *4(3-1) . F. Preq: Grad. Standing.* Examination of (1) theoretical framework for roles and functions of elementary and middle school counselors, (2) primary and secondary prevention strategies and (3) evaluation and administration procedures to develop and implement model programs forelementary and middle schools.

ECD 535 Student Development in Higher Education. *4(3-2) . F. Preq: Grad. standing or PBS status.* Student development theory, research and practice as well as overview of profession. Three main professional roles of counselor, administrator and student development educator. Discussion of cognitive, psychosocial, topological and person-environment theories and various functions in student affairs. Instruction in and design of structured group work in laboratory.

ECD 536 Community Service Agencies. *4(3-2) . F. Preq: Graduate Standing.* Issues, functions and scope of work being done in various human service agency programs; overview of helping approaches with selected client populations; related professional concerns. Instruction in and design of structured group work in laboratory.

ECD 539 Group Counseling. *3(3-0) . F. Sum. Preq. ECD 530 and one of the following: ECD 510, 534, 535 or 536.* Theory and practice of group counseling. Theoretical positions include client-centered, behavioral and rational-emotive. Aspects of group process include group leadership, group membership, establishing and maintaining a group.

ECD (WGS) 540 Gender Issues in Counseling. *3(3-0) . S,Sum. Preq: Grad. standing or 6 hrs. of ED or PSY.* Exploration of gender as primary identity and social construct. Emphasis on gender dynamics in counseling, client empowerment and preventive approaches.

ECD 543 The American College Student. *3(3-0) . S. Preq: ECD 535 or doctoral standing.* Advanced-level course designed for investigation of five main families of theories of college student development as presented by Chickering, Perry, R. Heath, Myers-Briggs, Holland and D. Heath. Assessment and research in student development and students design and implement a developmental intervention based on Knefelkamp and Wells' Practice-to-Theory-to-Practice model.

ECD 560 Research and Assessment in Counseling. *3(3-0) . S,Sum. Preq: Grad. standing.* Research and assessment issues in counseling. Emphasis on writing research proposals in counseling and critiquing articles in counseling research. Exploration of meaning and importance of assessment in counseling. Examination of research designs in counseling.

ECD 590 Special Problems in Guidance. *1-6. F,S. Preq: Six hrs. grad. work in dept. or equivalent and Consent of Instructor.* For individual or group studies of one or more of major problems in guidance and personnel work. Problems selected to meet interests of individuals. Workshop procedure used whereby special projects, reports and research developed by individuals and by groups.

ECD 620 Special Problems in Guidance. *1-6. F,S,Sum. Preq: Six hrs. grad. work in dept. or equivalent and Consent of Instructor.* For individual or group studies of one or more of major problems in guidance and personnel work. Problems selected to meet interests of individuals. Workshop procedure used whereby special projects, reports and research developed by individuals and by groups.

ECD 641 Introductory Practicum in Counseling. *1(1 0) . S. Preq: ECD 530, 525; Consent of Instructor.* Student participation in introductory supervised individual and group counseling experiences in laboratory setting.

ECD 642 Practicum in Counseling. *6(6-0) F Preq: ECD 641 and Consent of Instructor.* Student participation in individual and group counseling and consultation experiences under supervision in a school, college or agency setting.

ECD 651 Internship in School Counseling. *3-9. F S,Sum. Preq: ECD 642* A 600-hour internship for school counselors in training in a school setting under the supervision of qualified professionals. Students perform a variety of activities expected fo school counselors. Weekly meetings with faculty and on-site supervisors.

ECD 652 Internship in College Student Development. *3-9. F S Sum. Preq· ECD 642; Consent of Instructor.* A 600-hour internship. Professional experience in student affairs department with on-site supervision from qualified professional. Expectations including employment of broad repertoire of skills in roles of counselor, student development educatorand administrator. Weekly student meetings with faculty and on-site supervisors.

ECD 653 Internship in Agency Counseling. *3-9. F,S,Sum. Preq: ECD 642; Consent of Instructor.* A 600-hour internship for community agency counselors in agency counseling setting under supervision of qualified professional. Employment of broad repertoire of primary and secondary prevention approaches to individual and group techniques, workshop leadership skills, consultation techniques and advocacy methods. Weekly meetings with faculty and on-site supervisors.

ECD 660 Supervised Practice Teaching in Counselor Education. *3(1-6). F,S,Sum. Preq: Doctoral Standing, CI.* Participation of doctoral students in Counselor Education in teaching of approved master's level or undergraduate courses with graduate faculty members serving as mentors.

ECD 692 Research Projects in Counselor Education. *1-3. F,S,Sum. Preq: Consent of Instructor; ELP 532 or equivalent.* Project or problem in research in education for graduate students, supervised by members of graduate faculty. Research chosen on basis of individual students' interests and not to be part of thesis or dissertation research.

ECD 693 Master's Supervised Research. *1-6. F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ECD 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research.

ECD 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Doctoral student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

ECD 731 Career Development Theory and Research. *3(3-0) . F,S. Preq: ECD 524, ELP 532 and PSY 535.* Analysis of theory and research in career development and work adjustment as basis for intervention (career counseling, curricular, organizational) as research.

ECD 733 Cognitive-Behavioral Theory, Research, and Practice. *3(3-0) . S. Alt. Yrs.(even). Preq: ECD 737; Consent of Instructor. Coreq: ST 700.* Behavioral and cognitive behavioral change methods and research supporting their efficacy in counselor education. Major focus on synthesis of cognitive-developmental and cognitive-behavioral methods.

ECD 735 Counseling Supervision: Theory and Research. *3(3-0) . S. Preq: Doctoral standing; Consent of Instructor.* Examination of conceptual and methodological issues relating to supervision and evaluation of novice counselors. Special emphasis on developmental supervision approaches.

ECD 737 Cognitive Developmental Theory, Research and Practice. *3(3-0) . F, Alt Yrs.(odd). Preq: Doctoral standing. PSY 535, ST 507. Coreq: ST 508* Review of contemporary cognitive-developmental theories and literature describing their application. Theories by Piaget, Kohlberg, Hunt, Erikson, Loevinger, and Perry. Measurement of developmental constructs and their psychometric properties. Reviews of studies employing deliberate psychological education as method of primary prevention.

ECD 738 Research in Counselor Education. *3(3-0) S. Alt. Yrs. (even) Preq Doctoral standing; ST 507; PSY 535. Coreq. ST 508* Instruction in required skills and knowledge to conduct research in counselor education, including narrative and quantitative integration of research, experimental and quasi-experimental designs, analogue and process research, single subject and descriptive designs, and qualitative research. Preparation of narrative and meta-analytic research review and research proposal with oral presentation.

ECD 790 Special Problems in Guidance. *1-6. F,S,Sum. Preq: Six hrs. grad. work in dept. or equivalent and Consent of Instructor.* For individual or group studies of one or more of major problems in guidance and personnel work. Problems selected to meet interests of individuals. Workshop procedure used whereby special projects, reports and research developed by individuals and by groups.

ECD 820 Special ProblemsiIn Guidance. *1-6. F,S,Sum. Preq: Six hrs. grad. work in dept. or equivalent and Consent of Instructor.* For individual or group studies of one or more of major problems in guidance and personnel work. Problems selected to meet interests of individuals. Workshop procedure used whereby special projects, reports and research developed by individuals and by groups.

ECD 843 Advanced Counseling Practicum. *3(3-0) . S. Preq: Doctoral standing; ECD 642.* Participation of doctoral-level students with previous counseling experience in advanced, supervised counseling experience.

ECD 847 Counseling Supervision: Practicum. *3(3-0) . F. Preq: ECD 735.* A supervised practicum for doctoral students in assisting with the supervision of first-year students in laboratory and practicum experiences in individual and group counseling and consultation.

ECD 850 Doctoral Internship. *3-9. F,S,Sum. Preq: Nine hrs. in grad. level courses and Consent of Instructor.* Utilizing participant-observer role, participation required in selected educational situations with emphasis upon development of observational skills, ability to record relevant observations by means of written journals, skills in analyzing experiences identifying critical incidents and projection of events and consequences. Student required to develop possible alternative courses of action in various situations, select one of the alternatives and evaluate consequences.

ECD 860 Professional Issues in Counseling. *1-3. F,S, Alt. Yrs.. Preq: Doctoral standing.* Consideration of contemporary issues, trends and recent research in field of counseling.

ECD 886 Supervised Practice Teaching in Counselor Education. *3(1-6) . F,S,Sum. Preq: Doctoral standing, Consent of Instructor.* Participation of doctoral students in Counselor Education in teaching of approved master's level or undergraduate courses with graduate faculty members serving as mentors.

ECD 892 Doctoral Research Projects. *1-3. F S,Sum. Preq: Consent of Instructor.* Project or problem in research in education for graduate students, supervised by members of graduate faculty. Research chosen on basis of individual students' interests and not to be part of thesis or dissertation research.

ECD 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ECD 895 Doctoral Dissertation Research. *1-9. F,S,Sum. Preq: Doctoral student.* Dissertation research.

ECD 899 Doctoral Dissertation Preparation. *1-3. F,S,Sum. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

ELECTRICAL ENGINEERING

ECE 200 Introduction to Electrical and Computer Engineering Laboratory. *2(1-3) F,S. Preq: MA 241. Coreq: PY 208. Restricted to students who are enrolled in EE or CPE curricula* Laboratory with experiments in six groups designed to provide an overview of electrical and computer engineering: Fundamental Concepts, Analog Electronic Circuits, Digital Circuits, Communication Systems, Signal Processing

ECE 206 Introduction to Computer Organization. *3(3-1). F,S,Sum. Preq. Soph. standing and GPA 2.5 or above, with a C- or better in ENG 111, MA 141, MA 241 and PY 205. Coreq: ECE 200.* Introduction to key concepts in computer organization. Number representations, switching circuits, logic design, microprocessor design, assembly language programming, input/output, interrupts and traps, direct memory access, structured program development.

ECE 211 Electric Circuits. *3(3-0) . F,S,Sum. Preq: A grade of C- or better in MA 241; PY 208 and ECE 200.* Introduction to theory, analysis and design of electric circuits. Voltage, current, power, energy, resistance, capacitance, inductance. Kirchhoff's laws node analysis, mesh analysis, Thevenin's theorem, Norton's theorem, steady state and transient analysis, AC, DC, phasors, operational amplifiers, transfer functions.

ECE 212 Fundamentals of Logic Design. *3(3-0) . F,S,Sum. Preq: Soph. standing and GPA 2.4 or above, with a C or better in ENG 111, MA 141, MA 241 and PY 205.* Introduction to digital logic design. Boolean algebra, switching functions, Karnaugh maps, modular combinational circuit design, flip-flops, latches, programmable logic, and synchronous sequential circuit design. Use of several CAD tools for logicsynthesis, state assignment, and technology mapping.

ECE 213 Electric Circuits I Laboratory. *1(0-3) . F,S,Sum. Preq: ECE 211 (Independent Study Students). Coreq: ECE 211.* Laboratory work on material treated in ECE 211 emphasizing elementary design principles.

ECE 214 Fundamentals of Logic Design Laboratory. *1(0-3) . F,S,Sum. Coreq: ECE 212.* Laboratory on material treated in ECE 212 emphasizing elementary design principles.

ECE 220 Analytical Foundations of Electrical and Computer Engineering. *3(2-2) F,S. Preq: MA 242. Coreq: ECE 211.* The modeling, analysis and solution of circuit theory, control, communication, computer, and other system arising in electrical and computer engineering using various analytical techniques. Numerical solutions to ECE problems using MATLAB and SPICE.

ECE 221 Electric Circuits II. *3(2-2) . F,S,Sum. Preq: A grade of C or better in ECE 211.* Continuation of study of electric circuits. Multi-port networks, two-port networks with energy storage, ideal transformers. Analysis and design of nonlinear devices and linear models, load-line methods, diodes, and transistor models. Transients in linear circuits, complex impedance. AC power and three-phase circuits. Y-Delta equivalents, complex power. Amplifiers and frequency response, s-domain, Bode plots, filters. Matrix methods in circuit analysis and design.

ECE 223 Electric Circuits II Laboratory. *1(0-3) . F,S,Sum. Coreq. ECE 221.* Laboratory work on material treated in ECE 221 emphasizing elementary design principles.

ECE 292 Special Topics in Electrical and Computer Engineering. *1 3. F,S,Sum.* Special topics in electrical and computer engineering at the early undergraduate level.

ECE 301 Linear Systems. *3(2-2) . F,S,Sum. Preq: A grade of C- or better in ECE 221.* Representation and analysis of linear systems using differential equations: impulse response and convolution, Fourier series, and Fourier and Laplace transformations for discrete time and continuous time signals. Emphasis on interpreting system descriptions in terms of transient and steady-state response. Digital signal processing.

ECE 303 Electromagnetic Fields. *3(3-0) . F,S,Sum. Preq: MA 341 and a grade of C- or better in ECE 221.* Static electric and magnetic fields. Maxwell's equations and force laws. Propagation, reflection and refraction of plane waves. Transient and steady-state behavior of waves on transmission lines.

ECE 305 Electric Power Systems. *3(3-3) . F. Preq: A grade of C or better in either ECE 221 or ECE 331.* Principles, performance and characteristics of power-system components, including direct-current and alternating-current machinery, transformer banks and transmission lines. Principles and analysis of system power flow.

ECE 314 Electronic Circuits. *3(3-3) . F,S. Preq: ECE 211* Introduction to the physics of semiconductors, PN Junctions, BJT and MOS field Effect Transistors: Physics of operation, IV characteristics, circuit models. SPICE analysis; simple diode circuits; Single Stage Transistor Amplifiers: Common Emitter and Common Source configurations, biasing, calculations of small signal voltage gain, current gain, input resistance and output resistance; Introduction to Differential Amplifiers, Operational Amplifiers.

ECE 331 Principles of Electrical Engineering I. *3(3-0) . F,S,Sum. Preq: MA 241, PY 208. Not available to EE and CPE majors.* Concepts, units and methods of analysis in electrical engineering. Analysis of d-c and a-c circuits, characteristics of linear and non-linear electrical devices, transformers, motors and control systems.

ECE 339 Principles of Electrical Engineering Laboratory. *1(0-3) . F,S. Coreq: ECE 331. Not available to EE and CPE majors.* Basic concepts of electricity. Use of test equipment and development of lab skills to build and troubleshoot circuits. Passive and active components in analog circuits. Combinational logic and sequential logic in digital circuits. Major final project.

ECE 341 Solid-State Devices. *3(3-0) . F,S,Sum. Preq: A grade of C or better in ECE 221. Credit is not permitted in both ECE 341 and ECE 441.* Basic principles required to understand the operation of modern solid-state devices. Derivation of electrical characteristics of devices such as diodes, bipolar transistors, MOS transistors and LEDs. Applications to design of electronic circuits.

ECE 402 Communications Engineering. *3(2 3) . F,S. Preq: ECE 301, ECE 314, ST 370(MA 314).* Fundamentals of communications engineering. PCM, digital transmission, PSK, QAM, baseband, FSK, ASK; link budgets for satellite, cellular, and cable systems. Brief coverage of AM, FM, SSB, error correction/detection, modulation, the effects of noise and bandwidth.

ECE 403 Electronics Engineering. *3(2-3) . S. Preq: ECE 301, ECE 314.* Design and analysis of discrete and integrated electronic circuits, from single-transistor stages to operational amplifiers, using bipolar and MOS devices. Feedback in operational amplifier circuits, compensation and stability. Laboratory design projects.

ECE 406 Design of Complex Digital Systems. *3(3-3) . F,S. Preq. A grade of C or better in ECE 206.* Design principles for complex digital systems: Iteration, top-down/bottom-up, divide and conquer, and decomposition. Descriptive techniques, including block diagrams, timing diagrams, register transfer, and hardware-description languages. Consideration of transmission-line effects on digital systems.

ECE 407 Introduction to Computer Communications. *3(3-0) . S. Preq. ECE 301, MA 314.* Engineering principles of computer communications: summary of digital transmission, media and switching; error control, layering concept, overview of protocols; architectures for local, metropolitan, and wide-area networks; emerging issues in digital communications systems.

ECE 420 Wireless Communication Systems. *3(3-0) . F,S. Preq: ECE 402.* System level understanding of wireless mobile communications systems. Mobile radio propogation, system definitions, applicable traffic models, coding, modulation, frequency reuse, cellular concept, equalization; standards such as AMPS, USDC, CDMA(IS-95), GSM.

ECE 421 Introduction to Signal Processing. *3(3-0) . F,S. Preq: ECE 301, ECE 221, MA 314.* Concepts of electrical signal processing. Fourier series, Fourier transform, Z-transform, advanced linear systems and stochastic processes. Analog/digital and digital/analog conversion, digital filters and modulation. Major design project.

ECE 422 Transmission Lines and Antennas for Wireless. *3(3-0) . F. Preq: ECE 303.* Review of time-varying electromagnetic theory. A study of the analytical techniques and the characteristics of several useful transmission lines and antennas. Examples are coaxial lines, waveguides, microstrip, optical fibers and dipole, monopole and array antennas.

ECE 434 Electronic Energy Converters. *3(3-0) . F. Preq: ECE 314.* Energy conversion using switched high-voltage high-current diodes, transistors and SCRs in combination with inductors and capacitors. Converter families: rectifiers, phase-controlled rectifiers, line-commutated inverters, dc-to-dc converters, and dc-to-ac inverters. Basic closed-loop control techniques. Sample applications for each family of converter. Substantial independent group design project.

ECE 435 Elements of Control. *3(3-0) . F. Preq: ECE 301.* Analog system dynamics, open- and closed-loop control, block diagrams and signal flow graphs, input-output block diagrams and signal flow graphs, input-output relationships, stability analyses using Routh-Hurwitz, root-locus and Nyquist, time- and frequency-domain analysis and design of analog control systems. Use of computer-aided analysis and design tools. Class project.

ECE 436 Digital Control Systems. *3(3-0) . S. Preq. ECE 435.* Discrete systems dynamics, sampled-data systems, mathematical representations of analog/digital and digital/analog conversions, open- and closed-loop systems, input-output relationships, state-space and stability analyses, time- and frequency-domainanalyses. Design and implementation of digital controllers.

ECE 437 Distributed Real Time Control Systems. *3(2-4) . F,S. Preq: ECE 206, ECE 301.* principles for designing an intelligent distributed control system which includes multiple embedded microprocessors communicating over a computer network. Design of basic components, modes, input/output interface, and communication network. Real-time implementation issues, such as sampling, task scheduling, and network traffic control. Lab experiments on design of basic components, plus a major design project.

ECE 441 Introduction to Solid-State Devices. *3(3-0) . F. Preq: ECE 314, ECE 303.* Basic principles required to understand the operation of solid-state devices. Semiconductor device equations developed from fundamental concepts. P-N junction theory developed and applied to the analysis of devices such as varactors, detectors, solar cells, bipolar transistors, field-effect transistors. Emphasis on device physics rather than circuit applications.

ECE 442 Integrated Circuit Technology and Fabrication. *3(2-3) . F. Preq: ECE 341 or 441.* Semiconductor device and integrated-circuit processing and technology. Wafer specification and preparation, oxidation, diffusion, ion implantation, photolithography, design rules and measurement techniques.

ECE 451 Power System Analysis. *3(3-0). Preq: ECE 305.* Long-distance transmission of electric power with emphasis on load flow, economic dispatch, fault calculations and system stability. Applications of digital computers to power-system problems. Major design project.

ECE 453 Distribution System Analysis, Design and Operation. *3(3 0) . S. Preq: ECE 305.* Electric power distribution systems: load characteristics, short-term load forecasting, capacitive compensation, voltage regulation and control. Distribution transformers. Design of subtransmission and distribution substations, distribution primary systems. Distribution system operations and automation.

ECE 455 Computer Control of Robots. *3(2-3) . F,S. Preq: ECE 314 and a grade of C or better in ECE 206.* Techniques of computer control of industrial robots: interfacing with synchronous hardware including analog/digital and digital/analog converters, interfacing noise problems, control of electric and hydraulic actuators, kinematics and kinetics of robots, path control, force control, sensing including vision. Major design project.

ECE 456 Mechatronics. *3(2-3) . F,S. Preq: ECE 301, ECE 206.* The study of electro-mechanical systems controlled by microcomputer technology. The theory, design and construction of smart systems; closely coupled and fully integrated products and systems. The synergistic integration of mechanisms, materials, sensors, interfaces, actuators, microcomputers, controllers, and information technology.

ECE (CSC) 460 Digital Systems Interfacing. *3(3-0) . F. Preq: A grade of C or better in either ECE 206 or CSC 312.* Concepts of microcomputer system architecture and applications to fundamental computer hardware. Theoretical and practical aspects of interfacing and a variety of microprocessor peripheral chips with specific microprocessor/microcomputer systems from both hardware and software points of view.

ECE 463 Advanced Microprocessor Systems Design. *3(3-0) . Preq: ECE 406.* Advanced topics in microprocessor systems design, including processor architectures, virtual-memory systems, multiprocessor systems, and single-chip microcomputers. Architectural examples include a variety of processors of current interest, both commercial and experimental. Major design project.

ECE 464 ASIC Design. *3(2-3) . S. Preq: ECE 342; ECE 314.* Design of digital application specific integrated circuits (ASICs) based on hardware description languages (Verilog, VHDL) and CAD tools. Emphasis on design practices and underlying algorithms. Introduction to deep sub-micron design issues like interconnections and low power and to modern applications including multi-media, wireless. Telecommunications and computing. Required design project.

ECE 465 Engineering Applications of Artificial Intelligence. *3(3 0) . Preq: Senior standing in CPE or EE.* Engineering applications of artificial intelligence (AI): Problem-solving techniques, knowledge acquisition, knowledge representation, production systems, expert systems, AI languages, neural networks, and machine learning. Design projects required.

ECE 466 Compiler Optimization and Scheduling. *3(3-0) . S. Preq: ECE 206 and CSC 314* Provide insight into current compiler designs dealing with present and future generations of high performance processors and embedded systems. Investigate dataflow analysis and memory disambiguation, classical and parallelism enhancing optimizations, scheduling and speculative execution, and register allocation. Review of techniques used in current research compilers.

ECE 470 Internetworking. *3(2-3) . F,S. Preq: ECE 410 (formerly ECE 407) or CSC 401.* Introduction, Planning and Managing networking projects, networking elements-hardware, software, protocols, applications; TCP/IP, ATM, LAN emulation. Design and implementation of networks, measuring and assuring network and application performance; metrics, tools, quality of service. Network-based applications, Network management and security.

ECE 471 Introduction to Telecommunications Engineering. *3(3-0) . F,S Preq. ECE 301, MA 314.* Design and operation of telecommunications systems: switching hierarchy, characteristics of signals and impairments, measurements of signals and noise, transmission media, teletraffic theory, switching systems.

ECE 480 Senior Design Project in Electrical Engineering. *4(3-3) . F,S. Preq: ECE 206, 301, 303, 305 or 341 314; COM 110, ENG 331. EE majors only.* Applications of engineering and basic sciences to the total design of electrical engineering circuits and systems. Consideration of the design process including feasibility study, preliminary design detail, cost effectiveness, along with development and evaluation of a prototype accomplished through design-team project activity. Complete written and oral engineering report required.

ECE 481 Senior Design Project in Computer Engineering. *4(3-3) . F,S. Preq: ECE 301, 314, 342; CSC 244, 314; COM 110; ENG 331. CPE majors only.* Application of engineering and basic sciences to the total design of hardware and software systems. Consideration of the design process including feasibility study, preliminary design detail, cost effectiveness, along with development and evaluation of a prototype accomplished through design-team project activity. Complete written and oral engineering report required.

ECE 492 Special Topics in Electrical and Computer Engineering. *1-4. F,S. Preq: Consent of instructor.* Offered as needed for development of new courses in electrical and computer engineering.

ECE (CSC) 506 Architecture of Parallel Computers. *3(3-0) . F. Preq: CSC 312 or ECE 342.* Need for parallel computers and their potential performance. Taxonomy of parallel computer architecture. Arithmetic pipeline design and vector processes. Single and multi-stage interconnection networks, massively parallel computing with array machines shared memory and distributed memory multi-processor computers. Memory system, design issues, applications/ algorithms for parallel computers.

ECE (CSC) 510 Software Engineering. *3(3-0) . F. Preq: CSC 314 and CSC 224.* An introduction to software life cycle models; size estimation; cost and schedule estimation; project management; risk management; formal technical reviews; analysis, design, coding and testing methods; configuration management and change control; and software reliability estimation. Emphasis on large development projects. An individual project required following good software engineering practices throughout the semester.

ECE (CSC) 517 Object-Oriented Languages and Systems. *3(3 0) . F.* Object-oriented languages and systems built with object-oriented software components. Systems concepts, including inheritance, dynamic binding, type systems and genericity; implementation in specific languages, e.g., Smalltalk, C++ and Eiffel. Object-oriented programming environments and object-oriented databases. Project required.

ECE 520 Digital Asic Design. *3(3-0) . Preq: ECE 342.* Design of digital Application Specific Integrated Circuits (ASICs) based on Hardware Description Languages (Verilog, VHDL) and CAD tools, particularly login synthesis. Emphasis on design practices and underlying algorithms. Introduction to timing-driven design, low-power design, design-for-test and ASIC applications. Project.

ECE 521 Computer Design and Technology. *3(3-0) . S. Preq: ECE 342.* Design of general-purpose computers through cost-performance analysis. Emphasis on making design decisions regarding the instruction set architecture and organization of single-processor computer. Discussion of design choices, role of compiler and techniques for analysis, simulation and implementation. Consideration of relationships between architecture, organization and technology

ECE 549 RF Design for Wireless. *3(3-0) . S. Preq: ECE 303, ECE 314.* Design of the hardware aspects of wireless systems with principle emphasis on design of radio frequency (RF) and microwave circuitry. Introduction of system concepts then functional block design of a wireless system. RF and microwave transistors, noise, power amplifiers, CAE, linearization and antennas.

ECE (PY) 552 Introduction to the Structure Of Solids. *3(3-0) . Preq: PY 401.* Basic considerations of crystalline solids, metals, conductors and semiconductors.

ECE (CSC) 570 Computer Networks. *3(3-0) . S. Preq: CSC 312.* Detailed description and related performance issues of OSI layers two and three for wide-area networks, well-known standards for metropolitan area networks such as FDII and DQDB, and basic random access mechanisms for local area networks.

ECE (CSC) 571 Telecommunications Systems Engineering. *3(3-0) . F,S. Preq: ECE 471 and ECE 402; ST 361 or ST 422.* Systems aspects of telecommunications system design and analysis. Interrelationships of component subsystems affecting behavior of whole system. Statistical definitions of system requirements and system performance. Economics of telecommunications systems and regulated environment. Case studies.

ECE (CSC) 572 Introduction to Computer Communications. *3(3-0) . F. Preq: CSC 312 or ECE 206. Coreq: B average in technical subjects.* Computer communications including local area networks (LANs), metropolitan area networks (MANs), wide area networks (WANs), standard organizations, open system architecture (OSI), IBM's system network architecture (SNA), network performance and topological optimization.

ECE (CSC) 573 Internet Protocols. *3(3-0) . F. Preq: CSC/ECE 570.* Principles and issues underlying provision of wide area connectivity through interconnection of autonomous networks. Internet architecture and protocols today and likely evolution in future. Case studies of particular protocols to demonstrate how fundamental principles applied in practice. Selected examples of networked clinet/server applications to motivate the functional requirements of internetworking. Project required.

ECE (CSC) 576 High Speed Networks. *3(3-0) . S. Preq: CSC/ECE 571.* Topics related to high-speed networks such as: frame relay, high-speed LANs and MANs, the asynchronous transfer mode (ATM) architecture, adaptation layers, switch architectures, preventive and reactive congestion control schemes, schemes for connectionless services over ATM, transmission schemes and signaling.

ECE (CSC, OR) 579 Introduction to Computer Performance Modeling. *3(3-0) . F. Preq: CSC 312 and MA 421.* Workload characterization, collection and analysis of performance data, instrumentation, tuning, analytic models including queuing network models and operational analysis, economic considerations.

ECE 591 Special Topics in Electrical Engineering. *3(3-0) . F,S. Preq: B average in technical subjects.* Two-semester sequence to develop new courses and to allow qualified students to explore areas of special interest.

ECE 592 Special Topics in Electrical Engineering. *3(3 0) . F,S. Preq. B average in technical subjects.* Two-semester sequence to develop new courses and to allow qualified students to explore areas of special interest.

ECE 633 Individual Topics in Electrical Engineering. *1 3. F,S. Preq: B average in technical subjects.* Provision of opportunity for individual students to explore topics of special interest under direction of a member of faculty.

ECE 634 Individual Studies in Electrical Engineering. *1-3 F,S. Preq. Grad. standing.* The study of advanced topics of special interest to individual students under direction of faculty members.

ECE 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ECE 693 Master's Supervised Research. *1-9. F,S. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ECE 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research.

ECE 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

ECE 703 Instrumentation Circuits. *3(3-0) . S. Preq: ECE 403.* Design principles of instrumentation circuits from functional perspective. Detailed discussion of circuit techniques used in analog subsystems such as amplifiers, filters, mixers and power supplies. Broad coverage of circuit applications such as voiceband CODECs, FM receivers and automatic impedance analyzers.

ECE 704 Logic Design for Testability. *3(3 0) . S. Preq: ECE 320.* Survey of design for testability and testing methods. Fault modeling, fault simulation, test generation, built-in self test, scan methods and automatic test equipment.

ECE 711 Analog Electronics. *3(2-3) . F. Preq: ECE 403, grad standing or B average in ECE and MA.* Analog integrated circuits and analog integrated circuit design techniques. Review of basic device and technology issues Comprehensive coverage of MOS and Bipolar operational amplifiers. Brief coverage of analog-to-digital conversion techniques and switched-capacitor filters. Strong emphasis on use of computer modeling and simulation as design tool. Students required to complete an independent design project.

ECE 712 Analog VLSI. *3(3 0) . S* Survey of advanced topics in very large scale analog circuits (VLSI). In-depth coverage of analog-to-digital and digital-to-analog conversion, and switched-capacitor and other monolithic filtering techniques. Brief coverage of special circuits for telecommunications and biomedical applications.

ECE 713 Digital Signal Processing. *3(3-0) . S. Preq: ECE 421, B average in ECE and MA or Consent of Instructor.* Digital processing of analog signals. Offline and real-time processing for parameter, waveshape and spectrum estimation. Digital filtering and applications in speech, sonar, radar, data processing and two-dimensional filtering and image processing.

ECE 714 Random Processes. *3(3-0) . F. Preq: ECE 301, MA 314.* Probabilistic descriptions of signals and noise, including joint, marginal and conditional densities, autocorrelation, cross-correlation and power spectral density. Linear and nonlinear transformations. Linear least-squares estimation. Signal detection.

ECE 715 Digital Communications. *3(3 0) . S. Preq: ECE 714.* Theory and analysis of digital communications in presence of noise and channel distortion. Information theory, modulation/demodulation, block and convolutional encoding/decoding, bit error rate analysis and detection theory. Modulation/ demodulation techniques include frequency shift keying, M-level phase shift keying and quadrature amplitude modulation.

ECE 716 System Control Engineering. *3(3-0) F. Preq: ECE 432 or ECE 301.* Introduction to analysis and design of continuous and discrete-time dynamical control systems. Emphasis on linear, single-input, single-output systems using state variable and transfer function methods. Open and closed-loop representation; analog and digital simulation; time and frequency response; stability by Routh-Hurwitz, Nyquist and Liapunov methods; performance specifications; cascade and state variable compensation. Assignments utilize computer-aided analysis and design programs.

ECE (MAE, TE) 717 Multivariable Linear Systems Theory. *3(3-0) .S. Alt yrs (even). Preq: ECE 716 or MAE 721.* Advanced theory of control to linear systems with application to textile processing systems. Transfer matrices, controllability/observability, LQR. Algebraic treatment of feedback systems, coprime factorization. Analytic and harmonic functions, H design.

ECE 718 Computer-Aided Circuit Analysis. *3(3-0) . F. Preq: ECE 711.* Steady state and transient analysis of circuits with emphasis on circuit theory and computer methods. Consideration of many analysis techniques, including linear nodal, signal flow graph, state equation, time-domain and functional simulation and analysis of sampled data systems. Sensitivity and tolerance analysis, macromodeling of large circuits and nonlinear circuit theory.

ECE 719 Microwave Circuits Design. *3(3-0) . S. Alt. Yrs Preq: ECE 732.* Development and examination of techniques for design of microwave and millimeterwave components and systems. Introduction and discussion of radar and radiometer systems. Investigation of system-imposed constraints upon component performance. Specific topics include mixer, oscillator and amplifier performance and design. Usage of modern computer-aided design techniques.

ECE 722 Electronic Properties of Solid-State Materials. *3(3-0) .S Preq ECE 730.* Review of energy bands in semiconductors. Detailed treatment of thermal and electrical transport phenomena, equilibrium and non-equilibrium semiconductor statistics. Also optical properties and hot electron effects in solid-state materials.

ECE 723 Optical Properties of Semiconductors. *3(3-0) . F, Alt. Yrs. Preq: ECE 730.* Materials and device-related properties of compound optical semiconductors studied. Included topics: optical constants, absorption and emission processes in semiconductors, photodetectors, LED's semiconductor lasers.

ECE 724 Electronic Properties of Solid-State Devices. *3(3-0) . S. Preq: ECE 730.* Basic physical phenomena responsible for operation of solid-state devices. Examination and utilization of semiconductor equations examined and utilized to explain basic principles of operation. Examination of rectifying and ohmic contacts. Various state-of-the-art devices studied in detail.

ECE 725 Optical Signal Processing. *3(3-0) . F Preq: ECE 301.* Review of key principles from geometric optics; resolving power and the optical invariant and their relation to principles of communication theory: Fresnel and Fourier transformations and a study of direct and heterodyne detection, photodetectors, dynamic range, spatial filtering and carrier-frequency methods; applications such as spectrum analysis, pattern recognition and signal detection.

ECE 726 Advanced Feedback Control. *3(3-0) . S Preq: ECE 716.* Advanced topics in dynamical systems and multivariable control. Current research and recent developments in the field.

ECE (PY) 727 Semiconductor Thin Films Technology. *3(3-0) . S, Alt. yrs. Preq: ECE 730.* Techniques and processes encountered in growth and characterization of epitaxial semiconductor films. Examples of growth techniques: solution growth, chemical vapor deposition, molecular beam epitaxy and sputtering. Film characterization includes electrical characterization using Hall techniques, optical characterization using x-ray and electron microscopy techniques, surface and thin film analysis such as auger and secondary ion mass-spectrometer.

ECE 728 Preparation of Electronic Materials. *3(3-0) . S, Alt. Yrs. Preq: ECE 730.* The principles governing preparation of electronic materials from solid, liquid and gaseous states. Emphasis on experimental methods and on factors affecting electronic behavior of materials, such as non-stoichiometry, charged and uncharged defects.

ECE 729 Growth of Thin Films From the Vapor Phase. *3(3-0) . S, Alt Yrs Preq: ECE 730.* Practical and basic aspects of single and polycrystal growth using chemical vapor transport processes. Emphasis on materials of interest in microelectronics and on experimental methods used to implement chemical vapor processes and to understand chemical vapor processes.

ECE 730 Physical Electronics. *3(3-0) . F. Preq: ECE 303, B average in ECE and MA.* Properties of charged particles under influence of fields and in solid materials. Quantum mechanics, particle statistics, semi-conductor properties, fundamental particle transport properties, p-n junctions.

ECE 731 Principles of Transistor Devices. *3(3-0) . S. Preq: ECE 441.* Analysis of operating principles of transistor structures. Basic semi-conductor physics reviewed and used to provide explanation of transistor characteristics. Development and usage of device-equivalent circuits to interpret semi-conductor-imposed limitations on device performance. Devices analyzed include MISFIT'S, HEMT'S, Bipolar transistors, PBT'S, heterojunction BJT'S and SIT's.

ECE 732 Principles of Microwave Circuits. *3(3-0) . F. Preq: ECE 442.* Principles required to understand behavior of electronic circuits operating at microwave frequencies. Review of elector-magnetic theory and establishing an understanding of techniques required for working with electronic circuits at microwave and millimeter-wave frequencies. Discussion of circuit components operating at these frequencies.

ECE 733 Digital Electronics. *3(3-0) . S. Preq: ECE 314.* Digital integrated circuits and digital integrated circuit design techniques. Aims in digital circuit design; DC and transient analysis of CMOS, TTL. ECL, BiCMOS and GaAs digital circuits: optimizing for speed and power consumption; interconnect design and analysis; semiconductor memory circuits; packaging and timing considerations.

ECE 734 Switchmode DC-to-DC Converters. *3(3-0) . S. Preq: ECE 314, ECE 403 or equivalent.* Analysis and design of switch mode dc-to-dc converters. Basic converter topologies: buck, boost and buck/boost and their transformer-couples derivatives. Closed-loop converter control by pulse width modulation. Limitations of semi conductor components as characterized by their behavior under clamped inductive switching. Properties of magnetic materials and their influence on design of high-frequency inductors and transformers. Example applications.

ECE 735 Advanced Solid-State Device Theory. *3(3-0) . F. Preq. ECE 724.* The latest developments in solid-state devices. Discussion of topics selected from subjects of current interest and state-of-tne-art results. Emphasis on basic fundamental physical principles of operation as opposed to circuit applications.

ECE 736 Power System Stability and Control. *3(3-0) . S. Preq: ECE 451, ECE "16.* Modeling of synchronous machines and their control systems. Coupled electric circuit approach, Park's transformations, additional rotor windings. Rudiments of dynamic and transient stability. Excitation systems, governor-control systems, power-system stabilizers. State space formulations for computer-based dynamic studies.

ECE 737 Characterization of High-Speed Devices. *3(1-5) . F. Preq: ECE 422.* A laboratory in principles of microwave characterization and operation of microwave test equipment such as spectrum analyzers, power meters, detectors and network analyzers. Performance of measurements of impedance noise figure, equivalent circuit parameters and frequency response on various circuit elements and devices.

ECE 738 Integrated Circuits Technology and Fabrication. *3(3-0) . F. Preq: ECE 441.* Processes used in fabrication of modern integrated circuits. Process steps for crystal growth, oxidation, diffusion, ion implantation, lithography, chemical vapor deposition, etching, metallization, layout and packaging. Process integration for MOS and biopolar processes. Characterization techniques, simulation, yield and reliability.

ECE 739 Integrated Circuits Technology and Fabrication Laboratory. *3(1-4) . S Preq: ECE 738.* Integrated circuit laboratory companion to ECE 738. Fabrication and testing of integrated circuit devices. Effects of process variations on measurable parameters. Hands-on experience in the semiconductor laboratory.

ECE 740 Electromagnetic Fields. *3(3-0) . S. Preq: ECE 422.* Brief review of Maxwell's Equations, constitutive relations and boundary conditions. Reflection and refraction of plane waves; power and energy relations in isotropic media. Potential functions, Green's functions and their applications to radiation and scattering. Antenna fundamentals: linear antennas, uniform linear arrays and aperture antennas. Introduction to special relativity, uniform linear arrays and aperture antennas. Introduction to special relativity.

ECE 741 Sequential Machines. *3(3-0) . F. Preq: ECE(CSC) 520.* Advanced topics in sequential machine theory and languages, Turing machines, decision problems.

ECE 742 Artificial Neural Networks. *3(3-0) . S. Preq: ECE 421 and ECE (CSC) 520.* Artificial neural networks in pattern recognition, artificial intelligence, adaptive signal processing, self-organization and goal-directed behavior.

ECE 743 High Performance Multicomputer Architecutre. *3(3-0) F. Preq. ECE 740.* Cray T3D, nCUBE3, VPP500, Paragon, Cenju-3, SP2, Dataflow, K-2, DASH, Reconfigurable Mesh, Superpipeline-Superscalar, Hierarchical MIN, Cache for Vector Oricessubgm generalized hypercube, Hierarchical networks, Wormhole routing, neurocomputers, earth and space applications, seminars.

ECE 744 Design Of Electronic Packaging and Interconnects. *3(3-0) . S. Preq ECE 314.* Electrical design and optimization of interconnects and packaging. Topics: single chip, PCB and multichip module packaging technologies; design for delay and noise control (signal integrity); backplane design; EMI and EMC control; CAD CAE tools; measurement issues; thermal design; packaging technology selection/system optimization.

ECE 746 VLSI Systems Design. *3(3 0) . F. Preq: ECE 342* Digital systems design in CMOS VLSI technology: CMOS devise physics, fabrication, primitive components, design and layout methodology, integrated system architectures, timing, testing future trends of VLSI technology.

ECE 747 Digital Signal Processing Architecture. *3(3-0) . S. Preq: ECE 342, ECE 421 and CSC 114.* Design of parallel algorithms and special purpose architectures for digital signal and image processing applications with emphasis on high-speed communications and computational engineering. Mapping digital signal and image processing algorithms to pipeline arrays, systolic arrays, wave-front arrays and other parallel architectures. Register transfer level design of application-specific and special-purpose digital processing systems.

ECE (CSC) 748 Parallel Processing. *3(3-0) . S. Preq: ECE(CSC) 506.* Concepts of parallelism, data-flow, program flow, partitioning and scheduling, performance metrics and scaleability, vector processing, Superscalar and VLIW, SIMD and MIMD machines, recent parallel machines, such as T3D, DASH, Tera KSR1, SP/1 and SP2, parallel models and program development.

ECE 750 Power System Operation and Control. *3(3-0) . F. Preq: ECE 305 or ECE 331, B average in ECE and MA.* Fundamental concepts of economic operation and control of power systems. Real and reactive power balance. System components, characteristics and operation. Steady state and dynamic analysis of interconnected systems. Tieline power and load-frequency control with integrated economic dispatch.

ECE 751 Detection and Estimation Theory. *3(3-0) . S. Preq: ECE(CSC) 714, ECE 421.* Methods of detection and estimation theory as applied to communications, speech and image processing. Statistical description of signals and representation in time, spatial and frequency domains; Baysian methods, including Wiener, Kalman and MAP filters; performance measures; applications to both continuous and discrete systems.

ECE 753 Computer Analysis of Large-Scale Power Systems. *3(3 0) . F Preq: ECE 750* Computer-based matrix methods of analysis of large networks. Problem statements, algorithmic formulations and solution techniques emphasizing efficient use of the computer for short-circuit calculations, computations of power flows under normal and emergency conditions and stability studies. Linear programming and optimization methods in power system planning.

ECE 755 Fault Tolerant Computing. *3(3-0) . F. Preq: ECE 520.* Methods for designing highly reliable computer systems. Design project. Latest fault tolerance methods proposed in literature.

ECE 756 High Performance VLSI Design. *3(3-0) . S. Preq: ECE 746.* Design methods and principles for high-speed digital systems. ASIC design using advanced CAD tools for logic synthesis, layout generation and testability. Packaging issues and choices. Design and analysis of high-speed interconnect. Timing analysis and optimization. Advanced technologies and design methods.

ECE 757 Principles of MOS Transistors. *3(3-0) . F, Alt. yrs., Preq: ECE 341 or 441 or equivalent.* MOS capacitor and transistor regions of operation. Depletion and enhancement mode MOSFETs. MOSFET scaling, short and narrow channel effects. MOSFETs with ion-implanted channels. High field effects in MOSFETs with emphasis on recent advances in design of hit carrier suppressed structures. Small and large signal MOSFET models. State of the art in MOS process integration.

ECE 758 Digital Image Processing. *3(3 0) . F. Preq: ECE 713, ECE 714.* A study of advanced techniques of image processing. Image formation and perception, digitalization, Fourier transform domain processing, restoration and tomographic reconstruction.

ECE 759 Pattern Recognition. *3(3-0) . S. Preq: ECE(CSC) 714, ST 371, B average in ECE and MA.* Image pattern recognition techniques and computer-based methods for scene analysis, including discriminate functions, fixture extraction, classification strategies, clustering and discriminant analysis. Coverage of applications and current research results.

ECE 760 Multidimensional Digital Signal Processing. *3(3-0) . F. Preq: ECE 713.* Multidimensional signal processing techniques and algorithms. Multidimensional transforms, multidimensional digital filters, computational structures for implementation of multidimensional systems and multidimensional filter design.

ECE 761 Design Automation for VLSI. *3(3-0) . S. Preq: CSC 505.* VLSI CAD (computer-aids-to-design) tools research: physical design automation--layout, module generator, silicon compiler; logical design automation--CAD language, synthesis; simulation--circuit level, switch level, logic level, functional level; optimization techniques: graph theory, simulated annealing.

ECE 762 Advanced Digital Communications Systems. *3(3-0) . F.* Advanced concepts for modern digital communications systems. Signal acquisition and tracking. Channel characteristics and modeling. Adaptive processing for echo cancellation and channel equalization. Emphasis on computer simulation of systems using computer-aided-design environments.

ECE 763 Computer Vision. *3(3-0) . F. Preq: MA 501 and MA 502.* Analysis of images by computers. Specific attention given to analysis of the geometric features of objects in images, such as region size, connectedness and topology. Topics include: segmentation, template matching, motion analysis, boundary detection, region growing, shape representation, 3-D object recognition including graph matching.

ECE 764 Digital Image Processing. *3(3-0) . F.* A study of advanced techniques of image processing. Image formation and perception, digitalization, Fourier transform domain processing, restoration and tomographic reconstruction.

ECE (CSC) 776 Performance Evaluation of Computer Networks. *3(3-0) . S. Preq: ECE(CSC) 570.* Performance modeling of random access networks. Synthesis and analysis of local area networks, metropolitan area networks and packet radio networks. Routing and flow control in computer networks.

ECE (CSC) 777 Telecommunications Network Design. *3(3-0) . S. Preq: ECE(CSC) 572.* Analytic modeling and topological design of telecommunications networks, including centralized polling networks, packet switched networks, T1 networks, concentrator location problems, routing strategies, teletraffic engineering and network reliability.

ECE 778 Optical Fiber Communications. *3(3-0) . S. Preq: ECE 402 or equivalent.* Components, subsystems and system design techniques used in optical fiber communications systems. Up-to-date information pertaining to components and design techniques. Analysis and design of subsystem and system levels. Historical aspects, optical fiber technology, cabling, optical sources and detectors, transmitter and receiver techniques.

ECE (CSC) 779 Advanced Computer Performance Modeling. *3(3-0) . S, Alt. Yrs. Preq: CSC (ECE) 579 or OR (IE) 761.* In-depth study of computer performance modeling techniques such as exact and approximate analysis of queuing networks and direct and iterative numerical solutions of queuing systems.

ECE 781 Special Studies in Electrical Engineering. *3(3-0) . F,S.* Opportunity for small groups of advanced graduate students to study topics in their special fields of interest under direction of members of graduate faculty.

ECE 782 Special Studies in Electrical Engineering. *3(3-0) . F,S* Opportunity for small groups of advanced graduate students to study topics in their special fields of interest under direction of members of graduate faculty.

ECE 791 Special Topics in Electrical Engineering. *3(3-0) F,S Preq. B average in technical subjects.* Two-semester sequence to develop new courses and to allow qualified students to explore areas of special interest.

ECE 792 Special Topics in Electrical Engineering. *3(3-0) F,S Preq: B average in technical subjects.* Two-semester sequence to develop new courses and to allow qualified students to explore areas of special interest.

ECE 801 Seminar in Electrical and Computer Engineering. *F,S.*

ECE 802 Seminar in Ckts/Syst.

ECE 803 Seminar in Computer Engineering.

ECE 804 Seminar in Comm/Sig PR.

ECE 805 Seminar in Solid State.

ECE 833 Individual Topics in Electrical Engineering. *1-3. F,S. Preq. B average in technical subjects.* Provision of opportunity for individual students to explore topics of special interest under direction of a member of faculty.

ECE 834 Individual Studies in Electrical Engineering. *1-3. F,S. Preq: Grad. standing.* The study of advanced topics of special interest to individual students under direction of faculty members.

ECE 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ECE 890 Doctoral Preliminary Examination. *1-9. F,S,Sum. Preq: Doctoral student.* For students who are preparing for and taking writte and/or oral preliminary exams.

ECE 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ECE 895 Doctoral Dissertation Research. *1-9. F,S Sun. Preq. Doctoral student* Dissertation research.

ECE 899 Doctoral Dissertation Preparation. *1-3 F,S,Sum Preq: Doctoral student* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

CURRICULUM AND INSTRUCTION

ECI 102 Orientation to Middle Grades Education. *0(1 0) . F,S. Restricted to MSL majors and unclassified students in MSL.* Orientation and introduction to department, college, and university expectations and procedures Advisor advisee interaction and discussion of practical aspects of academic life.

ECI 185 Introduction to Academic Discourse & Learning. *3(3-0) F.* Socializes students to the intellectual conventions of the university by focusing on the learning process and critical thinking with academic discourse, both written and oral

ECI 205 Introduction to Teaching Humanities and Social Sciences. *3(2-3) . S. Preq: Sophomore standing.* For prospective teachers in secondary and middle years social studies, English, language arts, and foreign languages. An emphasis on differing aspects and procedures of instruction and analysis of the competencies required of teachers. Field work ina variety of educational settings including an extended period in one curriculum area.

ECI 210 College Tutoring. *2(2-0) . F,S. Preq. Registration priority will be given to students who plan to become tutors or who are tutoring.* Develop skills in general tutoring. Areas of emphasis include recognizing and responding to various learning difficulties, implementing a variety of tutoring methods and developing self-evaluation of effective tutoring skills.

ECI 296 Special Topics in Education. *1-3. F,S,Sum.* Individual or group study of particular areas of education at the freshman and sophomore levels. Specific topics will vary from semester to semester.

ECI (GEO) 300 World Regional Geography. *3(3 0) . Preq: GEO 200.* Geography of selected industrial and Third World regions in which the evolution of settlement, culture, economy and political forms are treated in geographical perspective.

ECI 305 Principles of Teaching Diverse Populations. *3(3-0) . F,Sum. Preq: ECI 205 or EMS 203.* Impact of cultural factors on experiences of teachers and students in contemporary schools. Teaching techniques and development of instructional plans to enhance schooling experiences of culturally diverse students.

ECI 306 Middle Years Reading. *3(3-0) . S. Preq: 6 hours ED and/or PSY.* Reading skills in middle years education developed with emphasis on application of the reading process to content area.

ECI 307 Teaching Writing Across the Curriculum. *3(3-0) . S. Preq: ENG 112.* For prospective teachers of all disciplines in middle/high school. Practical strategies for writing as a learning tool and for teaching writing. Lesson plans, assignments, experiences appropriate to content areas. Focus on writing, writing instruction, and technology. Separate sections for Middle Grades (MSL) and English (LTN) majors.

ECI 309 Teaching in the Middle Years. *3(3-0) . F,S. Preq: 6 hours ED/PSY.* Nature and purposes of middle grades education. Early adolescent development, curriculum, teaching/learning methods, school organization, and characteristics of effective middle years teachers. Includes field experience.

ECI 331 Health Professions. *3(3-0) . Sum, Alt. Yrs.* An examination of key occupations and professions in the health cluster. Emphasis is on educational preparation, requirements for practice, potential advancement, inter- and intra professional relationships, ethical foundations of practice, and the concept of commitment. Theoretical concept of role structure and function.

ECI 332 Health Promotion and Disease Prevention. *3(3-0) . S, Alt. Yrs. Preq. For credentialed health professionals only.* Emphasis on education of the public regarding general health concerns including cancer, cardiovascular disease, accident prevention, nutrition, drugs, alcohol, mental health, sexuality, and environmental hazards.

ECI 333 Health Care Delivery. *3(3-0) .* The historical basis of healthy care delivery in the U. S. with emphasis on hospitals, health maintenance organizations, ambulatory care centers, ambulatory surgery, nursing homes, and private care practice. Philosophical issues of funding health care, promoting health care, and the training of healthy care workers.

ECI 335 Planning Classroom and Clinical Curricula. *3(3-0) . Preq EOE 101, ECI 205. For credentialed health professionals only.* Procedures for planning health occupations curricula for classroom and clinical settings. Practice in writing, updating, and refining health curriculum with emphasis on selection and sequencing. Comparison of styles of writing curricula. Roles and responsibilities of healthy curriculum planner.

ECI 336 Strategies for Teaching a Health Occupations Course. *3 3-0) S Preq. For credentialed health professionals only.* Planning and implementation of effective instructional strategies for clinical and classroom settings. The nature of the teaching learning process, psychological and philosophical aspects of teacher choice of various strategies.

ECI (ENG) 405 Literature for Adolescents. *3(3-0) . F. Preq: Junior standing or above.* Reviews the history, types, and characteristics of literature for adolescents. Emphasizes reading and analyzing the literature by exploring the themes, literary elements, and rationale for teaching literature for adolescents. Addresses ways in which this literature can be integrated and implemented in English/Language Arts curriculum.

ECI 414 Human Relations and Discipline in the Classroom. *3(3-0) . Alt. Yrs. Preq: PSY 304 and 6 hours of education.* Designed to help prospective teachers foster positive interpersonal relationships in classrooms, build a sense of community and create a purposive environment for learning. Investigates issues such as group building, active listening, and major approaches to discipline. Uses case studies and problem solving methods.

ECI 415 The Arts and Adolesecence. *2(2 0) . S. Preq: 6 hours ED and/or PSY, Middle Grades Majors (MSL MSD).* Relationship of the arts to the academic work of adolescent learners. Arts and adolescent development; arts and learning processes within and outside of the classroom; experimentation and skill development in graphic arts, sculpture, music, drama, dance/movement, film, and poetry.

ECI 416 Teaching Exceptional Students in the Mainstreamed Classroom. *3(3-0) . S Preq: Six hours ED and/or PSY* Provides classroom teachers in all disciplines and grade levels with a knowledge of various handicapping conditions, as well as with techniques to assist exceptional students within the mainstreamed classroom. Required for MSL majors.

ECI 423 Methods and Materials in Teaching Modern Foreign Languages. *5(4-2) F. Preq: Admission to Professional Semester. Coreq: ECI 424. Taught M-F during first 7 weeks of the semester.* Methods and materials for teaching modern foreign languages K-12 including the use of instructional media.

ECI 424 Student Teaching in French or Spanish. *8(2-15) . F. Preq: Admission to Professional semester. Coreq: ECI 423.* Ten-week teaching experience for prospective teachers of French or Spanish in a selected elementary, middle or high school under the supervision of a cooperating teacher and a university faculty supervisor.

ECI (FL) 425 Methods and Materials in Teaching English as a Second Language. *3(3 0) . F. Preq: Admission to Teacher Education Candidacy.* Methodologies and current approaches to teaching English as a Second Language. Techniques and strategies for teaching reading, writing, listening, speaking and culture. Selection, adaptation, and creation of instructional materials for various levels of proficiency and teaching situations.

ECI (FL) 426 Evaluation and Assessment in Teaching English as a Second Language. *3(3-0) . S. Preq: Admission to Teacher Education Candidacy.* Evaluation and Assessment of written and oral language proficiency through standardized and non-standardized assessment tools. Examination and development of assessment instruments to assess language proficiency and progress. Development, adaptation and evaluation of ESL materials and curricula.

ECI 430 Methods and Materials for Teaching Language Arts in the Middle Grades. *4(3-2) . F. Preq: ECI 205,ELP 344,PSY 304,ECI 309, ECI 306, ECI 307, Senior Standing. Coreq: ECI 435. Admission to candidacy in Middle Grades Teacher Education; senior standing..* Inquiry, activity-oriented course provides opportunities for prospective language arts middle school teachers to integrate knowledge of English with effective materials, strategies, methods of instruction. Students observe middle school classes, plan lessons, and units, practice varied classroom strategies, technologies in micro-lessons. Prepared students for teaching language arts with other content areas in middle schools.

ECI 434 Clinical Supervision in Health Occupations. *3(3 0) . S, Alt Yrs. Preq: Six hours of Health Occupations courses.* Supervisory techniques for health care professionals in initial levels of administrative positions. Internal and external factors affecting and staffing and supervision process. Organization of the supervisory process. Government and labor relations in the health industry.

ECI 435 Methods and Materials for Teaching Social Studies in the Middle Grades. *4(3-2) . F. Preq: Admission to professional semester.* For preservice middle school social studies teachers. Focus on: teaching and evaluation skills, adaptation of instruction to individual learner differences, identification and creation of instructional materials appropriate for use in social studies teaching.

ECI 436 Evaluative Skills in Teaching Health Occupations. *3(3-0) .* Program and process evaluation in health care curriculum, instruction, learning and clinical performance. Analysis of existing instruments/designs for clinical evaluation with respect to validity and reliability. Development of instruments to evaluate clinical performance, construction of test items, and health care program effectiveness.

ECI 437 Health Occupations Teaching Practicum. *F,S.* Practical teaching experience in health occupations. Certification majors complete 15 weeks of student teaching in secondary programs (8 credit hours). Non-certification majors teach in a hospital, community college, technical institute, private health industry, or other health-care setting(3-8 credit hours.)

ECI 438 Medical Law and Ethics. *3(3-0) . F.* Ethical and legal issues involved in delivering health care, such as euthanasia, reproductive technology, organ transplants, patients' rights, and confidentiality. Classical ethical theories and principles. Systematic review procedures and current medical law used to examine current case dilemmas in the health professions.

ECI 444 Administration of Marketing Education. *3(3-0) . F Preq: Admission to Teacher Education Candidacy. EOE 207* The theory and skills necessary to plan, administer, operate, and evaluate effective programs in marketing education.

ECI 446 Curriculum and Methods of Teaching Marketing Education. *3(3 0) . F. Preq: Admission to Teacher Education Candidacy.* Curriculum common to marketing education and research behind its development. Methods common to instructional planning, implementation, and evaluation of effective marketing education programs.

ECI 447 Student Teaching in Marketing Education. *8(2-12) S Preq: Admission to Professional Semester. Coreq: ECI 494* Skills and techniques required by prospective teachers in the marketing education classroom. Fifteen weeks student teaching full-time in a public school: observation, instruction, evaluation, advisement, and administration.

ECI 450 Methods and Materials in Teaching English. *4(3-2) . F. Preq: ECI 205 ELP 344, PSY 304; senior standing and admission to Teacher Education candidacy with a major in English. Taught during the first seven weeks of the semester.* Methods and materials of teaching English in grades 9-12, with an emphasis on lesson planning and demonstrations/practice in teaching literature, study skills, speaking, listening, and writing.

ECI 451 Improving Reading in Secondary Schools. *2(2-0) . F,S,Sum. Preq: 6 hours of ED and/or PSY.* A study of methods and materials for teaching reading in the secondary school, with an emphasis on the effective use of written materials for content area instruction.

ECI 454 Student Teaching in English/Language Arts. *1-8. S. Preq. Admission to Student Teaching Professional Semester. For MSL students: ECI 430; 416, 464. For LTN students: ECI 450.* Provides the prospective teacher with experience in the techniques and skills involved in teaching English or Language Arts. Ten weeks in a selected off-campus station. Student teachers become familiar with the total school program and participate in selected school and community activities.

ECI 460 Methods and Materials in Teaching Secondary Social Studies. *4(3-1) . F. Preq: ECI 205, ELP 344, Sr. standing and admission to professional semester with a major in either history, sociology, political science. Taught during the first six weeks of the semester.* Teaching techniques, innovations, and development of teaching and evaluation skills in the area of secondary school social studies. Adaptation of instruction to individual learner differences, and selection and design of instructional materials. Taught during the first six weeks of the semester.

ECI 464 Student Teaching in Social Studies. *3-8. F. Preq: Admission to professional semester. Coreq: For LTH, LTP, LTS students: ECI 460. For MSL students: ECI 454, 430, 416.* Skills and techniques in teaching social studies in secondary and middle schools. Each student spends ten weeks in a selected off-campus center. The student demonstrates competencies essential for teaching social studies, becomes familiar with the total school program, and participates in a variety of school and community activities.

ECI 483 An Introduction to Media and Instructional Technology. *3(3-0) . F,S,Sum. Preq: Junior standing.* Survey of instructional media and instructional technology. Relationship between media and instructional objectives. Computer based projects in designing and developing instructional materials using software.

ECI 488 Basic American Sign Language. *3(3-0) . F,S. Restricted elective for communications majors.* Conversational sign language skill development and introduction to aspects of American Sign language, deafness, and deaf culture.

ECI 494 Senior Seminar in Marketing Education. *3(3-0) . S* Analysis and discussion by marketing education majors of problems and successes experienced while student teaching in the public schools.

ECI 496 Special Topics in Education. *1-3. F,S,Sum. Preq: Junior or senior standing and consent of instructor.* Individual or group study of special topics in professional education. The topic and mode of study are determined by the faculty member after discussion with the student.

ECI 500 Theory and Practice in Teaching Diverse Populations. *3(3-0) . S. Preq Graduate standing* Analysis of literature and research in related to impact of cultural factors on teaching and learning in contemporary schools. Exploration of teaching techniques and curricular directions designed to improve school experiences for diverse populations in K-12 settings.

ECI 502 Teaching through the Arts. *3(3 0) F,S. Preq· 6 hrs. in ED and/or PSY* The role of the arts in the teaching/learning process, emphasizing ways classroom teachers can use the arts to foster students personal growth, creativity and academic achievement. Develops teaching skills through explorations in graphic arts, sculpture, dance/movement, drama, film, creative writing and poetry.

ECI 503 Effective Teaching. *3(3-0) . S, Alt. yrs.(odd). Preq: Twelve hrs. ED including student teaching.* Analysis of the teaching-learning process; assumptions that underlie course approaches; identifying problems of importance; problem solution for effective learning; evaluation of teaching and learning; making specific plans for effective teaching.

ECI 504 Principles and Practices of Supervision. *3(3-0) . S. Preq: 6 hrs. ED/PSY graduate study and Consent of Instructor.* Designed to provide educational leader with an understanding of nature of instructional supervision, skills needed in supervising educational programs and an analysis of promising practices for improving programs. Opportunity for application of principles of supervision to one or more practical problems.

ECI 509 Special Problems in Curriculum and Instruction. *1-6. F,S,Sum. Preq: Six hours of ED or PSY and Consent of Instructor.* In-depth study of topical problems in curriculum and instruction selected from areas of current concern to practitioners in education.

ECI 510 Research Applications in Curriculum and Instruction. *3(3-0) . S. Preq: ST 507 or equivalent; doctoral students in C&I.* Focus on current issues and research methods used in the areas of curriculum development and supervision, instructional technology, English education, middle grades education, reading education, social studies education and special education.

ECI 511 Computer Applications and Curriculum Integration in K-12 Instruction. *3(3-0) . F,S,Sum. Preq: Graduate Standing.* Use and evaluation of existing educational software, research findings with respect to integration of computers and new technologies in instruction.

ECI 514 Multimedia Design and Applications in K-12 Instruction. *3(3-0) . F. Preq: Graduate Standing.* Instructional design principles underlying development of computer-based instructional software and multimedia, and multimedia applications in K-12 settings.

ECI 515 Internet Applications and Web Design in K-12 Settings. *3(3-0) . S. Preq: ECI 511, ECI 514* Review of research findings related to Internet usage and web-based applications in K-12 environment. Internet applications in classroom, online projects and activities, educational web page design and evaluation, building and publishing educational web pages, educational applications of multimedia and form on web.

ECI 517 Advanced Multimedia Design and Applications in K-12 Instruction. *3(3-0) S Alt Yr(odd). Preq: ECI 511, ECI 514.* Advanced study and application of instructional design principles underlying development, evaluation, and integration of multimedia and hypermedia in K-12 settings.

ECI 518 Program and Staff Development in Instructional Technology. *3(3-0) . S, Alt yrs(even). Preq: ECI 511, ECI 514, ECI 515, ECI 642.* Study and application of principles related to educational computing and technology planning, facilities and resource management, and technology staff development in K-12 settings.

ECI 519 Special Problems in Instructional Technology. *1-6. F,S,Sum. Preq: Six hours of ED or PSY and Consent of Instructor.* In-depth study of topical problems in instructional technology selected from areas of current concern to practitioners in education.

ECI 520 The Teaching of Composition. *3(3-0) . S. Preq: 9 hrs. of ED, PSY and/or ENG; to take this course in sum. as part of Capital Area Writing Project, student must apply and be selected.* For classroom teachers. Practical field-tested ideas to help students improve as writers by focusing on composition as a process as well as a product. Activities for teaching prewriting, drafting, revising, proofreading, grammar and evaluating with suggestions for individual and group learning. Writing in content areas and composition research/ theory.

ECI 521 Teaching Literature for Young Adults. *3(3-0) . S. Preq: Sr. or grad. standing or PBS status.* Designed to acquaint in-service and pre-service teachers with breadth and diversity of contemporary literature for adolescents, with emphasis on teaching young adult literature. Addresses history and themes of young adult literature, readability of materials, reading preferences, literary merit, skills that can be taught through literature, censorship, motivating students to read and organizing literature units.

ECI 524 Issues in Elementary School Teaching. *3(3-0) . F, Alt. yrs.(even). Preq: Graduate Standing.* Analysis of contemporary elementary school environments, developmental trends of childhood affecting teaching of elementary age students, nature of professionalism among elementary school teachers including pedagogical skills and subject matter knowledge, and ways to improve teaching effectiveness in elementary classrooms settings.

ECI 525 Contemporary Approaches in the Teaching Of Social Studies. *3(3-0) . S. Preq: Advanced undergrad. or grad. standing.* Analysis of principles, strategies and application of new teaching approaches. Structured projects and practical experiences.

ECI 526 Theory and Research on Teaching and Learning Social Studies. *3(3-0) . F, Alt. Yrs. Preq: ECI 530 or ECI 525 or Consent of Instructor.* A critical analysis of the literature relating to the teaching and learning of social studies and the drawing of implications for instructional practices.

ECI 527 Special Problems in Social Studies. *1-6. F,S,Sum. Preq: Six hours of ED or PSY and Consent of Instructor.* In-depth study of topical problems in social studies education selected from areas of current concern to practitioners in education.

ECI 529 Special Problems in English Education. *1-6. F,S,Sum. Preq: Six hours of ED or PSY and Consent of Instructor.* In-depth study of topical problems in English education selected from areas of current concern to practitioners in education.

ECI 530 Social Studies in the Elementary School. *3(3-0) . S. Preq. Six hrs. in ECI.* Advanced professional training in teaching of social studies for middle grades and elementary teachers, including in-depth introduction to research-based teaching strategies, instructional resources and literature of the field.

ECI 532 Early Childhood Education. *3(1-4) . F, Alt. yrs. Preq: PSY 4~5 or PSY 584.* Planning, selection and usage of human resources, activities, materials and facilities in education of young children. Student observation, participation and evaluation of educational experiences for developmental level of individual children for anoptimum learning environment. A synthesis of the student's knowledge of human development, learning theory and research findings as related to classroom application.

ECI 533 Language Arts in the Elementary School. *3(3-0) . S,Alt. Yrs. Preq. Six hrs. in ED* Advanced professional training in teaching of language arts for middle grades and elementary teachers, including in-depth introduction to research-based teaching strategies, new instructional resources and the literature on the field.

ECI 539 Special Problems in Elementary School. *1-6. F,S,Sum Preq. Six hours of ED or PSY and Consent of Instructor.* In-depth study of topical problems in elementary education selected from areas of current concern to practitioners in education.

ECI 540 Reading in the Elementary School. *3(3-0) . F. Preq: Six hrs. ED or PSY.* Theoretical foundations of reading instruction and current methods and materials for teaching reading, with emphasis on planning and implementing reading programs for children in kindergarten through grade six.

ECI 541 Reading in the Content Areas. *3(3-0) . S,Sum. Preq: Six hrs. in ED or PSY.* Methods in instruction for applying reading to content areas, with emphasis on means of improving comprehension, vocabulary and learning strategies in subject matter classrooms.

ECI 542 Literacy Instruction for College Students: Research, Theory and Practice. *3(3-0) . F. Preq: ECI 541.* Examination of research, theory and classroom practices in relation to literacy instruction for academically at-risk students at postsecondary level.

ECI 543 Diagnosis of Reading Disabilities. *3(3-0) . F. Preq: ECI 540 or ECI 541.* Formal and informal instruments for diagnosing reading disabilities including completion of a diagnostic case study describing reading performance of a disabled reader.

ECI 544 Remediation Of Reading Disabilities. *3(3 0) . S Preq: ECI 543 or Consent of Instructor.* Advanced approaches to reading remediation including theory and research related to remedial instructional strategies, analyses of instructional designs and evaluations of effectiveness of intervention programs.

ECI 545 Literacy Theory and Research. *3(3-0) . S, Alt. yrs.(even). Preq: ECI 540 and Consent of Instructor.* Advanced study of theoretical models of reading, research issues in reading and in other language processes. In-depth theoretical models of reading. Emphasis on critical examination and analysis of research investigating reading acquisition, matureread ing behavior and related language processes.

ECI 546 Literacy Instruction, Technology and Media. *3(3-0) . F. Preq: Graduate status.* Critical analysis of emerging technologies and media sources as applied to literacy acquisition and instruction. Integration of new technologies into literacy curriculum.

ECI 547 Teaching Children's Literature. *3(3-0) . Sum. Preq: Graduate status.* Instructions for educators in quality children's literature, specific needs of young reader, genres of children's literature, strategies for instructing children's literature, ways to target reader's interests, and design of literature units.

ECI 549 Special Problems in Reading. *1-6. F,S,Sum. Preq: Six hours of ED or PSY and Consent of Instructor.* In-depth study of topical problems in reading education selected from areas of current concern to practitioners in education.

ECI 550 Foundations of Middle Years Education. *3(3-0) . F,S. Preq: 6 hrs. of ED and PSY.* Examination of five major aspects of middle years education: (a) history and purposes of middle/junior high school, (b) pre- and early adolescent needs, interests and abilities, (c) curriculum design and content, (d) teaching methods and (e) school organization. Emphasis on both theoretical understandings and effective classroom strategies.

ECI 551 Teaching/Learning Approaches for Emerging Adolescents. *3(3 0) . S. Preq. ECI 550 or equivalent; grad standing and Consent of Instructor.* Exploration of teaching/learning approaches appropriate to emerging adolescents. Learning styles; interdisciplinary inquiry; community-based curriculum; simulations and games; learning centers; minicourses; design of physical space: all-school activities.

ECI 559 Special Problems in Middle Years Education. *1 6. F,S,Sum. Preq: Six hours of ED or PSY and Consent of Instructor.* In-depth study of topical problems in middle years education selected from areas of current concern to practitioners in education.

ECI 560 Professional Development in Business and Marketing Education. *3(3-0) Sum. Preq: Graduate Standing.* The organizational and leadership structure in marketing education; strategies for increasing the effectiveness of local, state, and national marketing education programs through organizational development and professional leadership.

ECI 561 Curriculum and Instruction in Business and Marketing Education. *3(3-0) F. Preq: Graduate Standing.* Design and management of curriculum in marketing education. Development of concepts and skills necessary for effective instruction in marketing education classrooms.

ECI 562 Business and Marketing Education Program Management. *3(3-0) . S. Preq: Graduate Standing.* The management of secondary, postsecondary, and industry based marketing education programs; usage of a strategic planning model to improve and expand programs. Application of national and state models for marketing, curriculum, development, and evaluation.

ECI 569 Special Problems in Business and Marketing Education. *1-6. F,S,Sum. Preq: Consent of Instructor.* In-depth study of topical problems in business and marketing education selected from areas of current concern to practitioners in education.

ECI 570 Learning Disabilities. *3(3-0) . F. Preq: ECI 585 or Consent of Instructor.* Field of learning disabilities, including definitions, prevalence, etiology, characteristics and current educational trends for educating students with learning disabilities.

ECI 571 Methods and Materials in Learning Disabilities. *3(3-0) . S. Preq: Consent of Instructor.* Current methods and materials for the teaching students with learning disabilities in elementary and/or secondary schools, including curriculum and instructional techniques. Focus on examination of commercial materials and development of teacher-made materials for use with students with learning disabilities.

ECI 572 Resource Teaching in Special Education. *3(3-0) . F,S. Preq: ECI 585 or Consent of Instructor.* Resource teaching in area of special education, with emphasis on resource teaching with students with special needs. Types of resource programs, establishment and maintenance of a program, selection of students, curriculum and materials.

ECI 573 Classroom Management in Special Education. *3(3-0) . F,S. Preq: ECI 585 or Consent of Instructor.* Concepts and procedures involved in design and implementation of techniques for managing students with disabilities in classroom setting. Focus on methods for increasing and maintaining appropriate classroom behaviors in learners with disabilities.

ECI 574 Mental Retardation. *3(3-0) . F. Preq: ECI 585 or Consent of Instructor.* Definitions, classifications, diagnostic and treatment procedures for mental retardation from medical, sociological and educational points of view. Categories of retardation including mild, moderate, severe and profound.

ECI 575 Communication Disorders in the Classroom. *3(3-0) . Alt. Yrs. Preq: ECI 570 or Consent of Instructor.* Occurrence of communication disorders in the school-age population, including types of disorders, prevalence, etiology, characteristics and corrective therapy. Focus on communication disorders among exceptional students and classroom teacher's role in working with communication disorders.

ECI 576 Methods and Materials in Teaching Persons with Mental Retardation. *3(3-0) . S. Preq: ECI 585 and ED 574 or Consent of Instructor.* Methods and materials related to teaching mentally retarded school-age children. Learning and behavioral characteristics and educational programs for mentally retarded in areas of motor, communications, social, academic and vocational development.

ECI 577 Education of Severely Handicapped. *3(3-0) . Preq: ECI 585 or ECI 574 or Consent of Instructor.* Severe and profound mental retardation and autism, including assessment procedures, educational and social/vocational programs, instructional strategies and evaluation. Legal and ethical issues involved in working with severely handicapped.

ECI 578 Methods for Teaching the Gifted. *3(3-0) . S. Preq: ECI 582 or Consent of Instructor.* Major approaches used in education of gifted, including an opportunity to develop unit plan based upon one of these approaches.

ECI 580 Transition Program for Students with Mild Disabilities. *3(3-0) . Sum Preq: ECI 585.* Educational and other procedures involved in providing transition programming to students with mild disabilities. Examination of secondary-level special education service delivery, as well as post secondary interventions, from critical, practical, empirical and theoretical perspectives.

ECI 581 Educational Diagnosis and Prescription for Children with Exceptionalities. *3(3-0) . F,S. Preq: ECI 585 or Consent of Instructor.* Concept of educational diagnosis of students with exceptionalities, including examination of educational diagnostic procedures in current use in special education. Development of informal diagnostic techniques and procedures for adapting curriculum and instruction for learner with exceptionalities.

ECI 582 Introduction to the Gifted Individual. *3(3-0) . Preq: ECI 585 or Consent of Instructor.* Theories and concepts of giftedness and procedures in identifying gifted, with a consideration of factors influencing giftedness and ways it may be fostered.

ECI 583 Behavior Disorders. *3(3-0) . F. Preq: ECI 585 or Consent of Instructor.* Definitions, etiology, characteristics, philosophies and approaches to educational programming for children and youth with behavior disorders, including emotionally handicapped, autistic and socially maladjusted.

ECI 584 Methods and Materials: Behavior Disorders. *3(3-0) . S. Preq: ECI 583 or Consent of Instructor.* Curriculum materials, instructional strategies and behavior management techniques related to teaching children and youth with behavioral disorders including individualized instruction, group process, organization and evaluation of classroom programs, parent involvement, community resources and teachers' personal and professional growth and development.

ECI 585 Education of Exceptional Children. *3(3-0) . F,S. Preq: 9 hrs. of ED or PSY.* Introduction to field of special education. Focus on historical overview, definitions and terminology in basic areas of exceptionality; etiological factors in exceptionality; developmental and learning characteristics of each area of exceptionality; and educational settings and strategies employed in special education. Review of current educational laws and policies affecting special education.

ECI 597 Special Problems in Special Education. *1-6. F,S,Sum. Preq: Six hours of ED or PSY and Consent of Instructor.* In-depth study of topical problems in special education selected from areas of current concern to practitioners in education.

ECI 601 Seminar in Curriculum and Instruction. *1-3. S.* Consideration of contemporary issues, trends and recent research and development findings in curriculum and instruction.

ECI 602 Seminar in Selected Topics in Curriculum and Instruction. *3(3 0) F* A seminar-type course with topics selected each semester.

ECI 603 Advanced Seminar in Literacy Research. *3(3 0) . S. Preq. ECI 648.* Critical analyses of research and methodology in reading comprehension processes and strategies for comprehension and retention of written discourse. Opportunity for design and conduct of a research project in reading or related area.

ECI 604 Seminar in Conflict Resolution and Mediation in Schools. *3(3-0) S Alt.Yr(odd). Preq. Graduate Status.* Theory and practice in resources and methods of conflict resolution and mediation in school settings; original research, investigation and critique of programs and integration strategies. Analysis of research and effectiveness of program implementation in schools and classrooms. Development of critical inquiry, research and analytical writing skills.

ECI 607 Advanced Seminar in Multicultural Education. *3(3-0) . S. Alt Yr (odd). Preq: Graduate Status and ECI 500.* Application and analysis of research and scholarship in multicultural education and topics related to effective schools for contemporary culturally diverse student populations in K-12 settings.

ECI 620 Special Problems in Curriculum and Instruction. *1-6. F,S,Sum. Preq. Six hrs. of ED or PSY and Consent of Instructor.* In-depth study of topical problems in curriculum and instruction selected from areas of current concern to practitioners in education.

ECI 630 Independent Study in Curriculum and Instruction. *1-6. F,S,Sum. Preq: Consent of Instructor.* Independent curriculum or research project in curriculum and instruction.

ECI 640 Practicum in Curriculum and Instruction. *1-6. F,S. Preq: Grad. standing in Col. of ED and PSY or Consent of Instructor.* Supervised practical experiences in schools and area agencies concerned with curriculum and instruction or educational supervision.

ECI 641 Practicum in Mentoring Of Teachers. *1-6. F, Alt. yrs.(even). Preq: ECI 705; grad. standing in College of ED and PSY or Consent of Instructor.* Supervised practical experiences in which participants become mentor to a student teacher or a teacher in a school system.

ECI 642 Practicum in Instructional Technology - Computers. *1-6. Sum. Preq: 12 hrs. in instructional technology; grad. standing in College of ED and PSY or Consent of Instructor.* Supervised practical experiences in schools and area agencies concerned with using instructional technology.

ECI 643 Practicum in Social Studies. *1-6. F,S,Sum. Preq: 9 hrs. in C&I; grad. standing in College of ED and PSY or Consent of Instructor.* Supervised practical experiences in schools and area agencies concerned with teaching of high school social studies.

ECI 644 Practicum in Elementary Education. *1-6. F,S,Sum. Preq: Grad. standing in College of ED and PSY or Consent or Instructor.* Supervised practical experiences in schools and area agencies concerned with education of elementary-age students.

ECI 645 Diagnostic-Prescriptive Practicum in Reading. *3(3 0) . F,S. Preq: ECI 540, ECI 541 and ECI 543; grad. standing in College of ED and PSY and Consent of Instructor.* Supervised teaching experience with students using diagnostic test data to prescribe remedial programs for reading-disabled individuals, implementing instructional prescriptions and evaluating success of remedial plans.

ECI 646 Practicum in Middle Grades Education. *1-6. F,S,Sum. Preq: ECI 550, ECI 551; grad. standing in College of ED and PSY or Consent of Instructor.* Supervised practical experiences in schools and area agencies concerned with education of middle school students in language arts and social studies.

ECI 647 Practicum in Business and Marketing Education. *1-6. F,S.Sum Preq: Consent of Instructor.* Supervised practical experiences in schools and area agencies concerned with business and marketing education.

ECI 648 Practicum in Special Education. *1-6. F,S,Sum. Preq: Grad. standing in College of ED and PSY or Consent of Instructor.* Supervised practical experiences in schools and area agencies concerned with teaching children and adolescents with disabilities.

ECI 650 Internship in Curriculum and Instruction. *1-6. F,S. Preq: Grad. standing in Col. of ED and PSY and Consent of Instructor.* Supervised opportunities for advanced professional development in contexts concerned with curriculum development and/or educational supervision.

ECI 651 Internship in Mentoring. *1-6. F,S. Preq: ECI 641 and ECI 705; grad. standing in Col. of ED and PSY or Consent of Instructor.* Supervised opportunities teaching educational personnel in local school systems how to serve as mentors to their colleagues.

ECI 652 Internship in Instructional Technology - Computers. *1-6. F, Alt. Yrs.(odd). Preq: Grad. standing in Col. of ED and PSY and Consent of Instructor.* Supervised opportunities for advanced professional development in contexts concerned with instructional technology.

ECI 653 Internship in Social Studies. *1-6. F,S,Sum. Preq: 9 hrs. in C&I; grad. standing in Col. of ED and PSY or Consent of Instructor.* Supervised opportunities for advanced professional development in contexts concerned with social studies education.

ECI 654 Internship in Elementary Education. *1-6. S, Alt. Yrs.. Preq: 3 hrs. grad.-level elementary education course work; grad. standing in Col. of ED and PSY and Consent of Instructor.* Supervised opportunities for advanced professional development in contexts concerned with elementary grades education.

ECI 655 Internship in Reading Education. *1-6. S. Preq: 9 hrs. in reading course work, grad. standing in Col. of ED and PSY and Consent of Instructor.* Supervised opportunities for advanced professional development in contexts concerned with literacy education.

ECI 656 Internship in Middle Grades Education. *1-6. F,S,Sum. Preq: ECI 550, ECI 551; grad. standing in College. of ED and PSY or Consent of Instructor.* Supervised opportunities for advanced professional development in contexts concerned with the education of young adolescents.

ECI 657 Internship in Business and Marketing Education. *Preq: Consent of Instructor.* Supervised opportunities for advance professional development in contexts concerned with business and marketing education.

ECI 658 Internship in Special Education. *1-6. F,S,Sum. Preq. Grad. standing in Col. of ED and PSY and Consent of Instructor.* Supervised opportunities for advanced professional development in contexts concerned with special education.

ECI 680 Directed Study in Curriculum and Instruction. *1-6. Preq: Consent of Instructor.* Curriculum or research project in curriculum and instruction under the direct supervision of a faculty member.

ECI 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the studnet in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ECI 690 Master's Examination. *1-6 F,S. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

ECI 692 Research Projects in Curriculum and Instruction. *1-3. F,S,Sum. Preq. Consent of Instructor; ELP 532 or equivalent.* Project or problem in research in education for graduate students, supervised by members of graduate faculty. Research chosen on basis of individual students' interests and not to be part of thesis or dissertation research.

ECI 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ECI 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research.

ECI 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

ECI 700 Curriculum Theory and Development. *3(3-0) . F,S. Preq: 9 sem. hrs. graduate PSY, ECI 502, ECI 514 or Consent of Instructor.* Theory and research in behavioral sciences and education designed to provide theoretical background for development of elementary and secondary curricula. Exploration of knowledge base and skills for critical review of curricula and instructional materials and provision of an application opportunity.

ECI 701 Foundations of Curriculum. *3(3-0) . Sum. Preq: 12 sem. hrs. graduate ED and PSY or consent of Instructor.* Origin, development, and current status of elementary and secondary school curriculum and an evaluation of trends and issues likely to influence the curriculum in the future.

ECI 705 Instructional Supervision of Teachers. *3(3-0) . S. Alt yrs.(odd). Preq: Consent of Instructor.* Theory, research and practice of the professional role of a supervisor in the development of the effective and self-analytic teacher: pre-service (student teacher) and in-service (beginning and experienced teacher). For persons with at least two years of teaching experience in K-12 schools.

ECI 709 Special Problems in Curriculum and Instruction. *1-6 F,S,Sum Preq: Six hrs. of ED or PSY and Consent of Instructor* In-depth study of topical problems in curriculum and instruction selected from areas of current concern to practitioners in education.

ECI 710 Research Applications in Curriculum and Instruction. *3(3-0) S. Preq ST 507 or equivalent: doctoral students in C&I.* Focus on current issues and research methods used in the areas of curriculum development and supervision, instructional technology, English education, middle grades education, reading education, social studies education and special education.

ECI 714 Computer Applications in Instruction. *3(3-0) . F,S. Preq: Six hrs. ED or PSY or Consent of Instructor.* Emphasis on use and evaluation of existing educational software and research findings with respect to uses of computers in instruction.

ECI 715 Development of Microcomputer Software for Instruction. *3(3-1) . F. Preq: Six hrs. ED or PSY or Consent of Instructor.* Instructional design principles underlying development of microcomputer-based instructional software and accompanying materials and programming principles and their implementation in courseware development. Additional topics include authoring languages, programming languages and graphics.

ECI 716 Design and Evaluation of Instructional Materials. *3(3-0) . S. Preq: Grad. standing.* Characteristics and selection of various media for instruction and their use in educational settings. Design and production of instructional materials. Analysis of research in the field. Individualized projects and assignments. Application of grounded research and theory concerning learning to design of instructional materials. Structured projects and practical experiences used to transfer design principles and evaluate instructional products.

ECI 719 Special Problems in Instructional Technology. *1-6. F,S,Sum. Preq: Six hours of ED or PSY and Consent of Instructor.* In-depth study of topical problems in instructional technology selected from areas of current concern to practitioners in education.

ECI 727 Special Problems in Social Studies Education. *1-6. F,S,Sum. Preq: Six hours of ED or PSY and Consent of Instructor.* In-depth study of topical problems in social studies education selected from areas of current concern to practitioners in education.

ECI 729 Special Problems in English Education. *1-6. F,S,Sum. Preq: Six hours of ED or PSY and Consent of Instructor.* In-depth study of topical problems in English education selected from areas of current concern to practitioners in education.

ECI 731 Teachers and the Elementary School Curriculum. *3(3-0) . F. Preq: Grad. standing.* Exploration and analysis of issues surrounding teacher's role in development, implementation and evaluation of elementary school curricula designed to meet schooling needs of diverse student populations.

ECI 739 Special Problems in Elementary Education. *1-6. F,S,Sum. Preq: Six hours of ED or PSY and Consent of Instructor.* In-depth study of topical problems in Elementary education selected from areas of current concern to practitioners in education.

ECI 749 Special Problems in Reading Education. *1-6. F,S,Sum. Preq: Six hours of ED or PSY and Consent of Instructor.* In-depth study of topical problems in reading education selected from areas of current concern to practitioners in education.

ECI 759 Special Problems in Middle Years Education. *1-6. F,S,Sum. Preq: Six hours of ED or PSY and Consent of Instructor.* In-depth study of topical problems in middle years education selected from areas of current concern to practitioners in education.

ECI 769 Special Problems in Business and Marketing Education. *1-6 F,S,Sum. Preq: Consent of Instructor.* In-depth study of topical problems in business and marketing education selected from areas of current concern to practitioners in education.

ECI 786 Introduction To Issues and Techniques in Visual Impairments. *3(3-0) . Preq: ECI 503.* Addresses historical developments, trends, issues and basic skill techniques for the visually impaired. Includes societal perceptions, societal integration, effects of a visual impairment on development, psychosocial adjustment and Braille transcription skills.

ECI 787 Orientation and Mobility of the Visually Impaired. *3(3-0) . Preq. Consent of Instructor.* The sensory processes and sensory cues on which independent mobility depends for the visually impaired person. Various techniques and modes of travel considered. Emphasis on instruction and background which will enable person not teaching orientation mobility as a skill to reinforce the learning taking place in other situations.

ECI 788 Structure and Function of the Eye and Use of Low Vision. *3(3-0) Preq Consent of Instructor.* Special institute for participants to spend minimum of 45 hours in class and class-related activities. Medical and educational consultants discuss structure and function of the eye, eye anomalies affecting children with low vision, methods of teaching children to use minimal vision effectively.

ECI 789 Teaching Braille and Communication Skills. *3(3-0) . Preq: ECI 786 or equivalent.* Information-access methods for visually impaired learners. Methods and materials for teaching Braille reading and selecting and teaching the use of electronic aids.

ECI 790 Methods and Materials in Visual Impairments. *3(3-0) .* A study of current methods and materials for teaching visually impaired learners. Includes curriculum and materials development, adaptation, instructional techniques, educational assessment and diagnosis.

ECI 797 Special Problems in Special Education. *1-6. F,S,Sum. Preq: Six hours of ED or PSY and Consent of Instructor.* In-depth study of topical problems special education selected from areas of current concern to practitioners in education.

ECI 801 Seminar in Curriculum and Instruction. *1-3. F, Alt. yrs.(even). Preq: Doctoral standing.* Consideration of contemporary issues, trends and recent research and development findings in curriculum and instruction.

ECI 802 Seminar in Selected Topics in Curriculum and Instruction. *3(3-0) .* A seminar-type course with topics selected each semester.

ECI 803 Advanced Seminar in Literacy Research. *3(3-0) . S. Preq: ECI 545.* Critical analyses of research and methodology in reading comprehension processes and strategies for comprehension and retention of written discourse. Opportunity for design and conduct of a research project in reading or related area.

ECI 804 Seminar on Attention Deficit Hyperactivity Disorder, Research and Treatment. *3(3-0) . S. Preq: 9 hrs. grad. credit in PSY or SPE.* Critical analysis of theory, research and interventions in Attention-Deficit-Hyperactivity-Disorder. Reading and synthesization of literature and student-led class discussions of such topics as characteristics, diagnosis, etiology, long-term outcomes and management of ADHD.

ECI 806 Seminar on Teacher as Learner: Developmental Theory, Research and Practice. *3(3-0) . F, Alt Yr(odd). Preq: Graduate Status (6 hrs course work at 500-level)* Analysis of major contemporary theories and research of learning and development as a basis for individual and organizational change and development in educational settings.

ECI 807 Advanced Seminar in Multicultural Education. *3(3-0) . S, Alt Yr.(odd). Preq: Graduate Status and ECI 500* Application and analysis of research and scholarship in multicultural education and topics related to effective schools for contemporary culturally diverse student populations in K-12 settings.

ECI 820 Special Problems In Curriculum and Instruction. *1-6. F,S,Sum. Preq: Six hrs. of ED or PSY and Consent of Instructor.* In-depth study of topical problems in curriculum and instruction selected from areas of current concern to practitioners in education.

ECI 830 Independent Study in Curriculum and Instruction. *1-6. F,S,Sum. Preq: Consent of Instructor.* Independent curriculum or research project in curriculum and instruction.

ECI 840 Practicum in Curriculum and Instruction. *1-6. F,S. Preq: Grad. standing in Col. of ED and PSY or Consent of Instructor.* Supervised practical experiences in schools and area agencies concerned with curriculum and instruction or educational supervision.

ECI 841 Practicum in Mentoring. *1-6. F. Preq: ECI 705; grad. standing in College of ED and PSY or Consent of Instructor.* Supervised practical experiences in which participants become mentor to a student teacher or a teacher in a school system.

ECI 842 Practicum in Instructional Technology. *F, Alt. Yrs. Preq: 12 hrs. in instructional technology; grad. standing in College of ED and PSY or Consent of Instructor.* Supervised practical experiences in schools and area agencies concerned with using instructional technology.

ECI 843 Practicum in Social Studies. *1-6. S, Alt. Yrs. Preq: 9 hrs. in C&I; grad. standing in College of ED and PSY or Consent of Instructor.* Supervised practical experiences in schools and area agencies concerned with teaching of high school social studies.

ECI 844 Practicum in Elementary Education. *1-6. F. Preq. Grad. standing in College of ED and PSY or Consent of Instructor.* Supervised practical experiences in schools and area agencies concerned with education of elementary-age students.

ECI 845 Diagnostic-Prescriptive Practicum in Reading. *3(3-0) . F,S. Preq: EC.I 540, ECI 541 and ECI 544; grad. standing in College of ED and PSY and Consent of Instructor.* Supervised teaching experience with students using diagnostic test data to prescribe remedial programs for reading-disabled individuals, implementing instructional prescriptions and evaluating success of remedial plans.

ECI 846 Practicum in Middle Grades Education. *1-6. F,S Sum. Preq: ECI 550, ECI 551; grad. standing in College of ED and PSY or Consent of Instructor.* Supervised practical experiences in schools and area agencies concerned with education of middle school students in language arts and social studies.

ECI 847 Practicum in Business and Marketing Education. *1 6. F,S Sum. Preq: Consent of Instructor.* Supervised practical experiences in schools and area agencies concerned with business and marketing education.

ECI 848 Practicum in Special Education. *1-6. F,S,Sum. Preq: Grad. standing in College of ED and PSY or Consent of Instructor.* Supervised practical experiences in schools and area agencies concerned with teaching children and adolescents with disabilities.

ECI 850 Internship in Curriculum and Instruction. *1-6. F,S. Preq: Grad. standing in Col. of ED and PSY and Consent of Instructor.* Supervised opportunities for advanced professional development in contexts concerned with curriculum development and/or educational supervision.

ECI 851 Internship in Mentoring. *1-6. F,S. Preq: ECI 845 and ECI 705; grad. standing in Col. of ED and PSY or Consent of Instructor.* Supervised opportunities teaching educational personnel in local school systems how to serve as mentors to their colleagues.

ECI 852 Internship in Instructional Technology - Computers. *1-6. F Alt Yrs. Preq: ECI 550, ECI 521; grad. standing in College of ED and PSY or Consent of Instructor.* Supervised opportunities for advanced professional development in contexts concerned with instructional technology.

ECI 853 Internship in Social Studies. *1-6. Sum Preq: 9 hrs. in C&I; grad. standing in College of ED and PSY or Consent of Instructor* Supervised opportunities for advanced professional development in contexts concerned with social studies education.

ECI 854 Internship in Elementary Education. *1 6. S, Alt Yrs. Preq. 3 hrs. grad.-level elementary education course work; grad. standing in College of ED and PSY and Consent of Instructor.* Supervised opportunities for advanced professional development in contexts concerned with elementary grades education.

ECI 855 Internship in Reading Education. *1-6. F S. Preq: 9 hrs. in reading course work; grad. standing in Col. of ED and PSY and Consent of Instructor* Supervised opportunities for advanced professional development in contexts concerned with literacy education.

ECI 856 Internship in Middle Grades Education. *1-6. F,S,Sum. Preq: ECI 550, ECI 521; grad. standing in College of ED and PSY or Consent of Instructor* Supervised opportunities for advanced professional development in contexts concerned with the education of young adolescents.

ECI 857 Internship in Business and Marketing Education. *1 6. S. Preq: ECI 561.* Supervised opportunities for advanced professional development in contexts of secondary marketing education.

ECI 858 Internship in Special Education. *1-6. F,S,Sum. Preq: Grad. standing in Col. of ED and PSY and Consent of Instructor.* Supervised opportunities for advanced professional development in contexts concerned with special education.

ECI 880 Directed Study in Curriculum and Instruction. *1-6. F,S,Sum. Preq: Consent of Instructor.* Curriculum or research project in curriculum and instruction under the direct supervision of a faculty member.

ECI 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ECI 890 Doctoral Preliminary Examination. *1-9. F,S,Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

ECI 892 Research Projects in Curriculum and Instruction. *1-3. F,S,Sum. Preq: Consent of Instructor; ELP 732 or equivalent.* Project or problem in research in education for graduate students, supervised by members of graduate faculty. Research chosen on basis of individual students' interests and not to be part of thesis or dissertation research.

ECI 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ECI 895 Doctoral Dissertation Research. *1 9. F,S.Sum. Preq: Doctoral student.* Dissertation research.

ECI 899 Doctoral Dissertation Preparation. *1-3 F.S.Sum. Preq: Doctoral student.* For students who have completed all credit hour, tull-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

ECOLOGY

ECO 601 Ecology Seminar. *1(1-0) . F. Preq: Grad. standing.* Scientific articles, progress reports and special problems of interest to ecologists are reviewed and discussed. Minimum of one seminar presentation required for credit.

ECO 620 Special Problems in Ecology. *1-6. F.S.Sum Preq: Grad. standing* Investigation of special problems in ecology of particular interest to advanced students under direction of a faculty member. Directed research in some specialized phase of ecology other than thesis problem, but designed to provide experience in training and research.

ECO 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ECO 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ECO 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research.

ECO 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

EDUCATION

ED 103 Teaching Fellows Seminar. *1(0-2) . F.* An orientation to academic requirements of higher education, a review of teacher education components and elements of teacher education curricula, identification of characteristics of an effective student, and an introduction to instructional methods and issues in the field of education.

ED 111 Education and Psychology Scholars Forum. *0(2-0) . F,S. Preq: Enrollment limited to participants in the Education and Psychology Scholars Program.* Interdisciplinary seminar with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

ED (AEE) 206 Introduction to Teaching Agriculture. *3(2-3) . F.* Introduction to teaching agricultural education in middle and secondary schools and collaborative efforts for teaching agricultural education to adults as rural community situations dictate. Field experiences include three hours per week of structured observations of classroom teachers, teacher assistant activities, and reflections of the experience.

ED 211 Education and Psychology Scholars Forum. *0(2-0) . F,S. Preq: Enrollment is limited to participants in the Education and Psychology Scholars Program* Second level of interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

ED (AEE) 226 Computer Applications and Information Technology in Agricultural & Extension Ed. *3(1-4) F,S* Use of computers and commercially produced agricultural software; the computer as a management tool; agricultural occupational applications of the computer; a multimedia instructional tool in agricultural classrooms and training situations; use of technology for processing information and imaging; network access; and electronic communications.

ED 296 Special Topics in Education. *1 3. F,S.* Individual or group study of particular areas of education at the freshman and sophomore levels. Specific topics will vary from semester to semester.

ED (AEE) 303 Administration and Supervision of Student Organizations. *3(2-2) S. Preq: AEE 206 or EOE 207.* Principles and techniques for organizing, administering and supervising student organization activities.

ED 310 Tutoring Adolescents. *1(1-2) . F,S. Preq: ECI 205 or EOE 20~ Coreq: EMS 203.* Developing skills in tutoring adolescent students. Emphases include identifying adolescent learning difficulties, using a variety of tutoring methods and a tutorial self-evaluation process. Requires off-campus field work.

ED (AEE) 322 Experiential Learning in Agriculture. *2(2 0) . F.* Planning, organizing, implementing, supervising and evaluating Supervised Agricultural Experience (SAE) programs in agriculture.

ED (AEE) 327 Conducting Summer Programs in Agricultural Education. *1(0-3) F Preq: AEE(ED)206; AEE 322' and AEE 323.* Field experience emphasizing summer agricultural education programs. Individualized instruction for students during supervised agricultural experience visits and youth organization activities. Professional development and program improvement activities.

ED (AEE) 426 Methods of Teaching Agriculture. *3(2-3) . F. Preq: Jr. standing or Consent of the Instructor.* Discussion and practice in planning and presenting instruction in agriculture in formal and informal settings. Principles and application of approaches to teaching and organizing instruction, motivating students, developing instructional objectives, selecting and using teaching techniques, evaluating instruction, and managing classroom and laboratory instruction.

ED (AEE) 427 Student Teaching in Agriculture. *8(2-15) . S. Preq: AEE (ED) 426; Admission to Professional Semester. Coreq AEE (ED) 490, AEE (ED) 424* Skills and techniques in teaching agriculture in a public school setting. Secondary agricultural education program teaching experience under the supervision of university faculty and an experienced agriculture teacher.

ED 403 Teaching Fellows Senior Seminar. *1(1 0) . F,S Preq: Senior standing.* A casebook study of first-year teacher experiences and an examination of professional, ethical, and legal issues in education as found in cases dealing with new teachers

ED (AEE) 490 Seminar in Agricultural and Extension Education. *1(1-0) S. Sum Admission to Professional Semester.* Analysis of opportunities and challenges facing educational leaders in agriculture.

ED 496 Special Topics in Education. *1-3. F,S .Preq' Junior or Senior Standing* Individual or group study of special topics in professional education. The topic and mode of study are determined by the faculty member after discussion with the student.

ED (AEE) 501 Foundations of Agricultural and Extension Education. *3(3 0) .S* Development and organization of agricultural and extension education in America from colonial times to the present. Emphasis on role of societal and scientific changes, the federal government and philosophy on evolution of agricultural and extension education.

ED (AEE) 530 Priority Management in Agricultural and Extension Education. *3(3-0) . S,Sum.* Examination of theoretical, psychological and empirical bases for strategies and techniques contributing to enhancement of managerial and personal effectiveness of agricultural educators and individuals in related agricultural organizations.

ED (AEE) 535 Teaching Agriculture in Secondary Schools. *3(3 0). F Alt Yrs.(odd).* Application of theoretical models and research on effective teaching in secondary agricultural education programs. teaching strategies, planning required, and instructional management for students with varying backgrounds. Evaluation of student learning and teacher evaluation of instruction.

ED (AEE) 641 Practicum in Agricultural and Extension Education. *1 6. F,S,Sum.* Faculty-supervised practicum in an educational, extension or agricultural industry setting.

ED (AEE) 735 Effective Teaching in Agriculture and Life Sciences. *3(3 0) Preq' Grad. standing.* Theory and practice of effective teaching in agricultural and life sciences. Emphasis on course planning, teaching and learning styles, instructional techniques, laboratory instruction, text construction, student evaluation, instructional technology, and faculty roles and responsibilities.

ED (AEE) 841 Practicum in Agricultural and Extension Education. *1-6 F,S,Sum* Faculty-supervised practicum in an educational, extension or agricultural industry setting.

EDUCATIONAL LEADERSHIP AND PROGRAM EVALUATION

ELP 296 Special Topics in Education: General Studies. *1-3. F,S,Sum.* Individual or group study of particular areas of education at the freshman and sophomore levels. Specific topics will vary from semester to semester.

ELP 344 School and Society. *3(3-0) . F,S,Sum. Preq: Jr. standing.* The interrelationship between the school and other institutions, values, and patterns of thought in American society.

ELP 496 Special Topics in Education: General Studies. *1-3. F,S,Sum. Preq: Junior or senior standing and consent of instructor.* Individual or group study of special topics in professional education. The topic and mode of study are determined by the faculty member after discussion with the student.

ELP 514 Formative Ideas in American Education. *3(3-0) . F Preq: Six hrs. ED or PSY or Consent of Instructor.* Consideration of theory and practice of American education as an extension of philosophical climate of opinion of different intellectual ages and how present status of our educational system grounded in thought of the past.

ELP 515 Education and Social Diversity. *3(3-0) . S. Preq: Six hrs. ED, PSY and/or social science.* Overview of role of education within a culturally diverse society. Major attention to racial, ethnic, socioeconomic and regional subpopulations. Subcultural influences on public school performances, equality of educational opportunity, social stratification and mobility and impact of schooling on intergroup relations.

ELP 518 Introduction to Education Law. *3(3-0) . F. Preq: Six hrs. grad. credit.* Relationship of constitutional, statutory and case law to elementary and secondary public school settings, particularly in areas of students, teachers and liability. Particular emphasis on N.C. and federal law.

ELP 532 Introduction to Educational Inquiry. *3(3-0) . F,S,Sum. Preq: Grad. standing or PBS status.* Basic concepts and methods of educational inquiry. Emphasis on logic underlying various approaches to problem definition and solution and on tools of investigator, as well as on sources and interpretation of research information related to student's particular area of study.

ELP 534 Ethics and Educational Decision Making. *3(3-0) . S. Alt. Yrs. Preq: Introduction to philosophy, ethics or Consent of Instructor; grad. standing* Application of moral theories and methods of moral reasoning to problems and issues involving educational policy and decision making. Character of morality; moral autonomy and leadership; intellectual freedom and public interest; authority and education; punishment and due process; and leadership and rationality.

ELP 550 Principles of Educational Administration. *3(3-0) . F,S. Preq: Grad. standing. Consent of Instructor.* Introductory course in educational administration. Emphasis upon basic principles of administration, drawing upon administrative theory, business and public administration models as well as theoretical constructs from various disciplines.

ELP 589 Personnel Appraisal in Education. *3(3-0) . S. Preq: ELP 532 or PSY 535.* Examination of issues, models, theories and research pertaining to personnel appraisal in education.

ELP 595 Special Topics. *F,S.*

ELP 620 Special Problems in Education. *1-3. F,S,Sum. Preq: Grad. standing or PBS status.* Opportunity for graduate students in education to study problem areas in professional education under direction of member of graduate faculty.

ELP 641 Practicum in Education Administration. *1-6. F,S. Preq: ELP 550 and Consent of Instructor.* Supervised experience in appropriate educational setting to enable student to gain practice in applying concepts, principles and theories of education administration.

ELP 651 Internship in Educational Leadership and Program Evaluation. *3-9. F,S. Preq: Nine hrs. in grad.-level courses and Consent of Instructor.* Utilization of participant-observer role and required participation in selected educational situations with emphasis upon development of observational skills, ability to record relevant observations by means of written journals, skills in analyzing experiences identifying critical incidents and projection of events and consequences. Required development of possible alternative courses of action in various situations, selection of one of alternatives and evaluation of consequences of selected course of action.

ELP 685 Master's Supervised Teaching. *1-3. F,S. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ELP 692 Master's Research Projects in Educational Leadership and Program Evaluation. *1 3. F,S,Sum. Preq: Consent of Instructor; ELP 532 or equivalent.* A project or problem in research in education for graduate students, supervised by members of graduate faculty. Research chosen on basis of individual students' interests and not to be part of thesis or dissertation research.

ELP 693 Master's Supervised Research. *1-9. F,S. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ELP 695 Master's Thesis Research. *1-9. F,S. Preq: Master's student.* Thesis research.

ELP 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

ELP 720 Cases in Educational Administration. *3(3-0) . F. Preq: Grad. standing and Consent of Instructor.* Utilization of case study and case simulation approach to study of school administration. Development and application of administrative concepts to simulated situations and to actual case histories. View of administrative process as a decision-making process. Student expected to make decisions after considering alternative courses of action and after projecting probable consequences.

ELP 724 Contemporary Educational Thought. *3(3 0) . F. Preq: Twelve hrs. ED. Consent of Instructor.* Reading and discussion of 20th-century works in educational philosophy. Consideration of such movements as pragmatism, reconstruction, perennialism and existentialism.

ELP 728 School Law for the Administrator. *3(3-0) . S. Alt. Yrs. Preq. ELP 518 or equivalent.* Comprehensive study of constitutional, statutory and case law as related to elementary and secondary school administration. Emphasis on legal issues associated with governance, finance, property, personnel and curriculum.

ELP 735 Decision Research In Education. *3(3-0) . F. Preq: ELP 532; Grad. standing or Consent of Instructor.* Intuitive and graphic approaches to modeling for purpose of supporting decisions in public sector, especially in education. Decision making with determinant and probabilistic data. Optimization methods. Practical applications and solution to common problems. Frequent computer-based assignments.

ELP 736 Qualitative Research in Education and Policy Analysis. *3(3-0) . F. Preq: ELP 532 or equivalent.* Provision of public school personnel and educational policy analysts with research training and experience to address educational research and policy problems using qualitative methods. Qualitative research design and strategies; data collection, management and analysis; interpretation and writing; qualitative evaluation and formation as applied particularly to educational research and policy analysis.

ELP 742 Applied Research Methods in Education. *3(1–4) . S. Preq: ST 507 and ELP 532 or equivalent. Coreq: ST 508 or Consent of Instructor.* Through use of simulated educational settings, consideration given to development of research proposals or plans, selection and/or development of appropriate measurement instruments and purposes and functions of various statistical designs and procedures. Preparation and analysis of simulated data using computer-based statistical packages, interpretation of results and production of a research report.

ELP 780 Evaluation Theory and Practice in Education. *3(3 0) . F. Preq: ELP 532 or equivalent.* Review of educational program evaluation with emphasis on (1) theory and conceptual models of evaluation, (2) evaluation design, and (3) environmental practical factors influencing design and implementation of evaluation studies.

ELP 820 Special Problems in Education. *1-3 F,S,Sum Preq: Grad. standing or PBS status.* Opportunity for graduate students in education to study problem areas in professional education under direction of member of graduate faculty.

ELP 841 Practicum In Education Administration. *1-6. F,S Preq: ELP 550 and Consent of Instructor.* Supervised experience in appropriate educational setting to enable student to gain practice in applying concepts, principles and theories of education administration.

ELP 851 Internship in Educational Leadership and Program Evaluation. *3 9. F,S Preq: Nine hrs. in grad. level courses and Consent of Instructor* Utilization of participant-observer role and required participation in selected educational situations with emphasis upon development of observational skills, ability to record relevant observations by means of written journals, skills in analyzing experiences identifying critical incidents and projection of events and consequences. Required development of possible alternative courses of action in various situations, selection of one of alternatives and evaluation of consequences of selected course of action.

ELP 885 Doctoral Supervised Teaching. *1-3. F,S Preq. Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ELP 890 Doctoral Preliminary Exam. *1-9. F,S. Preq· Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

ELP 891 Problems of Research Design in Education. *1-3. F,S. Preq: ELP 742 and Consent of Instructor.* Provision of individualized but structured investigation of alternative problem definitions, research methodologies and statistical analyses for a problem of student's choosing, usually associated with thesis or dissertation. In small groups or individually with instructor, student consideration of research design, measurements and statistical analysis necessary to conduct research.

ELP 892 Research Projects in Educational Leadership and Program Evaluation. *1-3. F,S,Sum. Preq: Consent of Instructor; ELP 732 or equivalent.* A project or problem in research in education for graduate students, supervised by members of graduate faculty. Research chosen on basis of individual students' interests and not to be part of thesis or dissertation research.

ELP 893 Doctoral Supervised Research. *1-9. F,S. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ELP 895 Doctoral Dissertation Research. *1-9. F.S. Preq: Doctoral student.* Dissertation research.

ELP 899 Doctoral Dissertation Preparation. *1-3. F,S. Preq: Doctoral student.* For students who have completed all credit hours, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

MATHEMATICS, SCIENCE AND TECHNOLOGY EDUCATION

EMS 101 Orientation to Mathematics and Science Education. *0(1-0) F.S. Open only to students in Math and Science Education.* Overview of departmental expectations and procedures and introduction to practical aspects of academic life. Opportunity for interaction of students with advisors and with other undergraduates who are nearing completion of programs.

EMS 203 Introduction to Teaching Mathematics and Science. *3(2-3) . F.S.* Introduces prospective teachers to the teaching of mathematics and science in the middle school and high school. As an important part of the course, students serve as teacher assistants to a classroom teacher. Ideas and questions arising from this experience provide an integral part of the classroom instruction on campus.

EMS 296 Special Topics in Education. *1-3.* Individual or group study of particular areas of education at the freshman and sophomore levels. Specific topics will vary from semester to semester.

EMS 470 Methods and Materials for Teaching Mathematics. *3(3-0) . F. Preq: Admission to the professional semester. Taught during the first seven weeks of the semester* Purposes, methods, curricula and evaluation practices for teaching mathematics in middle school and high school.

EMS 471 Student Teaching in Mathematics. *3-8. F. Preq: Admission to professional semester. Coreq: EMS 470* Supervised experience in a selected middle or secondary school for 10 weeks, to develop and practice the skills and techniques for teaching mathematics.

EMS 472 Teaching Mathematics Topics in Senior High School. *3(3-0) . F. Preq: Admission to professional semester. Coreq: EMS 470. Taught during the first 7 weeks of the semester.* Preparation for teaching mathematics from both the college preparatory (algebra, geometry, trigonometry, advanced mathematics) and general courses (pre-algebra, technical and consumer mathematics) offered in grades 9-12.

EMS 474 Teaching Mathematics Topics in the Middle Grades. *3(3-0) . F. Preq: Admission to professional semester. Coreq: EMS 470. Taught during the first 7 weeks of the semester.* Methods of teaching arithmetic, geometry, and pre-algebra topics in grades 6-9. Emphasizes approaches that actively involve learners and relate operations on concrete and pictorial representations to mathematical symbols.

EMS 475 Methods of Teaching Science. *3(3-0) . F. Preq: EMS 203, ELP 344, ED 310, PSY 304. Coreq: EMS 476. Taught during the first seven weeks of the semester.* Goals, methods, curricula, and evaluation practices in teaching the physical and biological sciences at the middle and secondary school levels.

EMS 476 Student Teaching in Science. *4-8. F. Preq: EMS 203, ELP 344, ED 310, PSY 304. Coreq: EMS 475. Students must have senior standing and be admitted to the professional semester.* Supervised classroom experience in developing the skills and techniques for teaching science in a selected middle or secondary school for 10 weeks.

EMS 477 Instructional Materials in Science. *3(2-2) . F. Preq: EMS 203, ELP 344, PSY 304. Coreq: EMS 475. Part of professional semester; 2 lecture hours and 6 lab hours per week for 7 weeks.* Development and selection of teaching materials that reflect concepts of content and emphasis in middle and secondary school science. Experimental and laboratory approaches, including use of microcomputer and video technologies.

EMS 480 Teaching Mathematics with Technology. *3(3-0) . F,S. Preq: EMS 203; MA 131 or 141.* Prepares prospective mathematics teachers to use technology in their classrooms to assist students in formulating and solving math problems in the middle and high school mathematics curricula.

EMS 495 Senior Seminar in Mathematics and Science Education. *1-3. Preq: Advanced undergraduate and consent of department.* In-depth investigation of one or more teaching areas in mathematics or science education.

EMS 496 Special Topics in Education. *1-3. Preq: Junior or senior standing and consent of instructor.* Individual or group study of special topics in professional education. The topic and mode of study are determined by the faculty member after discussion with the student.

EMS 511 Implications Of Mathematical Content, Structure, and Processes for the Teaching. *3(3-0) . S,Sum,Alt. Yrs. Preq: Bachelor's degree in elementary educ. or Consent of Instructor.* For teachers and supervisors of mathematics in elementary or middle school. Special emphasis on implications of mathematical content, structure, and processes in teaching arithmetic and geometry.

EMS 570 Foundations Of Mathematics Education. *3(3-0) . S. Preq: EMS 471 or equivalent.* The current status of mathematics education with special emphasis on study and critical analysis of current practices in mathematics instruction from elementary school through college.

EMS 575 Foundations of Science Education. *3(3-0) . S,Alt. Yrs. Preq: EMS 475 or equivalent.* Study and analysis of philosophical, historical, sociological, political and economic factors affecting science education in schools of the U.S. Implications for science education of various learning theories along with models for curriculum development and program planning. Critical analysis of current trends, issues and problems in science education in terms of multiple perspectives.

EMS 577 Improving Classroom Instruction in Science. *3(3-0) . S, Alt. Yrs. Preq: EMS 475 or equivalent.* Application of major principles of education and psychology to improvement of science teaching in elementary, middle and secondary schools. Emphasis on critical analysis of research and the development of research-based classroom applications. Goals and objectives of science teaching, instructional strategies, development or selection of science materials, evaluation of achievement and elements of a desirable classroom climate.

EMS 592 Special Problems in Mathematics Teaching. *1-3. F,S,Sum. Preq: EMS 471 or equivalent.* In-depth investigation of topical problems in mathematics teaching chosen from areas of curriculum, methodology, technology, supervision and research.

EMS 594 Special Problems in Science Teaching. *1-6. F,S,Sum. Preq: EMS 476 or equivalent.* In-depth investigation of topics in science education not covered in existing courses. Includes critical analysis of research and may include field work. May be offered on individual basis or as a class.

EMS 621 Special Problems in Mathematics Teaching. *1-3. F,S,Sum. Preq: EMS 471 or equivalent.* In-depth investigation of topical problems in mathematics teaching chosen from areas of curriculum, methodology, technology, supervision and research.

EMS 622 Special Problems in Science Teaching. *1-6. F,S,Sum. Preq: EMS 476 or equivalent.* In-depth investigation of topics in science education not covered in existing courses. Includes critical analysis of research and may include field work. May be offered on individual basis or as a class.

EMS 641 Practicum in Science and Mathematics Education. *1-6 F,S. Preq: EMS 770 or EMS 775.* Supervised practicum in appropriate settings both on- and off-campus. Provision for opportunity for development, implementation and evaluation in science and mathematics in clinical environment under faculty supervision.

EMS 651 Internship in Mathematics and Science Education. *3-9. F,S,Sum. Preq: Nine hrs. in grad. level courses and Consent of Instructor.* Utilizing the participant-observed role, required participation in selected educational situations with emphasis upon development of observational skills, ability to record relevant observations by means of written journals, skills in analyzing experiences identifying critical incidents and projection of events and consequences. Student required to develop possible alternative courses of action in various situations, select one of the alternatives and evaluate consequences of selected course of action.

EMS 685 Master's Supervised Teaching. *1-4. F,S. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

EMS 686 Teaching in College. *3(3 0) . Sum.* Focus on development of competencies to perform fundamental tasks of a college teacher as well as consideration of more long-range tasks such as course development and university responsibilities of a professor. In addition to attending lectures and other types of presentations, students make video tapes of their teaching, develop tests, design introductory courses in their teaching fields and consider current issues related to university and college teaching.

EMS 690 Master's Examination. *1-6. F,S. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

EMS 692 Research Projects in Mathematics and Science Education. *1-3 F,S,Sum. Preq: Consent of Instructor; ELP 532 or equivalent.* A project or problem in research in education for graduate students, supervised by members of the graduate faculty. The research chosen on basis of individual students' interests and not to be part of thesis or dissertation research.

EMS 693 Master's Supervised Research. *1-9. F,S. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

EMS 695 Master's Thesis Research. *1-9. F,S. Preq: Master's student.* Thesis research.

EMS 699 Master's Thesis Preparation. *1-3. F,S. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

EMS 703 Teaching Mathematics and Science in Higher Education. *3(3-0) . S. Preq: EMS 770, 621 or 622, grad. standing, Consent of Instructor.* Examination of collegiate mathematics and science instruction with respect to goals and objectives, design of courses and curricula, innovative programs and facilities, and methods and materials for instruction.

EMS 704 Curriculum Development and Evaluation in Science and Mathematics. *3(3-0) . S, Alt. Yrs. Preq: 500-level statistics. PSY 535, Consent of Instructor.* Critical study of elements of curriculum design and theory in mathematics education and science education and examination of evaluation procedures for assessing educational innovations.

EMS 705 Education and Supervision of Teachers of Mathematics and Science. *3(3-0) . S. Alt. Yrs. Preq: EMS 770 or 621 or 622.* Critical analysis of theories, programs and techniques designed to promote interpersonal interactions leading to more effective teaching of science and mathematics.

EMS 712 Teaching Mathematics in Elementary and Junior High School. *3(3-0) . S,Sum,Alt. Yrs. Preq: EMS 471 or equivalent.* Comprehensive study of teaching mathematics in elementary and junior high schools. Major emphasis on building skills in teaching arithmetic, elementary algebra and intuitive geometry. Thorough search of literature relative to mathematics curricula conducted, designing and sequencing of learning activities, teaching mathematical concepts and relationships, building skill in computation, reading mathematics, problem solving and measurement.

EMS 770 Foundations of Mathematics Education. *3(3-0) . S. Preq: EMS 471 or equivalent.* The current status of mathematics education with special emphasis on study and critical analysis of current practices in mathematics instruction from elementary school through college.

EMS 775 Foundations of Science Education. *3(3-0) . S,Alt. Yrs. Preq: EMS 475 or equivalent.* Study and analysis of philosophical, historical, sociological, political and economic factors affecting science education in schools of the U.S. Implications for science education of various learning theories along with models for curriculum development and program planning. Critical analysis of current trends, issues and problems in science education in terms of multiple perspectives.

EMS 777 Improving Classroom Instruction in Science. *3(3-0) . S, Alt. Yrs. Preq: EMS 475 or equivalent.* Application of major principles of education and psychology to improvement of science teaching in elementary, middle and secondary schools. Emphasis on critical analysis of research and the development of research-based classroom applications. Goals and objectives of science teaching, instructional strategies, development or selection of science materials, evaluation of achievement and elements of a desirable classroom climate.

EMS 786 Teaching in College. *3(3-0) . Sum.* Focus on development of competencies to perform fundamental tasks of a college teacher as well as consideration of more long-range tasks such as course development and university responsibilities of a professor. In addition to attending lectures and other types of presentations, students make video tapes of their teaching, develop tests, design introductory courses in their teaching fields and consider current issues related to university and college teaching.

EMS 792 Special Problems in Math Teaching. *3(3-0) . F,S,Sum. Preq: EMS 471 or equivalent.* In-depth investigation of topical problems in mathematics teaching chosen from areas of curriculum, methodology, technology, supervision and research.

EMS 794 Special Problems in Science Teaching. *3(3-0) . F,S,Sum. Preq: EMS 476 or equivalent* In-depth investigation of topics in science education not covered in existing courses. Includes critical analysis of research and may include field work. May be offered on individual basis or as a class.

EMS 802 Seminar in Mathematics Education. *F,S. Preq: Departmental major or Consent of Instructor.* In-depth examination and analysis of literature and research in a particular topic(s) in mathematics education.

EMS 803 Seminar in Science Education. *2(2-0) . F,S. Preq: Department major or Consent of Instructor.* In-depth examination and analysis of literature and research in a particular topic(s) in science education.

EMS 821 Special Problems in Mathematics Teaching. *1-3. F,S,Sum. Preq: EMS 471 or equivalent.* In-depth investigation of topical problems in mathematics teaching chosen from areas of curriculum, methodology, technology, supervision and research.

EMS 822 Special Problems in Science Teaching. *1-6. F,S,Sum. Preq: EMS 476 or equivalent.* In-depth investigation of topics in science education not covered in existing courses. Includes critical analysis of research and may include field work. May be offered on individual basis or as a class.

EMS 841 Practicum in Science and Mathematics Education. *1-6. F,S. Preq: EMS 770 or EMS 775.* Supervised practicum in appropriate settings both on- and off-campus. Provision for opportunity for development, implementation and evaluation in science and mathematics in clinical environment under faculty supervision.

EMS 851 Internship in Mathematics and Science Education. *3-9. F,S,Sum. Preq: Nine hrs. in grad. level courses and Consent of Instructor.* Utilizing the participant-observer role, required participation in selected educational situations with emphasis upon development of observational skills, ability to record relevant observations by means of written journals, skills in analyzing experiences identifying critical incidents and projection of events and consequences. Student required to develop possible alternative courses of action in various situations, select one of the alternatives and evaluate consequences of selected course of action.

EMS 885 Doctoral Supervised Teaching. *1-3. F.S. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

EMS 890 Doctoral Preliminary Exam. *1-9. F,S. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

EMS 892 Research Projects in Mathematics and Science Education. *1-3. F,S,Sum. Preq: Consent of Instructor; ELP 532 or equivalent.* A project or problem in research in education for graduate students, supervised by members of the graduate faculty. The research chosen on basis of individual students' interests and not to be part of thesis or dissertation research.

EMS 893 Doctoral Supervised Research. *1 9. F,S Preq. Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

EMS 895 Doctoral Dissertation Research. *1-9. F,S Preq· Doctoral student.* Dissertation research.

EMS 899 Doctoral Dissertation Preparation. *1-3. F,S. Preq: Doctoral student* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

ENGLISH

ENG 110 Developmental English. *3(3-0) . F,S,Sum. Credit is not applicable toward graduation in any curriculum. Students placed in ENG 110 must receive a grade of S in order to advance to ENG 111.* Development of basic writing skills through supervised writing, analyzed readings, and self-paced drills. Parts of speech; principles of spelling, capitalization, and punctuation; vocabulary study; composition of sentences, simple paragraphs, and short essays. Role of invention and revision in the writing process.

ENG (FLE) 111 Composition and Rhetoric. *3(3-0) . F,S,Sum. Students must take the freshman composition courses in succession until they complete both requirements. They must receive at least a C- in 111 in order to advance to 112.* Introduction to elements and strategies of argumentative writing for civic and academic audiences. Strategies for generating, organizing, and revising texts. Includes instruction in library research methods, use of evidence, and essay exams. Attention to grammar and conventions of standard written English.

ENG (FLE) 112 Composition and Reading. *3(3-0) . F,S Sum. Preq: C- or better in ENG 111.* Continued study of elements and strategies of argumentative writing for academic audiences, with attention to the connections between critical reading and writing. Analysis of arguments from different disciplines. Interpretation, analysis, and evaluation of a substantial number of literary works. Continued instruction in research and use of evidence, and attention to grammar and conventions of standard written English.

ENG 113 Composition and Reading. *3(3-0) . F,S,Sum. Preq: A grade of C or better in ENG 111.* This composition course serves students with high scores on the SAT-Verbal and Advanced Placement (Language and Composition) tests. Students read and write both civic and academic argument, studying the elements and strategies of argument in both contexts. They also read, interpret, and write about imaginative literature. Library research is required for at least one assignment. Students write a minimum of thirty typewritten pages, including at least six separate, fully developed pages.

ENG 205 Studies in Great Works of Western Literature. *3(3-0) . F S.Sum* Literary masterpieces from the classical period to the present. Emphasis on reading for understanding and enjoyment of both works themselves and the cultural contributions to Western civilization of the periods from which the works are drawn. Includes works by writers such as Homer, Sophocles, Dante, Chaucer, Shakespeare, Cervantes, Swift, Goethe, Austen, Flaubert, and Woolf.

ENG 206 Studies in Drama. *3(3-0) . F,S.* Selected drama from the classical period to the present. Emphasis on reading for enjoyment as well as understanding theory and development of tragedy, comedy, and other modes of dramatic expression. Writers such as Sophocles, Euripides, Shakespeare, Ibsen, and Shaw, and contemporary playwrights.

ENG 207 Studies in Poetry. *3(3-0) . F,S* Main features of poetry such as tone, voice, form, diction, figurative language, and sound patterns. Reading of poetry from different periods with the goal of learning how to understand, appreciate, and analyze different kinds of poems.

ENG 208 Studies in Fiction. *3(3-0) . F,S,Sum.* Representative examples of novels and short stories from different periods, emphasizing understanding and appreciation of fiction as a genre, a knowledge of the features and techniques of fiction, and a sense of the development of the genre.

ENG 209 Introduction to Shakespeare. *3(3-0) . F,S. Does not satisfy requirements for English major.* Shakespeare for non-English majors. Seven to ten major plays, including representative comedies, such as The Taming of the Shrew; histories, such as Richard III; tragedies, such as Hamlet; and romances, such as The Tempest.

ENG 210 Introduction to Language and Linguistics. *3(3-0) . F,S. Preq: ENG 112.* Linguistics theory and method. Topics include the English sound system, morphology, syntactic structure, semantics, and historical and contemporary dialect variation. Language acquisition, language and the brain, and computer processing and human language.

ENG 214 Introduction to Editing. *3(3-0) . F,S,Sum. Preq: ENG 112.* Basic editorial skills with a wide range of publications. Stylistic editing (conventions of written English, consistency, effectiveness of syntax, appropriateness of diction), substantive editing (accuracy, legal issues, ethics), and production editing (layout, typography, electronic publication processing). Introduction to resources such as standard reference works and professional organizations.

ENG 215 Principles of News and Article Writing. *3(3-0) . F,S,Sum.* Techniques of writing news stories and feature articles. Components of newsworthiness, examination of evidence, interview techniques, varied writing styles. Role of newspapers and journalism in America.

ENG (FL) 221 Literature of the Western World I. *3(3 0) . F.* Readings from English translations of Biblical, Classical, Medieval, and Early Renaissance literature, including works by such authors as Homer, Plato, Virgil, Ovid, St. Paul, St. Augustine, Marie de France, and Dante.

ENG (FL) 222 Literature of the Western World II. *3(3-0) . S.* Readings from English translations of Renaissance, Neo-Classical, Romantic, and Early Modern literature, emphasizing the cultures of continental Europe from the Renaissance to 1900, and including such authors as Petrarch, Erasmus, Rabelais, Machiavelli, Shakespeare, Moliere, Voltaire, Rousseau, Goethe, Flaubert, Tolstoy.

ENG (FL) 223 Contemporary World Literature I. *3(3-0) . F.* Twentieth-century literature of some of the following cultures: Russian, Eastern European, Western European, Latin American, Canadian, Australian.

ENG (FL) 224 Contemporary World Literature II. *3(3-0) . S.* Twentieth-century literature of some of the following cultures: Asian, Arabian, African, Caribbean, Native-American.

ENG 246 Literature of the Holocaust. *3(3-0) . S. Alt. Yrs.* Fictional and nonfictional versions of the Holocaust, focusing on themes of survival, justice, theology, and the limits of human endurance.

ENG 248 Survey of African-American Literature. *3(3-0) . F,S.* African-American writing and its relationships to American culture and history. Covers such writers as Wheatley, Douglass, Chesnutt, Dunbar, DuBois, Hughes, Hurston, Wright, and Morrison.

ENG 251 Major British Writers. *3(3-0) . F,S,Sum. Credit will not be given for both ENG 251 and either ENG 261 or 262.* Significant British authors chosen from among such figures as Chaucer, Shakespeare, Milton, Swift, Pope, Austen, Wordsworth, Coleridge, Tennyson, Browning, Bronte, Dickens, Joyce, Eliot, Woolf, and Yeats.

ENG 252 Major American Writers. *3(3-0) . F,S,Sum. Credit will not be given for both ENG 252 and either ENG 265 or 266.* Significant American authors chosen from among such figures as Franklin, Emerson, Thoreau, Hawthorne, Melville, Douglass, Stowe, Whitman, Dickinson, Twain, James, Frost, Faulkner, Hemingway, and Morrison.

ENG 260 Introduction to Literary Study. *3(3-0) . F,S,Sum. Preq: ENG 112.* Introduces fundamental questions in literary history and critical theory. Emphasizes critical reading skills and prepares students for the kinds of courses--surveys, genre courses, author courses, problem-based courses--that are part of the English major. Papers prepared using standard word processing programs.

ENG 261 English Literature I. *3(3-0) . F,S,Sum.* A survey of English literature to 1660, including Old English, Middle English, and Renaissance writing, focusing on such central authors as Chaucer, Spenser, Marlowe, Shakespeare, Jonson, Donne, and Milton.

ENG 262 English Literature II. *3(3-0) . F,S,Sum.* A survey of English literature from 1660 to the present. Poetry, fiction, drama and intellectual prose by such central writers as Dryden, Pope, Swift, Johnson, Wollstonecraft, Wordsworth, Keats, Shelley, BrontÜ, Carlyle, Tennyson, Browning, Yeats, Woolf, Joyce and Eliot.

ENG 265 American Literature I. *3(3-0) . F,S,Sum.* A survey of American literature from the beginnings to the Civil War, including such central authors as Edwards, Franklin, Irving, Emerson, Hawthorne, Melville, Poe, Stowe, Douglass, Thoreau, and Whitman.

ENG 266 American Literature II. *3(3-0) . F,S,Sum.* A survey of American literature from the Civil War to the present, including such central authors as Whitman, Dickinson, Twain, James, Crane, Wharton, Frost, Eliot, Hemingway, Hurston, Faulkner, Wright, O'Connor, and Morrison.

ENG 282 Introduction to Film. *3(2-2) . F,S.* Examination of basic film techniques and basic methods of film analysis. Emphasis on understanding and appreciating film as a major art form.

ENG 283 Introduction to American Folklore. *3(3-0) . S.* Principal types of folklore; field work in collecting and assimilating material from various cultural traditions. Emphasis on American folklore and its origins.

ENG 288 Fiction Writing. *3(3-0) . F,S.* Experience in writing short prose fiction. Class critiquing of student work and instruction in techniques of fiction.

ENG 289 Poetry Writing. *3(3-0) . F,S.* Experience in writing poetry. Class critiquing of student work and instruction in techniques of poetry.

ENG 298 Special Projects in English. *1-3. F,S,Sum.* Faculty-guided independent study, or courses on special topics determined by departmental interest or need.

ENG (WGS) 305 Women and Literature. *3(3-0) . S.* Nineteenth- and twentieth-century womens' literature, as shaped by the intersecting and competing claims of gender, race, sexuality, and culture. Focus on fiction, accompanied by critical readings from American studies, feminist literary criticism, and postmodern theory.

ENG 314 Technical Document Design and Editing. *3(3-0) F,S,Sum. Preq: ENG 214.* Layout and design principles for written documents; desktop building; legibility, readability testing; conventions of proposals, instructions, and reports; basics of technical editing: usage, vocabulary, style manuals, editing mathematical equations, graphs, tables.

ENG 315 Advanced News and Article Writing. *3(3-0) S. Preq: ENG 215.* Advanced work in writing news stories, profiles, features, and investigative stories. Includes analysis and critical reading of print media. Assumes thorough knowledge of AP style and rudiments of news and feature writing.

ENG (COM) 321 Survey of Rhetorical Theory. *3(3-0) F. Preq: COM 201 or permission of instructor.* Principles of rhetorical theory from its classical origins through the modern period to the present time. Key concepts and theories that provide a critical understanding of the processes of persuasive symbol use.

ENG 322 Advanced Composition and Rhetoric. *3(3-0) . F,S,Sum. Preq: Junior standing.* Classical and modern views of rhetoric and psychological and social aspects of writing. Varied practice in writing; assignments with different audiences, aims, contexts, and conventions.

ENG 323 Writing in the Rhetorical Tradition. *3(3-0) . F,S,Sum. Preq: ENG 112.* A writing course based on the study of rhetoric. Readings on the principles of intervention, arrangement, and style; analysis of written texts; writing of persuasive texts for a variety of audiences and purposes.

ENG 324 Modern English. *3(3-0) . F,S. Preq: ENG 111, ENG 112, ENG 210.* Study of Modern English at the sentence level. Analysis of grammatical structure. Consideration of language variation in English.

ENG 326 History of the English Language. *3(3-0) . F,S. Preq: ENG 112.* Development of the English language from its Indo-European origins to the present. Emphasis on historical and comparative linguistic methodology and on changes in sound, syntax, and meaning.

ENG 327 Language and Gender. *3(3-0) S Preq. ENG 111, ENG 112* Introduction to the use of language by men and women. Research in Linguistics and Women's Studies addressing issues such as the acquisition of gender-differentiated language, gender and conversational interaction, sexism in language, gender issues in society, and the relationship between language, gender, and other social constructs (e.g., class, culture, and ethnicity).

ENG 328 Language and Writing. *3(3-0) S. Preq: ENG 112* Study of language structure; specific attention to differences between spoken and written language; print conventions; error analysis; and the application of linguistics to rhetoric and composition. Analysis of a variety of grammatical approaches; how to evaluate grammar textbooks and compositions. Intended for English Education majors. Credit will not be awarded for both ENG 328 and ENG 324.

ENG 331 Communication for Engineering and Technology. *3(3 0) . F S,Sum. Preq: Junior standing. Credit is not allowed for more than one of ENG 331, ENG 332, and ENG 333.* Written communication in industrial and technical organizations, emphasizing internal communication with managers and technical personnel and including external communication with regulators, vendors, and clients. Intensive practice in writing; relationship of writing to oral and visual communication. For students in engineering and other primarily technological curricula.

ENG 332 Communication for Business and Management. *3(3-0) F S,Sum Preq: Junior standing Credit is not allowed for more than one of ENG 331, ENG 332, and ENG 333.* Written communication in business and public organizations, including both internal communication (such as instructions, policies, management reports) and external communication with clients, vendors, and publics. Intensive practice in writing; relationship of writing to oral and visual communication. For students in business and management-related programs.

ENG 333 Communication for Science and Research. *3(3-0) . F,S. Preq: Junior standing. Credit is not allowed for more than one of ENG 331, 332, and 333.* Written communication in scientific and research contexts, emphasizing relationship between research and writing in problem formulation, interpretation of results, and support and acceptance of research. Intensive practice in writing; relationship of writing to oral and visual communication. For students who plan careers in scientific research.

ENG 349 African Literature in English. *3(3-0) . S.* Anglophone literature in Africa. Emphasis on the relationship between the African world-view and literary production and the persistent trend by African writers to connect literature with politics. Writers such as Achebe, Ngugi, Soyinka, and Serote.

ENG 350 Internship in Writing and Editing. *3(1-10) . F,S. Preq: ENG 215, ENG 314.* Directed work experience for English majors including work-site mentoring and evaluation. Department supervision includes course work directed toward designing employment application materials, developing a portfolio of professional work, and reading the literature on workplace socialization.

ENG 362 The British Novel of the 18th Century. *3(3-0) . S.* Emphasizes major novelists such as Defoe, Richardson, Fielding, Sterne, and Austen.

ENG 363 The British Novel of the 19th Century. *3(3-0) . F.* Emphasizes major novelists such as Dickens, Trollope, the Brontes, Eliot, and Hardy.

ENG (COM) 364 History of Film to 1940. *3(3-0) . F. Preq: Junior standing.* Technological developments and aesthetic movements that shaped cinema production and direction from the beginning of the industry to 1940. Evolution in camera movement, editing, sound storyline, and the documentary. Rise to prominence of the Hollywood studio systems and the contributions of foreign filmmakers.

ENG 368 American Poetry to 1900. *3(3-0) . S. Preq. ENG 111, ENG 112.* American poetry written in English from the colonial period to 1900. Development of styles and themes in relation to historical context. Emphasis on poets such as Bradstreet, Taylor, Wheatley, Poe, Sigourney, Emerson, Longfellow, Whitman, Dickinson, and Robinson.

ENG 369 The American Novel of the 19th Century. *3(3-0) . F.* Major novels illustrating the development of American fiction from Romanticism to Realism and Naturalism. Works by such writers as Brown, Cooper, Hawthorne, Stowe, Melville, Twain, Howells, James, Norris, Crane, Chopin, and Dreiser.

ENG 370 Early Twentieth-Century Fiction. *3(3-0) S. Alt Yrs. Preq: ENG 111and ENG 112: or ENG 113* Study of narrative fiction written during the first half of the twentieth century. Typical subjects: James, Conrad, Stein, Hemingway, Woolf, Faulkner, Hurston, Wright, Beckett.

ENG 371 Late Twentieth-Century Fiction. *3(3 0) . S, Alt. Yrs.* Study of narrative fiction written during the second half of the twentieth century. Typical subjects: Beckett, O'Brien, Welty, O'Connor, Naipaul, Lessing, Gordimer, Morrison, Rushdie, DeLillo, Pynchon, McCarthy.

ENG 372 Early Twentieth-Century Poetry. *3(3-0) F, Alt. Yrs.* Study of poetry written in English during the first half of the twentieth century. Typical subjects: Hardy, Robinson, Yeats, Eliot, Pound, H.D., Williams, Hughes, Moore, Stevens.

ENG 373 Late Twentieth-Century Poetry. *3(3-0) . F, Alt. Yrs.* Study of poetry written in English during the second half of the twentieth century. Typical subjects: Auden, Lowell, Larkin, Olson, Heaney, Plath, Ginsberg, Smith, Ashbery, Rich, Brooks, Walcott, Lorde.

ENG (COM) 374 History of Film From 1940. *3(3-0) . S. Preq: Junior standing.* Technological developments and aesthetic movements that have shaped cinema production and direction from 1940 to the present. Evolution in camera movement, editing, sound, storyline, and the documentary. Post-war decline and re-emergence of the Hollywood film industry and the contributions of foreign filmmakers.

ENG 376 Science Fiction. *3(3-0) . F,S. Preq: ENG 111, ENG 112.* Representative works of science fiction. Emphasis on works written in the twentieth century, with some attention to the history and development of the genre.

ENG 377 Fantasy. *3(3-0) . F,S.* Representative works in the genre of fantasy. Emphasis on works of 19th and 20th centuries. Authors such as Carroll, Lewis, Tolkien, Borges, LeGuin, and Gardner.

ENG 380 Modern Drama. *3(3-0) . F.* Major plays and playwrights from Ibsen to Pinter, including at least some of the following: Strindberg, Chekhov, Shaw, O'Neill, Hellman, Pirandello, Brecht, Williams, Miller, Albee.

ENG 381 Special Topics in Modern Drama. *3(3-0) . F. Preq: ENG 111 and ENG 112; or ENG 113.* Various topics in modern dram covering different cultures, issues, and theatrical practices within the last 100 years. Modern American drama, modern British drama, modern World Drama, and European theatre from World War II to the present.

ENG 382 Film and Literature. *3(2 2) . F.* Ways of adapting literary works to film form. Similarities and differences between these two media. Emphasis on the practical art of transforming literature into film. Attention to the impact of film upon literature

ENG 383 Folklore and Literature. *3(3 0) . F.* Relationships between traditional culture and written literature. Genre theory; interchanges between print media and oral tradition; nature of plot, character, and form in Western and non-Western cultural traditions; performance theory. Influence of regional traditions and American literature.

ENG 384 Film Theory. *3(3 0). F. Preq: ENG 282.* Survey of critical approaches to film art. Application of theoretical paradigms formalist, realist, psychoanalytic, feminist, poststructuralist—to individual films, genres, national cinemas and directors.

ENG 385 Biblical Backgrounds of English Literature. *3(3-0) . F, Alt. Yrs.* Influences of the Bible-principal forms, genres, and texts-on major English and American writers such as Milton, Spenser, Melville, Eliot, and Faulkner.

ENG 390 Classical Backgrounds of English Literature. *3(3-0) . S.* Literature of the ancient Western world and its influence on English and American writing. Emphasis on the connections between the two bodies of literature. Covers such writers as Plato, Horace, Virgil, and St. Augustine.

ENG (FL) 394 Studies in World Literature. *3(3-0) . F,S.* Study of a subject in world literature; for example, African literature, Asian literature, Hispanic literature, East European literature, comedy, the epic, the lyric, autobiography, the Faust legend, or metamorphosis. Subjects vary according to availability of faculty. Readings in English translation.

ENG 398 Contemporary Literature I (1900 to 1940). *3(3-0) . F.* British and American literature from 1900 to World War II, with representative authors such as Conrad, Yeats, Eliot, Joyce, Woolf, Faulkner, Shaw, Stein, O'Neill, and Wright. For comparative purposes, continental authors such as Kafka and Mann.

ENG 399 Contemporary Literature II (1940 to Present). *3(3-0) . S.* Literature from World War II to the present, with representative authors such as Murdoch, Beckett, Nabokov, Ginsberg, Achebe, Fuentes, Kundera, Naipaul, and Morrison.

ENG 400 Applied Criticism. *3(3-0) . F. Preq: Majors in LTN; senior standing; formal admission to the methods and student teaching courses. Coreq: ECI 450* Types and methods of literary criticism designed specifically for students intending to teach English in high school.

ENG (ECI) 405 Literature for Adolescents. *3(3-0) F Preq: Junior standing or above* The history, types, and characteristics of literature for adolescents. Emphasizes reading and analyzing the literature by exploring the themes, literary elements, and rationale for teaching literature for adolescents. Addresses ways in which this literature can be integrated and implemented in English/Language Arts curriculum.

ENG (FL) 406 Modernism. *3(3-0) . F. Preq. ENG 111 and ENG 112, or ENG 113.* International Modernist movement in literature, from its nineteenth-century origins to its culmination in the early twentieth century. Definitions of modernity, as embodied in a variety of genres. Placement of Modernist texts within a variety of cultures that produced them.

ENG (FL) 407 Postmodernism. *3(3-0) . S. Preq: ENG 111 and ENG 112; or ENG 113.* Literary expressions of Postmodernism, from its origins in the Modernist movement through its culmination in the later decades of the twentieth century. Definitions of postmodernity, as embodied in a variety of genres. Placement of Postmodernist texts within a variety of cultures that have produced them.

ENG (COM) 411 Rhetorical Criticism. *3(3-0) . S.* Rhetorical analysis of public speeches, social movements, political campaigns, popular music, advertising, and religious communication. Neo-Aristotelian criticism, movement studies, genre criticism, dramatistic analysis, content analysis, fantasy theme analysis.

ENG 417 Editorial and Opinion Writing. *3(3-0) . S. Preq: ENG 214, ENG 215.* Discussing and writing newspaper and magazine editorials, with added attention to other forms of opinion in print, such as columns and books and music reviews.

ENG 420 Major American Author. *3(3-0) . F.* Intensive study of the writings of one (or two) American author(s). Developments across the career, relationships between the writing and the life, the writer's participation in a culture and an historical moment. Sample subjects: Emerson and Thoreau, Melville, Whitman, Stowe and Douglass, Dickinson, Twain, James and Wharton, Frost, O'Neill, Fitzgerald and Hemingway, Faulkner, Hurston and Wright, O'Conner, Morrison.

ENG 421 Computer Documentation Design. *3(3-0) . F Preq: ENG 314, 331, 332 or ENG 333.* Theory and design of documentation for computer hardware and software, including user guides, reference manuals, quick reference guides, tutorials, online documentation, and CD-based media delivery. Training in alternative documentation testing procedures, usability testing, and collaborative revision.

ENG 422 Writing Theory and the Writing Process. *3(3-0) . F,S. Preq: ENG 112; Jr. standing.* Theory and research on the processes and contexts of written discourse; cognitive, socio-cultural, educational perspectives; reflective and research-based accounts of the writing process; analysis of discourse contexts and communities.

ENG 425 Analysis of Scientific and Technical Writing. *3(3-0) . S. Preq: ENG 314 331, 332, 333.* The role of communication in the creation of scientific knowledge and technical designs and artifacts; methods of analyzing texts and of studying their creation and use; relationships between writing and other forms of communication. Field research in a scientific or technological setting.

ENG 426 Analyzing Style. *3(3-0) . F,S. Preq. ENG 260.* Development of a greater understanding of and facility with style in written discourse. Theories of style, stylistic features; methods of analysis, imitation.

ENG 433 Screenwriting. *3(3-0) . S, Alt. Yrs. Preq: 6 credit hours from courses in writing for media, creative writing, or Film Studies.* Writing for films, story planning, character development, communicating information, building scenes, relationships between script and cinematic dimensions, working with studios and editors.

ENG 439 17th-Century English Literature. *3(3-0) . S.* Works of major nondramatic literary figures in England during the period 1600-1700, such as Donne, Jonson, Herbert, Marvell, Bacon, and Browne.

ENG 448 African-American Literature. *3(3-0) . S. Preq: Junior standing.* Survey of African-American literature and its relationships to American culture, with an emphasis on fiction and poetry since 1945. Writers such as Bontemps, Morrison, Huston, Baldwin, Hayden, Brooks, Naylor, Harper, and Dove.

ENG 449 16th-Century English Literature. *3(3-0) . F* Nondramatic prose and poetry of the sixteenth century, with consideration of literary types and movements. Emphasis on major authors, including Sidney and Spenser.

ENG 451 Chaucer. *3(3-0) . F,S.* Introduction to the study of Chaucer through an intensive reading of The Canterbury Tales.

ENG 452 Medieval British Literature. *3(3-0) . S.* Readings in the rich poetic, thematic, and generic diversity of Medieval British literature. Representative selections from romance, dream-vision, allegory, fabliau, lyric, chronicle, saint's life, satire, in historical and cultural contexts. Prior knowledge of Middle English unnecessary.

ENG 453 The Romantic Period. *3(3 0) . F.* Emphasis on the major poetry of Blake, Wordsworth, Coleridge, Byron, Shelley, and Keats, with selected readings from other poets, prose writers, and dramatists of the period.

ENG 462 18th-Century English Literature. *3(3-0) . F.* Major figures in English literature between 1660 and 1790. Works studied in relation to social, cultural, political, and religious developments. Emphasis on writers such as Dryden, Swift, Pope, Johnson.

ENG 463 The Victorian Periods. *3(3-0). F,S.* Major British poets and selected prose writers studied against the social, economic, scientific, and theological background of the Victorian period.

ENG 464 British Literature, 1900-1945. *3(3-0) . S, Alt. Yrs.* Variety of writings by British authors between the death of Queen Victoria and the end of World War II. Typical subjects: Hardy, Conrad, Shaw, Yeats, Forster, Joyce, Lawrence, Eliot, Woolf, Beckett.

ENG 465 British Literature, Since 1945. *3(3-0) . S, Alt. Yrs.* Study of a variety of writings by British authors since World War II. Typical subjects: Beckett, O'Brien, Orwell, Lessing, Murdoch, Rhys, Auden, Larkin, Osborne, Rushdie.

ENG 468 American Romantics. *3(3-0) F.* Major American writers from 1825 to 1865. Relationship between literary developments and social change. Emphasis on such writers as Emerson, Hawthorne, Cooper, Poe, Melville, Douglass, Stowe, Thoreau, and Whitman.

ENG 469 American Realism and Naturalism. *3(3 0) S.* Major American writers from 1865 to 1914, with emphasis on novelists such as Twain, James, Howells, Chopin, and Dreiser.

ENG 470 American Literature, 1914-1945. *3(3-0) . F, Alt. Yrs.* Variety of writings by U.S. authors from World War I to World War II. Typical subjects: Stein, Adams, Anderson, Williams, Cullen, Hilda Doolittle, Faulkner, Hurston, Hemingway, Fitzgerald, Frost, O'Neill.

ENG 471 American Literature, Since 1945. *3(3-0) . F, Alt. Yrs.* Study of a variety of writings by U.S. authors since World War II. Typical subjects: Ellison, Lowell, Williams, Welty, Bellow, Baldwin, O'Conner, Barthelme, Albee, Mailer, Ashbery, Morrison, McDermott, DeLillo.

ENG 475 Literature, the Arts, and Mass Culture. *3(3-0) . F,S.* A review of the debate regarding art and mass culture, with attention to recent developments in cultural theory and practice.

ENG 476 Southern Literature. *3(3-0) . F.* Literary traditions of the Southeastern United States from colonization through the present, including study of such major writers as Byrd, Jefferson, Simms, Poe, Douglass, Twain, Chesnutt, Glasgow, Hurston, Tate, Wolfe, Faulkner, Warren, Wright, Welty, Williams, O'Conner, Percy, and Lee Smith.

ENG 486 Shakespeare, The Earlier Plays. *3(3-0) . F. Preq: ENG 112.* Shakespeare's major works before 1600 with emphasis on his development as a playwright.

ENG 487 Shakespeare, The Later Plays. *3(3-0) . S. Preq: ENG 112.* Shakespeare's major works after 1600 with emphasis on his tragedies and the late romances.

ENG 488 Advanced Fiction Writing. *3(3-0) . F,S. Preq: A grade of B or better in ENG 288 or 289, or demonstrated competence in creative writing.* Workshop in creative writing for the student with demonstrated understanding of the basic techniques of writing prose fiction.

ENG 489 Advanced Poetry Writing. *3(3-0) . S. Preq: A grade of B or better in ENG 288 or 289, or demonstrated competence in creative writing.* Workshop in creative writing for the student with demonstrated understanding of the basic techniques of writing poetry.

ENG 490 Studies in Medieval Literature. *3(3-0) . F. Preq: ENG 111 and 112 or 113; ENG 261.* Topics (in rotation) in medieval English and continental literature, such as Arthurian legend and literature; women in medieval society and literature; the self in the late Middle Ages. Focus on special areas of interest, with attention to cultural and historical backgrounds and contemporary scholarship. Some texts in Middle English, some in translation; no prior knowledge of Middle English needed.

ENG 491 Honors in English. *3(3-0). Preq: Open only to English majors* Intensive course or independent study project designed as one portion of the Honors Program in English. Subject varies.

ENG 492 Special Topics in Film Styles and Genres. *3(2-2) . S.* Critical approaches to focused film topics involving film genres, directorial styles, or trends within a national cinema. Topics will vary from semester to semester.

ENG 493 Special Topics in Folklore. *3(3-0) . S.* Topics and genres in folklore, such as Folktale and Legend, Folklore and Religion, African-American Folklore. Topics will vary from semester to semester.

ENG 494 Special Topics in Linguistics. *3(3-0) . S. Preq: ENG 112; 6 credit hours linguistics.* (May be repeated for credit with new topic.) Methodology and analysis within various branches of linguistics, e.g. syntax, semantics, computational linguistics, phonology, dialectology, historical linguistics, discourse analysis. Examination of topic's basic methods, controversial issues, analysis of linguistic data. Projects may include novel analyses of English constructions, parsing programs, field work reports.

ENG 495 Seminar in Writing and Editing. *3(3-0) . F,S. Preq: Senior standing in LWE.* Applies principles and experiences gained in previous study to practical problems and projects such as document design and production, document testing, professional ethics, literacy education, and style analysis and evaluation.

ENG 496 Seminar in Literary Criticism. *3(3-0) . F,S. Preq: 9 hours of literature at the 300 level or above.* Introduction to theoretical and applied criticism of literature, primarily for English majors and minors. May include traditional theory from Plato and Aristotle to New Criticism, as well as contemporary psychoanalytical, social, historical, and linguistic approaches to literature.

ENG (FL) 497 Senior Seminar in World Literature. *3(3-0) . S. Junior or Senior standing.* Rotating topics in world literature, including treatment of materials from more than one culture and including consideration of the subject's theoretical or methodological framework. Readings in English (original languages encouraged but not required).

ENG 498 Special Topics in English. *1-6. F,S,Sum. Preq: Six hours in ENG above the 100 level.* Directed individual study or experimental course offerings in language or literature. Individual study arranged through consultation with faculty member and Director of Undergraduate Studies.

ENG 508 Usability Studies for Technical Communication. *3(3 0) . S. Preq. ENG 517.* Advanced study of usability inspection, inquiry, and testing theories and practices related to instrumental and instructive texts (i.e., computer-related, legal, medical, pharmaceutical, financial, etc.). Practical experience testing a variety of texts using several testing methods, including completion of a substantial, lab-based usability test. For students planning careers in technical communication, human factors, software design, and multimedia design.

ENG 509 Old English Literature. *3(3-0) . S. Alt. Yrs.* Study of Old English language with selections from important poems including Beowulf. Examination of the poetry in the light of various modern critical approaches.

ENG 510 Middle English Literature. *3(3 0) . S, Alt. Yrs* Study of major works of medieval English literature (exclusive of Chaucer's Canterbury Tales) in historical context, as reflections of and influences on social and cultural change. Includes works such as Sir Gawain and the Green Knight, Pearl, Langland's Piers Plowman and Malory's Morte d'Arthur.

ENG 511 Theory and Research in Composition. *3(3-0) .* Research and scholarship in composition and the teaching of writing. Major theoretical perspectives (such as expressive, social, cognitive, feminist), current issues (such as audience, invention, revision, evaluation) and various research methods.

ENG 512 Theory and Research in Professional Writing. *3(3-0) F Coreq. ENG 666.* Introduction to research and scholarship in professional writing and writing in the workplace. Major theoretical perspectives for studying writing; current issues (such as usability, readability, collaboration, gender, authorship); and various research methods.

ENG 513 Empirical Research in Composition. *3(3-0) S.* Reading and evaluation of empirical research in written composition; guided practice in qualitative and quantitative methods. Basic principles of research; problem definition, research design and statistical analysis, description and assessment of written products and processes.

ENG (COM) 514 History of Rhetoric. *3(3-0) . S.* Contemporary rhetorical theory and its development from classical rhetoric; emphasis on differences between oral and written communication and the relevance of traditional theory to purposes and constraints of writing. Special attention to current issues: revival of invention, argumentation and truth, contributions of research in composition.

ENG 515 Rhetoric of Science and Technology. *3(3-0) . S.* The relationships among rhetoric, scientific knowledge and technological development and of changes in how these relationships understood historically. Practice in critical analysis of scientific and technical discourse. Consideration of scientific and technical language and of public controversy concerning science and technology.

ENG (COM) 516 Rhetorical Criticism: Theory and Practice. *3(3-0) . F. Preq: COM 321 or 411 or ENG 514 or 515.* Development, achievements, limitation of major critical methods in the 20th century, including neo-Aristotelian, generic, metaphoric, dramatistic, feminist, social-movement, fantasy-theme and postmodern approaches. Criticism of political discourse, institutional discourse, discourses of law, medicine, religion, education, science, the media. Relations between rhetorical and literary criticism and other forms of cultural analysis.

ENG 517 Advanced Technical Writing, Editing and Document Design. *3(2-1) . F Preq: ENG 314.* Advanced study of document design, technical editing and usability. For students planning careers as technical communicators.

ENG 518 Publication Management for Technical Communicators. *3(2-1) . S. Preq. ENG 517.* Advanced study of publication and team management issues such as staffing, scheduling, cost-reduction and subcontracting. For students planning careers as technical communicators.

ENG 519 Online Information Design and Evaluation. *3(3-0) . F.S. Preq: ENG 521.* Planning, collaboratively writing, revising, and linking online information using workstation-based technology. Theory and practice of human-computer interaction. Prototype design of an online publishing and information delivery system. Exposure to the Internet as a research tool. Exploration of Mosaic, List servers, Multi-User Domains(MUDs), Bulletin Boards, and E-Mail systems in the transformation of ways of reading, research and communication

ENG 520 Science Writing for the Media. *3(3-0) . F.* Coverage of three areas: how to write science articles for a variety of mass media, how to think critically about how mass media cover science, and how to think critically about science itself. Preparation for careers not only in mass media, but also in scientific and technological organizations.

ENG 521 Modern English Usage. *3(2-1) . F, Alt. Yrs. Preq: ENG 524.* Analysis of what "usage" means, a look at the shaping of attitudes about English in the twentieth century and the service of language during that period to form social groups. Attention to the transmission of these attitudes and to the role of the schools in that transmission.

ENG 522 Linguistics and Literacy. *3(3-0) . S. Preq: One course in linguistics or reading* Focus on two-way relationship between linguistic theory and literacy. Metalinguistic awareness and acquisition of literacy, orthography and phonology, oral vs. written language, oral vs. literate cultures, and metalinguistic assumptions in linguistic theory.

ENG 523 Language Variation Research Seminar. *3(3 0) . S. Preq: ENG 525.* Field-initiated research. Group and individual research topics focused on current sociolinguistic issues related to language variation and changes. Ethnographic and quantitative methods of analysis.

ENG 524 Introduction to Linguistics. *3(3-0) . F. Preq: Grad. standing or 12 hrs. in ENG.* Introduction to theoretical linguistics, especially for students in language, writing and literature curricula. Phonology, syntax, semantics, history of linguistics; relation of linguistics to philosophy, sociology and psychology; application of theory to analysis of texts.

ENG 525 Variety in Language. *3(3-0) . S. Preq: Grad. standing or 12 hrs. in ENG.* Language variation description, theory, method and application; focus on regional, social, ethnic and gender varieties; sociolinguistic analysis, basic discourse analysis.

ENG 526 History Of the English Language. *3(3-0) . F, Alt. Yrs.* A survey of the growth and development of the language from its Indo-European beginnings to the present.

ENG 527 Critical Discourse Analysis. *3(3-0) . F.* Pragmatic, discourse-analytic and sociolinguistic theories; application of methods analysis to different varieties of text; particular emphasis on literary text.

ENG 528 Language Change Research Seminar. *3(3-0) . S, Alt. Yrs. Preq: ENG 526.* Study of English development and English dialects; processes of language change; historical linguistic methodology; field research; language variation and change.

ENG 529 16th-Century Non-Dramatic English Literature. *3(3-0) . F.* Prose and poetry of the English Renaissance, excluding drama. Special attention to major authors, including Spenser and Sidney, and to intellectual, cultural and literary backgrounds and developments. Introduction to pertinent methods and issues of scholarly inquiry and critical interpretation.

ENG 530 17TH-Century English Literature. *3(3-0) . S.* A close examination of the literature of England from 1600 to 1660 with emphasis on major literary figures and movements, development of important literary forms and genres and relationship between literary texts of this period and their philosophical, political and theological contexts. Some bibliographical and textural assignments. Content and focus varies according to instructor's emphasis, but writers covered usually include Donne, Herbert, Crashaw, Marvell and Browne.

ENG 531 American Colonial Literature. *3(3-0) . S, Alt. Yrs.* Survey of American literature and thought from the beginning to adoption of the constitution. Representative works such as travel and exploration reports, Indian captivity narratives, diaries, journals, auto biographies, sermons and poetry.

ENG (FL) 539 Seminar in World Literature. *3(3 0) . S.* Rotating topics in world literature, including treatment of the subject's theoretical or methodological framework. Possible subjects: colonialism and literature; orality and literature; the Renaissance; the Enlightenment; translation; comparison of North and South American literatures; African literary traditions; post-modernism and gender. Readings in English(original languages encouraged but not required).

ENG 540 History of Literary Criticism. *3(3-0) . F. Preq: Grad. standing or PBS status.* Survey of the history of literary criticism from Antiquity to early Modern period. Introduction to major theoretical definitions of literature and modes of practical criticism. Close study of Aristotle's Poetics, Sidney's Apology for Poetry, Pope's Essay on Criticism, Coleridge's Biographia Literaria, Eliot's essays and other landmark works in development of literary criticism.

ENG 541 Contemporary Literary Theory. *3(3 0) . S. Preq: Grad. standing or PBS status.* Survey of major developments in 20th-century literary theory. Introduction to central concepts, issues and theorists in contemporary literary criticism. Examination of range of modern critical practices. Study of relations between literary theory and such adjacent disciplines as linguistics, anthropology, social theory, psychology and philosophy.

ENG 548 African-American Literature. *3(3-0) . F Preq: Grad. standing.* Advanced study of critical theories of African-American literature, the contexts of cultural criticism and 20th-century novels of African-American writers within these frames.

ENG 549 Modern African Literature. *3(3-0) . S, Alt. Yrs.* The works of the most important writers shaping modern African literature in English (and English translation). Selections from East, West, North and South Africa, spanning colonial through post-colonial Africa--from literature of protest and culture conflict to that of disillusionment, reappraisal and feminism.

ENG 550 English Romantic Period. *3(3-0) . F.* A detailed study of the six major romantic poets--Blake, Wordsworth, Coleridge, Byron, Shelley, and Keats; some attention as well to the political, social and literary background and to a few minor writers and critics.

ENG 551 Chaucer. *3(3-0) . F. Preq: ENG 451 or equivalent and grad. standing.* Intensive study of the works of Chaucer in the light of medieval literary traditions, medieval history and a variety of medieval and modern critical approaches.

ENG 555 American Romantic Period. *3(3-0) . F.* The literary culture of the United States from 1820s through 1860s, setting works of transcendentalists and other romantic writers within sociohistorical contexts. Consideration of writing by women, slave narratives and popular fiction as well as such major figures as Emerson, Hawthorne, Thoreau and Melville.

ENG 558 Studies In Shakespeare. *3(3-0) .*

ENG 560 Victorian Poetry and Critical Prose. *3(3 0) . S* The literature of Victorian England: 1837-1901; the major poets and essayists, movements and questions in their historical contexts, religious, political and aesthetic.

ENG 561 Milton. *3(3-0) . S.* An intensive reading of Milton with attention to background materials in history and culture of seventeenth-century England..

ENG 562 18TH-Century English Literature. *3(3-0) F.* British writers of the period 1600-1790 studied in historical and cultural contexts. Usually includes works by Dryden, Swift, Pope, Defoe, Mandeville, Boswell and Johnson, but addition of other significant writers possible.

ENG 563 18TH-Century English Novel. *3(3-0) . S, Alt. Yrs* Selected British novels of the Restoration and eighteenth century from a variety of contemporary critical perspectives. Such writers as Fielding, Richardson, Sterne, Burney, Smollett and Austen.

ENG 564 Victorian Novel. *3(3-0) F, Alt. Yrs* Study of selected British novels published between 1837 and 1901 in contexts of the development of the genre, historical period and current literary theory. Such writers as Dickens, Thackeray, Bronte, Trollope, Eliot, Meredith and Hardy.

ENG 565 American Realism and Naturalism. *3(3-0) . S* Study of literary culture of United States from 1860s to early 1900s with emphasis on fiction by such realists and naturalists as Twain, Howells, Chesnutt, James, Crane, Wharton, Dreiser and Norris. Inclusion of prose of writers such as Adams and DuBois possible.

ENG 570 20TH-Century British Prose. *3(3-0) . F, Alt. Yrs.* Examination of British fiction of this century and relationship of significant intellectual, historical and political issues. Inclusion of such writers as Joyce, Conrad, Woolf, Lawrence, Beckett and Murdoch possible but also post-colonial novelists as well.

ENG 571 20TH-Century British Poetry. *3(3-0) . S, Alt. Yrs.* Development of English poetry from its late Victorian phase through Modernism to present post-war scene. Inclusion of such writers as Hardy, Yeats, Eliot, Smith, Auden, Larkin, Heaney, Wolcott and Hill possible.

ENG 572 Modern British Drama. *3(3-0) . F, Alt. Yrs.* Survey of modern British drama from its beginnings at turn of the century to present.

ENG 573 Modern American Drama. *3(3-0) . F, Alt. Yrs.* A survey of modern American drama centering on major figures.

ENG 574 Comparative Drama: The Theater as Supranational Expression. *3(3-0) . S, Alt. Even Yrs.* Intensive comparative analysis of selected plays, from outstanding periods in world drama, leading to independent research on a comparative topic. Close reading of primary and secondary sources, using a variety of modern critical approaches, such asthematology, intertextuality and genology, to determine what qualities resonate across national and linguistic boundaries. Class presentations and collaboration culminating in extensive final research papers.

ENG 575 Southern Writers. *3(3-0) . S.* Introduction to literary culture of "the South," tracing the roots of the twentieth-century "Southern Renaissance" in such antebellum genres as plantation fiction, Southwestern humor, fugitive-slave narration and pastoral elegy. Examination of persistence of "Southern" writing within increasingly standardized culture of the United States.

ENG 576 20TH-Century American Poetry. *3(3-0) . S, Alt. Yrs.* Development of modern American poetry from rebellion against the romantic and genteel verse of the 1890's; special attention to Robinson, Frost, Pound, Williams, Stevens and Ransom.

ENG 577 20th-Century American Prose. *3(3-0) . S.* An examination of representative American writers of novel and short fiction.

ENG 578 English Drama to 1642. *3(3-0) . Alt. F. Preq: ENG 261 and upper division or grad. standing.* Elizabethan and Jacobean drama from 1580 to 1642, excluding Shakespeare. Coverage of such writers as Marlowe, Jonson, Webster, Beaumont and Fletcher, Heywood, Tourneur and Ford.

ENG 579 Restoration and 18th-Century Drama. *3(3 0) . Alt. S.* Representative British plays of the period 1660-1780 studied in cultural, social and ethical contexts. Usually includes works by Etherege, Wycherley, Behn, Dryden, Otway, Vanburgh, Farquhar, Congreve, Lillo, Gay, Goldsmith and Sheridan.

ENG 580 Literary Postmodernism. *3(3-0) . S, Alt. Yrs. Preq: Grad. standing.* Post-1945 literary theory in relationship with representative avant-garde writers. Theoretical and argumentative essays in such areas as chaos theory, deconstruction, feminism and the limits of fiction. Fiction readings by Calvino, Pynchon, Barthelme, Cortazar and others.

ENG 582 Studies in Literature. *3(3-0) . F,S. Preq: Grad. standing.* Variation in content. Selected problems and issues in literature.

ENG 583 Studies in Composition and Rhetoric. *3(3-0) . F,S. Preq: Grad. standing.* Variation in content. Selected problems and issues in composition and rhetoric.

ENG 584 Studies in Linguistics. *3(3-0) . F,S. Preq: Grad. standing.* Variation in content. Selected problems and issues in linguistics.

ENG 585 Studies in Film. *3(3-0) . F,S. Preq: Grad. standing.* Variation in content. Selected problems and issues in film.

ENG 586 Studies in Theory. *3(3-0) . F,S. Preq: Grad. standing.* Variation in content. Selected problems and issues in theory.

ENG 588 Fiction Writing Workshop. *3(3-0) . F. Preq: ENG 488 or ENG 489 and Consent of Instructor.* Advanced work in techniques of writing fiction for students with substantial experience in writing. Workshop sessions with students commenting on each other's work.

ENG 589 Poetry Writing Workshop. *3(3-0) . S. Preq: ENG 488 or ENG 489 and Consent of Instructor.* Advanced work in techniques of writing poetry for students with substantial experience in writing. Workshop sessions with students commenting on each other's work.

ENG 590 Studies in Creative Writing. *3(3-0) . S. Preq: ENG 588 or 589.* Techniques special to a particular kind of writing within the traditional genres of prose, poetry or drama, such as "Speculative Fiction" or "The Long Poem or Poetic Sequence." Various subjects.

ENG 610 Special Topics English. *F,S,Sum.*

ENG 624 Problems in College Composition. *3(3-0) . F, Alt. Yrs. Preq: Grad. standing.* Study of the history and theory of rhetoric; practices in writing and in literary analysis; preparation for the profession of teaching composition and literature. Required of all teaching assistants in English; graduate teaching assistants only

ENG 636 Directed Readings. *1-6. F,S,Sum. Preq: Grad. standing.* Intensive study of a specific topic from various specializations of the English faculty. Negotiation between the student and the director for variable credit and approved by Director of Graduate Studies.

ENG 666 Teaching Methods for Professional Writing. *3(3-0) . F. Preq: Appt. as teaching assistant in Technical Communication. Coreq: ENG 512.* Study and practice in techniques and approaches for teaching undergraduate technical writing courses; study of the uses and functions of writing in business, industry and research; practice in this kind of writing.

ENG 669 Bibliography and Methodology. *1-3.* Intensive study of the bibliography and methodology of literary research. Required of all graduate students in English.

ENG 675 Projects in Technical Communication. *3(1-2) . S. Preq: ENG 518.* Capstone course for M.S. in Technical Communication. Students engage in major semester-long individual project under direction of instructor.

ENG 685 Master's Supervised Teaching. *1-3. F,S. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ENG 690 Master's Examination. *1-6. F,S,Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

ENG 693 Master's Supervised Research. *1-9. F,S. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ENG 695 Master's Thesis Research. *1 9. F,S. Preq: Master's student* Thesis research.

ENG 699 Master's Thesis Preparation. *1-3. F,S. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

ENTOMOLOGY

ENT 201 Insects and People. *3(3 0) . S.* Introduction to the fascinating world of insects and how they interact with people. Survey of insect history, diversity, structure and function, and behavior. Examples of harmful and beneficial insects in a variety of human activities concluding with some profound impacts insects have had on history, society and culture.

ENT 203 An Introduction to the Honey Bee and Beekeeping. *3(3-0) . F.* Introduction to honey bee biology and a fundamental understanding of beekeeping management including crop pollination by bees. Examination of the relationships between honey bees and humans from prehistoric through modern times and the behavior and social system of one of the animal world's most complex and highly organized non-human societies.

ENT 401 Advanced Beekeeping. *3(2-3) . S. Preq: ENT 203. Credit not allowed for both ENT 401 and ENT 501.* A hands-on course in honey bee management including bee pollination of selected crops based on an understanding of bee biology, bee behavior, bee pathology, and bee botany.

ENT (FOR) 402 Forest Entomology. *3(2-2) . S. Preq: Junior Class Standing and BIO 125.* Fundamentals of morphology, classification, biology, ecology and control of insects attacking trees, with emphasis on silvicultural practices.

ENT (ZO) 425 General Entomology. *3(2-3) . F. Preq: ZO 150.* Explores the science of entomology by focusing on the basic principles of systematics, morphology, physiology, development, behavior, ecology, and control of insects. Field trips provide opportunities to collect insects and study their adaptations to a wide variety of natural environments.

ENT 492 External Learning Experience. *1-6. F,S. Preq. Sophomore standing.* A learning experience within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

ENT 493 Special Problems in Entomology. *1-6. F,S. Preq: Sophomore standing* A learning experience in agriculture and life sciences within an academic framework that utilizes campus facilities and resources. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

ENT 495 Special Topics in Entomology. *1-3 F,S,Sum.* Offered as needed to present materials not normally available in regular course offerings or for offering of new courses on a trial basis.

ENT 501 Advanced Beekeeping. *3(2-3) . S. Preq: ENT 203. Credit not allowed for both ENT 401 and ENT 501.* A hands-on course in honey bee management with some emphasis on bee pollination of selected crops based on an understanding of bee biology, bee behavior, bee pathology and bee botany.

ENT 502 Insect Systematics. *4(2-4) F. Preq. ENT 425 or equivalent.* Diversity of insect biology and structure with emphasis upon identification of adults; includes speciation, evolutionary relationships, approaches to classification, nomenclature, zoogeography and techniques of collection.

ENT 503 Insect Morphology and Physiology. *4(3 3) . S. Preq: CH 221. 223 and ENT 425 or equivalent.* Morphology, histology and function of organ systems of insects. Basic physiological principles discussed in context of insect growth and development. Laboratory to give students practical experience with modern physiological techniques.

ENT (ZO) 509 Ecology of Stream Invertebrates. *4(2-6) . S. Alt. Yrs Preq: ZO 150 or 402, BO 360 or ZO 260.* Introduction to stream ecology and analysis of animal communities. Lectures cover community structure and function, life histories of dominant animals, sampling design and techniques and responses to pollution. Laboratory exercises include field collections, identification of animals and quantitative research techniques. A personal collection of animals and a weekend field trip to mountain streams required.

ENT 550 Fundamentals of Insect Control. *3(2-2) . F. Preq: ENT 425.* The principles underlying modern methods for protecting food, clothing, shelter and health from insect attack.

ENT (ZO) 582 Medical and Veterinary Entomology. *3(2-3) . S, Alt. Yrs.. Preq: ENT 425 and ZO 315 or equivalent.* The morphology, taxonomy, biology and control of the arthropod parasites and disease vectors of man and animals. The ecology and behavior of vectors in relation to disease transmission and control.

ENT 601 Seminar. *1(1-0) . F,S. Preq: Grad. standing in ENT or closely allied fields.* Discussion of entomological topics selected and assigned by seminar chair.

ENT 604 Insect Natural History and Field Ecology. *1(0-3) . F. Preq: Graduate Status in Entomology. Taught during the two weeks prior to the Fall semester.* Diversity of ecological roles and lifestyles of insects and related arthropods using techniques in field ecology. Two week-long field trips to Coastal Plain and Mountains with orientation walks, evening lectures, and field projects.

ENT 620 Special Problems. *F,S. Preq: Consent of Instructor. Credits Arranged.* Original research on special problems in entomology not related to a thesis problem. Provides experience and training in research.

ENT 641 Agricultural Entomology Practicum. *3(3-0). Sum. Alt. Yrs. Preq Economic entomology (ENT 762 recommended)* Practical experience in research, extension and commercial aspects of insect pest management on a broad range of agricultural crops under actual field conditions. Class meets 9 hours each Friday for 10 weeks from early June to mid-August. Students should register for second summer session.

ENT 685 Master's Supervised Teaching. *1-3. F,S. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ENT 690 Master's Examination. *1-6. F.S. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

ENT 693 Master's Supervised Research. *1-9. F,S. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ENT 695 Master's Thesis Research. *1-9. F,S. Preq: Master's student.* Thesis research.

ENT 699 Master's Thesis Preparation. *1-3. F,S. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

ENT 720 Insect Pathology. *3(2-3) . S, Alt. Yrs. Preq: ENT 425 and MB 351 or equivalent.* A treatment of the noninfectious and infectious diseases of insects, the etiological agents and infectious processes involved, immunological responses and applications.

ENT (TOX) 722 Insecticide Toxicology. *3(3-0) . S,Alt. Yrs. Preq: BCH 451, CH 223.* Chemistry, biochemistry and toxicology of major classes of insecticide chemicals including relationships between chemical structure and toxicity; mode of action of insecticides; metabolism of insecticides in insects, mammals and environment; insecticide selectivity and resistance mechanisms; nontarget and environmental effects from insecticide use; registration and regulation of insecticides; and risk assessment associated with insecticide use.

ENT 731 Insect Ecology. *3(2-2) . F, Alt. Yrs. Preq: ENT 425 and BO (ZO) 760 or equivalent.* The interrelationships among insects and components of their effective environments which result in dynamic spatial and temporal patterns of particular species. Also, the diverse roles of insects in structure and function of communities and ecosystems.

ENT 741 Immature Insects. *3(1-4) . F, Alt. Yrs. Preq: ENT 502 or equivalent.* Biology and taxonomy of immature insects with emphasis on identification of the larval stage of endopterygote orders. A collection of immature insects required.

ENT 762 Insect Pest Management in Agricultural Crops. *3(3-0) . S, Alt. Yrs. Preq: ENT 425 or Consent of Instructor.* Critical review of the biology and ecology of representative beneficial and injurious insects and arachnids of agricultural crops and the advantages and limitations of advanced concepts of their management in selected agroecosystems.

ENT (FOR) 765 Advanced Forest Entomology. *3(2-2) . S, Alt. Yrs. Preq: ENT 402 or ENT 502 or Consent of Instructor.* Coverage of the important insect pests of forest and shade trees including regeneration pests, defoliating insects, inner-bark borers, wood borers, sucking insects, and bud, twig and root feeding insects. Detailed examination of concepts in forest pest management and population dynamics.

ENT 791 Special Topics in Entomology. *1-3. F,S. Preq: Grad. standing.* A variable credit lecture and laboratory series offering topics such as advanced beekeeping, morphology, physiology, systematics, behavior, biological control, nursery and ornamental pests, host plant resistance, information retrieval, biological monitoring and sampling, population modelling, extension entomology, computer methods and urban, forest and stored product pests.

ENT 801 Seminar. *1(1-0) . F,S. Preq: Grad. standing in ENT or closely allied fields.* Discussion of entomological topics selected and assigned by seminar chair.

ENT 804 Insect Natural History and Field Ecology. *1(0-3) . F. Preq: Graduate Status in Entomology. Taught during the two weeks prior to the Fall semester.* Diversity of ecological roles and lifestyles of insects and related arthropods using techniques in field ecology. Two week-long field trips to Coastal Plain and Mountains with orientation walks, evening lectures, and field projects.

ENT 820 Special Problems. *F,S. Preq: Consent of Instructor. Consent of Instructor.* Original research on special problems in entomology not related to a thesis problem. Provides experience and training in research.

ENT 841 Agricultural Entomology Practicum. *3(3 0) . Sum, Alt. Yrs. Preq: Economic entomology (ENT 762 recommended).* Practical experience in research, extension and commercial aspects of insect pest management on a broad range of agricultural crops under actual field conditions. Class meets 9 hours each Friday for 10 weeks from early June to mid-August. Students should register for second summer session.

ENT 885 Doctoral Supervised Teaching. *1-3. F,S. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ENT 890 Doctoral Preliminary Exam. *1-9. F,S. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

ENT 893 Doctoral Supervised Research. *1-9. F,S. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ENT 895 Doctoral Dissertation Research. *1-9. F,S. Preq: Doctoral student.* Dissertation research.

ENT 899 Doctoral Dissertation Preparation. *1-3. F,S. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

OCCUPATIONAL EDUCATION

EOE 101 Introduction to Occupational Education. *1(1-0) F.* Orientation to occupational teacher education curricula. Overview of philosophy, objectives and scope of occupational education programs in the public schools; multi-cultural and individual differences of students. Orientation to microcomputers and their potential uses by occupational education teachers.

EOE 207 Introduction to Teaching Occupational Education. *3(2-3) F, S.* Introduction to teaching vocational education programs in middle and secondary schools. Field experiences and course assignments including three hours each week assisting classroom teachers in the public schools.

EOE 241 Foundations of Marketing Education. *2(2-0) . F.* An introduction to Marketing Education and its role in secondary, postsecondary, and adult education.

EOE 298 Special Topics in Occupational Education. *1-3. F,S,Sum.* Individual or group study of particular areas of education at the freshman and sophomore levels.

EOE 307 Field Work in Occupational Education. *2-6. F,S,Sum. Preq: Sophomore standing and consent of instructor. May be repeated for a maximum of 6 credits.* A supervised off-campus field experience in Occupational Education that relates on-the-job experiences in the field to the technical competencies which are the content of the curriculum.

EOE 444 Administration of Marketing Education. *3(3-0) F, Alt Yrs. Preq: EOE 241 and admission to teacher education candidacy.* The theory and skills necessary to plan, administer, and evaluate effective programs in Marketing Education classroom. Student teachers spend ten weeks full-time in a public school: observing, teaching, and participating in the total school program.

EOE 452 Lab Planning in Technology Education. *3(1-4) S. Preq: Senior standing. Coreq: EOE 457 or 307.* Laboratory planning, management, and safety for technology education. Physical layout, selection, specification, and cost of equipment; the safe operation, repair and maintenance of both power and hand tools; specification of expendable supplies, estimating, and ordering.

EOE 456 Curriculum and Methods in Technology Education. *3(2 2) . F. Preq: Admittance to teacher education candidacy. Open only to Technology Education majors.* Methods of teaching technology education. Emphasis on curriculum development, instructional methods, laboratory instruction, meeting needs of special populations, and management of student organizations.

EOE 457 Student Teaching in Technology Education. *3-8. S Preq: Admission to professional semester. Coreq: EOE 452 and EOE 495.* Skills and techniques involved in teaching technology education through practice in a public school setting.

EOE 495 Senior Seminar in Technology Education. *1-3. F,S. Preq: Junior standing in ED and consent of the department.* An in-depth investigation of a topic or a set of problems and/or issues in Technology Education.

EOE 498 Special Topics in Education. *1-3. Preq: Junior or senior standing and consent of instructor.* Individual or group study of special topics in professional education. The topic and mode of study are determined by the faculty member after discussion with the student.

EOE 610 Special Problems in Occupational Education. *1-3. F,S,Sum. Preq: Grad. standing or PBS status.* Designed to provide graduate students in education opportunity to study problem areas in professional education under direction of a member of graduate faculty.

EOE 621 Special Problems in Occupational Education. *1-6. F,S,Sum. Preq: Sr. standing, PBS status or grad. standing in OED.* Guided independent or group study of current problems or topics in occupational education.

EOE 641 Practicum in Occupational Education. *1-6. F,S. Preq: Grad. standing or PBS status.* Under a faculty-supervised practicum in educational, industrial or governmental setting, student participates in and analyzes activities associated with planning, implementation and evaluation of instructional programs or services in vocational education. A unique plan developed by student and approved by supervisor.

EOE 645 Marketing Education Program Management. *3(3-0) . F, Alt. yrs. Preq: Grad. standing, EOE 701.* The management of secondary, postsecondary and industry-based marketing education programs; usage of a strategic planning model to improve and expand programs. Application of national and state models for marketing, curriculum, development and evaluation.

EOE 651 Internship in Occupational Education. *3-9 F,S,Sum Preq: Nine hrs. in grad level courses and Consent of Instructor.* Utilizing the participant-observed role, this course requires participation in selected educational situations with emphasis upon development of observational skills, ability to record relevant observations by means of written journals, skills in analyzing critical incidents and projection of events and consequences. Student required to develop possible alternative courses of action in various situations, select one of the alternatives and evaluate consequences of selected course of action.

EOE 685 Master's Supervised Teaching. *1-3. F,S. Preq. Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

EOE 690 Master's Examination. *1-6. F,S. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

EOE 692 Research Projects in Occupational Education. *1-3. F,S,Sum. Preq: Consent of Instructor; ELP 732 or equivalent.* A project or problem in research in education for graduate students, supervised by members of graduate faculty. The research chosen on the basis of individual students' interests and not to be part of thesis or dissertation research.

EOE 693 Master's Supervised Research. *1-9. F,S. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

EOE 695 Master's Thesis Research. *1-9. F,S. Preq: Master's student.* Thesis research.

EOE 699 Master's Thesis Preparation. *1-3. F,S. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

EOE 701 Philosophy of Occupational Education. *3(3-0) . F. Preq: 12 hrs. professional ed. courses.* Historical and philosophical investigation into social and economic aspects of occupational education; an overview of broad field of occupational education for youth and adults, with emphasis upon trends and problems connected with conduct of occupational education under federal and state guidance. Overview study of federal and state legislation pertaining to occupational education.

EOE 702 Laws, Regulations and Policies Affecting Occupational Education. *3(3-0) F, Alt. Yrs.* Detailed study of legislation (national and state) applying directly to occupational education. Basic social issues and economic conditions which precipitated the legislation. Review of organizational structure and policies under which national legislation converted into programs of occupational education.

EOE 705 Curriculum Materials Development. *3(3-0) . S. Preq: Grad. standing.* Selection and organization of curricula and instructional materials in occupational education.

EOE 706 Cooperative Occupational Education. *3(3-0) . F. Preq: Grad. standing or PBS status.* Individuals preparing to be directors, administrators or supervisors of occupational education programs at local, state and/or national levels. Emphasis on organization and operation of cooperative occupational education programs. Coverage of entire field of cooperative occupational education on secondary, postsecondary and adult levels with references to accepted essentials of cooperative education so details of planning, organization, establishment and operation of cooperative occupational programs practical and meaningful. Student visitations to existing quality programs in cooperative occupational education to study on-site conditions in specialized areas.

EOE 709 Seminar in Occupational Education. *3(3-0) . F,S. Preq: EOE 701.* A seminar-type course with topics selected each semester. Attention given to broad concepts of occupational education as manifested in the Vocational Education Act of 1963 and its amendments. Problems and issues underlying development and implementation of programs of occupational education at elementary, junior high, senior high and postsecondary levels.

EOE 710 Career Exploration. *3(3-0) . F,S,Sum. Preq: 12 hrs. professional ed. courses.* For teachers in public schools of North Carolina who teach in "Career Exploration" programs. Emphasis on philosophy of career exploration, theories supporting career exploration, place of exploration programs in overall school curriculum, correlation of occupational information in academic subjects, sources of occupational information and its use and approaches to teaching in a career exploration program.

EOE 712 Analysis of Occupational Information, Trends and the Labor Market. *3(3-0) . S. Preq: Six hrs. of professional ED courses.* Overview of federal, state and local sources of labor market information. Analysis of labor market concepts and applications for career exploration and decision making. Use of community surveys in vocational program planning.

EOE 722 Finance, Accounting and Management of Occupational Education Programs. *3(3-0) . S, Alt. Yrs.* The steps in financing a new occupational enterprise, following the determination of curriculum by area study. Detailed investigation of all financial transactions such as costs of operation, equipment purchase procedures and costs for construction.

EOE 751 Technology Education: A Discipline. *3(3-0) . F, Alt. Yrs. Preq: Grad. standing or PBS status.* Essential attributes of technology and relationship between technology education and related disciplines. Analysis of theory, models and literature and constitution of technology education foundation. Synthesis of relevant research and identification of areas of needed research.

EOE 752 Curricula for Emerging Technologies. *3(3 0) . F, Alt Yrs Preq: Grad. standing or PBS status.* Analysis of advanced technologies and development of instructional programs for technology education curricula in secondary schools. Technologies in production, transportation and communication.

EOE 755 Developing and Implementing Technology Education. *3(3-0) . S. Alt. Yrs. Preq: Grad. standing or PBS status.* Technology education curriculum trends, standards, design, implementation and management. Analysis of current curricular trends and development of strategies for implementation and management of technology education programs.

EOE 758 Teaching Creative Problem Solving. *3(2-2) S Alt Yrs Preq: Grad standing or PBS status.* Theories and research related to development of higher order thinking skills through design of appropriate technology-based learning activities for development of creative problem-solving abilities.

EOE 765 Advanced Trade Analysis and Course Construction. *3(3-0) . F. Preq: 12 hrs. professional ed. courses.* Principles and practices in analyzing occupations for purpose of determining teaching content. Practice in principles underlying industrial course organization based on occupational analysis. Instructional skills and technology, including course outlines, job sequences and development of industrial materials and instructional schedules.

EOE. 779 Research Application in Occupational Education. *3(3-0) . Preq: ELP 732.* Methodology, application, analysis and synthesis of research in occupational education. Review of current occupational education studies, clustered by areas, made with attention to statistical techniques, data collecting, data handling, and the audience and impact of particular projects and research organizations. Class activities in research application designed to bridge gap between theories of research methodology and student's independent research projects.

EOE 797 Special Topics. *3(3-0) .*

EOE 802 Seminar in Occupational Education. *3(3-0) . F,S. Preq: EOE 701.* A seminar-type course with topics selected each semester. Attention given to broad concepts of occupational education as manifested in the Vocational Education Act of 1963 and its amendments. Problems and issues underlying development and implementation of programs of occupational education at elementary, junior high, senior high and postsecondary levels.

EOE 810 Special Topics. *1-3. F,S,Sum. Preq: Grad. standing or PBS status* Designed to provide graduate students in education opportunity to study problem areas in professional education under direction of a member of graduate faculty.

EOE 821 Special Problems in Occupational Education. *1-6. F,S,Sum. Preq: Sr. standing, PBS status or grad. standing in OED.* Guided independent or group study of current problems or topics in occupational education.

EOE 841 Practicum in Occupational Education. *1 6. F,S. Preq: Grad. standing or PBS status.* Under a faculty-supervised practicum in educational, industrial or governmental setting, student participates in and analyzes activities associated with planning, implementation and evaluation of instructional programs or services in vocational education. A unique plan developed by student and approved by supervisor.

EOE 851 Internship in Occupational Education. *3-9. F,S,Sum. Preq: F,S,Sum.* Utilizing the participant-observer role, this course requires participation in selected educational situations with emphasis upon development of observational skills, ability to record relevant observations by means of written journals, skills in analyzing critical incidents and projection of events and consequences. Student required to develop possible alternative courses of action in various situations, select one of the alternatives and evaluate consequences of selected course of action.

EOE 885 Doctoral Supervised Teaching. *1-3. F,S. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

EOE 892 Research Projects in Occupational Education. *1-3. F,S,Sum. Preq: Consent of Instructor; ELP 532 or equivalent.* A project or problem in research in education for graduate students, supervised by members of graduate faculty. The research chosen on the basis of individual students' interests and not to be part of thesis or dissertation research.

EOE 895 Doctoral Dissertation Research. *1-9. F,S. Preq: Doctoral student.* Dissertation research.

EOE 899 Doctoral Dissertation Preparation. *1 3. F,S. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

ENVIRONMENTAL SCIENCES

ES 100 Introduction to Environmental Sciences. *3(3-0) .* Environmental Science majors only, permission of instructor. Interrelationships between human populations and the natural environment. Human population trends, agriculture, air and water pollution, biological diversity, forest and land use, energy and mineral resources, and toxic substances. Consideration of related economic factors, laws, politics, political behavior, and ethical questions.

FOREIGN LANGUAGES AND LITERATURES

FL 215 Discovering France. *3(3-0) . S.* A wide-ranging exploration of the French experience--from the glories of the past to the uncertainties of the future. Examination of social, political, economic, and cultural issues, with guest speakers offering complementary perspectives. Special emphasis on the role of France and the French cultural heritage in today's rapidly changing world. Course taught in English.

FL (ENG) 221 Literature of the Western World I. *3(3-0) .* Readings from English translations of Biblical, Classical, Medieval, and Early Renaissance literature, including works by such authors as Homer, Plato, Virgil, Ovid, St. Paul, St. Augustine, Marie de France, and Dante.

FL (ENG) 222 Literature of the Western World II. *3(3-0).* Readings from English translations of Renaissance, Neo-Classical, Romantic, and Early Modern literature, emphasizing the cultures of continental Europe from the Renaissance to 1900, and including such authors as Petrarch, Erasmus, Rabelais, Machiavelli, Shakespeare, Moliere, Voltaire, Rousseau, Goethe, Flaubert, Tolstoy.

FL (ENG) 223 Contemporary World Literature I. *3(3-0) . Preq: ENG 112.* Twentieth-century literature of some of the following cultures: Russian, Eastern European, Western European, Latin American, Canadian, Australian.

FL (ENG) 224 Contemporary World Literature II. *3(3-0) . Preq: ENG 112.* Twentieth-century literature of some of the following cultures: Asian, Arabian, African, Caribbean, Native-American.

FL 295 Special Topics in Foreign Languages and/or Literatures. *3(3-0) . Preq: Consent of department.* A special projects course on topics to be determined as needed in the departmental program.

FL 298 Independent Study in Foreign Language or Literature. *1-6. F,S,Sum. Preq: Consent of department.* Individualized study in a foreign language or literature. Topic, mode of study and credit hours to be determined in consultation with the faculty member supervising work.

FL 350 Modern European Literary Criticism. *3(3-0) . Preq: 6 hours of any 300-level literature courses.* Study of theoretical and philosophical foundations and applied methods in major currents of modern European literary criticism. Includes structuralism, poststructuralism, feminism, and psychoanalytical and ideological criticism. Examination of critical works and application to literary texts. Course taught in English.

FL (ENG) 394 Studies in World Literature. *3(3-0) Preq: ENG 111 and 112 or 113.* Study of a subject in world literature: for example, African literature, Asian literature, Hispanic literature, East European literature, Comedy, the Epic, the Lyric, Autobiography, the Faust legend, or Metamorphosis. Subjects vary according to availability of faculty. Readings in English translation.

FL 395 Study Abroad Programs. *1-3.* Specific category of courses involving language and/or culture taught in foreign countries through the Department Study Abroad Program.

FL (ENG) 406 Modernism. *3(3-0). ENG 111 and ENG 112 or 113.* International Modernist movement in literature, from its nineteenth-century origins to its culmination in the early twentieth century. Definitions of modernity, as embodied in a variety of genres. Placement of Modernist texts within a variety of cultures that produced them.

FL (ENG) 407 Postmodernism. *3(3-0). Preq: ENG. 111 and ENG. 112; or ENG. 113.* Literary expressions of Postmodernism, from its origins in the Modernist movement through its culmination in the later decades of the twentieth century. Definitions of postmodernity, as embodied in a variety of genres. Placement of Postmodernist texts within a variety of cultures that have produced them.

FL (ECI) 425 Methods and Materials in Teaching English as a Second Language. *3(3-0). F. Preq: Admission to Teacher Education Candidacy.* Methodologies and current approaches to teaching English as a Second Language. Techniques and strategies for teaching reading, writing, listening, speaking and culture. Selection, adaptation, and creation of instructional materials for various levels of proficiency and teaching situations.

FL (ECI) 426 Evaluation and Assessment in Teaching English as a Second Language. *3(3-0). S. Preq: Admission to Teacher Education Candidacy.* Evaluation and Assessment of written and oral language proficiency through standardized and non-standardized assessment tools. Examination and development of assessment instruments to assess language proficiency and progress. Development, adaptation and evaluation of ESL materials and curricula.

FL 495 Special Topics in Foreign Languages and Literatures. *3(3 0). Preq: Consent of department.* A concentrated study of a special period, author or genre to be determined as needed in the departmental program.

FL (ENG) 497 Senior Seminar in World Literature. *3(3-0). S. Junior or Senior standing.* Rotating topics in world literature, including treatment of materials from more than one culture and including consideration of the subject's theoretical or methodological framework. Readings in English (original languages encouraged but not required).

FL 498 Independent Study in Foreign Language or Literature. *1-6. F,S,Sum Preq: Consent of department.* Individualized study of a foreign language or literature. Topic, mode of study, and credit hours to be determined in consultation with the faculty member supervising work.

FL (ENG) 539 Seminar in World Literature. *3(3-0). S.* Rotating topics in world literature, including treatment of the subject's theoretical or methodological framework. Possible subjects: colonialism and literature; orality and literature; the Renaissance; the Enlightenment; translation; comparison of North and South American literatures; African literary traditions; post-modernism and gender. Readings in English (original languages encouraged but not required).

FL (ENG) 540 History of Literary Criticism. *3(3-0). F Preq. Grad. standing or PBS status.* Survey of the history of literary criticism from Antiquity to early Modern period. Introduction to major theoretical definitions of literature and modes of practical criticism. Close study of Aristotle's Poetics, Sidney's Apology for Poetry, Pope's Essay on Criticism, Coleridge's Biographia Literaria, Eliot's essays and other landmark works in development of literary criticism.

FOREIGN LANGUAGES AND LITERATURES - CHINESE

FLC 101 Elementary Chinese I. *3(3-0). F.* Introduction to Modern Standard Chinese. Emphasis on speaking and listening with an introduction to reading, writing and Chinese culture.

FLC 102 Elementary Chinese II. *3(3-0). S. Preq: FLC 101.* Continuation of basic skills. Emphasis on speaking and listening with some reading, writing and Chinese culture.

FLC 105 Intensive Elementary Chinese. *6(6-0).* Intensive introduction to Modern Standard Chinese. Emphasis on speaking and listening with an introduction to reading, writing and Chinese culture.

FLC 201 Intermediate Chinese I. *3(3-0). F. Preq: FLC 102.* Continuation of basic skills. Greater emphasis on reading, writing and Chinese cultural traditions.

FLC 202 Intermediate Chinese II. *3(3-0). S. Preq: FLC 201.* Continuation of basic skills. Focus on reading, writing, Chinese cultural traditions and patterns of behavior.

FLC 301 Intermediate Chinese III. *3(3-0). F. Preq. FLC 202.* Last of the foundation courses in Chinese. Continued practice in speaking and understanding Chinese with new emphasis on writing and on the reading of cultural and literary texts.

FLC 302 Intermediate Chinese IV. *3(3-0) . S. Preq: FLC 301.* Continued practice in speaking and understanding Chinese with greater emphasis on reading and writing. Continued study of cultural and literary texts.

FOREIGN LANGUAGES AND LITERATURES - ENGLISH

FLE 110 Developmental Written English for International Students. *3(3-0) . F,S.* Development of basic writing skills through supervised writing, analyzed reading, and self-paced drills, Focus on basic elements of English grammar important for non-native speakers and on the mechanics of writing, such as spelling, capitalization, and punctuation. Vocabulary study, composition of sentences, simple paragraphs, and short essays. Introduction to the writing process.

FLE (ENG) 111 Composition and Rhetoric. *3(3-0) . F,S. Only for non-native speakers of English. Successful completion of FLE 111 required a grade of C or better* For non-native speakers of English

FLE (ENG) 112 Composition and Reading. *3(3-0) . F,S Preq: A grade of C or better in FLE 111 or ENG 111. Only for non-native speakers of English. Successful completion of FLE 112 requires a grade of C or better.* For non-native speakers of English.

FLE 201 Oral Communication in English for International Students. *3(3 0) . F,S.* Oral communication in English; active and interactive speaking skills, listening comprehension and reading. Specific tasks in spoken English such as communicating information, making inquiries, requests and complaints. Individual and group work inthe form of oral reports, role play, presentations, etc. Listening to lectures and note taking skills.

FLE 400 American English Pronunciation for International Students. *3(3-0). F,S.* Intensive pronunciation practice for non-native speakers of English. Emphasis on improved intelligibility through practice on English rhythm, stress and intonation. Individual and classwork on vowel and consonant difficulties.

FLE 401 Advanced Oral Communication in English for International Students. *3(3-0. F,S.* Oral communication in English; pronunciation skills, reading, aural comprehension and oral skills; communication strategies and cross-cultural communication; individual and group activities such as presenting information, teaching a class, fielding questions and leading a discussion.

FLE 402 Advanced Written Communication in English for International Students. *3(3-0). F,S.* Written communication skills for graduate students; integrated writing tasks focusing on writing, reading, grammar and comprehension, specifically geared to the needs of research students and teaching assistants. Reading, critical analysis and synthesis of written material such as journal articles, research reports, etc.

FOREIGN LANGUAGES AND LITERATURES - FRENCH

FLF 101 Elementary French I. *3(3-0) . F,S,Sum.* First in a four-course sequence to develop language skills. Oral and written practice in classroom and language laboratory. Readings in French culture and civilization.

FLF 102 Elementary French II. *3(3-0) . F,S,Sum. Preq: FLF 101.* Continuation of FLF 101 with intensive practice in spoken French. Readings in French culture and civilization.

FLF 105 Intensive Elementary French. *6(6-0) .* An intensive course aimed at developing a balanced foundation in listening, speaking, reading, and writing French. Equivalent to FLF 101 plus FLF 102.

FLF 201 Intermediate French I. *3(3-0) . F,S,Sum. Preq: FLF 102.* Third of four consecutive courses to develop skills of speaking, listening, reading and writing. Readings and discussions of French culture, civilization and literature.

FLF 202 Intermediate French II. *3(3-0) F,S,Sum. Preq: FLF 201.* Last of four sequential language courses. Increased emphasis on reading and writing. Readings in the literature, culture, and civilization of France and the Francophone world.

FLF 301 Survey of French Literature from the Middle Ages through the Enlightenment. *3(3-0) . F. Preq: An advanced language skills course (FLF 308, 310, 311, 315) or FLF 202* Reading and discussion of representative works with attention to literary analysis as well as to historical and cultural background.

FLF 302 Survey of French Literature from Romanticism to the Contemporary Period. *3(3-0) S Preq· An advanced language skills course (FLF 308, 310, 311, 315) or FLF 202 with permission of instructor* Reading and discussion of representative works with attention to literary analysis as well as to historical and cultural background.

FLF 306 French Business Communication. *3(3-0) . Alt. Year (even). Preq: FLF 202 or by instructor's permission.* Study of major forms of written and oral business communication used in the French-speaking world. Extensive work with current, culturally authentic materials. Emphasis on development of practical communicative skills, with special attention to cross-cultural comparisons of French and American business practices and modes of communication.

FLF 307 Business French. *3(3-0) . F. Preq: FLF 202 or permission of instructor.* Business French vocabulary and concepts with emphasis on cultural differences and their importance in the new global village business world.

FLF 308 Advanced Conversation: Contemporary French Cultures. *3(3-0) . S. Preq: FLF 202.* Conversation and reading emphasizing idiomatic and practical usage with attention to contemporary civilization and cultures of the French speaking world. Emphasis on social structures, political features, events, world views and modes of communication.

FLF 309 French Phonetics and Pronunciation. *3(3-0) . F. Preq: FLF 202 or FLS 105.* A study of the oral production of standard French with the aim of improving pronunciation, fluency and skill in communication. Extensive oral practice through conversation and phonetics.

FLF 310 Advanced Written Communication. *3(3-0) . F. Preq: FLF 202.* An in-depth study of French written communication at the advanced level, including the more advanced aspects of the French grammar with extensive writing practice serving a variety of practical communicative needs.

FLF 311 Methods and Techniques in French Translation. *3(3-0) . F, Alt. yrs.(odd). Preq: FLF 202.* Translation from French to English and English to French. Emphasis on differences and similarities between the two languages. Development of practical translation skills, using current materials on science, technology, medicine, cinema, arts, literature, culture, politics, law, business, and other topics of interest to the students.

FLF 315 French Civilization and Culture. *3(3-0) . S. Preq: FLF 202.* French civilization and culture from its origins to the modern period. Reading and discussion of the social, cultural, economic and political structures of France, including its geography, history, music, art and national consciousness.

FLF 318 The Heritage of French Cinema. *3(3-0) . S. Preq: 3 hrs. in French at 300 level or permission of instructor.* Survey of the major contributions of French cinema from its origins to the present. Attention to film as an artistic medium and to the cinematic representation of French history and culture. Reading, discussion, and viewing of films including Un Chien Andalou, La Passion de Jeanne d'Arc, Le Retour de Martin Guerre, La Marseillaise, Les 400 Coups, and Diva.

FLF 321 French Cultures and contexts. *3(3-0) . S, Alt. Yrs. (odd). Preq: FLF 202.* An approach to important periods in the history of French culture through the reading of texts by several important writers. Films, slides, painting, music, and the Internet will be included to put the readings in a cultural context.

FLF 323 The French Novel of the Twentieth Century. *3(3-0) . F. Preq: 3 hrs. in French at 300 level with 3 hrs. in literature.* Reading and discussion of novels by representative authors of the period such as Gide, Proust, Colette, Malraux, Camus, Robbe-Grillet, Duras, Sarraute.

FLF 352 Literature, Cinema and Culture of the Francophone World. *3(3-0) . S, Alt. yrs.(odd). Preq: 6 hours in French above 200 level (3 hours must be in Literature) or permission of the instructor.* Literary, cinematic and cultural productions of the Francophone World: North and West Africa, the Caribbean and Quebec. Taught in French.

FLF 401 French For Graduate Students. *3(3-0) .* Basic French grammar, with special attention to characteristics of formal expository style, and illustrative readings. Study of extracts from scholarly publications in students' areas of research. Prepares students to take the graduate foreign language certification exam.

FLF 414 Studies in French Prose. *3(3-0) . F,S. Preq: 3 hrs in French at 300 level with 3 hrs in literature.* Major developments in the French essay, letter, novel and other prose forms from the Renaissance to 1900. Readings from such authors as Montaigne, Sevigne, Lafayette, Rousseau, Sand, Balzac, Stendhal, Flaubert.

FLF 492 Seminar in French Studies. *3(3-0) . S. Preq: Junior standing and 6 hrs in French literature.* A small-group study of a topic in literature resulting in either a substantial essay or series of essays by each student. Topics vary each semester.

FOREIGN LANGUAGES AND LITERATUARES - GERMAN

FLG 101 Elementary German I. *3(3-0) . F,S,Sum.* The first in a four-course sequence to develop the language skills of listening, speaking, reading, and writing. Emphasis on the acquisition of everyday German and cultural awareness. Active class participation, practice in the language lab and computer lab, and written assignments.

FLG 102 Elementary German II. *3(3-0) . F,S,Sum. Preq: FLG 101.* Second in a four-course sequence to develop the language skills of listening, speaking, reading, and writing. Emphasis on the acquisition of everyday German and cultural awareness. Active class participation, practice in the language lab and computer lab, and written assignments.

FLG 201 Intermediate German I. *3(3-0) . F,S,Sum. Preq: FLG 102.* The third of four consecutive courses in German. Intensive conversational practice to develop proficiency in speaking and listening, advanced reading and writing skills by learning complex grammatical structures and through the use of authentic texts. Acquisition of cultural knowledge about the German-speaking countries.

FLG 202 Intermediate German II. *3(3-0) . F,S. Preq: FLG 201.* Last of four consecutive courses in German. Continued conversational practice to develop proficiency in speaking and listening. Development of advanced writing skills by refining grammatical structures and style through assignments, and of advancedreading skills through the use of cultural and literary texts from the German-speaking countries.

FLG 208 Intermediate German Conversation. *3(3-0) . F,S. Preq: FLG 201.* Intensive practice in speaking and understanding German through role playing, debates, interviews and use of audio-visual materials.

FLG 307 Business German. *3(3-0) . F,Alt.Yrs. Preq: FLG 202.* Business German vocabulary and terminology. Readings and discussions on current business topics. Special consideration to intercultural communication relative to international business operations.

FLG 309 Advanced German Conversation. *3(3-0) . F. Preq: FLG 202.* Intensive conversational practice in class based on current topics. Discussions about the cultures and civilizations of the German-speaking countries. Attention to cultural factors essential to effective communication. Oral reports by students.

FLG 310 Advanced German Syntax and Composition. *3(3-0) . Preq: FLG 202.* Advanced aspects of German syntax and writing styles. Assignments include paraphrasing and summarizing authentic German texts and writing compositions.

FLG 311 Introduction to German Translation. *3(3-0) . F, Alt. Yrs. Preq: FLG 202.* Introduction to theory, methods, and techniques in translation applied to materials of various fields and professions. Emphasis on written translation.

FLG 315 Germanic Civilization and Culture. *3(3-0) . Preq: FLG 202.* Culture and civilization of the German-speaking countries. Analysis of the social, economic and political structures of Germany, Austria, and Switzerland. Lectures, reports, conversation. Taught in German.

FLG 316 German Lyric Poetry. *3(3-0) . S Preq: FLG 202.* A historical and interpretative study of the German lyric from the fifteenth into the twentieth century with special attention to the poet's choice of theme, the ways in which that theme is treated, and the relevance of the poem to the human experience.

FLG 318 New German Cinema. *3(3 0) . S. Preq. FLG 202.* Survey of the major contributions to the "New German Cinema" (1970's to 1990's). Attention to film as an artistic medium and to the cinematic representation of German history and culture. Reading, discussion, and viewing of films including films by Schloendorff (Die Blechtrommel), Fassbinder (Die Ehe der Maria Braun), von Trotta (Rosa Luvemburg), Herzog (Stroszek), and Wenders (Der Himmel ueber Berlin).

FLG 323 Twentieth Century German Literature. *3(3-0) . Preq: FLG 202.* Twentieth century literature from German-speaking countries. Readings of Mann, Kafka, Rilke, Hesse, Durrenmatt, Frisch, Grass, and a variety of poets.

FLG 401 German for Graduate Students. *3(3-0) . F.* Basic German grammar, with special attention to characteristics of formal expository style, and illustrative readings. Study of extracts from scholarly publications in students' areas of research. Prepares students to take the graduate foreign language certification exam.

FOREIGN LANGUAGES AND LITERATURES - HEBREW

FLH (REL) 101 Elementary Biblical Hebrew I. *3(3-0) . F,S.* The elements of grammar and syntax essential for a reading knowledge of Biblical Hebrew. Reading is drawn primarily from the Book of Genesis and some attention given to exegetical method.

FLH (REL) 102 Elementary Biblical Hebrew II. *3(3-0) . F,S. Preq: REL (FLH) 101.* A continuation of REL (FLH) 101 with increased emphasis upon reading selected prose passages.

FLH (REL) 201 Intermediate Biblical Hebrew I. *3(3-0) . F,S. Preq: REL (FLH) 102.* Continuing development of vocabulary and understanding of grammar and syntax through reading of selected prose and poetic passages in the Hebrew Bible. Exegetical matters are considered.

FLH (REL) 202 Intermediate Biblical Hebrew II. *3(3-0) . F,S. Preq: REL (FLH) 201.* Exclusive attention devoted to reading and interpreting selected prose and poetic passages in the Hebrew Bible.

FOREIGN LANGUAGES AND LITERATURES - ITALIAN

FLI 101 Elementary Italian I. *3(3-0) . F.* Begins the development of a balanced foundation in all four language skills. Concentrates on listening and speaking, emphasizing idiomatic Italian. Short readings in Italian culture and civilization. Class and laboratory practice, written homework.

FLI 102 Elementary Italian II. *3(3-0) . Preq: FLI 101.* Continuation of FLI 101 with emphasis on acquisition of oral skills through class practice and use of audio aids. Readings in Italian culture, civilization and literature.

FLI 201 Intermediate Italian I. *3(3-0) . Preq: FLI 102.* Third of four consecutive courses to develop skills of speaking, listening, reading and writing. Readings and discussion of Italian culture, civilization and literature.

FLI 202 Intermediate Italian II. *3(3-0) . Preq: FLI 201.* Last of four sequential language courses. Increased emphasis on reading and writing. Readings in the literature, culture, and civilization of Italy.

FLI 208 Intermediate Italian Conversation. *3(3-0) . Coreq: FLI 201.* Intensive practice in speaking and understanding Italian through role playing, discussion, interviews, and use of audio-visual materials.

FLI 308 Italian Reading and Conversation. *3(3-0) . Preq. FLI 201.* Advanced readings and intensive conversational practice in Italian for students beyond the intermediate level.

FOREIGN LANGUAGES AND LITERATURES - JAPANESE

FLJ 101 Elementary Japanese I. *3(3-0) . Coreq: FLJ 103.* Introduction to standard, formal Japanese. Emphasis on speaking and listening skills. Exposure to Japanese culture, reading, and writing.

FLJ 102 Elementary Japanese II. *3(3-0) . Preq: FLJ 101. Coreq: FLJ 104.* Continuation of basic skills. Emphasis on speaking and listening skills; inclusion of Japanese cultural factors in communication. Some reading and writing.

FLJ 103 Elementary Japanese I Conversation. *1(1-0) . Coreq. FLJ 101* Supplements conversational practice in FLJ 101. Students are encouraged to use their speaking skills in a variety of situations. Special attention is given to correcting and improving pronunciation and intonation.

FLJ 104 Elementary Japanese II Conversation. *1(1-0) . Preq· FLJ 101. Coreq· FLJ 102.* Supplements conversational practice in FLJ 102. Extensive use of speaking skills in a variety of situations. Special attention given to correcting and improving pronunciation and intonation.

FLJ 105 Intensive Elementary Japanese. *6(6-0)* An intensive introduction to standard, formal Japanese. Emphasis is on speaking and listening skills. Some reading and writing. Combines FLJ 101 and 102.

FLJ 201 Intermediate Japanese I. *3(3-0) . Preq: FLJ 102 or FLJ 105. Coreq: FLJ 203.* Continuation of basic skills. Greater emphasis on reading and writing. More exposure to Japanese cultural traditions.

FLJ 202 Intermediate Japanese II. *3(3-0) . Preq: FLJ 201. Coreq: FLJ 204.* Continuation of the learning of the basic skills. Emphasis on reading and writing as well as on spoken Japanese and on cultural patterns of behavior.

FLJ 203 Intermediate Japanese Conversation. *1(1-0) . Preq: FLJ 102. Coreq: FLJ 201, FLJ 202 or FLJ 301. May be repeated for a maximum of three credit hours.* Practice in spoken Japanese through use of the language in a variety of situations. Increase vocabulary and develop fluency and ease in the structural patterns of the language.

FLJ 204 Intermediate Japanese II Conversation. *1(1-0) . Coreq: FLJ 202.* Supplemental intermediate conversational practice. Drills and situational exercises to build oral proficiency with patterns introduced in FLJ 202.

FLJ 301 Intermediate Japanese III. *3(3-0) . Preq: FLJ 202.* Continued study of Japanese language. Primary emphasis on spoken Japanese, but attention also given to reading, writing and culture.

FLJ 302 Intermediate Japanese IV. *3(3-0) . Preq· FLJ 301.* Continued training in the foundations of Japanese language. Primary emphasis on spoken Japanese, with increased attention to reading and writing.

FLJ 401 Advanced Japanese I. *3(3-0) Preq FLJ 302.* Continued training in the foundations of Japanese language, with emphasis on complex verb forms. Increased attention to reading and writing.

FLJ 402 Advanced Japanese II. *3(3 0) . Preq. FLJ 401* Elaboration on grammatical forms learned in the previous courses with applications in reading and writing, combined with more sophisticated vocabulary and idioms and attention to development of natural reading skills.

FOREIGN LANGUAGES AND LITERATURES - SWAHILI

FLK 101 Elementary Swahili I. *3(3-0)* First in a four-course sequence to develop language skills in Swahili (Kiswahili). Oral and written practice. Readings in African culture and civilization.

FLK 102 Elementary Swahili II. *3(3-0) . Preq· FLK 101.* Second in a four-course sequence to develop language skills in Swahili (Kiswahili). Oral and written practice. Readings in African culture and civilization.

FLK 201 Intermediate Swahili I. *3(3-0) . Preq: FLK 102.* Third in a four-course sequence to develop language skills in Swahili (Kiswahili). Oral and written practice. Readings in African culture and civilizations.

FLK 202 Intermediate Swahili II. *3(3-0) . Preq: FLK 201.* Fourth in a four-course sequence to develop language skills in Swahili (Kiswahili). Oral and written practice. Readings in African culture and civilization.

FOREIGN LANGUAGES AND LITERATURES - HINDI

FLN 101 Elementary Hindi-Urdu I. *3(3 0) . F. Coreq: FLN 103.* Introduction to standard Hini-Urdu. Emphasis on speaking and listening, and on reading and writing in the Hindi writing system (Devanagari). Readings in South Asian culture and civilization. Offered jointly in teleconferencing format with HIND 101 at the University of North Carolina-Chapel Hill.

FLN 102 Elementary Hindi-Urdu II. *3(3-0) . S. Preq: FLN 101 Coreq: FLN 104.* Continuation of FLN 101. Emphasis on oral communication and reading and writing in the Hindi writing system (Devanagari). Further readings in South Asian culture and civilization. Offered jointly in teleconferencing format with HIND 102 at the University of North Carolina-Chapel Hill.

FLN 103 Elementary Hindi-Urdu I Conversation. *1(1-0) . F. Coreq· FLN 101.* Required conversational practice for FLN 101. Special attention to individual pronunciation and intonation. Introduction of formal and informal speech. Use of audiovisual materials.

FLN 104 Elementary Hindi-Urdu II Conversation. *1(1-0) . S. Preq: FLN 101. Coreq· FLN 102.* Required conversational practice for FLN 102. Extensive use of speaking skills in variety of situations. Attention to supplemental non-verbal communication. Use of audiovisual materials.

FLN 201 Intermediate Hindi-Urdu I. *3(3-0) . F. Preq. FLN 102. Coreq· FLN 203* Continuation of basic language skills. Introduction of Urdu writing system (Nastaliq) through Hindi writing system (Devanagari). Introduction to grammatical divergence of Hindi and Urdu. Readings in South Asian culture and civilization. Offered jointly in teleconferencing format with HIND 103 a the University of North Carolina-Chapel Hill.

FLN 202 Intermediate Hindi-Urdu II. *3(3 0) . S. Preq: FLN 201 Coreq: FLN 204.* Continuation of FLN 201. Further practice of both Urdu (Nastiliq) and Hindi (Devanagari) writing systems. Further distinction of spoken and literary Urdu and Hindi. Further readings in South Asian culture and civilization. Offered jointly in teleconferencing format with HIND 103 at the University of North Carolina-Chapel Hill.

FLN 203 Intermediate Hindi-Urdu I Conversation. *1(1-0) . F Preq. FLN 102. Coreq. FLN 201* Required conversational practice for FLN 201. Advancement of speaking skills through role playing, interviews, debates. Further Hindi and Urdu non-verbal communication. Use of audiovisual materials, including responses to commercial television and movies.

FLN 204 Intermediate Hindi-Urdu II Conversation. *1(1-0) . S. Preq: FLN 201. Coreq: FLN 202.* Required conversational practice for FLN 202. Refinement of speaking skills through role playing, interviews, debates. Further Hindi and Urdu non-verbal communication. Use of audiovisual materials, including responses to commercial television and movies.

FLN 208 Intermediate Hindi Conversation. *3(3-0) . F. Preq: FLN 201 or permission of instructor.* Intensive practice in speaking and understanding Hindi through role playing, debates, interviews, and use of audio-visual materials.

FLN 301 Advanced Hindi: Readings in Literature I. *3(3-0) . F. Preq: FLN 202.* Reading and discussion of representative works with attention to literary analysis as well as to historical and cultural background. Taught through interactive TeleVideo.

FLN 302 Advanced Hindi: Readings in Literature II. *3(3-0) . S. Preq: FLN 301.* Reading and discussion of representative works with attention to literary analysis as well as to historical and cultural background. Taught through interactive TeleVideo.

FLN 308 Advanced Hindi Conversation. *3(3-0) . S Preq: FLN 208.* Conversation and reading emphasizing idiomatic and practical usage with attention to contemporary civilization and cultures of the Hindi speaking world. Emphasis on social structures, political features, events, world views and modes of communication.

FOREIGN LANGUAGES AND LITERATURES - PORTUGUESE

FLP 101 Elementary Portuguese I. *3(3-0) .* Introduction to the fundamentals of Brazilian Portuguese: pronunciation, comprehension, and spoken syntax and grammar.

FLP 102 Elementary Portuguese II. *3(3 0) . Preq: FLP 101.* Continuation of the essentials of Brazilian Portuguese. Further stress on pronunciation and comprehension and introduction of reading and writing skills.

FOREIGN LANGUAGES AND LITERATURES - RUSSIAN

FLR 101 Elementary Russian I. *3(3-0)* First in a four-course sequence to develop language skills in Russian. Oral and written practice in the classroom and language laboratory and attention to Russian cultural heritage.

FLR 102 Elementary Russian II. *3(3-0) . Preq: FLR 101.* Emphasis on acquisition of basic oral skills, with complementary reading and writing exercises and attention to Russian cultural heritage.

FLR 201 Intermediate Russian I. *3(3-0) . Preq: FLR 102.* Basic Russian language skills continued. More emphasis given to writing and essential conversational practice. Intermediate level readings in Russian literature and culture. Class and laboratory practice; written assignments.

FLR 202 Intermediate Russian II. *3(3-0) . Preq: FLR 201.* Advanced aspects of Russian syntax through study of text. Continued attention to conversational practice and vocabulary building.

FLR 303 Russian Literature in Translation: The Nineteenth Century. *3(3-0) .* A study of selected plays, short stories and novels of the great Russian writers of the nineteenth century: Pushkin, Lermontov, Gogol, Goncharov, Turgenev, Dostoevsky, Saltykov-Shchedrin, Leskov, Tolstoy and Chekhov. Examinations of peculiarly Russian as well as the universal aspects of this literature. All readings, lectures and discussions in English.

FLR 304 Russian Literature in Translation: The Twentieth Century. *3(3-0) .* A study of selected poems, plays, short stories and novels by major Russian writers of the twentieth century, such as Chekhov, Gorky, Blok, Mayakovsky, Esenin, Zamyatin, Olesha, Bulgakov, Babel, Pilnyak, Pasternak, Solzhenitsyn, Evtushenko, and Voznesensky. All readings, lectures and discussions in English.

FOREIGN LANGUAGES AND LITERATURES - SPANISH

FLS 101 Elementary Spanish I. *3(3-0) .* Listening and speaking; development of a balanced foundation in all Spanish languages skills. Idiomatic, everyday Spanish and cultural awareness. Class practice, laboratory and written homework.

FLS 102 Elementary Spanish II. *3(3-0) . Preq: FLS 101.* Use of Spanish through past tenses, regular and irregular, and various morphological and syntactical aspects. Emphasis on oral skills and increased cultural awareness. Written work and laboratory practice assigned daily.

FLS 105 Intensive Elementary Spanish. *6(6-0) .* An intensive course aimed at developing a balanced foundation in listening, speaking, reading, and writing Spanish. Equivalent to FLS 101 plus FLS 102.

FLS 110 Accelerated Elementary Spanish. *3(3-0) . F,S,Sum. A score of 14 24 on the Spanish placement exam is required for matriculation in this course.* Contents of FLS 101 and FLS 102 at an accelerated pace, for students placed into the course based on results of the Spanish placement test, or those with prior knowledge of another Romance language. Significant amount of work outside of class. Development of a balanced foundation in listening, speaking, reading, and writing Spanish, and understanding Hispanic cultures.

FLS 201 Intermediate Spanish I. *3(3-0) . Preq: FLS 102 or 105.* The third of four consecutive Spanish courses idiomatic, spoken Spanish. With special attention to reading and writing skills and the cultural heritage of the Spanish-speaking peoples. Class practice, laboratory and written assignments.

FLS 202 Intermediate Spanish II. *3(3-0) . Preq: FLS 201.* Last of four sequential courses in the foundations of the Spanish language. Attention to writing skills and cultural heritage of Spanish-speaking peoples.

FLS 208 Intermediate Spanish Conversation. *3(3-0) . Coreq: FLS 201.* Intensive practice in speaking and understanding Spanish through role playing, discussion, interviews and use of audio-visual materials.

FLS 219 Accelerated Intermediate Spanish. *3(3 0) . F S,Sum. A score of 25 30 on the Spanish placement exam is required for matriculation in this course.* Content of FLS 102 and FLS 201 at an accelerated pace, for students placed into the course based on results of the Spanish placement test, or those with significant knowledge experience with another Romance language. Substantial amount of work outside of class. Development of a balanced foundation in listening, speaking, reading, and writing Spanish, and understanding Hispanic cultures.

FLS 300 Introduction to Hispanic Literatures. *3(3-0) . Preq: FLS 202.* An introduction to the major literary genres and movements in Spanish and Latin American literatures. Lectures, discussions, films and written assignments.

FLS 301 Survey of Spanish Literature Through the Golden Age. *3(3-0) . F. Preq: FLS 202.* Literature of Spain from the Middle Ages to the beginning of the eighteenth century.

FLS 302 Survey of Spanish Literature: 1700 to Present. *3(3-0) . Preq: FLS 202 or FLS 105.* Introduction to Spanish Neoclassicism, Romanticism, Realism, and twentieth-century literature. Special attention to the quest for new values in contemporary literature.

FLS 303 Latin American Literature to 1898. *3(3-0) Preq: FLS 202; Recommended FLS 300.* Latin American literature beginning with the Chronicles and extending through the Colonial Period and the literature of independence.

FLS 304 Latin American Literature from 1898 to the Present. *3(3-0) Preq: FLS 202; FLS 300 recommended.* Latin-American literature beginning with the Modernista authors, including Regionalist and Avantgardiste authors, and extending to contemporary works.

FLS 307 Business Spanish. *3(3-0) . Preq: FLS 202.* Business Spanish vocabulary and terminology. Emphasis on everyday spoken and written Spanish. Readings and discussions of business topics. Cross-cultural considerations relative to international business operations.

FLS 308 Spanish Conversation and Reading. *3(3-0) . Preq: FLS 202.* Intensive practice in speaking and reading Spanish. Drills and conversation with emphasis on practical language and idiomatic expressions.

FLS 309 Spanish Phonetics and Advanced Conversation. *3(3-0) . Preq: FLS 202 or FLS 105.* A study of the production of the sounds of Standard Spanish with the sim of improving pronunciation, fluency, and skill in communication. Extensive oral practive in phonetics and conversation.

FLS 310 Advanced Spanish Grammar. *3(3-0) . F, S. Preq: FLS 202.* Review of advanced aspects of Spanish grammar, with extensive practice through a variety of contextualized exercises, analyses of readings and original compositions. Topics relevant to Hispanic culture and civilization in lectures, discussions, exercises and compositions. Emphasis on all language skills.

FLS 311 Advanced Spanish Composition. *3(3-0) . Preq: FLS 202.* An intensive course in the theory and practice of Spanish composition with lectures, discussions and weekly writing assignments.

FLS 315 Culture and Civilization of the Iberian Peninsula. *3(3-0) . F. Preq: FLS 202.* The Iberian Peninsula as a crossroads of civilizations from neolithic times to the present. The emergence of Spain and Portugal as nations, the rise and fall of their overseas empires, and their contemporary civilizations.

FLS 316 The Culture and Civilization of Latin America. *3(3-0) . S. Preq: FLS 202.* Survey of the cultural traditions of Latin America including Brazil. The major pre-Columbian civilizations, Spanish and Portuguese colonialism, the emergence of the modern nations. Films and recordings supplement readings and discussions.

FLS 318 Hispanic Cinema. *3(3-0) . Preq: 6 hrs Spanish at 300 level.* Survey of the major contributions of Hispanic cinema from its origins to the present. Analysis of film as an artistic medium and as the cinematic representation of Hispanic histories and cultures. Reading, discussions, and viewing of films by representative directors.

FLS 319 Children's and Adolescent's Literature in Spain and Latin America. *3(3-0). Preq: FLS 202.* Traditional and contemporary children's and adolescent's literature written originally in Spanish. Critical examination of picture books, folktales, poetry, theater and novels from a literary/artistic point of view and for their value in cultural development.

FLS 323 Contemporary Hispanic Literature. *3(3-0). Preq: FLS 202; Recommended FLS 301,302,303 and /or FLS 304.* Selected works of Hispanic fiction, essays and /or poetry of the twentieth century. The periods may include the generations of 1898 and 1927 and the post-Civil War writers in Spain; modernismo, the "Boom", the "post-Boom," testimonial literature, contemporary poetry in Latin America, women writers.

FLS 400 Methods and Techniques in Spanish Translation and Interpretation. *3(3-0). Preq: FLS 202.* Study and practical application of theory, methods and techniques of translation based on materials relevant to various fields and professions.

FLS 401 Spanish for Graduate Students. *3(3-0) . F,S.* Basic Spanish grammar, with special attention to characteristics of formal expository style, and illustrative readings. Study of extracts from scholarly publications in students' areas of research. Prepares students to take the graduate foreign language certification exam.

FLS 403 Hispanic Prose Fiction. *3(3-0) . Preq: Consent of department.* Nineteenth- and twentieth-century prose and fiction of Spain and Latin America, including Galdó¾s, Realism, the Boom, testimonial literature.

FLS 404 Hispanic Drama. *3(3-0) . Preq: Junior standing.* Selected topics in Spanish of Latin-American drama from the Golden Age to the present.

FLS 492 Seminar in Hispanic Studies. *3(3 0) . Preq: Junior standing and consent of department.* Advanced seminar on a specific area of Hispanic studies (topics vary), leading to a major term paper and/or a series of essays by the student.

FORESTRY

FOR 110 Introduction to Forestry. *2(1-3) .* Overview of the history and policies of forestry, the basis of forest management, the impact of forestry on nature and society, and the opportunities of a career in forestry.

FOR (WPS) 202 Introduction to Forestry. *3(2 3) .* Overview of the history and policies of forestry, the basis of forest management, the impact of forestry on nature and society, and the opportunities of a career in forestry.

FOR 204 Silviculture. *2(0 6). Preq: Summer camp eligibility.* Silvical characteristics and growth requirements of forest trees; dynamics of stand growth, species-site relationships, site productivity, forest pest interactions, hydrology and nutrient cycling in forest ecosystems; emphasis on understanding and applying ecological principles to the production of multiple benefits at the forest community level.

FOR 212 Dendrology. *4(2-4)* . Identification and elementary silvics of woody plants of eastern North America with studies of their classification, characteristics, and habitats. Consideration of trees from northern and western North America and the Caribbean region. Field identification with trips to forest communities.

FOR (FW, ZO) 221 Conservation of Natural Resources. *3(3 0)* . Importance of natural resources and their role in human environment. Physical, biological and ecological principles underlying sustainability of natural resources with attention to consequences of human impacts while meeting society needs.

FOR 248 Forest History, Technology and Society. *3(3-0)* . Examining forest resource use and issues throughout history. Tracing developments and concepts that created the context for today's issues concerning global forest resources. Examining how wood resource availability shaped civilization's development, and examining consequences on forest resources of civilization's scientific, social, and technological progress.

FOR 252 Introduction to Forest Science. *3(2 3)* . *Not open to Forest Management majors.* Integration of biological principles into studies of tree growth, reproduction, establishment, survival, and disturbance. Discussions of regional silviculture and of effects of humans on forest ecosystems. Instruction in forest sampling and tree identification. Many laboratories meet outdoors.

FOR 261 Forest Communities. *2(0-6)* . *Sum. Preq: FOR 212 or BO 220 or BO 403.* Study of the species composition, distribution, site requirements, and succession of the principal forest communities of southeastern North America. Identification of important member plant species. Field trips to typical examples.

FOR 264 Forest Wildlife. *1(0-3) Preq: Summer camp eligibility.* Diversity of fauna that inhabits forest communities in the Piedmont of North Carolina. Inventory terrestrial and aquatic habitats and identify various vertebrate and invertebrate species. Insect collection initiated. The life histories of representative species presented.

FOR 265 Fire Management. *1(0-3)* . *Preq: Summer camp eligibility.* Effects of wildfire and prescribed fire on forest ecosystem components and processes; fire behavior and the ecosystem and meterologic factors that affect it; silvicultural uses of fire; organization, equipment, and tactics for wildfire suppression; fire suppression exercises on the North Carolina Division of Forest Resources' Forest Fire Simulator.

FOR 274 Mapping and Mensuration. *4(1 12)* . *Sum. Preq: Summer camp eligibility.* Procedures and instruments for measuring tree parameters, stand density and site index. Determination of log and tree volume and planning, conducting and summarizing a timber inventory. Basic land measurements and the mapping of boundary surveys, use of maps and GPS will be included.

FOR 303 Silvics and Forest Tree Physiology. *3(3-0)* . *Preq: BIO 125, CH 201, PY 211, BO 360, SSC 200 & summer camp. Coreq: FOR 353, FOR 319, FW 353, ST 311.* Ecological and physiological processes influencing establishment, growth, and development of forest stands with particular emphasis on forest types of Southeastern United States; influence of resource availability on forest stand productivity; physical and biochemical processes associated with tree function, including water relations, mineral nutrition, transport and translocation, photosynthesis, respiration; internal and environmental factors regulating tree growth and development.

FOR 304 Theory of Silviculture. *4(3-3)* . *Preq. FOR 303,333,319, FW 353, ST 311. Coreq: FOR 374,434, ENT 402, PP 318.* Ecological processes affecting the establishment and growth of forest stands with particular emphasis on forest types of the Southeastern United States. Forest stand productivity, how productivity is influenced by site, stand, climatic factors, and the application of site specific prescriptions to establish and manipulate the composition, growth, and health of forest stands.

FOR (FW) 310 Fisheries and Wildlife Inventory and Management. *6(0 18) Preq: Junior standing in SFW, FOM, NRE, NRP, or SZO: FW/ZO 221* Field exercises involving resource inventory, habitat relationships, community structure and analysis, population estimation, forest mensuration and silviculture, and habitat manipulation. Activities predominately field-oriented in an off-campus environment. Overnight trips to observe management activities required.

FOR (PP) 318 Forest Pathology. *3(2-2)* . *Preq: BIO 125 or BO 200.* Major diseases of forest trees and deterioration of wood products emphasizing principles of plant pathology; diagnosis; nature, physiology, ecology, and dissemination of disease-causing agents; mechanisms of pathogenesis; epidemiology and environmental influences; principles and practices of control.

FOR 319 Forestry Economics. *3(3 0)* . *Preq: ARE 201.* Concepts and techniques for evaluating the profitability of long-term timber investments. Biological and market variables that affect profitability. Income tax treatment of timber income, including financial incentives provided through the tax system. Analysis of timer investment returns under a range of land, ownership, and market conditions. Emphasis on problem-solving.

FOR 353 Air Photo Interpretation and Photogrammetry. *3(2-3)* . *Preq: MA 114* Theory, principles, and techniques of utilizing air photos for inventory and management of renewable resources, photogrammetric and engineering applications, hydrologic and terrain analysis, and land use/cover mapping. Introduction to remote sensing and use of color infrared, thermal, Skylab, and Lands at imagery in resource mapping.

FOR 374 Forest Measurement, Modeling, and Inventory. *3(3-2) . Preq: MA 121 and 114; or 242; CFR 134, FOR 274, ST 311.* Mathematical functions required for quantifying the yield of timber and non-timber products. Procedures for planning, conducting, and analyzing forest inventories. Use of mathematical models to estimate growth and yield of forest stands and non-timber products for management decisions.

FOR (ENT) 402 Forest Entomology. *3(2-2) . S. Preq: Junior Class Standing and BIO 125.* Fundamentals of morphology, classification, biology, ecology and control of insects attacking trees, with emphasis on silvicultural practices.

FOR (FW) 404 Forest Wildlife Management. *3(3-0) . Preq: 9 hrs Biological Sciences.* Relationships between forest and wildlife management and the effects of silvicultural systems on wildlife. Species-habitat requirements, forest wildlife management techniques, and forest-wildlife policies and economics. (See Fisheries and Wildlife Sciences.)

FOR 405 Forest Management. *4(2-4) . Preq: FOR 319,304,374,434.* Fundamental principles and analytical techniques necessary in the planning, management and optimization of forest operations. Formulation of objectives and constraints, yield forecasting, forest regulation, procurement and marketing, inventory methods, and management plan preparation. Written and oral reporting.

FOR 406 Forest Inventory, Analysis and Planning. *4(0 16) . Preq: FOR 405, FOR 460.* Independent project in designing and implementing a multi-resource survey; analyze stand conditions; forecast growth, yield and revenue of timber and forest products; use linear programming to prepare a long-term management plan subject to economic,social, and ecological constraints; assess economic and environmental impacts of potential actions; and report results orally and in writing.

FOR 411 Forest Tree Genetics and Biology. *3(3 0) . Preq: Junior or senior standing with a biological background.* Genetics as it is applied in forest management for both conifers and hardwoods. The variation, evolution and genetics of forest trees. Methods for selection, breeding, seed production, and vegetative propagation. Exotics, wood properties, and tree improvement as a forest management tool.

FOR 414 World Forestry. *3(3-0) S.* Management of global forest resources; distribution and trends in forest cover; role of forests in economic development; international production and trade of forest products; current policy issues, including tropical deforestation, certification, and carbon sequestration; social forestry and non-timber forest products; international institutions and aid for conservation and development; identification and evaluation of sources of current information on global forestry issues.

FOR 415 World Forestry Study Tour. *1(1-0) . S. Coreq: FOR 414. Offered during spring break, as a one week field trip toMexico and/or Central America.* Field trip to Mexico and/or Central America for seven days over spring break. Examine tropical forestry issues through field visits to timber concessions, plantations, nurseries, wood products firms, protected areas, and agroforestry projects; meetings with representatives of forest research institutes, government agencies, timber industry, cooperatives, and environmental organizations; and interaction with local people. Fee for field trip determined annually.

FOR (NR) 420 Watershed and Wetlands Hydrology. *4(3-3) . F. Preq: SSC 200, BO 360. Credit will not be given for both FOR(NR)420 and FOR(NR)520.* Principles of hydrologic science; classification and assessment of watersheds and stream networks; hydrologic, erosion, and water quality processes in natural and managed watersheds; wetlands hydrology; hydrologic measurements and data analysis; applications of hydrology and water quality management for forest agriculture, and urban ecosystems; watershed restoration. Emphasis field study of watersheds and hydrologic measurements. Two weekend field trips are required.

FOR 422 Consulting Forestry. *3(2-2). Preq: Senior standing in Forest Management.* Forest land acquisition and ownership: ownership, appraisal, legal considerations, financial management and planning. Producing forest resources: timber, wildlife, recreation, farm products, water, minerals, specialty products, and development. Marketing forest resources: timber, recreation, farm leases, minerals, specialty products, and developed property. Forest resources consulting: forms of organization, pricing of services, consultant client relationships (Law of Agency), professional ethics and continuing education.

FOR (WPS) 423 Forest Machinery and Systems. *3(2-3) . F. Preq: Junior standing in FOM, BE, WP* Applications of engineering principles to problems in forest operations: power sources; testing; rating and capabilities of forest machinery; power requirements and utilization efficiencies; effects of vehicle design parameters on stability, safety, and operation under load; traction devices and vehicle mechanics.

FOR 434 Forest Operations and Analysis. *4(3-3) . S. Preq: FOR 303,319,353, FW 353, ST 311 Coreq: FOR 304 ENT 402, PP 318.* Management science and operational techniques in forestry. Road layout, construction, and machine systems: harvesting machine optimization, and selection. Harvesting, production and forest planning. Linear programming, queuing, decision and inventory theory, and other techniques for solving problems typically encountered in forest operations management.

FOR 460 Renewable Resource Policy and Management. *3(3-0) . Preq: Junior standing.* The interaction of legal principles and governmental institutions in the development and implementation of natural resource policy and management. Legal principles, constitutional provisions, and the location and organization of governmental programs. Examples from both historic and current case histories.

FOR (FW) 485 Natural Resources Advocacy. *3(2-3) . F,S. Preq: ENG 333: Jr or Sr level with at least 10 hrs. of Biology.* Analysis of natural resources problems affecting management agencies and user groups. Emphasis on professional attitudes, policies, and communication skills needed for management of sensitive natural resource issues. Guest professionals sharing their perspectives on dealing effectively with natural resource clientele groups. Student discussions, team projects, technical presentations citing popular articles on natural resources subjects.

FOR 490 Senior Seminar in Forestry. *1(1-0) . F,S Preq: Senior standing.* Attend departmental or university seminars or group discussions weekly to enrich and broaden student perspectives. Oral or written summaries of these seminars.

FOR (NR) 491 Special Topics in Forestry and Related Natural Resources. *1-4. F,S. Preq: Consent of Instructor.* Independent (or group) study or research of a forestry or related natural resources topic with a faculty supervisor of the student's choice. Also courses offered on a trial basis.

FOR 501 Dendrology. *3(2-4) . F. Preq: BO 200 or equivalent.* Identification and natural history of eastern woody species with studies of their taxonomic classification, physical characteristics, and typical habits. Laboratories stress sight recognition and use of identification keys and trips to natural forest communities.

FOR 502 Forest Measurements. *1(2-2) . F.* One-third semester mini-course. Forest measurements covering principles, terminology, and practical field applications. Land area measurement, units of timber measure (cubic feet, cords, weight, board feet), estimating volume of standing trees, sampling techniques for forest inventory (strips, plots, points), measures of site quality and stand density, methods for projecting future timber volumes.

FOR 503 Tree Physiology. *1(1-0) . F. Preq: Graduate Standing.* One-third semester mini-course. Fundamental principles of physiological processes in forest trees affecting tree and stand growth and development in natural forests and managed plantations. Concepts of whole plant physiological processes includingphotosynthesis, respiration, water relations, nutrition, periodic growth, sexual and vegetative reproduction, and seedling quality with forestry examples of each process.

FOR 505 Forest Management. *4(2-4) . F. Credit not allowed for both FOR 505 and FOR 405.* Fundamental principles and analytical techniques necessary in planning, management and optimization of forest operations. Formulation of objectives and constraints, yield forecasting, forest regulation, procurement and marketing, inventory methods,and management plan preparation. Written and oral reporting.

FOR 506 Timber Investment Analysis. *1(3-0) . F.* One-third semester mini-course. Concepts and techniques for evaluating profitability of long-term timber investments. Discounted cash flow analysis and measures of profitability such as net present value and internal rate of return. Identification of biological and market variables affecting profitability. Introduction to tax treatment of timber income, including financial incentives provided through tax system.

FOR 507 Silviculture Mini Course. *1(1 0) . S.* One-third semester mini-course. A condensed version of silviculture. Ecological processed affecting establishment and growth of forest stands with particular emphasis on forest types of southeastern United States. Forest stand productivity, how productivity influenced by site, stand, climatic factors, and application of site specific prescriptions to establish and manipulate composition, growth, and health of forest stands.

FOR 509 Forest Resource Policy. *1(1 0) . S.* One third semester mini-course. Principles of forest policies and processes. Political processes, institutional and interest group participation, forestry laws and programs, current issues, and policy analyses.

FOR 510 Introduction to GPS. *1(2-2) . F,S.* One-third semester mini-course. Introduction to collection and use of mapping grade global positioning satellite systems data. Includes review of cartographic properties, mission planning, hands-on collection of GPS points, lines, and areas, differential correction, editing, and exporting GPS files to a GIS.

FOR 513 Silviculture for Intensively Managed Plantations. *3(3-0) . F. Preq: FOR 507 or equivalent.* This course provides an up-to-date understanding of the ecological and physiological bases of forest stand productivity and a silvicultural systems framework to use this knowledge for making site specific prescriptions that are cost effective and environmentally sustainable.

FOR 519 Forest Economics. *3(3-0) . S, Alt. Yrs. Preq: Basic course in economics.* Economics applied to problems in forest management, including timber demand and supply models, optimal rotation length, benefit-cost analysis of forestry projects, impacts of forest taxation and consideration of non-market forest goods and services.

FOR (NR) 520 Watershed and Wetlands Hydrology. *4(3-4) . F. Preq: SSC 200, BO 360. Credit for both FOR(NR) 420 and FOR(NR) 520 is not allowed..* Principles of hydrologic science; classification and assessment of watersheds and stream networks; hydrologic, erosion, and water quality processes in natural and managed watersheds; wetlands hydrology; hydrologic measurements and data analysis; applications of hydrology and water quality management for forest, agriculture, and urban ecosystems; watershed restoration. Field study of watersheds and hydrologic measurements. Two weekend field trips required.

FOR 522 Consulting Forestry. *3(2-2) . F. Preq: Graduate standing. Credit for both FOR 422 and FOR 522 is not allowed.* Forest land acquisition and ownership: ownership, appraisal, legal considerations, financial management and planning. Producing forest resources: timber, wildlife, recreation, farm products, water, minerals, specialty products, and development. Marketing forest resources: timber, recreation, farm leases, minerals, specialty products, and developed property. Forest resources consulting: forms of organization, pricing of services, consultant client relationships (Law of Agency), professional ethics and continuing education. To receive graduate credit, a student must write a term paper on a topic mutually agreed upon with the instructor.

FOR 534 Forest Operations and Analysis. *4(3 3) . S Credit not allowed for both FOR 534 and FOR 434.* Management science and operational techniques in forestry. Road layout, construction, and machine systems. harvesting machine optimization and selection. Harvesting, production and forest planning. Linear programming, queuing, decision and inventory theory, and other techniques for solving problems typically encountered in forest operations management.

FOR 540 Advanced Dendrology. *3(2 3) . S,Alt. yrs.(odd). Preq: BO 403 or FOR 212.* Identification and life histories of native and naturalized woody plants. Use of taxonomic manuals and literature. Identification of problematic groups. Concentration on North America, with discussion of other continents. Overnight field trips to natural forest communities.

FOR 554 Principles of Spatial Analysis. *3(2-3) . F.* Principles and techniques for utilizing spatial information in natural resource inventory and analysis. Interpretation of conventional aerial photographs, principles of photogrammetry, sources of spatial data layers, and introductions to non-photographic remote sensing and digital photogrammetry.

FOR 561 Forest Communities of the Southeastern Coastal Plain. *1(0-2) . Sum. Preq: FOR 212, FOR 501 or equivalent course/experience in plant taxonomy.* Species composition, distribution, site requirements, and succession of principal forest communities of southeastern Coastal Plain. Identification of important member plant species. Overnight field trips to typical examples.

FOR 562 Forest Communities of the Southern Appalachians. *1(0-2) Sum. Preq FOR 212, FOR 501 or equivalent course/experience in plant taxonomy.* Species composition, distribution, site requirements, and succession of principal forest communities of southern Appalachians. Identification of important member plant species. Overnight field trips to typical examples.

FOR (CS,SSC) 577 Conservation and Sustainable Development I: Concepts and Methods. *3(3-0) . F. Preq: Consent of Instructor.* Agronomic, ecological and economic concepts of sustainability, with emphasis on application in developing countries; forest, soil and wildlife resources; models in conservation biology; historical, cultural and sociological perspectives; policy analysis. Offered as part of the program of Center for World Environment and Sustainable Development.

FOR (SSC) 578 Conservation and Sustainable Development II: Integrated Problem Solving. *3(3-0). F. Preq: FOR(CS,SSC) 577.* Approaches to reconciling conservation and development with emphasis on developing countries. Case studies; project formulation, implementation and evaluation; institutional policy formation; conflict resolution. Offered as part of the program of Center for World Environment and Sustainable Development.

FOR (SSC) 581 Agroforestry. *3(3-0) . Preq: Consent of Instructor.* Global agroforestry systems across diverse agroecological zones and under an array of socioeconomic conditions. Methods for selecting sustainable forestry, agricultural and silvipastoral crops that draw upon production agriculture and forestry, community and ecosystem ecology, sociology, and economics. Extension of research results to rural poor in developing countries.

FOR 583 Tropical Forestry. *3(3-0) . F, Alt. Yrs.(odd). Preq: Senior standing.* Principles of tropical ecology, dendrology and agroforestry. Primary emphasis on establishment and management of tropical plantations with lesser emphasis on natural stands. Operation and management of tropical nurseries.

FOR (FW) 585 Advanced Wildlife Habitat Management. *3(2-3) . Preq: ZO(FW) 553 and ZO(FW) 554.* Discussion and evaluation about assessing and modeling habitat capability for wildlife species. Student development of models of habitat requirements for wildlife species and integration of models into wildlife management plans. Laboratory exercises include manipulation of habitat management computer packages and development of a wildlife management plan.

FOR 595 Special Topics. *F,S,Sum.* Individual students or groups of students, under direction of a faculty member, may explore topics of special interest not covered by existing courses. Format may consist of readings and independent study, problems or research not related to thesis.Also used to develop and test new 500-level courses.

FOR 601 Graduate Seminar. *1(1-0) . F,S,Sum. Preq: FOR 420, ST 512.* Weekly seminar in which students registered for course present the results of research and special projects. Invitation to all graduate students and faculty in department to attend and join discussion.

FOR (FW) 602 Seminar in Wildlife Management. *1(1-0) . S Alt Yrs.* Current topics and issues in wildlife biology and management. Students select and research topics, give seminars and lead group discussions.

FOR 603 Seminar in Forest Research. *1(1-0) . S. Preq: Grad. standing.* Philosophy and objectives of scientific research and steps in the research process. Basic and applied research, inductive and deductive reasoning and need for hypothesis development and testing as a basis for scientific research. Special emphasis on preparation of study plans, graduate theses, published articles and technical presentations.

FOR 608 Forest Management and Planning. *1(1-0) . S. Preq: Graduate standing.* One-third semester mini-course. Forest management involves acquisition of land or forest management rights, long-term management of land and associated resources, and production and delivery of commodities and services produced on the land and the dynamics of these processes.

FOR 610 Special Topics in Forestry. *F,S,Sum. Credits Arranged* Individual students or groups of students, under direction of a faculty member, may explore topics of special interest not covered by existing courses. Format may consist of readings and independent study, problems or research not related to thesis.Also used to develop and test new 500-level courses.

FOR 615 Advanced Topics in Forestry. *F,S.* Individual students or groups of students, under direction of a faculty member, may explore topics of special interest not covered by existing courses. Format may consist of readings and independent study, problems or research not related to dissertation. Also used to develop and test new 600-level courses.

FOR 680 Field Practicum in Tropical Forestry. *2(2-0) . Sum.* Principles of tropical forest protection and management through case studies. Participants will travel to a tropical region outside the United States for two weeks of intensive field studies. Topics: balancing economic growth with environmental protection, industrial forestry, protection forestry, projects and organizations, policy issues.

FOR 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

FOR 690 Master's Examination. *1-6. F,S,Sum. Preq: Master's student.* For students in on thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

FOR 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

FOR 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research.

FOR 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

FOR 701 Advanced Hydrology. *3(3-0) S, Alt. Yrs. Preq. FOR 420, ST 512.* The physical concepts of water movement through hydrologic cycle and interactions with ecosystem components. Mathematical approaches to characterizing and quantifying hydrologic processes derived and applied to problem solutions. Discussion and utilization of experimental design and statistics needed for collecting and analyzing hydrologic data. Development and use of simulation models.

FOR 710 Quantitative Forest Genetics Methods. *3(3-0) . F. Alt. Yrs Preq. ST 512.* Fundamental principles and procedures for partitioning experimental variance, estimating parameters of interest from different mating schemes and experimental designs and their uses in making tree breeding decisions.

FOR 713 Advanced Topics in Silviculture. *3(3-0) F Preq: FOR 304.* Critical examination of selected silvicultural topics, with special emphasis on concepts and phenomena distinguishing forests from other biotic communities and silviculture from other fields of applied biology. Emphasis on intensive silviculture in United States and selected international locations. A required written research proposal.

FOR (GN) 725 Forest Genetics. *3(3-0) . S Preq: GN 411 or Consent of Instructor* Application of genetic principles to silviculture, management and wood utilization. Emphasis on variation in wild populations, the bases for selection of desirable qualities and fundamentals of controlled breeding.

FOR (GN) 726 Advanced Topics in Quantitative Genetics. *3(3-0) F, Alt yrs. Preq: GN(FOR) 725, GN(ST) 770 or GN(ANS) 713 or Consent of Instructor.* Advanced topics in statistics and population genetics pertinent to current research problems in genetics with special applications to forestry. Basic statistical and genetic theory reviewed as bases for intensive study of selection theory and experimental and mating design evaluation. Study of genetics of natural populations for evolutionary interest as well as for their implications to breeding theory.

FOR 727 Tree Improvement Research Techniques. *3(1-4) . S, Alt. Yrs. Preq. FOR 411 or GN 411.* Research methods involved in forest tree breeding and genetics programs. Emphasis on laboratory, greenhouse and field research techniques. Stress also on summary and presentation of research results.

FOR 728 Quantitative Forest Genetics Methods. *3(3-0) . F, Alt. Yrs.(odd). Preq: GN 703, ST 512.* Applications of basic quantitative genetic methods in forest tree breeding and genetic research. Principles and procedures for partitioning experimental variance, estimating genetic parameters from different mating and test designs. Predicting breeding value and gain and developing breeding strategies.

FOR 733 Forest Ecosystem Analysis. *3(3-0) . S, Alt. Yrs.(even). Preq: FOR 505 or FOR 501.* History, principles, mathematical formulations and solution techniques used in forest ecosystem analysis and decision making: Temporal and spatial analysis; aggregation/disaggregation problems; optimization; hierarchical and analysis methods.

FOR 734 Advanced Forest Management Planning. *3(3-0) . S, Alt. yrs. Preq: FOR 405 or FOR 434 or OR 501. Coreq: FOR 7~2.* History, principles, structures and use of modern forest management planning and decision-making techniques. Emphasis on optimization procedures and public forest management.

FOR 750 Ecological Restoration. *3(3-0) . S, Alt yrs(even). Preq. BO 360, SSC 200.* Historical bases and philosophical examination of concepts of ecosystem restoration. Mechanics of restoring soils, hydrology, plant community composition and structure, and landscape levels ecosystem functions. Quantitative evaluations of restoration success.

FOR 753 Environmental Remote Sensing. *3(2-3) . F, Alt. yrs. Preq: FOR 353.* Principles and applications of remote sensing technology to earth resources and environmental studies. Electromagnetic energy, data acquisition platforms, sensors and scanners, processing of digital remotely sensed data, error analysis and accuracy assessments, and integration of remotely sensed data with other data types used in natural resource management.

FOR (ENT) 765 Advanced Forest Entomology. *3(2 2) . S, Alt. Yrs. Preq: ENT 402 or Consent of Instructor.* Coverage of the important insect pests of forest and shade trees including regeneration pests, defoliating insects, inner-bark borers, wood borers, sucking insects, and bud, twig and root feeding insects. Detailed examination of concepts in forest pest management and population dynamics.

FOR 772 Forest and Renewable Resource Policies on the Public Lands. *1(1-0) . S, Alt. yrs.(odd).* History, development and current status of policies relating to forest management on public lands. Agencies include Forest Service, National Park Service, Fish and Wildlife Service, and Bureau of Land Management.

FOR (SSC) 773 Ecophysiology of Forest Production. *3(3-0) . F. Preq: BO(ZO)760.* Advanced ecophysiological consideration of forest stand productivity and how influenced by resource availability, genetics and their interactions. This knowledge used as a foundation to discuss the influence of natural stresses, silvicultural treatments and other anthropogenic disturbances on forest productivity.

FOR 774 Topics in Forest Modeling. *3(2-2) . F, Alt. yrs. Preq: MA 121, ST 311.* Development and use of quantitative models in forestry. Mathematical modeling and parameter estimation, tree growth and stand development, wildlife habitat and population dynamics, modeling amenity outputs. Emphasis on underlying biological and mensurational assumptions and their impact on applicability and analysis.

FOR (SSC) 782 Silviculture and Management of Forest Plantations in the Tropics. *3(3-0) . S. Preq. Grad. standing or Consent of Instructor.* Establishment and management of forest tree plantations in the tropics and subtropics. Genetic adaptability of trees used as exotics, establishment and management of tree improvement programs, tree harvesting, wood manufacturing, gene conservation and maintaining site productivity.

FOR 784 The Practice of Environmental Impact Assessment. *4(2-4) . F.* Impact assessment principles, practices and their evolution. Lectures and field practicums concerning problems addressed by environmental assessment practitioners. Practical implications of current regulatory requirements, especially concerning endangered species and wetlands, as they affect environmental practitioners' performance. Required reports combine varied technical tasks and documentation for regulatory process review.

FOR 795 Advanced Special Topics in Forestry. *F,S* Individual students or groups of students, under direction of a faculty member, may explore topics of special interest not covered by existing courses. Format may consist of readings and independent study, problems or research not related to thesis. Also used to develop and test new 700-level courses.

FOR 801 Seminar. *1(1-0) . F,S,Sum.* Weekly seminar in which students registered for course present the results of research and special projects. Invitation to all graduate students and faculty in department to attend and join discussion.

FOR 802 Seminar in Wildlife Management. *1(1-0) . S, Alt. yrs.* Current topics and issues in wildlife biology and management. Students select and research topics, give seminars and lead group discussions.

FOR 803 Seminar in Forest Research. *1(1-0) . S. Preq: Grad. standing.* Philosophy and objectives of scientific research and steps in the research process. Basic and applied research, inductive and deductive reasoning and need for hypothesis development and testing as a basis for scientific research. Special emphasis on preparation of study plans, graduate theses, published articles and technical presentations.

FOR 810 Special Topics in Forestry. *F,S,Sum.* Individual students or groups of students, under direction of a faculty member, may explore topics of special interest not covered by existing courses. Format may consist of readings and independent study, problems or research not related to thesis. Also used to develop and test new 800-level courses.

FOR 815 Advanced Special Topics in Forestry. *F,S. Credits Arranged.* Individual students or groups of students, under direction of a faculty member, may explore topics of special interest not covered by existing courses. Format may consist of readings and independent study, problems or research not related to dissertation. Also used to develop and test new 800-level courses.

FOR 885 Doctoral Supervised Teaching. *1-3. F,S Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

FOR 890 Doctoral Preliminary Exam. *1-9. F,S Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

FOR 893 Doctoral Supervised Research. *1-9. F,S. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

FOR 895 Doctoral Dissertation Research. *1-9. F,S. Preq: Doctoral student.* Dissertation research.

FOR 899 Doctoral Dissertation Preparation. *1-3. F,S. Preq. Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

FIBER AND POLYMER SCIENCE

FPS (TT) 704 Fiber Formation--Theory and Practice. *3(3-0) . F. Preq: MA 301, PY 208 or Consent of Instructor.* Practical and theoretical analysis of the chemical and physical principles underlying conventional methods of converting bulk polymer to fiber; rheology; melt, dry and wet polymer extrusion; fiber drawing; heat setting; general theory applied to unit processes.

FPS (TT) 720 Yarn Production/Properties: Advanced Topics. *3(2-2) . S, Alt. yrs.(Even). Preq: TT 520 or TE 501.* Lectures and seminar discussion of recent development in yarn manufacturing. Group research into topical areas of yarn production and properties.

FPS (TT) 721 Advanced Textile Testing. *3(2-2) . Preq: TT 530 or TAM 380 or TE 404 or equivalent.* Management and quality engineering concepts, strategies, practices and operating tools required to initiate and sustain a Total Quality Management program which can succeed in modern textile environments.

FPS (TT) 750 Advances in Woven Fabric Formation and Structure. *3(2-2) . S. Preq: TT 551 or equivalent Graduate Standing* Advances in formation mechanics and structure of woven fabrics covered through lectures, seminars and independent studies. Advances in yarn preparation processes, essential weaving motions, auxiliary motions, automation, and their impact on weaving room management. Recent research in formation of advanced complex woven structures.

FPS (TMS) 761 Mechanical and Rheological Properties of Fibrous Material. *3(3-0) S. Preq. MA 301* In-depth study of the stress-strain, bending, torsional, dynamic and rheological behavior of natural and man-made fibers. Presentation and discussion of theoretical relations and advanced techniques.

FPS (CH, MAT,TC) 762 Physical Chemistry Of High Polymers-Bulk Properties. *3(3-0) . F, Alt. Yrs. Preq. CH 220 or TC 203. CH 431.* Molecular weight description; states of aggregation and their interconversion; rubbery, glassy and crystalline states; rubber elasticity; diffusion properties.

FPS (MAT, TMS) 763 Characterization of Structure of Fiber Forming Polymers. *3(3 0) . F. Preq. MA 301, PY 208.* Theories, experimental evidence and characterization methods of the molecular fine structure of fiber forming polymers in the solid state. Characterization methods include X-ray diffraction, microscopy, infrared, thermal and magnetic resonance. An introduction to nucleation theory of polymer systems.

FPS (CHE, TC) 769 Polymers, Surfactants and Collodial Materials. *3(3-0) F. Preq: CHE 316, CH 223.* Relationships between molecular structure and bulk properties of nonmetallic materials applied to commercial products and chemical engineering processes. Applications of surface and colloid chemistry and polymer science to product development and process improvement.

FPS (TC) 771 Polymer Microstructures, Conformations and Properties. *3(3-0) . F,Alt Yrs (Even). Preq: CH 220 or equivalent or Consent of Instructor.* Exploration of connections between microstructures and properties of polymers afforded by analysis of their conformational characteristics. Analysis of NMR spectroscopy and conformational energy estimates to establish polymer microstructures and resultant sizes and shapes of polymer chains, which then related to their unique and rich variety of physical properties.

FPS (CH, MAT,TC) 772 Physical Chemistry of High Polymers--Solution Properties. *3(3-0) . S, Alt Yrs. Preq: CH 433, TC (CH, MAT) 762.* Thermodynamics of polymer solutions; phase equilibria; determination of molecular weight.

FPS (CHE,TC) 779 Diffusion In Polymers. *2(2-0) . S. Preq: CHE 769 or Consent of Instructor.* Theory of small molecule transport in polymers; applications of membrane transport processes in chemical, polymer, textile, coatings and natural fiber industries.

FPS (TC) 791 Special Topics in Textile Science. *1-4. F, S. Preq: Sr. or grad. standing and consent of instructor.* Intensive treatments of selected topics in textile, polymer and fiber science.

FPS (TC,TES) 792 Special Topics in Fiber Science. *1-3. F,S. Preq: Consent of instructor.* Study of selected topics of particular interest in various advanced phases of fiber science.

FPS (TT) 781 Mechanics of Twisted Structures. *3(3-0) . S,Alt yrs. (even). Preq: TES 561 or equivalent.* Structure and mechanics of twisted linear textiles (yarns, cords, ropes) with particular emphasis on translating fiber load deformation behavior into load deformation behavior of product, using micromechanics approach.

FPS (TT) 782 Mechanics of Fabric Structures. *3(3-0) . S, Alt. yrs.(odd). Preq: TES 561 or equivalent.* Structure and mechanics of woven, knit and nonwoven fabrics. Particular emphasis on translating fiber/yarn load deformation into in-plane and out-of-plane load deformation of fabrics through structure using micro-mechanics approach.

FPS 792 Special Topics in Fiber Science.

FPS 801 Seminar.

FPS 830 Independent Study.

FPS 876 Special Project in Fiber and Polymer Sciences.

FPS 885 Doctoral Supervised Teaching. *1-3. F,S. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

FPS 890 Doctoral Preliminary Exam. *1-9. F,S. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

FPS 893 Doctoral Supervised Research. *1 9. F.S. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

FPS 895 Doctoral Dissertation Research. *1-9. F.S. Preq: Doctoral student.* Dissertation research.

FPS 899 Doctoral Dissertation Preparation. *1 3. F.S. Preq. Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

FOOD SCIENCE

FS 201 Food Science and the Consumer. *3(3-0) .* Science and practice of providing a wholesome, nutritious, economical and readily available supply of basic and processed foodstuffs. Chemical nature of foods, nutritional requirements, health-related dietary considerations, microorganisms, foodborne illnesses, preservation and processing, food additives, food labeling, food safety and the consumer.

FS 231 Food Engineering. *4(3 3) . Preq: PY 211.* Engineering concepts and their applications to the food industry. Mass and energy balances and principles related to fluid flow, heat transfer, steam generation and use, psychrometry, and refrigeration.

FS 290 Preparing for Careers in Food Science. *1(1-0) . Preq: Sophomore standing in Food Science.* Careers and opportunities related to the food and allied industries and in governmental agencies. Development of professional enhancement skills; resume preparation; interviewing techniques; leadership development; communication; team building. Benefits of undergraduate research or internship experiences and continuing education.

FS 295 Special Topics in Food Science. *1-4.* Offerings of new or experimental courses in Food Science at the early undergraduate level.

FS (ANS, NTR) 301 Introduction to Human Nutrition. *3(3-0) . F,S,Sum. Preq: Sophomore standing. Food science majors may use as a free elective only.* Functions, dietary sources and deficiencies of essential nutrients in humans; a balanced diet; role of nutrients in heart disease, cancer, hypertension, osteoporosis; weight control and eating disorders; vegetarianism; food safety; dietary supplements; government regulation of food supply; food quackery.

FS (ANS, PO) 322 Muscle Foods and Eggs. *3(2-3) . Preq: BIO 125.* Processing and preserving fresh poultry, red meats, seafood, and eggs. Ante- and post-mortem events as they affect quality, yield, and compositional characteristics of muscle foods. Principles and procedures involved in the production of processed meat items.

FS (ANS) 324 Milk and Dairy Products. *2(2-0) . Preq: BIO 125.* Composition of milk and dairy products, federal standards, raw milk procurement, cleaning and sanitizing, and quality attributes.

FS (NTR) 400 Principles of Human Nutrition. *3(3-0) . Preq: CH 220 or 221; BIO 125.* Overview of fields of nutritional sciences; functions of nutrients in the human body; sources and properties of nutrients; relationships of food industry practices to nutrition.

FS 402 Food Chemistry. *3(2 3) . Preq: CH 220 or 221.* Molecules and reactions that account for the texture, flavor, color, stability and nutritional value of foods. Major emphasis on mechanisms and control of reactions involving carbohydrates, proteins, lipids and biological pigments.

FS 403 Food Analysis. *4(2-6) . Preq: FS 402.* Principles, methods and techniques for quantitative physical and chemical analyses of food and food products. Results of analyses evaluated in terms of quality standards and governing regulations.

FS (MB) 405 Food Microbiology. *3(3-0) . Preq: MB 351.* Microorganisms of importance in foods and their metabolic activities. Sources of microbial contamination during food production, processing and storage. Microbial spoilage; foods as vectors of human pathogens. Physical and chemical destruction of microorganisms in foods and the kinetics involved. Conversions of raw foods by microorganisms into food products. Microbiological standards for regulatory and trade purposes.

FS (MB) 406 Food Microbiology Lab. *1(0-2) . Coreq: FS (MB) 405.* Laboratory experience to complement FS/MB 405. Skills in detecting and quantitating microorganisms and their toxins in foods. Application of colony and direct microscopic counts, most probable numbers, enzyme immunoassays, nucleic acid probes and computer modeling are used to understand the numbers and types of microorganisms or microbial end products in foods. Laboratory safety and oral and written reports are emphasized.

FS 416 Quality Control of Food Products. *3(2-3) . Preq: FS 402; MB 351.* Organization and principles of quality control for the food industry. Physical, chemical, microbiological and sensory analysis. Total quality management, risk assessment, hazard analysis and critical control point (HAACP), water quality, wastewater analysis and reduction, cleaning and sanitation, and statistical quality control.

FS 421 Food Preservation. *3(2-3) . Coreq: MB 351.* Methods employed in food preservation. Emphasis on thermal, freezing, drying and fermentation processes and corresponding physical, chemical, and organoleptic changes in product. Relationship of these preservation techniques to development of an overall processing operation.

FS 425 Processing Dairy Products. *3(2-3) . Preq: FS 324, 421.* Unit operations in dairy processing. Formulation, processing, packaging and evaluation of fluid milk and manufactured products.

FS 453 Food Laws and Regulations. *3(3-0) . Preq: Junior standing required. Credit will not be given for both FS 453 and FS 553.* Federal and state laws and regulations, and case law history affecting food production, processing, packaging, marketing, and distribution of food and food products. History of food law, enactment of laws and regulations, legal research, and regulatory agencies.

FS (HS) 462 Postharvest Physiology. *3(3-0) . Preq: BO 421.* Preharvest and postharvest factors that affect market quality of horticultural commodities with an emphasis on technologies to preserve postharvest quality and extend storage life of fruits, vegetables and ornamentals.

FS 475 Problems and Design in Food Science. *3(1-6) . Preq. FS 231 FS 402, FS 405.* Team approach to problem solving and product/process design and development. Ingredient functionality; formulation, safety, processing, packaging, sensory evaluation, regulatory issues, hazard analysis, critical control points (HACCP), nutritional labeling and other pertinent scientific, technical, marketing and financial aspects. Oral and written presentations.

FS 492 External Learning Experience. *1 6. Preq. Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by the student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

FS 493 Special Problems in Food Science. *1-6. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes campus facilities and resources. Contact and arrangements with prospective employers must be initiated by the student and approved by a faculty adviser. the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

FS 495 Special Topics in Food Science. *1-3.* Offered as needed to present materials not normally available in regular course offerings or for offering new courses on a trial basis.

FS 553 Food Laws and Regulations. *3(3-0) . Preq: Credit for both FS 453 and FS 553 is not allowed.* Federal and state laws and regulations and case law history affecting food production, processing, packaging, marketing and distribution of food and food products. History of food law, enactment of laws and regulations, legal research, and regulatory agencies.

FS (ANS, NTR) 554 Lactation, Milk, and Nutrition. *3(2-2) . S, Alt. yrs.(even). Preq: ANS 230 or FS/NTR 400; BCH 451 or ZO 421. Credit will not be given for both ANS 454 and 554.* Nutritional properties of milk as a high-quality food with nutritional diversity. Principles of physiology, biochemistry and cell biology in the mammary gland. Procedures of milk production and milk collection for milk quality and nutrition. Human lactation vs. that of domestic animals. Impacts of biotechnology and food safety on dairy production.

FS 591 Special Problems in Food Science. *1-6. F,S,Sum. Preq: Grad. or sr. standing.* Analysis of scientific, engineering and economic problems of current interest in foods. Problems designed to provide training and experience in research.

FS 592 Special Research Projects in Food Science.

FS 620 Special Problems in Food Science. *1-6. F,S,Sum. Preq: Grad. or sr. standing.* Analysis of scientific, engineering and economic problems of current interest in foods. Problems designed to provide training and experience in research.

FS 623 Special Research Problems in Food Science. *F,S,Sum.* Directed research in a specialized phase of food science designed to provide experience in research methodology and philosophy.

FS 685 Master's Supervised Teaching. *1-3. F,S. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

FS 690 Master's Examination. *1-6. F.S. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

FS 693 Master's Supervised Research. *1-9. F,S. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

FS 695 Master's Thesis Research. *1-9. F.S. Preq: Master's student.* Thesis research.

FS 699 Master's Thesis Preparation. *1-3. F,S Preq: Master's student* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

FS 704 Food Proteins and Enzymes. *3(2-3) . F. Alt. yrs. Preq: FS 402 or BCH 451.* Advanced course in food chemistry with emphasis on proteins and enzymes of particular importance to foods. Protein interactions and their effect on physical-chemical characteristics of a product. Particular emphasis on preparation and kinetic properties of immobilized enzymes and their use as biochemical reactors in processing operations or as specific electrodes for analytical purposes.

FS 705 Physical and Chemical Properties of Muscle Foods. *3(3-0) . S, Alt. yrs. Preq: BCH 453/553.* Current knowledge and analysis of literature in muscle biology and muscle foods. Major topics: 1) muscle composition, structure and contraction, 2) structural/functional relationships in muscle proteins, 3) biological control of myofibrillar protein isoforms and 4) conversion of muscle to meat products.

FS (NTR) 706 Vitamin Metabolism. *2(2-0) . F,Even yrs. Preq: ANS(NTR,PO) 415 and BCH 453.* Structures, chemical and physical properties, functions, deficiency symptoms, distribution, absorption, transport, metabolism, storage, excretion and toxicity of vitamins in humans and domestic animals. Nutritional significance of essential fatty acids and metabolism of prostaglandins, prostacyclins and leucotrienes.

FS 709 Food Lipids. *3(2-3) . S. Preq: FS 402.* Chemical, physical and functional properties of food lipids. Effects of processing technology and biotechnology on functional properties of food lipids in foods and non-food systems. Separation, purification and analytization of lipids and lipid oxidation products of animal and plant origin.

FS 722 Microbial Food Safety. *3(3-0) . Every year. Preq: FS 405, MB 351.* Issues and developments related to microbial food safety, including emerging foodborne pathogens; virulence and pathogenicity factors associated with foodborne disease agents; epidemiological techniques used in investigation of foodborne disease; rapid methods for detection of foodborne pathogens; and application of quantitative risk assessment to food safety issues.

FS (MB) 725 Fermentation Microbiology. *3(3-0) . S, Alt. yrs. Preq: BCH 451.* Fermentation bioprocessing and characteristics, function and ecology of responsible microorganisms. Fermentative activities, growth responses and culture interactions related to metabolism, physiology and genetics of lactic acid bacteria and selected yeasts and molds. Current developments in starter culture technology and genetics; application to food and industrial fermentations.

FS (NTR) 730 Human Nutrition. *3(3-0) . S. Alt. yrs. Preq: FS 400 or NTR 415 or 419; BCH 451.* Biochemical and physiological bases of nutrition. Human nutrient requirements, assessment of nutritional status, clinical and subclinical disorders resulting from nutrient deficiencies or inadequacies.

FS 751 Food Ingredient Technology in Product Development. *4(3-3) . S. Preq: FS 402, FS 405, FS 421.* Chemistry and functional properties of major food ingredient materials. Legal and regulatory restrictions, as well as consumer biases, in existence with respect to selection of ingredients, package materials, processes and labeling statements. Necessary skills and techniques for efficiently and successfully conducting food product development projects in a competitive corporate setting.

FS 780 Seminar in Food Science. *1(1 0) . F,S.* Preparation and presentation of scientific papers, progress reports and research and special topics of interest in foods.

FS (BAE) 785 Food Rheology. *3(2-3) . F. Preq: MAE 314.* Principles and methods for measuring rheological properties. Theories of elastic, viscous, viscoelastic and viscoplastic behavior and relationships to food texture and commodity damage during harvest, handling and processing. Influence of time, composition and processing.

FS 791 Special Problems in Food Science. *F,S,Sum. Credits Arranged.* Directed research in a specialized phase of food science designed to provide experience in research methodology and philosophy.

FS 792 Special Research Projects in Food Science. *F,S,Sum. Credits Arranged.*

FS 820 Special Problems in Food Science. *1-6. F,S,Sum. Preq: Grad. or sr. standing.* Analysis of scientific, engineering and economic problems of current interest in foods. Problems designed to provide training and experience in research.

FS 823 Special Research Problems in Food Science. *F,S,Sum.* Directed research in a specialized phase of food science designed to provide experience in research methodology and philosophy.

FS 885 Doctoral Supervised Teaching. *1-3. F,S. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

FS 890 Doctoral Preliminary Exam. *1-9. F,S. Preq: Doctoral student.* For students who are preparing for and taking wirtten and/or oral preliminary exams.

FS 893 Doctoral Supervised Research. *1-9. F,S. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

FS 895 Doctoral Dissertation Research. *1-9. F,S. Preq: Doctoral student.* Dissertation research.

FS 899 Doctoral Dissertation Preparation. *1-3. F S. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

FOOD SAFETY

FSA 520 Pre-Harvest Food Safety. *3(2-3) . F.* Dairy, beef, swine, poultry, and seafood modules: production, government regulation of products, use of antimicrobials in production, and the emergence of resistant human pathogens. Field fruit and vegetable crops section: hazards in food including pesticide residues and philosophy and practice of organic farming and public's perception of food and biotechnology.

FSA 530 Post-Harvest Food Safety. *3(3-0) . F. Preq: MB 351/352 or equivalent or Consent of Instructor.* Background on the current issues and developments associated with post-harvest food safety, including biological, chemical, and physical food safety hazards. Additionally, regulations governing food safety and consumer perceptions.

FSA 540 Food Safety and Public Health. *3(3-0) . S. Preq: MB 351/352 or equivalent or Consent of Instructor.* Issues and developments related to the relationship between food safety and public health, including emerging foodborne pathogens; virulence and pathogenicity; foodborne toxins; epidemiological techniques used in the investigation of foodborne disease; rapid detection methods; and quantitative microbial risk assessment in food safety.

FISHERIES AND WILDLIFE SCIENCES

FW (FOR, ZO) 221 Conservation of Natural Resources. *3(3-0) .* Importance of natural resources and their role in human environment. Physical, biological and ecological principles underlying sustainability of natural resources with attention to consequences of human impacts while meeting society needs.

FW (FOR) 310 Fisheries and Wildlife Inventory and Management. *6(0-18) . Preq: Junior standing in SFW, FOR, CON, or SZO; FW ZO 221* Field exercises involving resource inventory, habitat relationships, community structure and analysis, population estimation, forest mensuration and silviculture, and habitat manipulation. Activities predominately field-oriented in an off-campus environment. Overnight trips to observe management activities required.

FW (ZO) 353 Wildlife Management. *3(3-0) Preq: ZO 150.* Describes historical development from empirical practices to the scientific American system. The principles of management, protection, and conservation of those warm-blooded vertebrates of aesthetic, sport or food values in urban, rural and wilderness areas.

FW (FOR) 404 Forest Wildlife Management. *3(3-0) . Preq: 9 hrs. Biological Sciences.* Relationships between forest and wildlife management and the effects of silvicultural systems on wildlife. Species-habitat requirements, forest wildlife management techniques, and forest-wildlife policies and economics.

FW (ZO) 420 Fishery Science. *3(3-0) . F. Preq ZO 150. Coreq: ZO 260 or BO 360.* Role of fish in aquatic ecosystems, fish biology, fish ecology, fisheries management and conservation. Emphasis on aquatic ecosystems and food webs, life history and ecology of important sport and commercial fishes, population and community dynamics, and theory and practice of fisheries management and conservation. Case studies from freshwater, estuarine and marine systems.

FW 423 Introduction to Fisheries Sciences Laboratory. *1(0-3) F. Coreq. FW (ZO) 420* General anatomy and identification of common freshwater, estuarine and marine fish, functional morphology, age and growth analyses, fish health and diets. Computer analyses of bioenergetic and population dynamics.

FW (ZO) 430 Fisheries and Wildlife Administration. *3(3-0). Preq: PS 201, PS 202; FW(ZO)420, FW(ZO)353.* Describes and compares the administrative structures and programs of federal and state fish and wildlife agencies and develops an understanding of the basis on which these agencies function. Evaluates the interrelationships that fisheries-wildlife professionals, special interest groups, public agencies and legislative bodies play in resource management programs.

FW (FOR) 485 Natural Resources Advocacy. *3(2-3). F,S. Preq: ENG 333. Jr. or Sr. Level with at least 10 hours of biology.* Analysis of natural resources problems as they affect management agencies and user groups. Emphasis on professional attitudes, policies, and communication skills needed for management of sensitive natural resource issues. Guest professionals sharing their perspectives on dealing effectively with natural resource clientele groups. Student discussions, team projects, technical presentations citing popular articles on natural resources subjects.

FW 492 External Learning Experience. *1-6. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

FW 493 Special Problems in Fisheries and Wildlife Sciences. *1-6. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes campus facilities and resources. Contact and arrangements with prospective employers must be initiated by student and approved

FW 495 Special Topics in Fisheries and Wildlife Science. *1-3. F,S.* Offered as needed to present materials not normally available in regular course offerings or for offering of new courses on a trial basis.

FW (ZO) 515 Fish Physiology. *3(2-3). F, Alt. yrs.. Preq: GN 411, ZO 420, 421, 441.* The biology of fishes: physiology, anatomy, endocrinology, behavior and genetics. Designed especially for graduate students in fisheries. Several trips to research laboratories taken.

FW (ZO) 553 Principles of Wildlife Science. *3(2-3). F. Preq. BO 360 or ZO 260.* The principles of wildlife management and their application studied in the laboratory and in the field.

FW (ZO) 554 Wildlife Field Studies. *3(2-3). S. Odd yrs. Preq: ZO 553, ST 311; Consent of Instructor.* Field application of methods for studying vertebrate wildlife populations; sampling methods, data gathering, analysis and interpretation of results practiced. Participation in field laboratories and one or two weekend field trips required.

FW (FOR) 585 Advanced Wildlife Habitat Management. *3(2-3). Preq: ZO(FW) 553 and ZO(FW) 554.* Discussion and evaluation about assessing and modeling habitat capability for wildlife species. Student development of models of habitat requirements for wildlife species and integration of models into wildlife management plans. Laboratory exercises include manipulation of habitat management computer packages and development of a wildlife management plan.

FW (ZO) 586 Aquaculture I. *3(3-0). F. Alt. yrs. Preq: BO 360 or ZO 260, Senior or grad. standing.* Biological and general principles of aquaculture. Emphasis on the present status of aquaculture, species involved, techniques employed, and problems encountered. Discussion of recent advances in research and development and identification of areas of future research and development.

FW (ZO) 587 Aquaculture I Laboratory. *1(0-3). F. Alt. yrs. Preq: BO 360 or ZO 260, Senior or grad. standing. Coreq: ZO 586.* Methods and techniques of cultivating aquatic organisms. Field trips and reports on local hatcheries and facilities required. (Three to four overnight field trips taken on week days to coastal areas, state hatcheries, and private hatcheries; students responsible for shared room costs and their meals. Four field trips also taken on laboratory day within driving range of Raleigh.)

FW (FOR) 602 Seminar in Wildlife Management. *1(1-0). S. Alt. yrs.* Current topics and issues in wildlife biology and management. Students select and research topics, give seminars and lead group discussions.

FW 685 Master's Supervised Teaching. *1-3. F,S. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

FW 690 Master's Examination. *1-3. F,S. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

FW 693 Master's Supervised Research. *1-9. F,S. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

FW 695 Master's Thesis Research. *1-9. F,S. Preq: Master's student.* Thesis research.

FW 699 Master's Thesis Preparation. *1-3. F,S. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

GRAPHIC COMMUNICATIONS

GC 101 Engineering Graphics I. *2(1-2) .* Graphical representation and solution of 2D and 3D spatial problems. Emphasis on development of logical and analytical approaches to problem solution. Conventional methods of graphically describing size and shape to represent basic mechanical elements. Includes practical engineering drawing applications.

GC 120 Foundations of Graphics. *3(2-2) . Credit cannot be given for both GC 101 and GC 120.* Introduction to technical graphics and computer-aided drawing. Major emphasis is on describing the shape and size of spatial problems by traditional and computer-aided drawing (CAD) methods. Application of graphical approaches to solve three-dimensional problems.

GC (IE) 210 Introductory Engineering Graphics for Industrial Engineering. *3(2-2) . Preq: E 115. Credit can be given for only one of the following. GC 101, GC 120 or GC/IE 210.* Introduction to the graphical representation and solution of 2D and 3D spatial problems. Conventional methods using computer-based tools to graphically describe 2D and 3D objects relevant to the field of IE. Overview of the fundamentals and applications of computer graphics and computer-aided design. Includes practical IE drawing applications.

GC 211 Introductory Engineering Graphics for Mechanical and Aerospace Engineers. *3(2-2) . Preq: E 115. Credit can be given for only one of the following: GC 101, GC 120 or GC 211.* Graphical representation and solution of 2D and 3D spatial problems relevant to the field of mechanical and aerospace engineering using sketching and computer-based tools. Computer-aided design in the engineering design and manufacturing process. Practical mechanical and aerospace engineering drawing applications.

GC 250 Engineering Graphics II. *3(2-2) . F, S, Sum. Preq: GC 120 or GC 210 or GC 211.* Advanced engineering graphics concepts and analytical skills relevant to the preparation of design, detail, and assembly production drawings for communicating technical data utilizing 2D & 3D sketching, instruments, and CADD methods. General manufacturing materials and processes, and the representation of common fasteners, basic machine elements, and structural components.

GC 320 3D Spatial Relations. *3(2-2) . Preq: GC 101 or GC 120 or GC/IE 210.* Analysis and solution of three-dimensional space problems utilizing graphic principles of orthogonal projection techniques. Application of studies of lines; surfaces; solids; surface intersections; surface development; vectors; and civil, mechanical, and geographical structures.

GC 350 Applied CAD/D and Geometric Controls. *3(2-2) . F, S, Sum. Preq: GC 120 or GC/IE 210 or GC 211.* Techniques for producing mid-level computer models of individual parts and assemblies of parts. Application of conventional tolerancing and geometric tolerancing and dimensioning. Investigation of design for manufacture and CAD/CAM (Computer-Aided Design/Computer-Aided Manufacture) processes. Conventions and standards for technical drawing documentation.

GC 410 Concepts of Desktop Publishing. *3(2-3) . F, S, Sum.* Provides an introduction to the concepts of electronic document production and explores the software packages involved in producing documents for print and electronic media. Structured for public school teachers and lay people. The course introduces basic standards and concepts of page layout.

GC 420 Visual Thinking. *3(2-2) . Designed for Engineering and technical students.* Develop visual thinking skills through a series of exercises using various visual media. Integrates and stresses drawing and construction activities essential to visual thinking. Emphasis on direct observation (seeing), mental imagery and sketching that is based upon three-dimensional space. Develops students' visual and drawing skills and provides for their application toward solving open-ended spatial problems. Intended for the scientific and technically oriented student.

GC 450 Advanced Graphics Usage with CAD. *3(2-2) . F,S. Preq: GC 330 or GC 250.* Advanced applications of 3-dimensional solid modeling tools in technical and engineering environments. Theory and application of manufacturing databases developed with 3-D modeling tools. Development and management of 3-D geometry using modeling software. Emphasis on application of 3-D modeling technology.

GC 496 Special Topics in Graphic Communications. *1-4. F, S, Sum.* Topical study in areas of current interests and needs to students and/or needs of curricula served by Graphic Communications.

GC 498 Independent Study in Graphic Communications. *F, S, Sum. Preq GC 120 or GC 210 or GC 211 and Consent of Instructor.* Independent study in areas of current interests and needs of students in the field of Graphic Communications and the visual sciences.

GRAPHIC DESIGN

GD 200 Introduction to Graphic Design. *3(3-0) .* Primary concepts of the design of visual communication and how they are applied by practitioners. Discussion of graphic design problem solving that draws heavily on ideas from the fine arts, social sciences, humanities. Student demonstration projects on methods, criticism, concern for context, communication and audience.

GD 201 Graphic Design Studio I. *6(0-9) . Preq: DF 101, DF 102. Coreq: GD 217 and GD 217L.* Principles and language of graphic design. Analysis, organization, invention of two-dimensional form for the purpose of communicating information, concepts, emotions. Varied means of graphic representation are explored.

GD 202 Graphic Design Studio II. *6(0-9) . Preq: GD 201, GD 217. Coreq: GD 310, GD 310L, GD 317, GD 317L.* Methods and processes of graphic design problem solving. Student exercises define communication problems; evaluate analytical, synthetic, and intuitive approaches to problem solving; develop critical thinking, oral presentation, and writing skills. Emphasis on the appropriateness of form to a given context.

GD 210 Imaging for Graphic Design I. *3(1.50-3) . Preq: DF 102.* Introduction to the technical and formal issues of photography and photomechanical processes as they relate to visual communication; terminology; photographic history within the context of graphic design.

GD 217 Typography I. *3(1-4) . Preq: DF 101, DF 102. School of Design majors and approved minors only.* Typography as a medium of visual communication. Student exercises focus on type as image and the relationship between visual and verbal language; the expressive characteristics of letter forms and text explored. Terminology, typographic history, technical issues related to typography.

GD 292 Special Topics in Graphic Design. *Preq: Consent of instructor.* Topics of current interest in Graphic Design. Normally used to develop new courses.

GD 301 Graphic Design Studio III. *6(0-9) . Preq: GD 202, GD 212, GD 317. Coreq: GD 410, GD 410L, GD 417, GD 417L.* Theoretical information related to semiotics and communication theory applied through demonstration projects. Projects center on tailoring communication to audiences and acknowledging the role of context in the interpretation of form.

GD 310 Imaging for Graphic Design I. *3(1.50-3) . Preq: GD 210.* Intermediate photography and introduction to digital imaging as they relate to visual communication design; simple serial imaging; using movement and point of view; discussion of examples from photography and graphic design history.

GD 317 Typography II. *3(1-4) . Preq: GD 217.* Exploration of design using text type and typographic technology. Student exercises explore congruency between visual and verbal hierarchies, expressive use of typographic form, format/informational organization problems, and technical details of typographic specification and computer layout.

GD 342 History of Graphic Design. *3(3-0) .* Events, ideas, movements, designs and individuals that have historical significance and influence on contemporary graphic design and the graphic design profession. Concentration on graphic design of the last 100 years.

GD 355 Graphic Design Production. *3(1-4) . Preq: GD 301.* Technology and concepts related to preparing art for offset printing. Technology in the service of ideas; examination of ways in which technical concerns enhance the formal/communicative opportunities for graphic design. Included is experience in preparing mechanicals on the computer.

GD 400 Advanced Graphic Design Studio. *6(0-9) . F,S,Sum. Preq: GD 301, GD 417, GD 342. Graphic Design majors only/other School of Design majors by permission of department head.* Advanced visual communication problems integrating typographic, photographic, and historical concepts in graphic design studio projects. Projects reflect applications with specific audiences, contexts, and production criteria.

GD 410 Imaging for Graphic Design III. *3(1.5-3) . Preq: GD 310, GD 310L.* Advanced photography and digital imaging; introduction to multi-media and narrative as they relate to visual communication design; discussion of authorship and images in culture and the communication environment.

GD 415 Micro-computers in Graphic Design. *3(2-2) . Preq: GD 301; GD 355.* Intermediate-level course in microcomputer imaging, processing and production for Graphic Design.

GD 417 Typography III. *3(1-4) . F. Preq: GD 202, GD 317. School of Design majors only.* Systematic approaches to structuring typographic form according to information hierarchies, user needs, and visual expression. Application to the organization of tables, charts, books, magazines, and corporate identities.

GD 492 Special Topics in Graphic Design. *1-3. Preq: Consent of instructor.* Topics of current interest in Graphic Design. Normally used to develop new courses.

GD 494 Internship in Graphic Design. *3(3 0) . F,S,Sum. Preq: Junior standing in Graphic Design and 3.0 GPA or better and written approval of department head.* Supervised field experience in graphic design offices and organizations.

GD 495 Independent Study in Graphic Design. *1-3. F,S,Sum. Preq: Junior standing in Graphic Design and 3 0 GPA or better and written approval of department head.* Special projects in graphic design developed under the direction of a faculty member on a tutorial basis.

GD 501 Graduate Graphic Design Studio. *9(0-18) . F. Coreq: GD 571.* Student-defined graphic design projects in response to critical content framework presentation by GD 571 faculty. Center of framework on role of design objects as cognitive artifacts and extension, transformation or diminishment of human thought by their form and content. Interaction of potential audiences with designer-created artifacts. Graphic design majors only.

GD 502 Graduate Graphic Design Studio II. *9(0-18) . S. Preq: GD 501. Coreq: GD 572.* Student-defined graphic design projects in response to critical content framework presentation by GD 572 faculty. Center of framework on role of design objects as cultural artifacts and their reflection on social diversity of both designers and audiences. Creation, reproduction, distribution and reception of messages in both designer-created artifacts and audience's response. Graphic design majors only.

GD 503 Graduate Graphic Design Studio III. *9(0-18) . F. Preq: GD 502. Coreq: GD 573.* Student-defined graphic design projects in response to critical content framework presentation by GD 671 faculty. Center of framework on nature of new information environments. Shape and response of technologies to new cognitive and cultural relationships among audiences.

GD 510 Imaging for Graphic Design IV. *3(1.50-3) . S. Preq: GD 410. School of Design majors only.* Advanced problems in the visual design and structuring of information in interactive multimedia presentations. Topics include the design of interfaces, navigation, motion graphics, and websites as well as exploration of narrative and hypermedia approaches to the organization of content.

GD 517 Type IV. *3(1.50-3) . S. Preq: GD 417 or equivalent. School of Design majors only, undergraduates by permission..* Advanced problems of typographic expression/communication in which typographic variables are used to alter, enhance, or reinforce verbal meaning. Historic precedent and experimentation with the conventions for typographic form are explored. The impact of the computer on changes in typographic aesthetics, including motion graphics, typeface design, and website design.

GD 570 Theory In Practice: Graphic Design Since 1945. *3(3-0) . S. Preq: GD 342.* Influence of critical theory on the creation, production and interpretation of graphic design since mid-century. Lectures, readings and discussions of contemporary issues in graphic design with focus on their social and cultural contexts.

GD 571 Design As Cognitive Artifact. *3(3-0) . F,S.* Relationship between theories of human cognition and graphic design. Analysis and critique of design objects as cognitive artifacts and extension, transformation or diminishment of human thought by their form and content. A critical examination of cognitive, linguistic and social science theories shaping graphic design. Non-majors by permission only.

GD 572 Design as Cultural Artifact. *3(3-0) . F,S.* Introduction to recent theories in various disciplines concerning a cultural understanding of graphic design. Theories of mass and popular culture, critiques of creativity and authorial intentionality, influences of interpretive criticism, theories of consumption and issues of cultural representation. Emphasis on adaptation of these theories to an understanding of the cultural significance of graphic design. Non-majors by permission only.

GD 573 New Information Environments. *3(3-0) F,S. Preq. GD 503.* Changing role of graphic design in new information environments. Implications of new technology on social construction of meaning, impact of electronic media on culture and cognition, and differences in designing artifacts and designing experiences. Non-majors by permission only.

GD 580 Special Topics in Graphic Design History. *3(3 0) . S. Alt. yrs. Preq. GD 342.* Topics of current interest in interpretation, criticism, methodology and research, relating to graphic design history. Further specialized study in history of printing, typography, communication, image-making and information systems. Investigation of how we study artifacts, production and producers.

GD 581 Graphic Design Final Project Research. *3(1-2) . F. Preq: GD 502.* A seminar course to assist students in preparing foundation for final project to be conducted in GD 688 Final Project Studio.

GD 588 Final Project Studio in Graphic Design. *6(0-12) . F,S. Preq: GD 581.* Final project for graduate students supervised by members of their graduate advisory committees.

GD 592 Special Topics in Graphic Design. *2-3. F,S. Preq: Grad. standing.* Topics of current interest to program/option offered by faculty in School. Subjects offered under this number normally used to test and develop new courses.

GD 610 Special Topics in Graphic Design. *1 6. F,S. Preq: Permission of grad. advisor.* An investigation of special topics in graphic design of a particular interest to advanced students under direction of chair of graduate committee on a tutorial basis; credit and content vary with each student.

GD 630 Independent Study in Graphic Design. *1-3. F,S,Sum.* Special problems in various aspects of graphic design developed under the direction of a faculty member on a tutorial basis.

GD 676 Special Project in Graphic Design. *1-3. F,S. Preq: Grad. standing.* Seminar on subjects of current interest in graphic design, presented by persons not part of regular faculty.

GD 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

GD 690 Master's Examination. *1-6. F,S,Sum. Preq: Master's student.* For students in non-thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

GEOGRAPHY

GEO 200 Principles of Geography. *3(3-0)* . Basic ideas in the field of geography. The scope of geography as an academic field explored. Emphasis placed on mastery of geographic tools, e.g., maps, globes, and media materials and sources. Regional study of contemporary world.

GEO (SOC) 220 Cultural Geography. *3(3-0)* . An investigation of the world's past and present cultural diversity by studying spatial patterns of population, language, religion, material and non-material culture, technology and livelihoods, communities and settlements, and political organization and interaction.

GEO (ECI) 300 World Regional Geography. *3(3-0) . Preq: GEO 200.* Geography of selected industrial and Third World regions in which the evolution of settlement, culture, economy and political forms are treated in geographical perspective.

GENETICS

GN 301 Genetics in Human Affairs. *3(3-0)* . Appreciation and understanding of genetics in everyday life. Genetic perspective on normal human development, birth defects, birth control, cancer, organ transplants, intelligence, mental illness, and radiation and chemical exposure and issues raised by applications of recently developed genetic techniques such as in vitro fertilization, genetic engineering and prenatal monitoring.

GN 411 Principles of Genetics. *4(4-0) . Preq: BIO 125, Junior standing.* Basic concepts and principles of prokaryotic and eukaryotic genetics. Mendelian inheritance, polygenic inheritance, linkage and mapping, chromosome aberrations, population genetics, evolution, DNA structure and replication, gene expression, mutation, gene regulation, extranuclear inheritance, bacterial and viral genetics, and recombinant DNA technology.

GN 412 Elementary Genetics Laboratory. *1(0-3) F,S Preq: GN 411* Genetic experiments and demonstrations using a variety of bacterial, plant and animal organisms. Mendelian inheritance, linkage analysis, population genetics, cytogenetics, biochemical genetics, DNA isolation, electrophoresis, and Southern blotting.

GN 413 Advanced Genetics. *3(3-0) . F,S. Preq: GN 411. Students cannot receive credit for both GN 413 and GN 513.* Biological macromolecules and their interactions. Chromatin and chromosome structure. Bacteria, viruses, plants, animals and fungi as genetic systems. Transcription, RNA processing, genetic code, translation, DNA replication and the cell cycle. RFLP mapping. DNA and forensics. Molecular genetics of desease. Genetic transformation and cloning of plants and animals. Recombinant DNA methodology.

GN 492 External Learning Experience. *1-6. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

GN 493 Special Problems in Genetics. *1-6. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes campus facilities and resources. Arrangements must be initiated by student and approved by a faculty adviser and the departmental teaching coordinator.

GN 495 Special Topics in Genetics. *1-3.* Offered as needed to present materials not normally available in regular course offerings or for offering of new courses on a trial basis.

GN 504 Human Genetics. *3(3-0) . F. Preq: GN 301 or 411.* Basic principles needed for an understanding of genetics of man. Current knowledge and important areas of research in human genetics.

GN 513 Advanced Genetics. *3(3-0) . F,S. Preq: GN 411. Credit for both GN 413 and GN 513 is not allowed..* Biological macromolescules and their interactions. Chromatin and chromosome structure. Bacteria, viruses, plants, animals and fungi as genetic systems. Transcription, RNA processing, genetic code, translation, DNA replication and cell cycle. RFLP mapping. DNA and forensics. Genetic transformation and cloning of plants and animals. Recombinant DNA methodology.

GN 685 Master's Supervised Teaching. *1-3. F,S. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

GN 690 Master's Examination. *1-6 F,S. Preq: Master's student.* For students in non-thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

GN 693 Master's Supervised Research. *1-9. F,S. Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

GN 695 Master's Thesis Research. *1-9. F,S. Preq: Master's Student.* Thesis Research

GN 699 Master's Thesis Preparation. *1-3. F,S. Preq: Master's Student. Credits arranged.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

GN 701 Molecular Genetics. *3(3-0) . F. Preq: GN 411.* A discussion of the structure and function of genetic material at a molecular level. Consideration of both prokaryotic and eukaryotic systems. The aim to describe genetics in terms of chemical principles.

GN 702 Cellular and Developmental Genetics. *3(3 0) . S. Preq: GN 701 or Consent of Instructor.* Regulation of genes involved in cellular function, differentiation and development in eukaryotes. Presentation of biological systems and model organisms used to study genetic control of cellular and developmental processes.

GN 703 Population and Quantitative Genetics. *3(3-0) . S. Preq: GN 411; ST 711.* Mutation and origin of genetic variation. Measuring genetic variation in natural populations. Gene and genotype frequencies. Hardy-Weinberg equilibrium. Values, means, genetic and environmental variance, heritability of quantitative traits. Random genetic drift and inbreeding. Natural and artificial selection. Theory and tests of models of maintenance of genetic variation. Molecular evolution of genes and proteins. Genome evolution.

GN (ANS) 708 Genetics of Animal Improvement. *3(3-0) . S. Preq: GN 411, ST 711.* Emphasis on the utilization of basic principles of population and quantitative genetics in animal improvement. Factors affecting genic and genotypic frequencies and methods of estimating genetic and nongenetic variance, heritabilities and breeding values. The roles of mating systems and selection procedures in producing superior genetic populations.

GN 710 Eukaryotic Regulatory Mechanisms. *3(3-0) . S, Alt. Yrs. (even). Preq: GN 701 or Consent or Instructor.* Detailed analysis of mechanisms regulating eukaryotic gene expression in plants, animals and smaller eukaryotes. Molecular interactions responsible for controlling gene function with emphasis on transcription.

GN (ANS) 713 Quantitative Genetics and Breeding. *3(3-0) . F.* Quantitative and population genetic theory of breeding problems; partitioning of genetic variance, maternal effects, genotype by environment interaction and genetic correlation; selection indexes; design and analysis of selection experiments; marker-assisted selection.

GN (CS) 719 Origin and Evolution of Cultivated Plants. *1(1-0) . Preq: CS(GN,HS)741; GN 511.* Review of concepts of speciation and classification; origin and variation in plants; theories related to agricultural origins; variation patterns of cultivated species; evolution under domestication; utilization of wild and unadapted germplasm in plant breeding.

GN (CS, HS) 720 Molecular Biology in Plant Breeding. *3(0-3) . S. (Alt. yrs.). Preq: CS(GN,HS) 741, GN 701.* Theory and principles of molecular biology applied to plant breeding. Experimental approaches to induce genetic change, cytoplasmic recombination, haploid utilization and potentials of molecular techniques for solving breeding problems.

GN (ST) 721 Genetic Data Analysis. *3(3-0) . S, Alt. yrs. Preq: ST 430 and GN 411.* Analysis of discrete data, illustrated with genetic data on morphological characters allozymes, restriction fragment length polymorphisms and DNA sequences. Maximum likelihood estimation, including iterative procedures. Numerical resampling. Development of statistical techniques for characterizing genetic disequilibrium and diversity. Measures of population structure and genetic distance. Construction of phylogenetic trees. Finding alignments and similarities between DNA sequences. Locating genes with markers.

GN (FOR) 725 Forest Genetics. *3(3-0) . S. Preq: GN 411 or Consent of Instructor.* Application of genetic principles to silviculture. management and wood utilization. Emphasis on variation in wild populations, the bases for selection of desirable qualities and fundamentals of controlled breeding.

GN (FOR) 726 Advanced Topics in Quantitative Genetics. *3(3 0) . F. Alt. yrs. Preq: GN(FOR) 722, GN(ST) 770 or GN(ANS) 713 or Consent of Instructor.* Advanced topics in statistics and population genetics pertinent to current research problems in genetics with special applications to forestry. Basic statistical and genetic theory reviewed as bases for intensive study of selection theory and experimental and mating design evaluation. Study of genetics of natural populations for evolutionary interest as well as for their implications to breeding theory.

GN (BO, MB, PP) 730 Fungal Genetics and Physiology. *3(2-3) . S. Alt. yrs. Preq: BCH 451, BO 775, GN 411 or PP 501.* Basic concepts of genetics and physiology of fungi, with emphasis on saprophytic and plant pathogenic mycelial fungi. Current literature on evolution, cell structure, growth and development, gene expression, metabolism, sexual and asexual reproduction and incompatibility systems. Laboratory exercises on mutant isolation, sexual and parasexual analysis, genetic transformation, and RFLP and isozyme analysis.

GN (ZO) 740 Evolutionary Genetics. *3(3-0) . F. Alt yr(even). Preq: GN 703 or Consent of Instructor.* Genetic basis of evolution. Molecular evolution, molecular population genetics, evolutionary genetics of quantitative characters and the genetics of speciation. Critical reading of original research publications and student seminars.

GN (CS, HS) 741 Plant Breeding Methods. *3(3-0) . F.* Advanced study of methods of plant breeding as related to principles and concepts of inheritance.

GN (CS, HS) 745 Quantitative Genetics in Plant Breeding. *1(1-0) . S. Alt. yrs. Preq: CS(GN, HS) 741, ST 512, course in quantitative genetics recommended.* Theory and principles of plant quantitative genetics. Experimental approaches of relationships between type and source of genetic variability, concepts of inbreeding, estimations of genetic variance and selection theory.

GN (CS, HS) 746 Breeding Methods. *2(2-0) . S. Alt. yrs. Preq: CS (GN, HS) 741, ST 512.* Theory and principles of plant breeding methodology including population improvement, selection procedures, genotypic evaluation, cultivar development and breeding strategies.

GN (CS, HS, PP) 748 Breeding for Pest Resistance. *2(2-0) . F, Alt. yrs. Preq: CS(GN, HS) 741, PP 315, ST 512.* Theory and principles of breeding for pest resistance. Experimental approaches for examining genetics of host-parasite interactions, expression and stability of pest resistance and breeding strategies for developing pest-resistant cultivars.

GN 750 Developmental Genetics. *3(3-0) . S, Alt. yrs. Preq: GN 701, GN 702.* Action and regulation of genes and gene-products in development and differentiation. Examples from microorganisms, plants and animals. Emphasis on molecular and biochemical aspects of mechanisms controlling gene expression in eukaryotic cell differentiation.

GN 755 Population Genetics. *3(3-0) . S, Alt. yrs. Preq: GN 703.* Theoretical population genetics and its relationship to natural and experimental populations. Single locus and multilocus systems, history of a gene in a population, diffusion approximations, suitability of models to natural and experimental populations.

GN (ST) 756 Computational Molecular Evolution. *3(3-0) F, Alt. yrs. Preq: GN 411 and ST 511 or Consent of Instructor.* Phylogenetic analyses of nucleotide and protein sequence data. Sequence alignment, phylogeny reconstruction and relevant computer software. Prediction of protein secondary structure, database searching, bioinformatics and related topics. Project required.

GN (ST) 757 Statistics for Molecular Quantitative Genetics. *3(3-0) . F, Alt Yr.(even) Preq. ST 512 and GN 703 or ST 721* Genetic mapping data. Linkage map reconstruction, quantitative genetical models. Statistical methods and computer programs for mapping quantitative trait loci and estimating genetic architecture of quantitative traits.

GN (MB) 758 Prokaryotic Molecular Genetics. *3(3-0) . S. Preq: BCH 451 or GN 411.* Structure and function in prokaryotic molecular genetics, with emphasis on mutations and mutagenic pathways, transcriptional and translational regulation, RNA processing, DNA replication and recombination and characterization of recombinant DNA molecules. Applications of genetic and recombinant DNA techniques to microbial processes, including strain construction and enhancement of gene expression.

GN (MB) 760 Experimental Microbial Genetics. *4(2-6) . S. Preq: BCH 561, GN 411.* Laboratory-oriented presentation of current methodologies and concepts in molecular microbial genetics and their application to strain construction, plasmid and phage manipulations, mutagenesis, cloning and genetic engineering of microorganisms.

GN (BCH) 761 Advanced Molecular Biology of the Cell. *3(3-0) . S, Alt. yrs. Preq: BCH 703 and 705.* An advanced treatment involving integrated approaches to biological problems at the molecular level, encompassing biochemistry, cell biology and molecular genetics. Broad, multidisciplinary approaches to solving research problems in biology and thecritical study of primary scientific literature, the development of a research proposal, oral presentations and class discussions.

GN (BCH) 768 Nucleic Acids: Structure and Function. *3(3-0) . S, Alt.yrs. Preq: BCH 701 and 703.* Study of well-defined models of steroid and protein hormone action via lectures, assigned readings and discussions. Students add breadth to the course and depth to their own understanding by searching the literature and writing or lecturing about a particular hormone of their own choosing.

GN (ST) 770 Statistical Concepts in Genetics. *3(3-0) . S, Alt. yrs. Preq: GN 703, Coreq: ST 512.* Migration, mutation, selection, drift, linkage, mating system and other processes bearing on rates of change in population frequencies, means and variances; magnitude and nature of genotypic and nongenotypic variability and their role in alternative procedures of plant and animal breeding; experimental and statistical approaches to the analysis of quantitative inheritance.

GN 801 Seminar. *1(1-0) . F,S. Preq: Grad. standing.* Informal group discussion of prepared topics assigned by instructor.

GN 809 Colloquium in Genetics. *2(2 0) . F,S. Preq. Grad. standing; Consent of Instructor.* Informal group discussion of prepared topics assigned by instructor.

GN 810 Special Topics in Genetics. *1 4. F,S.* Critical study of selected areas and special topics of current interest in genetics and related fields.

GN 820 Special Problems. *1-3. F,S. Preq. Advanced grad. standing. Consent of Instructor.* Special topics designed for additional experience and research training.

GN (CS, HS) 860 Plant Breeding Laboratory. *1(1-0) . S Alt yrs Preq. CS(GN,HS)741.* Visitation of plant breeding projects in the Depts. of CS and HS at NC State, along with commercial seed companies. Discussion and viewing of breeding objectives, methods and equipment and teaching and practice of hybridization methods.

GN (CS, HS) 861 Plant Breeding Laboratory. *1(1-0) F. Alt. yrs. Preq: CS(GN HS)741.* Visitation of plant breeding projects in the Depts. of CS and HS at NC State, along with commercial seed companies. Discussion and viewing of breeding objectives, methods and equipment and teaching and practice of hybridization methods.

GN 885 Doctoral Supervised Teaching. *1-3 F,S. Preq Doctoral Student* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

GN 890 Doctoral Preliminary Examination. *1 9 F'S. Preq· Doctoral Student* For students who are preparing for and taking written and/or oral preliminary exams.

GN 893 Doctoral Supervised Research. *1-9 F'S. Preq: Doctoral Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

GN 895 Doctoral Dissertation Research. *1-9. F,S. Preq· Doctoral Student.* Dissertation Research

GN 899 Doctoral Dissertation Preparation. *1-3. F,S. Preq: Doctoral Student.* For students who have completed all credit hour requirements, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

FOREIGN LANGUAGES AND LITERATURES - GREEK

GRK 101 Elementary Greek I. *3(3 0) .* Introduction to Classical Greek. Greek alphabet, basic grammar and syntax. Readings based on Greek mythology, philosophy, and literature.

GRK 102 Elementary Greek II. *3(3-0). 'Preq: GRK 101.* A second course in Classical Greek, continuing and expanding the work of GRK 101. completes study of grammar. Readings from major authors including Herodotus, Thucydides, and Zenophon.

GRK 201 Intermediate Greek I. *3(3-0) F. Alt Yrs (odd). Preq· GRK 102.* Introduction to Greek prose. Emphasis upon improvement of reading skill through vocabulary acquisition and study of complex grammar. Introduction to Attic dialect through reading Plato, and Koine Greek through reading the New Testament. Examination of the importance of these works to Western literature and culture.

GRK 202 Intermediate Greek II. *3(3-0) .Preq. GRK 201* Reading in Homer's Iliad and the New Testament. Techniques of oral poetry. Study of the use of myth, and of the literary and historical significance of the Iliad . Analysis of differences between classical and Koine Greek in the New Testament.

GRK (LAT) 310 Classical Mythology. *3(3 0)* Greek and Roman mythology through the writings and art of the Classical period. Discussion of creation stories, the major gods and heroes, the underworld and afterlife. Intellectual religious and educational role of myth and of the most important theories of interpretation and classification. All readings and discussion in English.

GRK 320 Greek Tragedy in Translation. *3(3 0) . S* Tragedies of Aeschylus, Sophocles and Euripides in translation. Literary and social aspects of individual plays and tragic genre in fifth century. Selections from Aristophanes, Plato, Aristotle and Seneca on Greek tragedy.

GRK 333 Medical Terminology. *2(2 0) .* Study of the formation of medical terms from their Greek and Latin roots designed both to build vocabulary and to teach the uses of a medical dictionary.

GRK 371 The Origins of American Mythology. *3(3-0) . S. Alt Yrs (odd).* Oral-traditional literature, formulaic myth composition and the Indo-European origins of the American folk hero. Readings include Iliad, Gilgamesh, Sanskrit Puranas and Beowulf; films such as Stagecoach and Superman.

HISTORY OF ART

HA 201 History of Art From Ancient Greece Through the Renaissance. *3(3-0) .* Art from Ancient Greece and Rome through Italian Renaissance. Major art forms of painting, sculpture, and architecture.

HA 202 History of Art From the Renaissance Through the 20th Century. *3(3 0)* Art from the Northern Renaissance in Europe through the 20th century in Europe and America: painting, sculpture and architecture recent mixed media techniques such as collage, and trottage.

HA 203 History of American Art. *3(3-0) .* A history of American Art (painting, sculpture and architecture) from the Colonial Period through the 20th century.

HA 298 Special Topics in Art History. *3(3-0)* . Special topics in art history with emphasis on chronological periods such as 20th-century art of the Italian Renaissance or on fields of art such as paintings, sculpture, photography, or architecture.

HA 310 History of Art and Photography. *3(3-0)* . History of and the interaction between art and photography from the invention of photography to the present.

HA 320 American Decorative Arts. *3(3-0)* . History of American Art (painting, sculpture, and architecture) from Colonial Period through 20th century.

HA 395 History of Art: Study Abroad. *3(3-0)* . Topical History of Art courses taught in NC State Study Abroad programs. (Current listings available in History Department, Study Abroad Office and CHASS Dean's Office.)

HA 401 19th Century European Art. *3(3-0) . Preq: HA 201 or HA 202.* Major stylistic movements of 19th century European art and the theoretical basis for their development. Covers Neo Classicism, Romanticism, Realism and Impressionism, and Post Impressionism.

HA 404 Italian Renaissance Masters. *3(3-0) . Preq: 3 hrs. of HA.* Selected problems in the development of Italian Renaissance art including painting, sculpture and architecture, 1300-1550: including the pioneers Giotto and Duccio; founders of the early Renaissance: Masaccio, Donatello, and Brunelleschi; great masters of the High Renaissance: Michelangelo, Raphael and Leonardo da Vinci. Works of art analyzed in terms of style, subject matter and historical context.

HA 498 Independent Study in History of Art. *1-6. F,S. Preq: 3 hours History of Art.* Directed independent study of topics in the History of Art.

HISTORY

HI 205 Western Civilization Since 1400. *3(3 0)* A survey of Western Civilization from the Renaissance to the present.

HI 207 Ancient World to 180 A.D.. *3(3 0)* . The ancient cultures of the Middle East, Greece and Rome, including Mesopotamian, Egyptian, Hebrew, Phoenician, Greek and Roman societies and cultures.

HI 208 The Middle Ages. *3(3-0)* . Medieval civilization as it emerged from the declining Roman Empire through its apogee in the 13th century. The transition from the classical to the medieval world, the impact of the Germanic influx, the Islamic influence, the Crusades, and the political, economic, and social institutions of the High Middle Ages.

HI 209 Europe, Renaissance to Waterloo, 1300-1815. *3(3-0)* . Transition from the medieval to modern Europe; decline of medieval institutions, Renaissance, Reformation and Counter-Reformation, rise of Absolutism, English 17th-century revolution, French Revolution and Napoleonic era.

HI 210 Modern Europe 1815-Present. *3(3-0)* . Survey of the history of European societies and political systems from 1815 to the present.

HI 215 Latin America to 1826. *3(3-0)* . The origins and development of social, political, economic and religious institutions from pre-conquest times to the achievement of independence. The ancient American cultures; Spain and Portugal before 1492; conquest and settlement, Spanish rule in theory and practice, economic life, the Church, land and labor; the African contribution; the Portuguese in Brazil; the independence movements.

HI 216 Latin America Since 1826. *3(3-0)* . Social, political, economic, and intellectual life in the 19th and 20th centuries in Central and South America. The social structure of the new nations; 19th century liberalism; the force of tradition; relations with Europe and the United States; economic change; caudillo rule; 20th century upheavals; revolutions; political conflict.

HI 221 British History to 1688. *3(3-0)* . History of the British peoples from earliest times to the Glorious Revolution. Social, political, constitutional developments; relationship between history and literature; synthesis of British cultures.

HI 222 History of British Cultures and Societies. *3(3-0)* . British people from Glorious Revolution to the present. Social, political, constitutional development; history and literature; growth and decline of British empire; spread of British culture.

HI 233 The World in the 20th Century. *3(3-0)* . National and international problems in the 20th Century Western and non-Western world; institutions and ideas at the turn of the century, origins and effects of the First World War, the postwar challenge to Western democratic supremacy, the Second World War, and problems of the postwar period.

HI 251 Early American History. *3(3 0)* Themes in early American history: colonial clash and mix of culture; generation of an American consciousness; federalism and democracy in national politics; expansion and immigration; racial and sectional division.

HI 252 Modern American History. *3(3 0)* Themes in modern American history: impact of war on American foreign and domestic policy; the repercussions of industrialization and economic modernization; continuity and change in American institutions and values; problem solving in pluralistic society.

HI 263 Asian Civilizations to 1800. *3(3-0) . F.* Introductory survey of the great civilizations of Asia; particular attention to India, China and Japan. Emphasis on comparative study of Asian religions, political systems, art, and literature.

HI 264 Modern Asia: 1800 to Present. *3(3 0) . S.* Introductory survey of 19th and 20th century Asia, with attention to Japan, Southeast Asia, India and China. Emphasis on cultural and political crises of the 19th century and revolutionary transformations of the 20th century.

HI 270 Modern Middle East. *3(3-0) .* Social and political change in the Middle East in the nineteenth and twentieth centuries. Decline of the Ottoman empire, the rise of nationalism, the waxing and waning of European imperialism in the region, and the creation of modern states and societies and their ideological and economic underpinnings.

HI 275 Introduction to History of South and East Africa. *3(3-0) . F, S, Sum.* The African kingdoms (Lunda, Buganda, and Zulu); the European encroachment; the origins of colonialism and the character of colonial societies and economies, South African apartheid; African protect, nationalism and independence.

HI 276 Introduction to History of West Africa. *3(3-0) .* The history of Western Africa. Forest civilizations and the slave trade, trade and the expansion of Islam, colonialism in West Africa; African nationalism and the achievement of independence; and postcolonial West Africa.

HI 300 Sophomore Seminar in History. *3(3-0) . F,S. Preq: 3 hours of history or Sophomore standing. Coreq: HSS 100. History majors only.* Introduction to the process of researching and writing history. Techniques for locating and interpreting primary sources. The craft of historical writing. Analysis and criticism of the varieties of history. Basic computer literacy: basic computing terms, electronic mail, online searching of the NCSU Libraries, use of the Internet, and word processing.

HI (REL) 320 Religion in American History. *3(3-0) . F. Preq: 3 hours of History or Sophomore standing.* Representative people, movements, and thought in the major religions within the context of American society and culture.

HI 321 Ancient and Medieval Science. *3(3-0) .* Selected topics in the history of pre-modern science are studied for both their intrinsic interest and to gain perspective on the nature of modern science. Examples are taken from pre-history, Mesopotamia, Egypt, Greece, Rome, Islam, and the medieval Christian West, with the possibility of comparisons to other cultures.

HI 322 Rise of Modern Science. *3(3-0) .* Science in the Renaissance and Scientific Revolution of the 16th and 17th centuries. Newtonian science. Mechanics and the chemical revolution in the 18th century. Scientific synthesis in the 19th century: physics, chemistry, geology, and biology. 20th century revolutions in physics. Attention is paid both to scientific ideas and to the cultural and institutional contexts of science.

HI (MDS) 340 Perspectives in Agricultural History. *3(3-0) . Preq: Jefferson Scholars Program or permission of instructor.* Historical topics related to the heritage of agriculture, the biological sciences, and the relationship among agriculture, technology, science and society.

HI 341 Technology in History. *3(3-0) .* The role of technology in society from earliest times to the present. Major achievements in technology and an examination of the nature of invention, innovation and adaptation of technologies and their impact on Western Civilization.

HI 350 American Military History. *3(3-0)* American military experience and its relationship to other historical developments. Use of military force in terms of strategy and tactics and as an element in the nation's diplomatic, political, social, economic and intellectual life.

HI 351 U.S. Naval History. *3(3-0) .* The role of the U.S. Navy in American history. Sea power, national defense and foreign policy. The impact of technology on naval warfare and the historical evolution of missions of the U.S. Navy.

HI 364 History of North Carolina. *3(3-0) .* History of North Carolina from early European exploration to the present. Features of North Carolina society which made this state similar to and different from other southern states and the nation as a whole.

HI 365 The American West. *3(3-0) . Preq. 3 hours of history or sophomore standing.* A history of the American Frontier with emphasis on the trans-Mississippi West. Cycles of exploration, conquest, and exploitation of this region. Influence of the frontier in the development of the United States.

HI 372 African-American History Through the Civil War, 1619-1865. *3(3-0)* African background and continuity of the particular role, experience and influence of African Americans in the United States through the Civil War.

HI 373 African-American History Since 1865. *3(3-0) .* The history of African-Americans from the Reconstruction Era through the Civil Rights movement of the 1950s and 1960s to the present.

HI 395 History: Study Abroad. *3(3-0) .* Topical History courses taught in NCSU Study Abroad programs. (Current listings available in Study Abroad Office, CHASS Dean's Office and History Department).

HI 400 Civilization of the Ancient Near East. *3(3-0). Credit for both HI 400 and HI 500 is not allowed.* The civilization of Mesopotamia and Egypt from earliest times to the fall of Babylon in 539 B.C.

HI (REL) 402 Early Christianity to the Time of Eusebius. *3(3-0) . S Alt Yrs.(odd). Preq: One of: REL 312, REL 317, or HI 207.* Growth and diffusion of early Christianity from the end of the first century up to the time of Eusebius and the conversion of Constantine (early fourth century); Christianity in its Greco-Roman environment; Roman policy towards Christianity; heterodox Christian movements; anti-heretical writings; orthodox institutions of authority.

HI 403 Ancient Greek Civilization. *3(3-0)* . The history of the Hellenes from the Minoan civilization through Alexander's legacy, with readings in Herodotus and Thucydides.

HI 404 Rome to 337 A.D.. *3(3-0) . Credit will not be given for both HI 404 and HI 504.* The development of ancient Rome from its origins in Italy, through the rise as an Empire embracing the entire Mediterranean World and Western Europe, to Constantine, Christianity and the foundation of Constantinople. Examines critically the political achievement of a people who rose from an obscure Italian city to a world empire, with emphasis on the analysis of primary sources.

HI 405 History and Archaeology of the Roman Empire. *3(3-0) . Credit will not be given for both HI 405 and HI 505.* Analysis of Rome's rule over the Mediterranean World in the first four centuries A.D. through the use of literary and archaelologic sources. Special emphasis on imperial army and frontier security.

HI 406 From Roman Empire to Middle Ages. *3(3-0) . Credit will not be given for both HI 406 and HI 506.* Late Antiquity and the early Middle Ages. The transition from classical civilization to the basis of modern civilizations; the fall of Rome, the Germanic kingdoms, Byzantium, the establishment of Christianity, the birth and growth of Islam.

HI (REL) 407 407 Islamic History to 1798. *3(3-0) . Credit will not be given for both HI 407 and HI 507.* Credit will not be given for both HI 407 and HI 507. The history of the Islamic Near East to 1798. Topics include the East Mediterranean before Islam, Muhammad and the development of Islam, sources of Muslim civilization, Islamic law, science, philosophy, art, and architecture, Islam in Spain, India, Asia, and Africa, the Crusades, the Ottomans, Islam and Europe.

HI (REL) 408 Islam in the Modern World. *3(3-0) . Preq: 3 hours of history or religious studies.* Evolution of modern Islam from 17th century to the present. Primary emphasis on North Africa, the Middle East and South Asia. Pre-modern Islamicate empires, reform and revival. Historical origins of current issues in the Islamic world.

HI 409 The High Middle Ages. *3(3 0) . Credit will not be given for both HI 409 and HI 509.* Medieval culture from 10th through 13th centuries: revival of the Roman Empire, monastic and papal reform, rise of universities, evolution of representative bodies, the Gothic style, troubadour and goliardic poetry, scholasticism, and revival of Roman law.

HI 410 Italian Renaissance. *3(3-0)* . Credit will not be given for both HI 410 and HI 510. Renaissance humanism, an educational ideal and an awareness of man as the sole creator in the historical world, is examined in its relationship to the Italian republics and princedoms of the 14th through the 16th century.

HI 411 The Protestant and Catholic Reformation of the 16th Century. *3(3-0) . Credit will not be given for both HI 411 and HI 511.* The conditions and criticisms which led to reform and the nature of the institutional and theological changes affected by the various churches and sects. Special attention to Luther and Calvin.

HI 414 France in the Old Regime. *3(3-0) . Credit will not be given for both HI 414 and HI 514.* France from the sixteenth century to the Revolution, development of renaissance and absolutist state, social and economic change, religious reform and Enlightenment, origins and beginnings of the revolution.

HI 415 The French Revolution. *3(3-0) . Credit will not be given for both HI 415 and HI 515.* Broadly based analysis of France's first revolutionary era; the enlightenment and its impact, the causes and character of the Revolution in-France; impact of these events in France and Europe.

HI 417 Europe in Crisis: 1890-1917. *3(3-0)* . Survey of the social, economic, political, ideological changes in Europe on the eve of World War I; prewar origins of fascism and communism; political polarization during World War I to the outbreak of the Bolshevik Revolution.

HI 418 Fascist Italy and Nazi Germany. *3(3-0) . F. Preq: 3 hours of history. Students will not receive credit for both HI 418 and HI 518.* Fascism as a theoretical concept, rise of fascism in Italy and Germany, seizure of power by Mussolini and Hitler, organization of the economy, churches, military, women, youth, and culture under the dictatorships.

HI 419 Modern European Imperialism. *3(3-0) . Credit will not be given for both HI 419 and HI 519.* Historical background of European overseas expansion; its impact on the economics, politics and culture of both Europe and the colonized world; the significance of imperialism and anti-colonial nationalism in shaping the modern world.

HI 420 European Diplomatic History. *3(3-0) . S, Sum. Credit will not be given both for HI 420 and HI 520.* Survey of major events in European international relations, including the Congress of Vienna in 1815, the unification of Germany, World War I and II, the origins of the Cold War, European unification, and the crisis of the Soviet bloc.

HI 421 European Intellectual History: The Eighteenth Century. *3(3-0) . Credit will not be given for both HI 421 and HI 521.* Historical examination of some of the major figures of the European Enlightenment, beginning with Locke and ending with Kant.

HI 422 European Intellectual History: The 19th Century. *3(3-0) . Credit will not be given for both HI 422 and HI 522.* Historical examination of some of the major figures of European thought during the 19th century, beginning with the enthusiasm of the period of the French Revolution and ending with the disillusionment of the fin de siecle.

HI 425 Tudor and Stuart England. *3(3-0) . Credit will not be given for both HI 425 and HI 525.* British history from the Reformation through the Civil War. Emphasis on key developments in social, political and economic life: The development of a new concept of kingship, the growing independence of Parliament, the search for religious uniformity and the changing status of the aristocracy and gentry.

HI 429 20th Century Britain. *3(3-0) .* British political, social and economic history since 1914, with reference to the effects of two world wars, the growth of the Welfare State, Britain's decline as a power, and its search for a new role in the world.

HI 430 Modern France. *3(3-0) . Credit will not be given for both HI 430 and HI 530.* French history from the downfall of Napoleon I to the present, with a short introductory survey of the Old Regime and the French Revolution. Cultural, social and economic developments and political trends.

HI 431 Germany: Luther to Bismarck 1500-1871. *3(3-0) . Credit will not be given for both HI 431 and HI 531.* Germany from the Reformation to the completion of national unification in 1871. Emphasizes the impact of socioeconomic changes on politics and culture.

HI 432 History of Germany Since 1871. *3(3-0) . Preq: 3 hours of History. Credit will not be given for both HI 432 and HI 532.* Germany from the Reformation through national unification. Emphasis on the impact of socio-economic changes on politics and culture.

HI 438 The Russian Empire to 1917. *3(3-0) .* Russian Empire to the Revolution of 1917. Kiev Rus and the Mongol conquest, serfdom, territorial expansion, cultural insularity of the Great Russian state in Moscow, Westernization, reform, and great power status in 18th and 19th centuries, peoples of the multi-national empire, cultural, educated society, and revolutionary opposition, industrialization, rapid urbanization, war, and revolution.

HI 439 History of the Soviet Union and After. *3(3-0) . Credit will not be given both for HI 439 and HI 539.* Soviet state and society from the 1917 Revolution, including the post-Soviet situation. Political disarray and resistance to the Bolshevik regime, 1917-21; industrialization, urbanization, and application of coercive techniques of rule; popular reconciliation with Party state and great power status during World War II and after; fate of non-Russian nationalities; de-Stalinization, stagnation, and the failed attempt at Party renewal after 1985.

HI 441 Colonial and Revolutionary U.S. *3(3-0) . Credit will not be given for both HI 441 and HI 541.* Origins of the English colonies in America to the American Revolution. European background to colonization, merging of different cultures, effects of mercantile doctrine, causes of revolution.

HI 442 Creating the Constitution : Origins and Development. *3(3-0) . S Alt Yrs (Odd). Preq: 3 hours of History.* Analysis of state and federal constitutions developed in the United States after 1776. Theories behind a federal constitution; the Philadelphia Convention of 1787; the ratification debate; and the Bill of Rights.

HI 443 U. S. Constitutional History. *3(3-0) Credit for both HI 443 and HI 543 is not allowed.* The origins and growth of the U. S. Constitution from its English common law heritage to the Modern era. Federalism and judicial interpretation: economic, social, and political movements; expansion of constitutional authority in the 20th century.

HI 446 Civil War and Reconstruction. *3(3-0) . Credit will not be given for both HI 446 and HI 546.* Examination of sectional polarization of the 1850's, impact of the war on both northern and southern societies, and trauma of reconstructing the Union.

HI (WGS) 447 History of American Women to 1900. *3(3-0) . Credit for both HI(WGS) 447 and HI(WGS) 547 is not allowed.* The historical experience of women in America from the colonial period to 1890. Women's work, education, legal and political status, religious experience, and sex roles: age, class, race, sexual preference, and region as significant variables in women's experience.

HI (WGS) 448 American Women in the Twentieth Century. *3(3 0) . Credit will not be given for both HI 448 and HI 548.* Women's historical experience in America, 1890-1990. Changes in women's work, education, legal and political status, and sex roles, age, class, race, sexual preference, and region as significant variables in women's experience.

HI 449 U.S. Labor to 1900. *3(3-0) . Credit will not be given for both HI 449 and HI 549.* History of work, workers, and working-class organizations and politics in colonial and nineteenth-century America.

HI 450 U.S. Labor Since 1900. *3(3-0) . Credit will not be given for both HI 450 and HI 550.* History of work, workers, and working-class organizations and politics in twentieth-century America.

HI 452 Recent America. *3(3-0) Credit will not be given both for HI 452 and HI 552.* Examination of contemporary opinions and historical interpretations of major problems in American life since 1939, including World War II, its social and economic consequences; Korea and the Cold War, big business and labor; civil rights and feminist movements; countercultures, Vietnam and Watergate.

HI 453 United States-Latin American Relations Since 1823. *3(3-0) . Credit will not be given both for HI 453 and HI 553.* Analysis of periods, issues, and events in U.S.-Latin American relations since 1823: Monroe Doctrine, Manifest Destiny, Mexican and Spanish-American Wars, Dollar Diplomacy, Good Neighbor Policy, anti-Communist crusade since 1945, Alliance for Progress, U.S. responses to revolution. Historical perspective on contemporary inter-American problems on drugs, environment, debt crisis, and human rights abuses.

HI 454 History of U.S. Foreign Relations, 1900-Present. *3(3-0) . Credit for both HI 454 and HI 554 will not be allowed.* America's emergence as a world power; American diplomatic history since 1900; the expansion of American economic and cultural relations; the evolution of the American foreign policy bureaucracy; and the historical forces and personalities that have shaped American relations with other nations.

HI 455 History of the Civil Rights Movement. *3(3-0) . Credit will not be given both for HI 455 and HI 555.* The black revolution; stages and leaders of the movement; successes and failures in the fight for desegregation, the vote, and economic opportunity; impact of Civil Rights movement on the United States.

HI 456 Early American Thought. *3(3-0) . Preq: 3 hours of history and junior standing. Credit will not be given for both HI 456 and HI 556.* American intellectual history to 1865. Influence of reformation, enlightenment, scientific revolution, capitalism and romanticism on social and political order.

HI 457 Twentieth-Century U.S. Intellectual History. *3(3-0). Credit for both HI 457 and HI 557 is not allowed.* American intellectuals and their views on 20th-century topics such as politics, culture, race and gender in historical context.

HI 458 Modern American Historical Biography. *3(3-0) . Credit will not be given for both HI 458 and HI 558.* Credit will not be given for both HI 458 and HI 558. American history in the 20th century through the medium of historical biography.

HI (REL) 460 American Religion After Darwin. *3(3-0) . F.S. Preq: 3 credit hours in REL or HI. Credit for both REL(HI) 460 and REL(HI) 560 is not allowed.* Major religious issues in America from the Civil War to the mid-1920s, including science and religion, the impact of Darwin's evolutionary theory, biblical criticism, liberalism versus fundamentalism, the churches in an industrial society.

HI 461 Civilization of the Old South. *3(3-0) . Credit will not be given for both HI 461 and HI 561.* The distinctive features of the Old South as part of the regional development of United States history. Consideration of colonial factors in the making of the South, development of the plantation system and slavery, Southern social order, intellectual and cultural life, economic development, and rise of Southern nationalism.

HI 462 Social History of the New South. *3(3-0) . Credit will not be awarded both for HI 462 and HI 562.* Analysis of the change and continuity in the American South from the end of the Civil War through the present.

HI 467 Modern Mexico. *3(3-0) .* Major developments in Mexican national life since 1821. The 19th century: the era of Santa Anna, the war with the United States, the Reform, the French intervention, and the dictatorship of Profirio Diaz. The 1910 Revolution and the resulting transformation of Mexico's political, social and economic institutions. Reading knowledge of Spanish helpful but not required.

HI 469 Latin American Revolutions in the Twentieth Century. *3(3-0) . Credit for both HI 469 and HI 569 will not be given.* Alt. yrs. Comparative analysis of causes, participants, process, and outcome of revolutions in Mexico, Bolivia, Cuba, and Central America.

HI 471 Revolutionary China. *3(3-0) . Credit will not be given for both HI 471 and HI 571.* China 1900 to present. Examination of political, cultural, and socio-economic revolutionary phases of China's 20th-century transformation from traditional empire to communism. Particular attention to post-1949 problems of nation-building.

HI 472 Modern Japan, 1850 to Present. *3(3-0) .* Japan's emergence as a nation and world power.

HI 474 Modern India. *3(3-0) . F (Alt. yrs.)even. Preq: 3 hours of history.* The history of the Indian sub-continent, from the 16th century to the present. Focus on political, economic and cultural change under the Mughal Empire and the British Raj; the problems of independent India, Pakistan and Bangladesh.

HI 475 History of the Republic of South Africa. *3(3-0) . Preq: 3 hours of history. Credit will not be given for both HI 475 and HI 575.* Evolution of the Republic of South Africa's society, with emphasis on the interaction of diverse peoples and cultures. Particular attention is given to the period since 1870.

HI 476 Leadership in Modern Africa. *3(3-0) .* Recent sub-Saharan African political history (excluding South Africa). Overview of concepts, vocabulary, historical trends. Detailed examination of specific African countries as case studies, such as Ghana, Nigeria, Zimbabwe, Tanzania.

HI 477 Women in the Middle East. *3(3-0) . S, Alt yrs.(odd). Preq: 3 hours of History.* The varied forces influencing lives of women in Middle East from beginning of Islam to present.

HI 479 Africa (sub-Saharan) in the Twentieth Century. *3(3-0) S, Alt. Yrs.(even). Preq: 3 hrs. of history. Credit will not be given for both HI 479 and 579.* Developments in sub-Saharan Africa during the colonial period, from the end of the nineteenth century to the advent of decolonization in the early 1960s. Interplay of political, social, economic and cultural factors in the experiences of African peoples during this period.

HI 480 Scientific Revolution: 1300-1700. *3(3-0) Credit will not be given for both HI 480 and HI 580.* Factors behind dramatic scientific changes of the seventeenth century. Role of mathematics and experiment. Interaction of the new science with trends in philosophy, religion, alchemy, magic, medicine, and with institutional, educational, political, economic and technological factors.

HI 481 History of the Life Sciences. *3(3-0) . Credit will not be given for both HI 481 and HI 581.* The major ideas, methods, institutions, and individuals that have contributed to the biological sciences from Renaissance to modern times. The connections between the life sciences and other aspects of culture, including the physical sciences, religious belief, medical practice, and agriculture.

HI 482 Darwinism in Science and Society. *3(3-0) . S (Alt. yrs) even. Preq: 6 hrs. of advanced history. Credit will not be given both for HI 482 and HI 582.* Scientific development of Darwinism and its reception by the scientific community and the general public. Social impact of theories of evolution as reflected in Social Darwinism, eugenics, sociobiology, and relationship of sciences to ethics and religion.

HI (MDS) 485 History of American Technology. *3(3-0) .* Technology in American history: the ideological, social, economic, and institutional contexts of technological change from the 1760s to the present. Impacts of new technological systems.

HI 491 Seminar in History. *3(3-0) . Preq: 3 hours of history; Junior standing.* Detailed investigation of selected topics in history. Consult Department of History for specific topics.

HI 495 Honors Research in History I. *2(0-2) . Open only to seniors in history honors program.* Preparation of the honors thesis. Topics and procedures to be determined by the student and the supervising faculty member.

HI 496 Honors Research in History II. *4(0-4) . Preq: HI 495. Open only to seniors in history honors program.* Completion of the honors thesis. Topics and procedures to be determined by the student and the supervising faculty member.

HI 498 Independent Study in History. *1-6. Preq: 3 hours of history.* Extensive readings on predetermined topics focused around a central theme. Permission of the department is required.

HI 500 Civilizations of the Ancient Near East. *3(3 0) . Credit for both HI 400 and HI 500 is not allowed.* The civilizations of Mesopotamia and Egypt from earliest times to fall of Babylon in 539 B.C.

HI 504 Rome To 337 A.D. *3(3-0) Credit for both HI 404 and Hi 504 is not allowed.* Development of ancient Rome from its origins in Italy, through its rise as an Empire embracing entire Mediterranean World and Western Europe, to Constantine. Christianity and the foundation of Constantinople. Critical examination of political achievement of a people who rose from an obscure Italian city to a world empire, with emphasis on analysis of primary courses.

HI 505 History and Archaeology Of the Roman Empire. *3(3-0) Credit for both HI 405 and HI 505 is not allowed.* Analysis of Rome's unparalleled rule over the entire Mediterranean World in first four centuries A D through use of literary and archaeological sources. Special emphasis on imperial army and frontier security.

HI 506 From Roman Empire To Middle Ages. *3(3 0) Credit for both HI 406 and HI 506 is not allowed* Late Antiquity and the early Middle Ages. The transition from classical civilization to basis of modern civilizations: the Fall of Rome, the Germanic kingdoms, Byzantium, establishment of Christianity, birth and growth of Islam.

HI 507 Islamic History To 1798. *3(3-0) . Credit for both HI(REL) 407 and HI 50" is not allowed.* History of Islamic Near East to 1798. The East Mediterranean before Islam, Muhammad and the development of Islam, sources of Muslim civilization; Islamic law, science, philosophy, art and architecture; Islam in Spain, India, Asia and Africa, the Crusades, the Ottomans; Islam and Europe.

HI 509 The High Middle Ages. *3(3-0) . Credit for both HI 409 and HI 509 is not allowed.* Medieval culture 936-1250: revival of the Roman Empire, monastic and papal reform, rise of universities, evolution of representative bodies, the Gothic style, troubadour and goliardic poetry, scholasticism and revival of Roman law.

HI 510 Italian Renaissance. *3(3-0) . Credit for both HI 410 and HI 510 is not allowed.* Examination of Renaissance humanism, an educational ideal and an awareness of humans as the sole creator in the historical world, in its relationship to the Italian republics and princedoms of the 14th through 16th century.

HI 511 The Protestant and Catholic Reformation of the 16TH Century. *3(3-0) . Credit for both HI 411 and HI 511 is not allowed.* Conditions and criticisms which led to reform and the nature of institutional, theological and social changes effected by various churches and sects. Special attention to Luther and Calvin.

HI 514 France in the Old Regime. *3(3-0) . Credit for both HI 414 and HI 514 is not allowed.* France from sixteenth century to the Revolution, development of renaissance and absolutist state, social and economic change, religious reform and Enlightenment, origins and beginnings of the Revolution.

HI 515 Revolutionary Europe. *3(3-0) . Credit for both HI 415 and HI 515 is not allowed.* A broadly based analysis of France's first revolutionary era. The Enlightenment and its impact, causes and character of the Revolution in France and impact of these events in France and Europe.

HI 518 Fascist Italy and Nazi Germany. *3(3-0) . F. Preq: 6 hours of advanced history. Students will not receive credit for both HI 418 and HI 518.* Fascism as a theoretical concept, rise of fascism in Italy and Germany, seizure of power by Mussolini and Hitler, organization of economy, churches, military, women, youth and culture under dictatorships.

HI 519 Modern European Imperialism. *3(3-0) . Preq: Grad. standing. Credit for both HI 419 and HI 519 is not allowed.* Historical background of European expression; its impact on the economics, politics and culture of both Europe and the colonized world; the significance of imperialism and anti-colonial nationalism in shaping the modern world.

HI 520 European Diplomatic History. *3(3-0) . Preq: Six hours of advanced history. Credit for both HI 420 and HI 520 is not allowed.* Survey of major issues and events in European international relations, including Congress of Vienna in 1815, unification of Germany, World War I and II, origins of Cold War, European unification, and crisis of Soviet bloc.

HI 521 European Intellectual History: The Eighteenth Century. *3(3-0) . Credit for both HI 421 and HI 521 is not allowed.* Historical examination of some of major figures of the European Enlightenment, beginning with Locke and ending with Kant.

HI 522 European Intellectual History: The 19TH Century. *3(3-0) . Credit for both HI 422 and HI 522 is not allowed.* Historical examination of some of major figures of European thought during 19th century, beginning with enthusiasm of the period of the French Revolution and ending with the disillusionment of the fin de siecle.

HI 525 Tudor and Stuart England. *3(3-0) . Credit for both HI 425 and HI 525 is not allowed.* British history from the Reformation to the Civil War. Primary emphasis on certain key developments in social, political and economic life, such as development of a new concept of kingship, the growing independence of Parliament, the search for religious uniformity and changing status of aristocracy and gentry.

HI 529 20TH Century Britain. *3(3-0) . Credit for both HI 429 and HI 529 is not allowed.* British political, social and economic history since 1914, with reference to effects of two world wars, growth of the Welfare State, Britain's decline in power and its search for a new role in the world.

HI 530 Modern France. *3(3-0) . Credit for both HI 430 and HI 530 is not allowed.* French history from the downfall of Napoleon I to the present, with a short introductory survey of the Old Regime and the French Revolution. Cultural, social and economic developments and political trends.

HI 531 Germany: Luther to Bismarck 1500-1871. *3(3-0) . Credit for both HI 431 and HI 531 is not allowed.* Germany from the Reformation through national unification. Emphasis on impact of socio-economic changes on politics and culture.

HI 532 History Of Germany Since 1871. *3(3-0) . Alt. yrs.(even). Preq: Six hours of advanced history. Credit for both HI 432 and HI 532 is not allowed.* Germany from Reformation through national unification. Impact of socio-economic changes on politics and culture.

HI 538 The Russian Empire to 1917. *3(3-0) . Credit for both HI 438 and HI 538 is not allowed.* History of the Russian Empire to the Revolution of 1917. Kiev Rus and the Mongol conquest; serfdom, territorial expansion and cultural insularity of Great Russian state in Moscow; Westernization, reform and great power status in 18th and 19th centuries; peoples of multinational empire; culture, educated society and revolutionary opposition; industrialization, rapid urbanization, war and revolution.

HI 539 History of the Soviet Union and After. *3(3-0) . Credit for both HI 439 and HI 539 is not allowed.* History of the Soviet state and society from the 1917 Revolution, including post-Soviet situation. Political disarray and resistance to the Bolshevik regime, 1917-21; industrialization, urbanization and application of coercive techniques of rule; popular reconciliation with Party state and great power status during World War II and after; fate of non-Russian nationalities; de-Stalinization, stagnation and failed attempt at Party renewal after 1985.

HI 541 Colonial and Revolutionary U.S. *3(3-0) . Preq: Grad. standing. Credit for both HI 441 and HI 541 is not allowed. Credit for both HI 441 and HI 541 is not allowed.* Origins of English colonies in America to the American Revolution. European background to colonization, merging of different cultures, effects of mercantile doctrine, causes of revolution.

HI 543 U.S. Constitutional History. *3(3-0) . Credit for both HI 443 and HI 543 is not allowed.* Origins and growth of the U.S. Constitution from its English common law heritage to the Modern era. Federalism and judicial interpretation; economic, social and political movements; expansion of constitutional authority in 20th century.

HI 546 Civil War and Reconstruction. *3(3 0) . Credit for both HI 446 and HI 546 is not allowed.* Examination of sectional polarization of the 1850s, the impact of the war on both northern and southern societies and trauma of reconstructing the Union.

HI (WGS) 547 History of American Women to 1900. *3(3-0) . Preq: 6 hrs. of advanced history. Credit for both HI 447(WGS) and HI(WGS) 547 is not allowed.* Historical experience of women in America from colonial period to 1900. Women's work, education, legal and political status, religious experience and sex roles: age, class, race, sexual preference and region as significant variables in women's experience.

HI (WGS) 548 American Women in the Twentieth Century. *3(3-0) . Credit for both HI 448 and 548 is not allowed.* Women's historical experience in America, 1890-1990. Changes in women's work, education, legal and political status, and sex roles; age, class, race, sexual preference and region as significant variables in women's experience.

HI 549 U. S. Labor to 1900. *3(3-0) . Preq: Grad. standing. Credit for both HI 449 and HI 549 is not allowed.* The history of work, workers, and working-class organizations and politics in colonial and nineteenth-century America.

HI 550 U. S. Labor Since 1900. *3(3-0) . Preq: Grad. standing. Credit for both HI 450 and HI 550 is not allowed.* History of work, workers, and working-class organizations and politics in twentieth-century America.

HI 552 Recent America. *3(3 0) . Credit for both HI 452 and HI 552 is not allowed.* Examination of contemporary opinions and "historial" interpretations of major problems in American life since 1939 including World War II, its social and economic consequences; Korea and the Cold War; big business and labor; civil rights and feminist movements; countercultures, Vietnam and Watergate.

HI 553 U. S.-Latin American Relations Since 1823. *3(3-0) . Credit for both HI 453 and HI 553 is not allowed.* Analysis of periods, issues and events in U.S.-Latin American relations since 1823, Monroe Doctrine, Manifest Destiny, Mexican and Spanish-American Wars, Dollar Diplomacy, Good Neighbor Policy, anti-Communist crusade since 1945, Alliance for Progress, U. S. responses to revolution. Historical perspective on contemporary inter-American problems--drugs, environment, debt crisis, human rights abuses.

HI 554 History Of U. S. Foreign Relations, 1900-Present. *3(3-0) . Credit for both HI 454 and HI 554 is not allowed.* American diplomatic history since 1900; the expansion of American economic and cultural relations; the evolution of the American foreign policy bureaucracy; and the historical forces and personalities that shaped American relations with other nations.

HI 555 History of the Civil Rights Movement. *3(3-0) . Preq: 6 hrs. of advanced HI; jr. standing. Credit for both HI 455 and HI 555 is not allowed.* The "black revolution;" stages and leaders of the movement; successes and failures in fight for desegregation, the vote and economic opportunity; impact of Civil Rights movement on the United States.

HI 556 Early American Thought. *3(3-0) . Preq: 3 hrs. of HI. Credit for both HI 456 and HI 556 is not allowed.* American intellectual history to 1865. Influence of Reformation, enlightenment, scientific revolution, capitalism and romanticism on social and political order.

HI 557 Twentieth-Century U. S. Intellectual History. *3(3-0) . Credit for both HI 457 and HI 557 is not allowed.* American intellectuals and their views on 20th-century topics such as politics, culture, race and gender in historical context.

HI 558 Modern American Historical Biography. *3(3-0) . Credit for both HI 458 and HI 558 is not allowed.* American history in the 20th century through medium of historical biography.

HI 560 American Religion After Darwin. *3(3-0) . Credit for both REL(HI) 460 and HI 560 is not allowed.* Major religious issues in America from Civil War to mid-1920's, including science and religion, impact of Darwin's evolutionary theory, biblical criticism, liberalism versus fundamentalism, churches in an industrial society.

HI 561 Civilization of the Old South. *3(3-0) Credit for both HI 461 and HI 561 is not allowed.* Distinctive features of the Old South as part of the regional development of the U. S. Colonial factors in the making of the South, development of the plantation system and slavery, Southern social order, intellectual and cultural life, economic development and rise of Southern nationalism.

HI 562 Social History of the New South. *3(3-0) . F. Preq. Six hours of advanced history. Credit for both HI 462 and HI 562 is not allowed.* Analysis of change and continuity in American South from end of Civil War through present.

HI 564 Topics in the History of North Carolina. *3(3-0) . Preq: Grad. standing.* Exploration of themes in North Carolina history, with special emphasis on long-term trends in social, economic and political character of the state.

HI 569 Latin American Revolutions in the Twentieth Century. *3(3-0) . Credit for both HI 469 and HI 569 is not allowed.* Comparative analysis of causes, participants, process and outcome of revolutions in Mexico, Bolivia, Cuba and Central America.

HI 571 Revolutionary China. *3(3-0) . Credit for both HI 471 and HI 571 is not allowed.* China 1900 to present. Examination of political, cultural and socio-economics revolutionary phases of China's 20th-century trans-formation from traditional empire to communism. Particular attention to post-1949 problems of nation building.

HI 575 History of the Republic Of South Africa. *3(3-0) . Preq: 6 hrs. of advanced history. Credit for both HI 475 and HI 575 is not allowed.* Evolution of Republic of South Africa's society, with emphasis on interaction of diverse peoples and cultures. Particular attention given to period since 1870.

HI 576 Leadership in Modern Africa. *3(3-0) . Credit for both HI 476 and HI 576 is not allowed.* Conditions under which 20th century African leaders have obtained and exercised power. Case studies of prominent leaders, both radicals, reactionaries, democrats and tyrants, such as Nkrumah, Kenyatta, Nyerere, Amin, Cabral, Vorster and Senghor.

HI 579 African (sub-Saharan) in the Twentieth Century. *3(3-0) . S. Preq: 6 hours of advanced history. Students will not receive credit for both HI 479 and HI 579.* Developments in sub-Saharan Africa during colonial period, from end of 19th century to advent of decolonization in early 1960s. Interplay of political, social, economic and cultural factors in experiences of African peoples during this period.

HI 580 Scientific Revolution: 1300-1700. *3(3-0) . Credit for both HI 480 and HI 580 is not allowed.* Factors behind dramatic scientific changes of the seventeenth century. Role of mathematics and experiment. Interaction of new science with trends in philosophy, religion, alchemy, magic, medicine and with institutional, educational, political, economic and technological factors.

HI 581 History of Life Sciences. *3(3-0) . Credit for both HI 481 and HI 581 is not allowed.* Major ideas, methods, institutions and individuals contributing to biological sciences from the Renaissance to modern times. Connections between life sciences and other aspects of culture, including physical sciences, religious belief, medical practice and agriculture.

HI 582 Darwinism in Science and Society. *3(3-0) . S (Alt yrs.) even Preq: 6 hrs. of advanced history. Credit for both HI 482 and HI 582 is not allowed.* Scientific development of Darwinism and its reception by the scientific community and the general public. Social impact of theories of evolution as reflected in Social Darwinism, eugenics, sociobiology, and relationship of sciences to ethics and religion.

HI 583 Science and Religion in European History. *3(3-0) . Alt. Years(odd). Preq 6 hours of advanced history* The historical conflict between science and religion; crisis of religon; science as a new cultural authority; political and institutional landscape of science and religion in Europe.

HI 586 History and Principles of the Administration of Archives and Manuscripts. *3(3-0).* Nature, importance and use of original manuscript resources; history and evolution of written records and the institutions administering them; the principles and practices of archival administration.

HI 587 Application of Principles of Administration of Archives and Manuscripts. *3(3-0) . Preq: Six hours of advanced history and HI 586* Training in the application of the principles and practices of archival management as developed in HI 586.

HI 588 Conservation of Archival and Library Materials. *3(3-0) . Preq: HI 586, 587, 596 or Consent of Instructor.* Introduction to archival materials. Examination of and practice in storage and care of paper and books, prints, engravings and maps. Films, transparencies, negatives, magnetic tapes and phonorecords. Emphasis on preventive conservation.

HI 589 Automation and Public History. *3(3-0) . Preq: HI 586 and 596.* Computer uses in public history, Library of Congress and other electronic protocols. Creation, accession and networking of records systems.

HI 590 Documentary Editing. *3(3-0) . Preq: HI 596.* Introduction to field of documentary editing and historical publication. Development of historical editing and rules of literal, expanded and modern editorial method. Special documentary/papers projects.

HI 591 Introduction to Museology. *3(3-0) . Preq: Grad. standing or PBS status.* Organization and operation of museums as historical agencies. Role of museums in historical research and education.

HI 592 Advanced Museology. *3(3-0) . Preq: HI 591 and 596, or Consent of Instructor.* Integration of historical knowledge and artifacts into museum exhibits.

HI 593 Material Culture. *3(3-0) . F, Alt. Yrs (even). Preq: HI 591 and 596.* Current theories of material culture analysis and their application to history museums.

HI 596 Introduction to Public History. *3(3-0) Preq: Grad standing or PBS status.* Introduction to applications of history to public life and to conservation and presentation of historical materials, with particular attention to conservation problems generated by modern technology. Archives, records management, historical editing, museology, historic preservation, historic sites and computer applications.

HI 597 Historiography and Historical Method. *3(3-0) .* Major steps in development of historical investigation; analysis of elements of historical research; discussion of methodology and archival materials used by contemporary scholarly historian.

HI 598 Historical Writing. *3(3-0) Preq: Grad. standing or PBS status.* Critical studies in the methods and practice of contemporary historical writing.

HI 599 Independent Study. *1-6 Preq: Grad. standing or PBS status.* Individualized study conducted under supervision of graduate faculty. Course of study, assigned readings, course projects or papers, and methods of evaluating work to be detailed in writing and approved by department head.

HI 642 Practicum in Public History. *1-6. Preq: HI 596,597,598 and Consent of Instructor.* Supervised internship experience in archival management and/or applied history.

HI 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

HI 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

HI 695 Master's Thesis Research. *1-9. F,S,Sum. Preq. Master's Student.* Thesis Research

HI 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's Student. Credits Arranged.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

HONORS

HON 101 Honors Colloquium I. *1(2-0). Coreq: Membership in University Honors Program. Permission of the University Honors Program.* Introduction to Honors at NC State University for University Honors Program students. Development of Honors Plan of Study and discussion of issues of concern in higher education and relationship between education, personal development, and community involvement.

HON 102 Honors Colloquium II. *1(2-0). Preq: HON 101 Coreq: Membership in University Honors Program. Permission of the University Honors Program* Introduction to Honors at NC State University for University Honors Program students. Development of plan for honors research project and proposal for study abroad experience Further reflection on purpose of higher education in addressing the issues and opportunities of our time

HON 298 Honors Research/Independent Study. *1-3. Permission of the University Honors Program.* Research/Independent Study for University Honors Program students. Repeatable if content differs. Research or independent study under the supervision of faculty members. Project approval by the Honors Program Advisory Committee necessary prior to registration.

HON 496 Honors Capstone Seminar. *3(3-0). Coreq: Membership in University Honors Program. Permission of the University Honors Program* Honors Seminars open to Juniors and Seniors in all disciplinary Honors Programs, and others with permission of the University Honors Program. Repeatable if content differs. A series of seminars with differing subjects, interdisciplinary in character and sometimes team-taught, allowing advanced students to explore topics from a multidisciplinary perspective and to apply their knowledge to issues and problems in the present world.

HORTICULTURAL SCIENCE

HS 100 Home Horticulture. *3(3 0)* . Introduction and review of home horticulture as it relates to the horticultural enthusiast. A general understanding of plant growth, structure, and development; house plant selection and care, selecting trees, shrubs, and flowers for the home landscape, and other related topics.

HS 201 Principles of Horticulture. *3(3-0)* . Principles of plant growth and development relating to production and utilization of fruit, vegetable, floricultural, and ornamental crops. Historical, economic, and global importance of horticultural crops and services.

HS 211 Ornamental Plants I. *3(1-5)* . *Preq. BIO 125.* Identification, distribution, growth, characteristics, adaptation, and usage of ornamental plants. Emphasizes bedding plants, trees, and gymnosperms.

HS 212 Ornamental Plants II. *3(1 5)* . *Preq· BIO 125* Identification, distribution, growth, characteristics, adaptation, and usage of ornamental plants. Emphasizes shrubs, ground covers, vines, bulbs, and interior landscape plants.

HS (ANS) 215 Basic Agricultural Genetics. *3(3-0) Preq: BIO 125* Basic principles of inheritance in plants and animals of agricultural significance. Transmission genetics and its effects on the usefulness of plants and animals. Basic principles of plant and animal improvement.

HS 290 Perspectives in Horticultural Science. *1(1-0)* Introduction and orientation to programs in horticultural science. Discussion of current status of horticulture, extension and research. Emphasis on undergraduate program management, internships, graduate education, and career planning. Guest lectures, career opportunities and qualifications for employment in horticulture and related fields.

HS 301 Plant Propagation. *4(3-3)* . *Preq: BIO 125, or BO 200.* Theoretical basis and techniques for successful asexual and sexual propagation of seed plants and ferns. Influence of heredity, phytopathological infection, and environmental conditions on success and quality of propagules. Recent developments and innovations in propagation techniques and methodologies.

HS 342 Landscape Horticulture. *3(2-3) .* Introduction to comprehensive process for small scale landscape projects. Includes garden history, social and environmental analysis, creative problem solving process and the practice of oral, written and graphic communication.

HS 371 Interior Plantscapes. *3(2-3) . Preq: BIO 125 or BO 200; second semester sophomore standing.* Identification, selection, installation, utilization, and maintenance of plants commonly used in commercial interior settings.

HS 400 Residential Landscaping. *6(0-9) . Preq: HS 211, 212, 342, 430. Coreq: LAR 457.* Equips students with the necessary skills to create functional, aesthetic, and humanistic designs for residential and other small scale projects. Aspects of problem identification, project organization, design, execution, and evaluation. Required field trip with fee.

HS 411 Nursery Management. *3(2-3) . Preq: BIO 125, SSC 200, Junior standing* Principles and practices of production, management, and marketing of field-grown and container-grown nursery plants. One of three scheduled weekend field trips required at students' expense.

HS 416 Principles of Ornamental Planting Design. *3(2 4) . Preq: HS 400, LAR 400.* Study and practice of plant selection process for ornamental planting design. Plant form, line, texture, color and scale are related to design principles. Plant cultural requirements and characteristics associated with site microclimates and conditions to promote environmentally sensitive and healthy landscapes. Hands-on experience. Two mandatory Saturday field trips.

HS 421 Physiology and Culture of Temperate-Zone Tree Fruits. *3(2-3) . Preq: BIO 125 or BO 200.* Physiology and culture of the major temperate-zone tree fruit and nut crops of the United States. Fundamental principles underlying woody plant growth as applied to the culture of specific tree-fruit crops with emphasis on crops of commercial importance to North Carolina.

HS 422 Small Fruit Production. *3(2-3) . S, Alt. Yrs(even). Preq: BIO 125; SSC 200; HS 201, and Permission of Instructor.* Importance and economic value of blackberries, blueberries, cranberries, grapes, raspberries, strawberries and minor small fruit crops in the agricultural economy of the USA and the world. Cultural requirements of these crops and manipulation of their known morphological and physiological traits for successful production. Six all afternoon field trips are required.

HS 431 Vegetable Production. *4(3-3) . Preq: BIO 125, SSC 200.* Principles and practices of production and marketing of seventeen vegetable crops grown in the U.S. Additional topics include pest management, seed technology, food safety, sustainable agriculture, use of genetically engineered crops, and consumer issues.

HS 440 Greenhouse Management. *3(2-3) . F. Preq: SSC 200 and HS 201.* Perspective of greenhouse systems management. Selection of greenhouse site, construction, heating, cooling and production systems. Emphasis on greenhouse operations, cost accounting and analysis. Other topics; root substrates, sanitation, water, fertilization, chemical growth regulation, temperature, light and marketing. Hands-on experience in greenhouse operations plus trips to commercial greenhouses and markets.

HS 442 Production of Floricultural Crops. *3(2-3) . S. Preq: SSC 200; HS 201.* Production of floricultural crops. Emphasis on environmental manipulation and scheduling of crop growth and development for targeted market periods. Specific flowering crops as models to demonstrate potted flowering plant, cut flower, and bedding plant production systems. Hands-on crop production experience plus field trips to commercial floriculture production and marketing facilities.

HS (FS) 462 Postharvest Physiology. *3(3-0) . Preq: BO 421.* Preharvest and postharvest factors that affect market quality of horticultural commodities with an emphasis on technologies to preserve postharvest quality and extend storage life of fruits, vegetables and ornamentals.

HS 471 Tree and Grounds Maintenance. *4(3-3) . Preq: SSC 200.* Principles and practices of tree and grounds maintenance. Physical (water) and chemical (fertility) properties of urban soils. Tree and shrubbery: physiology, selection, transplanting, pruning, fertilization, and protection. Weed biology and nonchemical and chemical management options.

HS 492 External Learning Experience. *1 6. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

HS 493 Special Problems in Horticultural Science. *1-6. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes campus facilities and resources. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

HS 495 Special Topics in Horticultural Science. *1-6.* Independent study under faculty supervision of horticultural topics in the student's area of interest not available in regular course offerings. Offering of new courses on a trial basis.

HS (CS, PP) 502 Plant Disease: Methods and Diagnosis. *2(0-6) . F. Preq. PP 315* Introduction to the basic principles of disease causality in plants and the methodology for the study and diagnosis of plant diseases caused by fungi. Identification of plant-pathogenic fungi. Research project, disease profiles and field trips are required.

HS 525 Advanced Plant Propagation. *3(2-3) . S. Alt. Yrs.(even). Preq: HS 301, BO 421. For graduates and advanced undergraduates.* Study of physiological processes influencing propagation by micropropagation (tissue culture), cuttings, seeds and grafting. Current techniques in plant propagation with attention to experimental application.

HS 590 Special Problems in Horticultural Science. *F,S,Sum.*

HS 610 Special Topics in Horticultural Science. *1-6. F,S,Sum. Preq: Consent of Instructor.* Investigation of special theoretical problems at 600 level in horticultural science not related to a thesis problem; new 600-level courses during developmental phase.

HS 615 Advanced Special Topics. *1-6. F,S,Sum. Preq: Consent of Instructor.* Investigation of theoretical problems at the 600 level in horticultural science not related to a thesis problem; new 600-level courses during the development phase.

HS 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

HS 690 Master's Examination. *1-6. F,S,Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

HS 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

HS 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research.

HS 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's Student.* Original research on specific problems in fruit, vegetable and ornamental crops.

HS 701 Carbohydrate Metabolism and Transport. *1(1-0) . S. Preq: BO 421.* Historical and current research related to regulation of aspects of carbohydrate metabolism important to plant growth, yield and quality. Taught first five weeks of semester. Drop date is by last day of 3rd week of minicourse.

HS 703 Breeding Asexually Propagated Crops. *1(1-0) . F Preq: CS 413* Principles and problems associated with breeding clonally propagated crops and techniques used in overcoming these problems. Taught third five weeks of semester. Drop date is by last day of 3rd week of minicourse.

HS 704 Plant Nomenclature. *1(1-0) . S. Preq. BO 421.* A practical foundation in plant nomenclature references. Emphasis on evolution of international rules for naming plant taxa and their application to both wild and cultivated plants. Nomenclature applications used in patents, cultivar releases and journal articles. Taught mid-semester. Drop date is by last day of 3rd week of minicourse.

HS 705 Physiology of Flowering. *1(1-0) . F. Preq: BO 421* Examination of physiological basis of flowering in plants such as: floral initiation, transition to reproductive growth; floral development; plant response to light, temperature, nutrition, water supply; plant age; chemical growth regulation and in vitro flowering. Taught first five weeks of fall semester. Drop date is by last day of 3rd week of minicourse.

HS 706 Fruit Development and Postharvest Physiology. *1(1-0) S Preq: BO 421* Theories of plant senescence, both physiological and biochemical, and postharvest changes in all types of plant parts. Emphasis on physiological principles underlying current postharvest handling and storage techniques. A study of fruit development from fruit set to senescence. Taught third five weeks of semester. Drop date is by last day of 3rd week of minicourse.

HS 707 Environmental Stress Physiology. *1(1-0) F Preq: BO 421.* Physiology of plant responses to environmental stresses, with emphasis on current research in selected physiological, molecular, and biochemical mechanisms for tolerance to environmental stresses such as temperature extremes, drought, salt, pathogens and other plants. Taught second five weeks of semester.

HS (CS) 715 Weed Science Research Techniques. *1(0-2) . F. Preq. CS 414 or equivalent.* Bioassay techniques for detection of herbicide residues in soils, chemical analytical (GLC, HPLC) techniques for identifying herbicide residues in soils and plants, procedures for studying adsorption and leaching in soils, procedures for measuring herbicide interference of photosynthesis and use of 14C-labeled herbicides for following uptake, transport and metabolism of herbicides in plants.

HS (CS) 716 Weed Biology. *1(0-1) . F. Preq: CS 414.* Weed seed development and dispersal, seed dormancy, soil seed bank, seedling development, growth analysis, reproduction, community structure, population dynamics, species interactions, environmental effects on interactions and influence of man. Taught first 5 weeks of semester. Drop date is by last day of 3rd week of minicourse.

HS (CS) 717 Weed Management Systems. *1(0-1) . F. Preq: CS 414 or equivalent.* Weed management systems including integration of cultural, biological, mechanical and chemical methods for vegetables, fruits, ornamentals, turf, small grains, corn, tobacco, cotton, peanuts, aquatic and non-cropland settings. Taught second 5 weeks of semester. Drop date is by last day of 3rd week of minicourse.

HS (BO, CS) 718 Biological Control of Weeds. *1(1-0) . F. Preq: CS 414 or equivalent.* Concepts and methods in use of biological agents for control of weeds. Primary emphasis on weed biocontrol with insects and plant pathogens. Taught third 5 weeks of semester.

HS (CS, GN) 720 Molecular Biology in Plant Breeding. *3(3-0) . S. Alt. yrs. Preq: CS(GN,HS) 741.* Theory and principles of molecular biology applied to plant breeding. Experimental approaches to induce genetic change, cytoplasmic recombination, haploid utilization and potentials of molecular techniques for solving breeding problems.

HS 722 Mineral Nutrition in Plants. *3(2-3) . S. Alt. yrs. Preq: BO 751, 752.* A comprehensive study of functional roles of nutrients essential to plant growth, their interrelationships and their mode of influence on quality indices of crops. Consideration of complexity of mineral nutrition experimentation and evaluation of results. A detailed look at establishment and application of foliar analysis, foliar fertilization and slow-release fertilizers. A general view of nutrient uptake process in plants.

HS (CS, SSC, TOX) 725 Herbicide Chemistry. *1(1-0) . S. Preq: CH 201 and 221.* Chemical properties of pesticides including hydration and solvation, ionization, volatilization, lipophilicity, molecular structure and size, and reactivity and classification according to chemical description, mode of action or ionizability. Taught during the first 5 weeks of semester. Drop date is last day of 3rd week of the minicourse.

HS (CS, SSC, TOX) 727 Herbicide Behavior in Soil and Water. *2(2-0) . S. Preq: CS(HS,SSC,TOX)725,SSC 200.* Sorption/desorption, soil reactivity, movement, volatilization, bioavailability, degradation and stability of pesticides in the environment. Taught during the last 10 weeks of semester. Drop date is last day of 3rd week of the minicourse.

HS (CS) 729 Herbicide Behavior in Plants. *2(2-0) . S. Preq: BO 751 and BO 752 and CS(HS,SSC) 725.* Chemical, physiological and biochemical actions of herbicides in plants including uptake, translocation, metabolism and mechanism of action.

HS 731 Physiology of Landscape Plants. *3(2-3) . S. Preq: BO 421 or Consent of Instructor.* Relationships of plants to landscape environments. Study of plant function, basic climatology and plant physiological principles involved in selection, utilization and maintenance of physical landscape environments in exterior and interior ornamental landscape plantings.

HS 732 Vegetable Crop Physiology. *2(2-0) . F. Alt. yrs. Preq: BO 421, HS 431, SSC 341.* Physiological aspects of field and greenhouse vegetable production: germination, photoperiod, nutrition, growth regulations, fruit quality, physiological disorders, source-sink interactions, environmental physiology and physiological aspects of plant protection. Emphasis on current areas of research and the physiological implications of new production techniques.

HS 734 Vegetable Crops Practicum. *3(1-6) . S. Alt. yrs.. Preq: HS 431.* Field techniques for research on vegetable production problems. Eleven all-day field trips (two overnight) required during the period May-August

HS (CS, GN) 741 Plant Breeding Methods. *3(3-0) . F.* Advanced study of methods of plant breeding as related to principles and concepts of inheritance.

HS (CS, GN) 745 Quantitative Genetics in Plant Breeding. *1(1-0) . S. Alt. yrs. Preq: CS(GN, HS) 741, ST 512, course in quantitative genetics recommended.* Theory and principles of plant quantitative genetics. Experimental approaches of relationships between type and source of genetic variability, concepts of inbreeding, estimations of genetic variance and selection theory.

HS (CS, GN) 746 Breeding Methods. *2(2-0) . S. Alt. yrs. Preq: CS (GN, HS) 741, ST 512.* Theory and principles of plant breeding methodology including population improvement, selection procedures, genotypic evaluation, cultivar development and breeding strategies.

HS (CS, GN, PP) 748 Breeding for Pest Resistance. *2(2-0) . F. Alt. yrs.* Theory and principles of breeding for pest resistance. Experimental approaches for examining genetics of host-parasite interactions, expression and stability of pest resistance and breeding strategies for developing pest-resistant cultivars.

HS 790 Special Problems in Horticultural Science. *F,S,Sum.*

HS 801 Seminar. *1(1-0) . F,S. Preq: Grad. standing.* Required of all graduate students with a minor in horticultural science. Optional for all horticultural science graduate students. Preparation of scientific articles and special lectures. Students required to present one or more papers.

HS 815 Advanced Special Topics. *1-6. F,S,Sum. Preq: Consent of Instructor.* Investigation of theoretical problems at 600 level in horticultural science not related to a thesis problem; new 600-level courses during development phase.

HS (CS, GN) 860 Plant Breeding Laboratory. *1(1-0) . S. Alt. yrs. Preq: CS(GN,HS)741.* Visitation of plant breeding projects in the Depts. of CS and HS at NC State, along with commercial seed companies. Discussion and viewing of breeding objectives, methods and equipment and teaching and practice of hybridization methods.

HS (CS, GN) 861 Plant Breeding Laboratory. *1(1-0) . F Alt. yrs. Preq: CS(GN,HS)741.* Visitation of plant breeding projects in the Depts. of CS and HS at NC State, along with commercial seed companies. Discussion and viewing of breeding objectives, methods and equipment and teaching and practice of hybridization methods.

HS 885 Doctoral Supervised Teaching. *1-3. F,S,Sum.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

HS 890 Doctoral Preliminary Examination. *1-9 F,S Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

HS 891 Research Principal.

HS 893 Doctoral Supervised Research. *1 9. F,S.Sum. Preq: Doctoral Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

HS 895 Doctoral Dissertation Research. *1-9. F,S,Sum. Preq: Doctoral Student.* Dissertation Research

HS 899 Doctoral Dissertation Preparation. *1-3. F,S. Preq: Doctoral Student.* For students who have completed all credit hour requirements, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

HUMANITITES AND SOCIAL SCIENCES

HSS 100 CHASS Computer Literacy. *0(0-1) . Preq: Departmental designated computer literacy course.* Computer Literacy Certification for majors in College of Humanities and Social Sciences.

HSS 101 CHASS First-Year Seminar. *0(0-0) . F,S. Coreq: CHASS-Designated lst year Seminar Sections. CHASS Freshmen Only (0-29 hours).* First-year seminar certification for majors in Humanities and Social Sciences.

HSS 110 Humanities and Social Sciences Scholars Forum. *0(0-0) . Preq: Enrollment limited to participants in the Scholars of the College Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

HSS 111 Humanities and Social Sciences Scholars Forum. *0(0 0) . Preq: Enrollment limited to participants in the Scholars of the College Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

HSS 200 Introduction to Women's Studies. *3(3-0).* Multidisciplinary approach to Women's Studies. Exploration of feminist scholarship and research about women and gender in contemporary American society.

HSS 210 Humanities and Social Sciences Scholars Forum. *0(0-0) . Preq. Enrollment limited to participants in. the Scholars of the College Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

HSS 211 Humanities and Social Sciences Scholars Forum. *0(2 0) . Preq Enrollment limited to participants in the Scholars of the College Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

HSS 294 Social Sciences Studied in an Overseas Context. *3(3 0) .* Social Sciences courses taught in NC State Study Abroad programs. (Current listings available in Study Abroad office and CHASS Dean's Office.)

HSS 298 Study Abroad Topics in Humanities and Social Sciences. *1-6.* Study Abroad Programs: selected topics in the humanities and social sciences.

HSS 310 Humanities and Social Sciences Scholars Forum. *0(2-0) . Preq: Enrollment limited to participants in the Scholars of the College Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

HSS 311 Humanities and Social Sciences Scholars Forum. *0(2-0) . Preq: Enrollment limited to participants in the Scholars of the College Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

HSS (ANT, COM) 392 International and Crosscultural Communication. *3(3-0) .* Patterns and problems of verbal and non-verbal forms of crosscultural communication. Avoidance and management of cultural conflict arising from awareness of characteristics of crosscultural communication. Impact on communication of differing cultural perspectives.

HSS 393 International Affairs Seminar. *3(3-0) .* An intensive study of selected international issues, global dimensions and implications.

HSS 398 Scholars Seminar in Humanities and Social Sciences I. *3(3-0) . Preq: Enrollment limited to participants in the Scholars of the College program.* Interdisciplinary study of selected topics in the humanities and social sciences; required of Scholars of the College students in their junior year.

HSS 399 Scholars Seminar in Humanities and Social Sciences II. *3(3-0) . Preq: Enrollment limited to participants in the Scholars of the College program.* Interdisciplinary study of selected topics in the humanities and social sciences; required of Scholars of the College students in their junior year.

HSS 410 Humanities and Social Sciences Scholars Forum. *0(2-0) . Preq: Enrollment limited to participants in the Scholars of the College Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

HSS 411 Humanities and Social Sciences Scholars Forum. *0(2-0) . Preq: Enrollment limited to participants in the Scholars of the College Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

HSS 492 Seminar in Women's Studies. *3(3-0) . Preq: HSS 200.* Examination of a topic or core area in Women's Studies, such as: women in literature, psychology of sex roles, changing gender relations in families, women's labor force participation, and the history of the women's rights movement.

INDUSTRIAL ARTS

IA 623 Laboratory Problems in Industrial Arts. *1-6. Preq: Senior standing, Consent of Instructor.* Individual problems designed to give advanced majors in Industrial Arts Education opportunity to broaden or intensify knowledge and abilities through investigation and research in various fields of industrial arts, such as metals, plastics, ceramics or electricity-electronics.

IA 745 Technology and Industrial Arts. *3(3-0) . Preq: EOE 651.* Technology: its nature, origins, advance. Impact of technological advance on man and culture. Technology as material culture. Changing concepts of work, skill, occupations, discretionary time. Technology and its relation to industrial arts education.

IA 823 Laboratory Problems in Industrial Arts. *1-6. Preq: Senior standing, Consent of Instructor.* Individual problems designed to give advanced majors in industrial arts education opportunity to broaden or intensify knowledge and abilities through investigation and research in various fields of industrial arts, such as metals, plastics, ceramics or electricity-electronics.

INDUSTRIAL DESIGN

ID 201 Basic Industrial Design Studio I. *6(0-9) . F. Preq: DF 102. Coreq: ID 255, ID 318, ID 318L. Industrial Design Majors or permission of Department Head.* Introduction to the theories, methods, and language of industrial design; elementary problems in form and function; transitional implications of hand-crafted and mass-produced objects, in various materials.

ID 202 Basic Industrial Design Studio II. *6(0-9) . S. Preq: ID 201. Coreq: ID 256, ID 418,ID 418L. Industrial Design Majors or permission of Department Head.* Introduction to the fundamentals of product development and design with emphasis on analytical and intuitive approaches to problem solving, technical skills, manufacturing and structural considerations in design of simple products/systems.

ID 215 Computer Imaging in the Design Process. *3(3-9) . F. School of Design Students Only.* Introduction to the computer as a design tool for generating two-and three-dimensional representations of product concepts. Development of product form and documentation.

ID 255 Contemporary Manufacturing Processes I. *3(3-9) . F.* Introduction to mass production processes and their influences on design. Wood, paper and metal manufacturing processes utilized in quantity production. Emphasis on materials comparison and process selection in relation to product function, form, safety, human factors and manufacturability. Field trips required.

ID 256 Contemporary Manufacturing Processes II. *3(3-9) . S.* Second course in mass production processes and their influences on design. Emphasis on material search and process selection in relation to form, function, human factors, finishes, and joining methods. Plastics and rubber and their specific manufacturing processes utilized in mass production.

ID 262 Professional Practice in Industrial Design. *3(3-9) . S. School of Design Students only.* Issues and situations encountered in a design practice. Topics include patents, trademarks, contracts, basic marketing skills within corporations and in free-lance design.

ID 292 Special Topics in Industrial Design. *1-3. F,S,Sum.* Topics of current interest in Industrial Design. Normally used to develop new courses.

ID 300 Intermediate Industrial Design Studio Series. *6(0-9) . F,S,Sum. Preq: ID 202. Coreq: ID 415. Industrial Design Majors or permission of Department Head. May be repeated.* Individual and team-oriented design experiences that expand upon and combine intellectual and manual skills required for the practice of industrial design. Emphasis on identifying and solving design problems through manipulation of design theory, application of human factors, product safety awareness, universal design principles, ecological/ environmental concerns, appropriate combination of materials and manufacturing techniques, and presentation of concepts.

ID 318 Ideation I. *3(2-2) .* The ideation process of conceiving, developing and recording ideas two-dimensionally. These techniques defined and practiced as an extension of understanding the human ideamotor process.

ID 400 Advanced Industrial Design Studio Series. *6(0-9) . F,S,Sum. Preq: ID 300 or written approval of the Department Head. Industrial Design Majors or permission of Department Head/May be repeated.* A series of advanced studio experiences that expands upon and combines intellectual and manual skills required for the practice of industrial design. Emphasis on identifying and solving design problems through manipulation of design theory, application of human factors, product safety awareness, appropriate combination of materials and manufacturing techniques, and presentation of concepts.

ID 415 Advanced Digital Design Processes. *3(3-0) . S. Preq: ID 215. Industrial Design Majors or permission of Department Head.* A progression of advanced digital experiences that expand upon and combine the intellectual and conceptual skills required for 3 dimensional design visualization. Emphasis on solving product design problems through development and manipulation of form within the virtual environment.

ID 418 Ideation II. *3(2-2) .* This is an advanced course which expands the ideation process with greater emphasis directed toward the creative development and recording of conceptual design phase.

ID 445 Human-Centered Design. *3(3-0) F. School of Design students only.* Introduction to the spectrum of human physical and cognitive capabilities as they relate to user interaction with designed products and environments.

ID 490 Industrial Design International Studio. *6(0-9) . F,S,Sum. Preq: Junior standing in ID, School of Design or equivalent program. Approval Study Abroad Office. School of Design or equivalent programs.* Define industrial design problems and develop design solutions in an international setting. Studio projects related to design, culture, and traditional and contemporary limited and mass produced products. Focus on artifact making through directed studies.

ID 492 Special Topics in Industrial Design. *Preq: Consent of instructor.* Topics of current interest in Industrial Design. Normally used to develop new courses.

ID 494 Internship in Product Design. *3-6. F,S,Sum. Preq: Junior standing, 3.0 GPA or better. Maximum of 6 credit hours.* Supervised field experience in product design offices, galleries, museums and other related organizations.

ID 495 Independent Study in Industrial Design. *1-3. F,S. Preq: Junior standing, 3.0 GPA or better in Industrial Design. Maximum 6 credit hours - May be repeated.* Special projects in industrial design developed under the direction of a faculty member on a tutorial basis.

ID 500 Advanced Industrial Design (Series). *6(0-12) . F,S. Preq: Portfolio review.* Advanced studies in industrial design. Special emphasis given to problem identification, program formulation and application of advanced design methods. All problems of an individual nature leading to a synthesis of previous design experience.

ID 511 Industrial Design Materials and Processes I. *3(3-0) . S. Preq: Grad standing.* Analysis of paper, wood, metal and manufacturing processes utilized in production of mass-produced products. Advanced studies in mass production processes and their influence on design and development of products. Emphasis on material search and process selection in relation to product safety, cost, function, human factors, form, finishes and joining methods.

ID 512 Industrial Design Materials and Processes II. *3(3-0) . S. Preq. Grad. standing.* Analysis of plastics and rubber and related manufacturing processes utilized in production of mass-produced products. Advanced studies in mass production processes and their influence on design and development of products. Emphasis on material search and process selection in relation to cost, product safety, function, human factors, form, finishes and joining methods.

ID 532 Advanced Concepts In Product Engineering. *3(3-0) F,S.* Group investigation of advanced concepts in industrial design with emphasis on engineering. Engineering principles an important role in design of useful products. Scope of this course includes mass movement of persons as well as designs of consumer products. Field of transportation and consumer products fast-changing to satisfy needs of present and future generations. To make designers aware of these needs by special investigations into future technologies and new material developments.

ID 570 Advanced Industrial Design-Textiles (Series). *6(0-12) . F,S.Sum. Preq: Portfolio review.* Advanced studies in textile styling. Special emphasis on problem identification, program formulation and application of advanced design methods. All problems of an individual nature.

ID 581 Industrial Design Project Preparation. *3(3-0) . S Preq: Grad. standing.* A seminar course designed to assist students in preparing groundwork for the final project to be conducted in design studio.

ID 582 Special Topics in Industrial Design. *1-3. F,S. Preq: Grad. standing.* F,S. Topics of current interest to program/option offered by faculty in the School. Subjects offered under this number normally used to test and develop new courses.

ID 588 Final Project Studio in Industrial Design. *6(0-12) . Sum. Preq: ID 581.* Final project for graduate students supervised by members of their graduate advisory committees.

ID 602 Special Seminar. *1-6. S Preq: Grad. standing.* Investigation of special topics in industrial design of a particular interest to advanced students under the direction of chair of graduate committee on a tutorial basis. Credit and content vary with each student.

ID 630 Independent Study in Industrial Design. *1-6 F,S,Sum. Preq: Grad. standing.* Special problems in various aspects of industrial design developed under the direction of faculty member on a tutorial basis.

ID 676 Special Project. *1-3 F,S. Preq. Grad. standing.* Seminars on subjects of current interest in industrial design which are presented by persons not part of regular faculty.

ID 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq. Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ID 690 Master's Examination. *1-6 F,S,Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

INDUSTRIAL ENGINEERING

IE (GC) 210 Introductory Engineering Graphics for Industrial Engineering. *3(2-2) . Preq: E 113.* Introduction to the graphical representation and solution of 2D and 3D spatial problems. Conventional methods using computer-based tools to graphically describe 2D and 3D objects relevant to the field of IE. Overview of the fundamentals and applications of computer graphics and computer-aided design. Includes practical IE drawing applications.

IE 216 Manufacturing Engineering Practicum. *3(1-5) . F,S. Coreq: IE/GC 210* Hands-on experimentation for students to learn the capabilities and limitations of basic manufacturing processes. Relationships between product design, quality, manufacturing, planning, computer simulation, material handling systems, time and motionstudies, and ergonomics.

IE 307 Real-Time Control of Automated Manufacturing. *3(2-2) . Preq: CSC 114, IE 351. Coreq: ECE 331.* Introduction to the concepts of real-time control of manufacturing processes. Design and implementation of control systems for discrete and continuous systems. PID control, Fuzzy Logic, PLC ladder programming, multi-tasking computer control. Experience in the use of system emulation for design and analysis.

IE 311 Engineering Economic Analysis. *3(3-0) . Preq: MA 141.* Engineering and managerial decision making. The theory of interest and its uses. Equivalent annual costs, present worth, internal rates of return, and benefit/cost ratios. Accounting depreciation and its tax effects. Economic lot size and similar cost minimization models. Sensitivity analysis. Cost dichotomies: fixed vs. variable, and incremental vs. sunk, use of accounting data. Replacement theory and economic life. Engineering examples.

IE 316 Manufacturing Engineering I - Processes. *3(2-3) . F,S. Preq: MAT 200; IE 216; IE/GC 210.* Analytical study and design of manufacturing engineering with emphasis on mfg. and processes. Addresses the interaction of design, materials, and processing. Laboratory instruction and hands-on experience in metrology, machining, process planning, economic justification, and current mfg. methodologies.

IE 330 Furniture Product Engineering. *3(3-0) . Preq: IE 210. Open only to students pursuing BS IE, Furniture Manufacturing Option, Wood Science and Technology and Industrial Design.* Introduction to use and properties of materials and construction methods used in mass production of furniture. Examines techniques of product engineering and its role in determining product quality and manufacturability. Emphasis on principles of computer-based product development, specification, and performance evaluation.

IE 331 Furniture Manufacturing Processes I. *3(3 1) . Preq: IE 330. Open only to students pursuing BS IE, Furniture Manufacturing Option. Wood Science and Technology, and Industrial Design.* Furniture manufacturing technology emphasizing mass production equipment capabilities and capacities. Relationship of product characteristics to machine selection and process planning activities. Introduction to computer-controlled machining and integrated manufacturing systems.

IE 351 Manufacturing Engineering. *3(2-3) . F,S. Preq: MAT 201, IE 210.* Analytical study and design of manufacturing engineering and processes. Emphasis on the interaction of design, materials, and processing, on the techniques of metrology, machining, process planning, computer-aided process control, economic justification, and state-of-the-art manufacturing technologies.

IE 352 Work Analysis and Design. *3(2-2) . Preq: ST 371.* Work methods and production processes to improve operator effectiveness and reduce production costs. Techniques studied include operation analysis, motion study, value engineering, predetermined time systems, time study and line balancing.

IE 361 Deterministic Models in Industrial Engineering. *3(3-0) . Preq: MA 303 or MA 341 or MA 405. For IE, ECE, and CSC majors and IE minors only.* Introduction to mathematical modeling, analysis techniques, and solution procedures applicable to decision-making problems in a deterministic environment. Linear programming models and algorithms and associated computer codes are emphasized.

IE 371 Furniture Production and Inventory Systems. *3(2 3) . Preq: IE 307, ST 361. Coreq: IE 430.* Forecasting, inventory control, production planning and scheduling, shop floor control. Organization of production control; use of computers. Examples from the furniture industry.

IE 401 Stochastic Models in Industrial Engineering. *3(3-0) . Preq: ST 371; MA 303 or MA 403. For IE, ECE, and CSC majors and IE minors only.* Introduction to mathematical modeling, analysis, and solution procedures applicable to decision making problems in an uncertain (stochastic) environment. Methodologies covered include dynamic programming, simulation, Markov chains, and classical optimization. Applications relate to problems such as inventory control, waiting lines, and system reliability and maintainability.

IE 408 Control of Production and Service Systems. *3(3-0) . F,S. Preq: IE 361; ST 371.* Planning and control of production and service systems. Production organization flow and inventory control methods: Systems approach.

IE 416 Manufacturing Engineering II - Automation. *3(3-0) . F,S. Preq: IE 316.* Integration of design and mfg. through computer aided/automated process planning, concurrent engineering, and rapid prototyping. Fixed and programmable automation in mfg. and service. Autonomous mfg. systems such as computer numerical control (CNC), industrial robotics, automated inspection, electronics manufacturing and assembly.

IE 417 Manufacturing Engineering III - Computer Integrated Manufacturing. *3(3-0) . F,S. Preq. IE 316 or IE 331.* Principles, economic justification, implementation, and performance evaluation of Computer Integrated Mfg. (CIM) systems. Fundamentals of group technology and cellular mfg. systems. Automation of information flow supporting the manufacturing operations using transaction processing via database technology. Real-time control of CIM systems including data acquisition, process control, and programmable logic controllers.

IE 430 Furniture Manufacturing Processes II. *3(3-1) . Preq: IE 331. Coreq: IE 352.* A survey of furniture manufacturing technology. Emphasis is on operations, production rates, and the integration of many types of equipment into a manufacturing system.

IE 431 Furniture Manufacturing Processes II. *3(3-1) . Preq. IE 430. Coreq. IE 352.* Engineering design of integrated furniture manufacturing facility. Emphasis on a coputer graphics based plant layout involving equipment selection/arrangement, materials handling and storage system design, and space utilization techniques. Additional topics include plant support and environmental systems.

IE 440 Furniture Management Analysis. *3(1-4) . Preq. IE 311, IE 431, IE 371.* Economic decision making applied to the furniture industry. Selection of equipment, materials, methods and strategy from several feasible alternatives studied with the aid of actual case histories.

IE (CSC) 441 Introduction to Simulation. *3(3-0) Preq: MA 242, ST 372, programming proficiency.* Discrete-event stochastic simulation for the modeling and analysis of systems. Programming of simulation models in a simulation language. Input data analysis, variance reduction techniques, validation and verification, and analysis of simulation output. Random number generators and random variate generation.

IE 443 Quality Design and Control. *3(2-2) . Preq: ST 372.* Statistical methods in quality control. Control charts for variables and attributes. Process capability assessment. Role of experimentation in designing for quality. Total Quality Management. Tools for continuous quality improvement. Quality Function Deployment.

IE 452 Ergonomics. *3(2-2) . Preq: CE 214 or equivalent. Coreq: IE 352.* Worker - machine environment systems, design and evaluation; applications to consumer products tools, equipment and the workplace. Consideration of anatomical, physiological and psychological capabilities and limitations as related to systems design and human performance. Use of anthropometric data in design of display and control systems. Effects of environmental stress upon work performance, safety, and health.

IE 453 Facilities Design. *3(2 2) . Preq: IE 351, IE 352.* Principles and practice in layout and material handling planning for industrial/service facilities. Integration of product and process and functional design of facilities. Computer software to optimize economic objectives. Group projects.

IE 495 Project Work in Industrial Engineering. *1 6. Preq: Jr standing.* Special investigations, study or research related to the field of industrial engineering. In a given semester several students and/or student groups may be working in widely divergent areas under the direction of several members of the faculty.

IE 498 Senior Design Project. *3(3-0) . Preq: IE 311, 408, 441, 443, 452 453.* Individual or group design projects requiring problem definition and analysis, synthesis, specification and presentation of a designed solution. Students work under faculty supervision either on actual industrial engineering problems posed by local industrial, service and governmental organization or on emerging research issues.

IE (MA, OR) 505 Linear Programming. *3(3-0) . F,S. Preq: MA 405.* Mathematical methods applied to problems of planning. Linear programming covered in detail. For those who desire an in-depth and detailed study. Provision for rigorous and complete development of theoretical and computational aspects of this technique as well as a discussion of a number of applications.

IE 510 Applied Engineering Economy. *3(3-0) . F. Preq: Undergrad. courses in engineering economics and ST or Consent of Instructor.* Engineering economy analysis of alternative projects including tax and inflation aspects, sensitivity analysis, risk assessment, decision criteria. Emphasis on applications.

IE 518 Manufacturing Operations Management. *3(3-0) . F,S. Preq: MA 242; ST(EC) 350 or ST 372. Not for IE majors.* Concepts, problems and procedures for the management of manufacturing operations. Emphasis on forecasting, capacity planning, material requirements planning, scheduling, inventory control and related computer-based control systems.

IE (CSC) 546 Management Decision and Control Systems. *3(2-2) . F. Preq: CSC 423 or BUS 541 or equivalent.* Planning, design, and development and implementation of comprehensive computer-based information systems to support management decisions. Formal information systems principles; information requirements analysis; knowledge acquisition techniques; information modeling. Information resource management for quality operational control and decision support; system evaluation, process improvement and cost effectiveness.

IE (CSC) 556 Voice Input/Output Communication Systems. *3(3-0) . F. Preq: IE 307 or CSC 312.* Introduction to physical, linguistic and computational principles underlying speech synthesis and speech recognition. Human factors of speech I/O. Advantages and disadvantages of implementing voice applications. Hands-on use of voice I/O equipment through class projects. Case studies of current applications of speech I/O technology.

IE 589 Special Topics In Industrial Engineering. *3(3-0) F,S. Preq: Consent of Instructor.* Special developments in some phase of industrial engineering using traditional course format. Identification of various specific topics and prerequisites for each section from term to term.

IE 601 Seminar. *1(1-0) . F,S* Seminar discussion of industrial engineering problems for graduate students. Case analyses and reports.

IE 610 Special Topics in Industrial Engineering. *3(3-0) . F,S. Preq Consent of Instructor* Special developments in some phase of industrial engineering using traditional course format. Identification of various specific topics and prerequisites for each section from term to term.

IE 637 Directed Study in Industrial Engineering. *1-6. F,S,Sum. Preq: Consent of Instructor.* Independent study providing opportunity for individual students to explore topics of special interest under direction of a member of faculty.

IE 639 Advanced Directed Study in Industrial Engineering. *1-6. F,S,Sum. Preq: Consent of Instructor.* Independent study providing an opportunity for individual graduate students to explore advanced topics of special interest under the direction of a member of the faculty.

IE 677 Industrial Engineering Projects. *1-6. F,S,Sum. Preq: MIE candidates only.* Investigation and written report on assigned problems germane to industrial engineering. Maximum of six credits to be earned for MIE degree.

IE 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

IE 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

IE 695 Seminar. Seminar discussion of industrial engineering problems for graduate students. Case analyses and reports.

IE 696 Research Practicum in Occupational Biomechanics. *3(1-4) . S. Preq: IE 764. Coreq: IE 765.* Biomechanics research topic development, literature evaluation, experimental design, use of bioinstrumentation, data collection, basic data interpretation, statistical analysis, manuscript preparation.

IE 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's student.* For student who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

IE 706 Design of Flexible Manufacturing Systems. *3(3-0) F. Preq: IE 307, IE 351 Coreq: IE 716.* Operational characteristics, information requirements, control structures and application of flexible manufacturing systems (FMS). Integration of technologies including computer numerical control (CNC) machining, robotics, intelligent sensors, automated material handling, and real-time computer control. Methodologies for design and evaluation of physical systems and associated control systems.

IE 707 Real-Time Control of Automated Manufacturing. *3(3-0) . S. Alt: yrs. Preq: IE 716.* Concepts and application of real-time control of automated manufacturing systems. Development of prototype manufacturing control applications involving introductions to following topics: computer architecture; real-time, multi-tasking operating systems; data modeling; multi-processing systems; local area networks; inter-task communication; and development of multi-tasking control systems. Design development of control system.

IE (OR) 709 Dynamic Programming. *3(3 0). S. Preq: MA 405, ST 421.* Introduction to theory and computational aspects of dynamic programming and its application to sequential decision problems.

IE 711 Capital Investment Economic Analysis. *3(3-0) . F. Preq: IE 311, ST 371* Analysis of economic merits of alternatives including interest and income tax considerations. Risk and sensitivity exploration techniques. Introduction to analytical techniques for multiple objectives or criteria. Use of mathematical programming and computers for capital budgeting.

IE 712 Bayesian Decision Analysis For Engineers and Managers. *3(3-0) . S. Preq: ST 371 or ST 421.* The Bayesian approach to decision making, with numerous applications in engineering and business. Expected value maximization, decision trees, Bayes' theorem, value of information, sequential procedures and optimal strategies. Axiomatic utility theory and controversies, utility of money, theoretical and empirical determination of utility functions and relationship to mean-variance analysis. Brief introduction to multi-attribute problems, time streams and group decisions.

IE 714 Product Engineering. *3(3-0) .*

IE 715 Process Engineering. *3(3-0) .*

IE 716 Computer-Aided Manufacturing. *3(3-0) . F,S. Preq: IE 351.* General principles of CAD/CAM integration. Elements of computer graphics. Engineering data base. Computer Process Control. Group Technology concepts and applications. Flexible manufacturing systems.

IE 717 Computerized Process Planning. *3(3-0) . S Preq: IE 716.* In-depth study of automated and Computer Aided Process Planning (CAPP). Analysis of process planning task and its various functions and stages; need for automation; approaches to CAPP system development; interrelationship of process planning with design and manufacturing, and their integration. Applications of CAPP and discussion of significant CAPP systems methodologies.

IE 719 CIM System Design. *3(2-3) . F. Preq: IE 716.* Tools and methods for design of computer-integrated manufacturing (CIM) systems in context of CIM development life-cycle. Emphasis on automation of information flow supporting process and assembly operations. Process flow techniques, hierarchical decomposition techniques, information structure analysis techniques; and methods to apply them to produce an integrated system.

IE (MAE) 720 Industrial Robotics. *3(3-0) F. Preq: IE 351; MA 301 or MA 303* Development, structure, specifications and capabilities of industrial robots. Robot control fundamentals. Kinematics of manipulators. Applications, selection, economics and implementation of robotic systems. Safety considerations, end-of-arm tooling and design of robotic workplace. Acutators, sensors including vision and tactile sensory systems for robots.

IE 721 Advanced Problems in Management Systems Engineering. *1-4. F. Preq: Consent of Instructor.* Coverage of advanced techniques, current research and contemporary problems in analysis, design and operation of management systems. Varied topics cover aspects of economic decision analysis, cost effectiveness, information flow, system performance evaluation and modern organization concepts.

IE 723 Production Planning, Scheduling and Inventory Control. *3(3-0) . F,S. Preq: OR 501 and ST 511 or equivalents.* An analysis of Production-Inventory systems. Discussion of commonly used planning and scheduling techniques. Introduction to use of math modeling for solution of planning and scheduling problems. Interface with quality control and information systems.

IE 725 Organizational Planning and Control. *3(3-0) . S. Preq: Three hrs. in operations management (such as IE 408).* Organization theory and systems approaches to administrative functions. Human and social influences of management systems for planning and control of activity. Policy, structure and procedure related to industrial engineering activities. Effects of automation.

IE (OR) 726 Theory of Activity Networks. *3(3-0) . S. Alt yrs. Preq: OR 501. OR(IE,MA) 505.* Introduction to graph theory and network theory. In-depth discussion of theory underlying (1) deterministic activity networks (CPM): optimal time-cost trade offs; the problem of scarce resources; (2) probabilistic activity networks (PERT): critical evaluation of underlying assumptions; (3) generalized activity networks (GERT, GAN): applications of signal flow graphs and semi-Markov process to probabilistic branching; relation to the theory of scheduling.

IE 731 Multi-Attribute Decision Analysis. *3(3-0) S. Preq: IE 711 or IE 712, OR 501 or OR 505.* Specification of attributes/criteria/objectives for complex decisions. Determination of alternatives, attribute weights and decision-making process. Graphical and weighted evaluation techniques. Multi-attribute utility, multi objective goal programming and analytic hierarchy process methodologies. Computer applications and case studies.

IE 736 Computer Integration of Manufacturing Systems. *3(3 0) . S. Preq: IE 716.* In-depth study of computer integration of manufacturing systems. CIM elements (CAD, CAPP, CNC, industrial robotics), manufacturing control, communication and networking, interfacing, database design, material handling and computer hardware requirements in automated manufacturing systems. Emphasis on integration of components involved in computerized manufacturing environments.

IE (PSY) 740 Human Factors in Systems Design. *3(3-0) . F. Preq: IE 452 or PSY 340. Coreq: ST 507 or 511.* Basic concepts of ergonomics and their application to design of human-machine systems and products. Consideration of human behavioral and biological capabilities and limitations in design for human efficiency, safety and comfort. Systems development cycle; human-machine function allocation; task and skill analysis; systems evaluation; anthropometry. Design of control and display systems, instrument panels, workplaces, seating and tools.

IE 741 Occupational Safety Engineering. *3(3-0) . S. Alt. yrs Preq: IE 452, PSY 340 or IE(PSY) 740; ST 372, 507 or 511.* Occupational accident-injury study; morbidity, mortality; investigation and analysis. Hazard control; energy countermeasure strategies; control technology. Impact biomechanics, trauma and survivability. Risk assessment; systems safety analysis. Product design, manufacturing defects, system failures and human error as causative factors. Safety program development. Near-accident reporting. OSHA compliance; standards. Accident, trauma and forensic case studies from manufacturing, motor carrier and construction industries.

IE 742 Environmental Stress, Physiology and Performance. *3(3-0) . S. Alt. yrs. Preq: IE(PSY) 740; IE(PSY) 745 or PSY 744.* Human skilled performance as affected by environmental stressors, including noise, vibration, heat, cold, accelerator, pressure altitude, toxic agents and illumination. Physiological effects of stressors and their relationship to health, performance and, ultimately, to safety. Impact biomechanics and crash survival. Human survival in adverse environments. Combined stressor effects, physiological arousal, fatigue and performance decrement.

IE (PSY) 743 Ergonomic Performance Assessment. *3(3 0) . F. Preq: PSY 200, ST 507 and 508 or equivalent* Fundamentals of ergonomic performance measurement used to assess the effects of environment and system design on human performance. Treatment of topics such as workload measurement, measurement of complex performance, simulator studies, measurement of change, task taxonomies, criterion task sets and statistical methods of task analysis. Problems of laboratory and field research, measurement of change and generalizability of findings.

IE (PSY) 744 Human Information Processing. *3(3-0) . S. Alt. yrs. Preq: PSY 200, ST 507 and 508 or equivalent.* Fundamentals of human information processing basic to skilled operator performance and the design of displays, controls and complex systems. Treatment of topics such as channel capacity, working memory, long-term memory, decision making, attention and process monitoring. Problems of display and control design and evaluation, evaluation of textual material, and human-computer interaction.

IE (PSY) 745 Human Performance. *3(3-0) . S. Alt. yrs. Preq: Grad. standing; ST 507 or equivalent.* Fundamentals of human perceptual and motor abilities basic to skilled operator performance. Theoretical models of man as an operator. The human as an information processing mechanism. Motor skills learning, performance decrement and information feedback. Channel capacity, stress, fatigue, arousal theory. Attention, time-sharing and workload. Sustained performance, vigilance, monitoring, search, inspection and tracking. Circadian rhythms; sleep loss; shift work.

IE 747 Reliability Engineering. *3(3-0) . F. Alt. yrs. Preq: ST 511 or equivalent.* Introduction to basic concepts of reliability engineering. Application of probability and statistics to estimate reliability of industrial systems; development of reliability measures; analysis of static and dynamic reliability models; development and analysis of fault trees; analysis of Markovian and non-Markovian models; and optimization of reliability models.

IE 748 Quality Engineering. *3(3-0) . S. Alt. yrs. Preq: OR 501, ST 511.* Introduction to basic concepts of quality engineering. Statistical process control (SPC) methods, acceptance sampling techniques, concept of parameter design and statistical as well as analytical techniques for its implementation, tolerance analysis and design, components of cost of poor quality and an introduction to quality management.

IE 749 Tolerances in Design and Manufacturing. *3(3-0) . S. Alt. yrs. Preq: IE 716, ST 372.* Tolerancing of discrete parts and assemblies. Limit tolerancing and geometric tolerancing techniques. American National Standard and its applications. Methods of tolerance analysis and synthesis including computer implementation. Tolerance representation in CAD systems. Relationship between tolerances and cost. Functional tolerancing.

IE 750 Concurrent Engineering. *3(3-0) . F. Preq: IE 716.* Approaches to concurrent engineering, concurrent engineering of printed wiring boards, design for testability, design for assembly, process selection, interface to feature-based computer-aided design systems, concurrent engineering of metal parts, concurrent engineering performance measurement, concurrent engineering and computer-integrated manufacturing.

IE 751 Modeling Imprecision in Design and Manufacturing. *3(3-0) F,S.* Computational tools using fuzzy logic and interval mathematics as applied to engineering applications exploring modeling imprecision in design and manufacturing. An understanding of imprecision in engineering, issues making modeling imprecision difficult, current methods to successfully model imprecision and areas of active research.

IE 753 Material Handling Systems. *3(3-0) . S. Preq: IE 453.* Analysis, design, evaluation and implementation of material handling systems. Principles, functions, equipment, concepts and traditional approaches of material handling. Impact of facilities design on material handling and application of quantitative techniques to material handling systems design. Description of factors and approaches to material handling management and the criticality of properly designed and operated material flow systems.

IE 754 Logistics Engineering. *3(3-0) . S. Preq: IE 453 and IE 723.* Elements of logistics networks. Supply chain design: facility location and allocation; great-circle distances; geocoding. Multi-echelon production and inventory systems; sourcing decision systems. Vehicle routing: exact, approximation, and heuristic procedures; traveling salesman problem; basic vehicle routing problem and extensions; backhauling; mixed-mode transportation system design.

IE 755 The Just-In-Time Production System. *3(3-0) . F. Preq: IE 723; OR 501.* Concepts, requirements, limitations, examples and implementation procedures of the Just-In-Time Production System (JIT). Relationship between JIT and total quality assurance, total employee involvement and computer-integrated manufacturing systems. Organizational changes under JIT. Mathematical programming models, simulation-animation models and object-oriented knowledge systems supporting the design of JIT.

IE (CSC) 756 Advances in Voice Input/Output Communications Systems. *3(2-3) S. Preq: IE(CSC) 556.* Selected topics from current literature in voice input/output research, technology and applications. Execution of a significant experiment or project by each student.

IE 759 Constraint Modeling of Manufacturing Systems. *3(3-0) . S. Alt. yrs. Preq: IE 750 or Consent of Instructor.* The formal basis for constraint-based modeling applied to manufacturing systems. Representing constraints, constraint propagation and detecting constraint violations. Applicability to modeling manufacturing problem solving.

IE 760 Applied Stochastic Models in Industrial Engineering. *3(3-0) . F. Preq: MA 303, ST 371.* Formulation and analysis of stochastic models with particular emphasis on applications in industrial engineering; univariate, multivariate and conditional probability distributions; unconditional and conditional expectations; elements of stochastic processes; moment-generating functions; concepts of stochastic convergence; limit theorems; homogeneous, nonhomogeneous and compound Poisson processes; basic renewal theory; transient and steady-state properties of Markov processes in discrete and continuous time.

IE (OR) 761 Queues and Stochastic Service Systems. *3(3-0) . S. Preq: MA 421* Introduction of general concepts of stochastic processes. Poisson processes, Markov processes and renewal theory. Usage of these in analysis of queues, from with a completely memoryless queue to one with general parameters. Applications to many engineering problems.

IE (CSC, OR) 762 Computer Simulation Techniques. *3(3-0) F Preq. ST 512 and a scientific programming language.* Basic discrete event simulation methodology: random number generators, simulation designs, validation, analysis of simulation output. Applications to various areas of scientific modeling. Simulation language such as SLAM and GPSS. Computer assignments and projects.

IE 764 Occupational Biomechanics. *3(2-2) . F. Preq: Grad. standing.* Anatomical, physiological, and biomechanical bases of physical ergonomics. Strength of biomaterials, human motor capabilities, body mechanics, kinematics and anthropometry. Use of bioinstrumentation, active and passive industrial surveillance techniques and the NIOSH lifting guide. Acute injury and cumulative trauma disorders. Static and dynamic biomechanical modeling. Emphasis on low back, shoulder and hand/wrist biomechanics.

IE 765 Musculoskeletal Mechanics. *3(2-2) . F. Preq: BIO 125 or grad. standing.* Anatomy, physiology and biomechanics of musculoskeletal system including muscle, bone, tendon, ligament, cartilage, nerve. Modeling of tissue and joints with special emphasis on spine and upper extremity. Physical, mathematical, optimization and finite element modeling techniques as applied in biomechanics research.

IE (MA, OR) 766 Network Flows. *3(2-2) . S. Alt. yrs. Preq: OR(IE,MA) 505 or equivalent.* Study of problems of flows in networks. These problems include the determination of shortest chain, maximal flow and minimal cost flow in networks. Relationship between network flows and linear programming developed as well as problems with nonlinear cost functions, multi-commodity flows and problem of network synthesis.

IE 767 Upper Extremity Biomechanics. *3(3-0) . F. Alt. yrs.(even). Preq: IE 763, IE 764.* Gross and functional anatomy of upper extremity; properties of tendons and synovial fluid; epidemiology; disorders of shoulder, elbow, wrist, hands, fingers; biomechanical modeling; personal factors affecting cumulative trauma disorder (CTD) risk, diagnosis and treatment of upper extremity CTDs; wrist splints; workplace ergonomics to alleviate upper extremity CTDs.

IE 768 Spine Biomechanics. *3(3-0) . F. Alt. yrs.(odd). Preq: IE 763, 764.* Gross and fine anatomy of spine, mechanism of pain, epidemiology, in vitro testing, psychophysical studies, spine stability models, bioinstrumentation: intradiscal pressure, intra-abdominal pressure and electromyography. Biomechanics of lifting and twisting, effects of vibration, effects of posture/lifting style, lifting belts, physical models, optimization models, mathematical models, muscle models, finite element models, current trends in medical management and rehabilitation, chiropractic.

IE (OR) 772 Stochastic Simulation Design and Analysis. *3(3-0) . S. Preq: (CSC,ECE,IE,OR) 762 and ST 516.* Advanced topics in stochastic system simulation, including random variate generation, output estimation for stationary and nonstationary models, performance optimization techniques, variance reduction approaches. Student application of these techniques to actual simulations. A current topic research paper required.

IE 789 Advanced Special Topics In Industrial Engineering. *3(3-0) . F,S. Preq: Consent of Instructor.* Advanced topics in some phase of industrial engineering using traditional course format. Identification of various specific topics and prerequisites for each section from term to term.

IE (MA, OR) 790 Advanced Special Topics System Optimization. *1-3. F,S.* Advanced topics in some phase of system optimization using traditional course format. Identification of various specific topics and prerequistes for each section from term to term.

IE 791 Advanced Special Topics in Manufacturing. *1-3. F,S.* Advanced topics in some phase of manufacturing systems using traditional course format. Identification of various specific topics and prerequistes for each section from term to term.

IE 793 Advanced Special Topics in Production. *1-3. F,S.* Advanced topics in some phase of production systems using traditional course format. Identification of various specific topics and prerequisites for each section from term to term.

IE 794 Advanced Problems in Ergonomics. *3(3-0) . F. Preq: IE(PSY) 740, ST 511.* Exploration in depth of a problem area of contemporary interest involving man-machine-environment interface. Class discussion and analysis of research and theory, with special focus on human factors aspects of systems design and operation.

IE 796 Research Practicum in Occupational Biomechanics. *3(1-4) . S. Preq: IE 764. Coreq. IE 765.* Biomechanics research topic development, literature evaluation, experimental design, use of bioinstrumentation, data collection, basic data interpretation, statistical analysis, manuscript preparation.

IE 801 Seminar. *1(1-0) . F,S.* Seminar discussion of industrial engineering problems for graduate students. Case analyses and reports.

IE 802 Area Seminar in Ergonomics. *1(1-0) . F. Preq: Grad. standing or PBS status.* Introduction to ergonomics as an area of study; historical aspects; contemporary issues; ethical questions; overview of campus research, facilities and courses in the area; consideration of information sources, financial support for research proposals and employment opportunities.

IE 803 Seminar in Product Safety and Liability. *1(1-0) . S. Alt. yrs. Preq: Grad. standing.* Consumer product safety, laws and standards. Products liability, negligence, due care, strict liability and foreseeability. Product defects, design flaws and liabilities, hazard control, ergonomics design, warnings and labels. Product safety programs for manufacturers; management guidelines. Litigation process, forensic investigation and expert witnessing. Accident case studies.

IE 804 Seminar in Applied Ergonomics. *1(1-0) . On demand. Preq: IE(PSY) 740; ST 511.* Discussion of contemporary issues involving ergonomic approaches to design of work, products and systems. Survey of current ergonomics research and methodologies and their application to areas of faculty and student interest, such as: industrial ergonomics, occupational safety, manufacturing, transportation, computer systems and process control.

IE (MA, OR) 812 Special Topics in Mathematical Programming. *S. Alt. yrs. Preq: IE(MA,OR) 705.* Study of special advanced topics in area of mathematical programming. Discussion of new techniques and current research in this area. The faculty responsible for this course select areas to be covered during semester according to their preference and interest. This course not necessarily taught by an individual faculty member but can, on occasion, be joint effort of several faculty members from this university as well as visiting faculty from other institutions.

IE 815 Advanced Special Topics in Industrial Engineering. *1-3. F,S.* Advanced topics in some phase of industrial engineering. Identification of various specific topics and prerequisites for each section from term to term.

IE (MA, OR) 816 Advanced Special Topics System Optimization. *1-3. F,S.* Advanced topics in some phase of system optimization. Identification of various specific topics and prerequisite for each section from term to term.

IE 817 Advanced Special Topics Manufacturing. *1-3. F,S.* Advanced topics in some phase of manufacturing systems. Identification of various specific topics and prerequisites for each section from term to term.

IE 818 Advanced Special Topics Production. *1-3. F,S.* Advanced topics in some phase of production systems. Identification of various specific topics and prerequisites for each section from term to term.

IE 837 Directed Study in Industrial Engineering. *1-6. F,S,Sum. Preq: Consent of Instructor.* Independent study providing opportunity for individual students to explore topics of special interest under direction of a member of faculty.

IE 839 Advanced Directed Study in Industrial Engineering. *1-6. F,S,Sum. Preq: Consent of Instructor.* Independent study providing an opportunity for individual graduate students to explore advanced topics of special interest under the direction of a member of the faculty.

IE 861 The Design of Production Systems. *3(3-0) . F, Alt. yrs. Preq: IE 723, OR 501.* The structure and operation of production planning, scheduling and control systems; emphasis on system structure, capacity planning, master production scheduling, shop loading and supply chain; investigation of current trends.

IE (OR) 862 Advanced Scheduling and Routing. *3(3-0) . S. Alt. yrs. Preq: IE 723, OR 501, OR(MA) 504.* In-depth study of analytical models of problems arising in the scheduling of single and parallel processors, flow shops and job shops and in routing and scheduling of delivery vehicles. Emphasis on analysis, solution methodologies and underlying theory. Discussion of recent trends and outstanding problems from both theoretical and applied points of view.

IE 877 Industrial Engineering Projects. *1-6. F,S,Sum. Preq: MIE candidates only.* Investigation and written report on assigned problems germane to industrial engineering. Maximum of six credits to be earned for MIE degree.

IE 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq: Doctoral Student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

IE 890 Doctoral Preliminary Examination. *1-9. F,S,Sum. Preq: Doctoral Student.* For students who are preparing for and taking written and/or oral preliminary exams.

IE 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq: Doctoral Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

IE 895 Doctoral Dissertation Research. *1-9. F,S,Sum. Preq: Doctoral Student.* Dissertation Research

IE 899 Doctoral Dissertation Preparation. *1-3. F,S,Sum. Preq: Doctoral Student.* For students who have completed all credit hour requirements, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

IMMUNOLOGY

IMM 595 Special Topics. *F,S.*

IMM 610 Special Topics. *F,S.*

IMM 620 Special Problems. *F,S.*

IMM 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

IMM 690 Master's Examination. *1-6. F,S,Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

IMM 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

IMM 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research.

IMM 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment of the master's degree and are writing and defending their theses.

IMM (TOX) 705 Immunotoxicology. *2(2-0) . S. Preq: TOX 701.* Concepts in the study of adverse effects of chemicals on the immune system, including allergic responses, autoimmunity and immunosuppression. Significance of immunotoxic effects resulting from environmental or workplace exposure. Role of immunotoxicity in risk assessment.

IMM (MB) 751 Immunology. *3(3-0) . S. Preq: BCH 451, GN 411, MB 351.* Introduction to mechanisms of immunity in man and animals. Emphasis on interactions between cells of the immune system in production of immune responses and the molecules in control of these interactions.

IMM (CBS) 755 Immunoparasitology. *2(2-0) . S. Alt. yrs. Preq: MB 751.* Helminth and protozoal parasite immune evasion and immunomodulation; consequences of parasite-induced immunopathogenesis; learning from failed attempts to develop protective vaccines against protozoa and helminths.

IMM (CBS, MB, PHY, PO) 756 Immunogenetics. *3(2-2) . F, Alt. yrs. Preq: MB 501C or MB 751 or Consent of Instructor.* Basic concepts of the immune system. Genetic basis of the immune response including immunoglobulin genetics, major histocompatibility complexes and their role in the immune response, the molecular basis of the immune system and effector mechanisms.

IMM (PO) 757 Avian Immunology. *2(1-2) . F (Odd yrs.). Preq: MB 751, PO 756 or Consent of Instructor.* Specific features of the avian immune system based on its organization, functions and comparison with its mammalian counterparts. Laboratory immunological techniques using the chicken as an animal model.

IMM (CBS, MB) 783 Advanced Immunology. *3(3-0) . F. Alt. yrs. Preq: CBS 753 or MB 751 or equivalent or Consent of Instructor.* The ontogeny and phylogeny of self and non-self recognition. Emphasis on basic mechanisms evolved during the evolution of the species. Speciality areas such as immunology of reproduction and genetic regulation of the immune response.

IMM 795 Special Topics. *F,S.*

IMM (CBS) 807 Seminar in Veterinary Microbiology/Immunology. *1(1-0) F S.* Presentation of ongoing research and current topics in microbiology.

IMM 810 Special Topics. *F,S.*

IMM (CBS) 816 Advanced Topics In Immunology and Biotechnology. *1(1-0) . F,S,Sum. Preq: MB "51 or Consent of Instructor.* A study of selected topics of current interest in immunology/biotechnology. A new topic selected each semester to keep the advanced graduate students up to date on the most recent developments in these fields.

IMM 820 Special Problems. *F,S.*

IMM 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq. Doctoral student* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

IMM 890 Doctoral Preliminary Examination. *1-9 F,S. Preq. Doctoral student* For students who are preparing for and taking written and or oral preliminary exams

IMM 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq. Doctoral student* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

IMM 895 Doctoral Dissertation Research. *1 9 F,S,Sum Preq: Doctoral student* Dissertation research.

IMM 899 Doctoral Dissertation Preparation. *1-3. F,S,Sum. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

INTEGRATED MANUFACTURING SYSTEMS ENGINEERING

IMS 675 Manufacturing Systems Engineering Project. *1-3. F,S. Preq: Grad. standing in IMSE; Consent of Instructor.* Individual or team project work in integrated manufacturing systems engineering resulting in an engineering report. Required of all degree candidates in IMSE master's program. Forms the basis for IMSE student's final oral examination.

IMS 680 Master's Directed Study. *1-3. F,S. Preq: Graduate Standing in IMSE, Consent of Instructor.* Independent study providing opportunity for individual students to explore topics of special interest under direction of a member of faculty.

IMS 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

IMS 690 Master's Examination. *1 6. F,S,Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master s exam.

LANDSCAPE ARCHITECTURE

LAR 221 Introduction to Environment and Behavior for Designers. *3(3-0) .* Integration of behavioral and environmental systems related to design. Exploration of humane, ecologically sound design alternatives.

LAR 222 Perception and Behavior for Designers. *3(3-0) .* Perceptual systems, linkages among them, and linkages between them and language and culture as these affect the design process.

LAR 292 Special Topics in Landscape Architecture. *1-3. Preq. Consent of instructor.* Topics of current interest in Landscape Architecture. Normally used to develop new courses.

LAR 400 Landscape Architecture Studio. *6(0-9) . Preq: DF 102 or written approval of department head and dean.* Projects cover small scale design, urban landscapes, community design, and environmental management. Design process stressed, including attention to project organization, design synthesis and realization.

LAR 421 Environmental Cognition for Designers. *3(3-0) .* Basic cognitive theory as a framework for exploration of cognitive imagery; images of self; and developmental images of home, school, neighborhood, and city.

LAR 423 Concepts of Space. *3(3-0)* . The role of space and its representation in design is considered against an overview of concepts of space drawn from psychology, anthropology, mathematics, art history, and philosophy.

LAR 430 Site Planning. *3(2-3) . Preq: MEA 101/110 or MEA 120/110 or SSC 200.* Technical operations and environmental landscape controls for site development. Site analysis, grading and drainage, earthwork, horizontal and vertical control for road alignment. Graphic exercises.

LAR 433 Native Plants in Environmental Design. *3(2-3)* . Analysis of natural processes relating to plant materials native to this region. Planting design theory. Planting design methods. Applications in a laboratory setting.

LAR 443 Landscape History. *3(3-0)* . Human impact on the land over the past 20,000 years: development of agriculture, commerce and industry and their role in changing the face of the earth.

LAR 444 History of Landscape Architeeture. *3(3-0) . F.* The history of designed landscapes. Environmental, social and cultural factors which influence human made landscapes presented with history and art of landscape architecture.

LAR 445 American Parks, Parkways and Estates. *3(3-0) . S. Preq. Junior standing.* Design and planning traditions of parks and parkways. Philosophical and social motivation for establishment of national parks. Field trip to Biltmore Estate and Blue Ridge Parkway.

LAR 457 Landscape Construction Materials, Methods and Documentation. *3(2-3) Preq: LAR 430.* Materials, standards, and construction methods used to implement landscape architectural designs. Development of construction documents.

LAR 465 Landscape Architecture International Studio. *6(6-0) . Sum. Preq: Junior standing in the School of Design or equivalent program and approval of the International Study Abroad Office.* Define landscape architectural problems and develop design solutions in an international setting. Exercises and projects related to design, culture and the physical environment of the host country. Focus on landscape architecture, gardens and urbanism studied through sketching and documentation, discussion, site investigation, historical context, current design examples and design applications.

LAR 492 Special Topics in Landscape Architecture. *Preq: Consent of instructor.* Topics of current interest in Landscape Architecture. Normally used to develop new courses.

LAR 494 Internship in Landscape Architecture. *1-3. F,S,Sum. Preq: Jr. standing in Landscape Architecture; 3.0 GPA or better.* Supervised field experience in landscape architecture office, related design office, or governmental agency. Students work in an office or agency for up to 12 hours per wek. A daily work journal and a final paper summarizing the work experience are required.

LAR 495 Independent Study in Landscape Architecture. *1-3. F,S,Sum. Preq: Jr. standing in Landscape Architecture 3.0 GPA or better.* Individual projects in landscape architecture developed under the direction of a faculty member on a tutorial basis.

LAR 500 Landscape Design Studio. *6(0-12) . F,S. Preq: Grad. standing.* Application of information and skills developed in course work to environmental design problems. Process of site selection, activity programming, site planning and program evaluation followed employing creation of interactive communication systems between designer, clients and users. Goals include design of satisfying new landscapes as well as conservation and design strategies for existing culturally important landscapes and townscapes.

LAR 510 Graphics for Landscape Architects. *3(3-0) F. Preq: Grad. standing or Consent of Instructor. Coreq: LAR 500 or Consent of Instructor.* A series of demonstrations and exercises to give students exposure to and experience with conventional techniques of graphic representation and presentation.

LAR 511 Community Design Policy. *3(3-0) . S Preq: Grad. standing or Consent of Instructor.* Exploration of theory and practices of social policy impact on designed environment and users of that environment. Study of public community development process studied in relation to built environment.

LAR 512 Landscape Resource Management. *3(1 4) . S. Preq: Consent of Instructor.* Laboratory techniques course in methodology of analysis and management of natural resources as related to landscape architecture. Case study approach to managed resource systems using spatial mapping and analysis techniques.

LAR 513 Social Factors Analysis In Site Planning. *3(2 1) . S. Preq: LAR 511 or Consent of Instructor.* Exploration of social factors, techniques and research applications to design of the landscape. Interaction, neighborhood theory and user preference analysis techniques presented through discussion and development of research and case studies.

LAR 515 Advanced Community Design and Development Control. *3(1-3) . S. Preq: LAR 511.* Advanced work in design and application of governmental planning and development control techniques to built environments, and impact of such controls on design solutions at varying scales. Emphasis on design implications of complex control systems: development rights transfer, land use intensity rating systems, planned unit development regulations and other zoning and non-zoning site planning regulations.

LAR 521 Values, Theory and Methods Of Landscape Architecture. *3(3-0) . F. Preq: Grad. standing.* Radical change in profession of landscape architecture in the past decade. New and emerging roles for landscape architect include regional analysis, landscape assessment, land development, urban planning, recreation planning, etc. Development of core values and theories from which each emerged and survey of the techniques and methods of their development.

LAR 530 Advanced Site Planning. *3(2-2) . S. Preq: LAR 430.* Expansion of fundamental site planning techniques applied to development of design proposals including grading, utilities, layout plans, hydrologic calculations, details and specifications.

LAR 533 Plants and Design. *3(2-2) . S.* Examination of three landscape types: natural landscapes, landscapes altered by man and designed landscapes. Investigation of relevant plant materials and planting design processes utilized to reveal natural principles as basis for a design theory and methodology. Course assignments range from an analysis of actual plant materials and landscapes to preparation of contract documents.

LAR 551 Ethics Of Professional Practice In Landscape Architecture. *3(3-0) . S.* Examination of place of professional in society, contents and philosophies of various professional codes of ethics, relationship of the practitioner with clients, peers and the public interest. Preparation of proposals, conduct as an expert witness, office organization and contracts.

LAR 564 Management and Marketing Techniques In Community Design. *3(3-0) S. Alt. yrs.* Methods for effective management of community design processes. Emphasis on personal management skills, group process techniques, publicity materials, public relations and marketing strategies. A technical assistantship with a local agency/organization required.

LAR 565 International Landscape Architecture Design Studio. *6(0-27) . Sum Preq: Graduate standing the School of Design or equivalent program and approval of the International Abroad Study Office.* Landscape architectural problems and design solution in international setting. Exercises and projects related to design, culture and physical environment of host country. Focus on landscape architecture, gardens and urbanism through sketching and documentation, discussion, site investigation, historical context, current design examples and design applications.

LAR 573 Historic Preservation. *3(3-0) . F Preq :Grad. standing and Consent of Instructor.* Seminar covering legal, administrative, fiscal and political aspects of preserving and conserving buildings, sites, districts, objects and landscapes of architectural, historical and design significance as related to community design and planning considerations. Subjects to be treated include federal, state and local statutes and ordinances; federal and state court decisions and administrative processes.

LAR 574 Landscape and Townscape Conservation. *3(3-0) . S. Preq: LAR 511.* Examination of local, state and federal law affecting the visual quality of large-unit natural and built environments such as landscapes and townscapes, as expressed in local ordinances, state statutes, executive orders, administrative regulations and court decisions. Emphasis on legal, administrative, fiscal and governmental tools and processes for maintaining and enhancing visual environmental quality.

LAR 575 Development Planning. *3(3-0) . F,S. Preq: Grad. standing or Consent of Instructor.* Seminar presentation of concepts, processes and principles used in design and development of communities. Focus discussions on a general development process, the development team and the role of designer in context of team. Discussion of wide range of project types. Relationships of public regulatory policies and programs to community design and development process.

LAR (ARC) 576 Community Design. *3(3-0) . F. Preq: Graduate Standing. For Master's student in School of Design or Department of City & Regional Planning (UNC-Chapel Hill). Consent of instructor required for non-design or non-planning students..* Processes through which citizens shape and manage built environment. Strategic planning, visioning process, community action, and mediation will be discussed and illustrated with case study examples from architecture, landscape architecture and planning. Analysis and assessment from case studies of participation techniques such as charrette, study circles, and visual appraisal.

LAR (ARC) 577 Sustainable Communities. *3(1.50-1.50) . S. Preq: Graduate Standing. For master's students in the School of Design or Department of City & Regional Planning (UNC-Chapel Hill). Permission of instructor required for non-design or non-planning students..* Historical precedents of sustainable communities. Examination of the Garden City, the New Towns Movement, and the New Urbanism. Comparison of sustainable communities to urban visions of Wright, Corbusier, Soleri and others. Virtual cities and digital communities.

LAR 578 Ecological Design. *3(2-1) . F. Preq: Graduate Standing. Master's students in the School of Design or Department of City & Regional Planning (UNC-Chapel Hill). Permission of instructor required for non-design or non-planning students.* An integrative approach to human and natural systems. Ecological scale, function, spatial structure, and human-ecosystem interaction will be examined through case studies at a variety of scales. Ecological concepts will be linked to design and planning principles.

LAR 579 Human Use of the Urban Landscape. *3(0-3) . F. Preq: Graduate Standing. For master's students in the School of Design or Department of City and Regional Planning (UNC-Chapel Hill). Permission of instructor required for non-design or non-planning students.* Techniques for documenting and analyzing user needs at site planning scale. Methods of integrating user needs into design programming in design and redesign projects. Community participation methods. Examples of best practice in design of user-intensive settings in residential, health, education, and recreation. Principles of Universal Design. Fieldwork oriented.

LAR 582 Special Topics In Landscape Architecture. *2-3. F,S. Preq: Grad. standing.* Topics of current interest to programs in School of Design offered by faculty in the School. Subjects offered under this number are normally used to test and develop new courses.

LAR 630 Independent Study. *1-6. F,S,Sum. Preq: Grad. standing.* Special problems in various aspects of design developed under direction of a faculty member on a tutorial basis.

LAR 679 Final Project Studio In Landscape Architecture. *2-6. F,S. Preq: LAR 697.* Graduate students sufficiently prepared may undertake selected research investigations. A proposal for such investigations must be submitted prior to consent for enrollment.

LAR 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

LAR 690 Master's Examination. *1-6. F,S,Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

LAR 697 Final Research Project. *0 F,S. Preq: 3 LAR 500 studios.* Each student in his or her terminal semester not registered in any other courses and in conjunction with terminal case study will prepare and submit to his or her committee a presentation on relevance of one's minor to design process with particular reference to individual's case study.

FOREIGN LANGUAGES AND LITERATURES - LATIN

LAT 101 Elementary Latin I. *3(3-0)* . Beginning course in Classical Latin, emphasizing elementary grammatical form and basic syntax. Readings based on brief selections from Roman authors, including Cicero and Catullus.

LAT 102 Elementary Latin II. *3(3-0)* . Continuation of Latin 101. Completion of the study of elementary grammar. Readings from a variety of Latin authors, including texts on mythological themes.

LAT 201 Intermediate Latin I. *3(3-0) . F. Preq. LAT 102.* Introduction to Latin prose and poetry. Emphasis on increased reading skill. Review of grammar fundamentals and exposure to new and more complex syntax. Examination of cultural significance of readings.

LAT 202 Intermediate Latin II. *3(3-0) . Preq: LAT 201.* Lyric poetry of Catullus and Horace emphasizing vocabulary, syntax, and techniques of Latin verse. Traditions and the evolution of lyric poetry and the social role of the Roman poet.

LAT (GRK) 310 Classical Mythology. *3(3-0)* . Greek and Roman mythology through the writings and art of the Classical period. Discussion of creation stories, the major gods and heroes, the underworld and afterlife. Intellectual religious and educational role of myth and of the most important theories of interpretation and classification. All readings and discussion in English.

LOGIC

LOG 201 Logic. *3(3-0)* . Introduction to methods of deductive inference. Concepts of inconsistency and entailment. Truth Functional Statement Logic and Quantifier and Predicate Logic. Representation of logically significant form of statements and arguments. Procedures to discover and notation to write down proofs.

LOG (MA) 335 Symbolic Logic. *3(3-0) . Preq: LOG 201 or MA 225.* Introduction to modern symbolic logic; the concept of proof, mathematical induction, recursion and the relationship between formal and informal theories (examples: group theory, Peano arithmetic). The G~del Theorems and the mathematical study of logic.

MANAGEMENT

M 200 Microcomputer Applications for Business and Accounting. *1(0-2) . Preq: Open to Accounting, Business Management, Economics, and Agricultural and Resource Economics majors only.* Use of microcomputers in business. Applications and exercises using operating system, word processing, and spreadsheet software for specific business problems. Integration of software packages to prepare business reports.

MATHEMATICS

MA 100 Precalculus by Self Study. *3(0-7) . Preq: Algebra I.* Enrollment is limited to students who have not received credit for a calculus course or higher at NC State. Freshman may attempt the course twice while all other classifications of students may take the course once. MA 100 may not be counted as credit toward meeting graduation requirements in any curriculum. Directed self study of precalculus topics to prepare students for a Mathematics Level II C Achievement Test in order to qualify for placement into the appropriate calculus course at NC State.

MA 101 Intermediate Algebra. *4(5-0) . Preq: Credit for MA 101 is not allowed if student has prior credit in any other mathematical course. MA 101 may not be counted as credit toward meeting graduation.* Preparation for MA 103, MA 105, MA 107, MA 111, and MA 114. Reviews main topics from high school Algebra I and Algebra II emphasizing functions and problem solving. Other concepts and skills covered include algebraic operations, factoring, linear equations, graphs, exponents, radicals, complex numbers, quadratic equations, radical equations, inequalities, systems of equations, compound inequalities, absolute value in equations and inequalities.

MA 103 Topics in Contemporary Mathematics. *3(3-0) . Preq: MA 101 or equivalent completed in high school.* Primarily for students in Humanities and Social Sciences. Illustrations of contemporary uses of mathematics, varying from semester to semester, frequently including sets and logic, counting procedures, probability, modular arithmetic, and game theory.

MA 105 Mathematics of Finance. *3(3-0) . Preq: MA 101 or equivalent completed in high school.* Simple and compound interest, annuities and their application to amortization and sinking fund problems, installment buying, calculation of premiums of life annuities and life insurance.

MA 107 Precalculus I. *3(3-1) . Preq: Placement via Achievement Test or MA 101. Credit is not allowed for both MA 107 and MA 111. Credit for MA 107 does not count toward graduation for students in Engineering, PAMS Design, Bio and Ag Engineering (Science Program), Bio Sci (all options), Math Edu, Sci Edu, Textiles, College of Management, and B.S. degrees in CHASS.* Algebra and basic trigonometry; polynomial, rational, exponential, logarithmic and trigonometric functions and their graphs.

MA 108 Precalculus II. *3(3-1) . Preq: C or better in MA 107. Credit is not allowed for both MA 108 and MA 111. Also, MA 108 should not be counted toward the GER mathematical sciences requirement. Credit for MA 107 does not count toward graduation for students in Engineering, PAMS, Design, Bio and Ag Engineering (Science Program), Bio Sci (all options), Math Edu, Sci Edu. Textiles. College of Management, and B.S. degrees in CHASS.* Algebra, analytic geometry and trigonometry; inequalities, conic sections, complex numbers, sequences and series, solving triangles, polar coordinates, and applications.

MA 111 Precalculus Algebra and Trigonometry. *3(3-1) . Preq: Placement via Level Two Achievement Test or MA 101; Credit is not allowed for both MA 111 and either MA 107 or MA 108. Credit in MA 111 does not count toward graduation for students in Engr., Physical & Math. Sci., Design, Biological & Ag. Engr. (Science Program), Biological Sci.(all options),Math. Edu., Forestry, & Textiles.* Real numbers, functions and their graphs (special attention to polynomial, rational, exponential, logarithmic, and trigonometric functions), analytic trigonometry.

MA 114 Introduction to Finite Mathematics with Applications. *3(3-0) . Preq: MA 101 or equivalent completed in high school.* Elementary matrix algebra including arithmetic operations, inverses, and systems of equations; introduction to linear programming including simplex method; sets and counting techniques, elementary probability including conditional probability; Markov chains; applications in the behavioral, managerial and biological sciences. Computer use for completion of assignments.

MA 121 Elements of Calculus. *3(3-0) . Preq: MA 107 or 111 or placement via Level Two Achievement Test. Credit is not allowed in more than one of MA 121, 131, 141. MA 121 may not be substituted for MA 131 or MA 141 as a curricular requirement.* For students who require only a single semester of calculus. Emphasis on concepts and applications of calculus, along with basic skills. Algebra review, functions, graphs, limits, derivatives, integrals, logarithmic and exponential functions, functions of several variables, applications in management, applications in biological and social sciences.

MA 131 Calculus for Life and Management Sciences A. *3(3-0) . F,S,Sum. Preq: C or better in MA 107 or MA 111 or placement via Level Two Achievement Test. Credit not allowed for more than one of MA 121, 131, and 141.* First order finite difference models; derivatives - limits, power rule, graphing, and optimization; exponential and logarithmic functions - growth and decay models; integrals - computation, area, total change; applications in life, management, and social sciences.

MA 132 Computational Mathematics for Life and Management Sciences. *1(1-0) S. Preq: C or better in MA 121 or MA 131.* Computational aspects of calculus for the life and management sciences; use of spreadsheets and a computer algebra system; applications to data models, differential equation models, and optimization.

MA 141 Calculus I. *4(4-0) . F,S,Sum. Preq: MA 111 with grade of C or better or placement via Level Two Achievement Test. Credit is not allowed for more than one of MA 141, 131, 121.* First of three semesters in a calculus sequence for science and engineering majors. Functions, graphs, limits, derivatives, rules of differentiation, definite integrals, fundamental theorem of calculus, applications of derivatives and integrals. Use of computation tools.

MA (CSC) 224 Applied Discrete Mathematics. *3(3-0) . Preq: Programming knowledge, MA 141.* Formal logic. Methods of proof including induction. Introduction to grammars and finite state machines. Recurrence relations and asymptotic behavior of functions. Sets and counting. Boolean expressions and logic networks. Graphs and relations.

MA 225 Foundations of Advanced Mathematics. *3(3-0) . Preq: MA 241.* Introduction to mathematical proof with focus on properties of the real number system. Elementary symbolic logic, mathematical induction, algebra of sets, relations, functions, countability. Algebraic and completeness properties of the reals.

MA 231 Calculus for Life and Management Sciences B. *3(3-0) . Preq: MA 131. MA 121 is not an accepted prerequisite for MA 231.* Differential equations - population growth, flow processes, finance and investment models, systems; functions of several variables - partial derivatives, optimization, least squares, multiple integrals; Lagrange multiplier method - chain rule, gradient; Taylor polynomials and series; numerical methods.

MA 241 Calculus II. *4(3-2) . F,S,Sum. Preq: MA 141 with grade of C or better.* Second of three semesters in a calculus sequence for science and engineering majors. Techniques and applications of integration, elementary differential equations, sequences, series, power series, and Taylor's Theorem. Use of computational tools.

MA 242 Calculus III. *4(3-2) . F,S,Sum. Preq: MA 241 with grade of C or better.* Third of three semesters in a calculus sequence for science and engineering majors. Vectors, vector algebra, and vector functions. Functions of several variables, partial derivatives, gradients, directional derivatives, maxima and mimima. Multiple integration. Line and surface integrals, Green's Theorem, Divergence Theorems, Stokes' Theorem, and applications. Use of computational tools.

MA 293 Special Topics in Mathematics. *Preq: Consent of Department Head.* Freshman-sophomore level experimental course offerings or directed individual study.

MA 301 Introduction to Differential Equations. *3(3-0) . Preq: Credit for 12 hours of calculus; primarily intended for transfer students whose calculus backgrounds do not include a study of first and second order linear differential equations. Credit not allowed if MA 241 taken previously at NCSU.* First order differential equations with applications; second order linear differential equations with applications in mechanics and other areas elementary matrix algebra, systems of linear equations and applications; Laplace transforms; Fourier series.

MA 302 Numerical Applications to Differential Equations. *1(1-0) . Preq: MA 241.* Numerical methods for approximating solutions for differential equations, with an emphasis on Runge-Kutta-Fehlberg methods with stepsize control. Applications to population, economic, orbital and mechanical models.

MA 303 Linear Analysis. *3(3-0) . Preq: MA 241. Credit not allowed if credit has been obtained for MA 301, 341 or 405.* Linear difference equations of first and second order, compound interest and amortization. Matrices and systems of linear equations, eigenvalues, diagonalization, systems of difference and differential equations, transform methods, population problems.

MA 305 Elementary Linear Algebra. *3(3-0) . F, S, Sum. Preq: MA 241 (with corequisite MA 242) or MA 231 and MA 132. Coreq. MA 242 (with prerequisite MA 241). Credit is not allowed for both MA 305 and MA 405* An elementary introduction to the essentials of linear algebra. Matrices and systems of linear equations, determinants. euclidean spaces as vector spaces, linear transformations of euclidean spaces, elementary treatment of eigenvalues and eigenvectors, applications to numerical solutions of equations and computer graphics.

MA 308 College Geometry. *3(3-0) . Preq: MA 225* The axiomatic approach to mathematics. Congruences for triangles. Parallel postulate and consequences. Right triangles. Circles, tangents, chords. Area. Coordinate geometry. Lines and planes in space. Non-Euclidean geometries.

MA 314 MA 314 Probability with Applications to Electrical and Computer Engineering. *3(3-0) . Preq: MA 242.* Fundamentals of discrete and continuous probability: conditional probability, independence, random variables, density and distribution functions, expected value and variance, common discrete and continuous distributions, joint distributions, and introduction to simple stochastic processes. Applications to electrical engineering; reliability of series and parallel circuits, models for waiting time phenomena.

MA (LOG) 335 Symbolic Logic. *3(3-0) . Preq: LOG 201 or MA 225.* Introduction to modern symbolic logic; the concept of proof, mathematical induction, recursion and the relationship between formal and informal theories (examples: group theory, Peano arithmetic). The G~del Theorems and the mathematical study of logic.

MA 341 Applied Differential Equations I. *3(3-0) . F, S, Sum. Preq: MA 242 or (MA 132 and MA 231). Credit is not allowed for both MA 301 and MA 341.* Differential equations and systems of differential equations. Methods for solving ordinary differential equations including Laplace transforms, phase plane analysis, and numerical methods. Matrix techniques for systems of linear ordinary differential equations.

MA 351 Introduction to Discrete Mathematical Models. *3(3-0) . Preq: MA 224, 231 or 241.* Basic concepts of discrete mathematics, including graph theory, Markov chains, game theory, with emphasis on applications; problems and models from areas such as traffic flow, genetics, population growth, economics, and ecosystem analysis.

MA 401 Applied Differential Equations II. *3(3-0) . Preq: MA 341 or 301. Credit for both MA 401 and MA 501 will not be given.* Wave, heat and Laplace equations. Solutions by separation of variables and expansion in Fourier Series or other appropriate orthogonal sets. Sturm-Liouville problems. introduction to methods for solving some classical partial differential equations. Use of power series as a tool in solving ordinary differential equations.

MA 402 Computational Mathematics: Models, Methods and Analysis. *3(3-0) . Preq: Fortran or C or Pascal, Physics.* Introduction to high performance computing and numerical modeling. Matrix models and boundary value problems with an emphasis on heat and mass transfer. Assessments of all approximations in the computational engineering and science process.

MA 403 Introduction to Modern Algebra. *3(3-0) . Preq: MA 225 or MA (CSC) 224. Credit is not allowed for both MA 403 and MA 407.* Sets and mappings, equivalence relations, rings, integral domains, ordered integral domains, ring of integers. Other topics selected from fields, polynomial rings, real and complex numbers, groups, permutation groups, ideals, and quotient rings.

MA 405 Introduction to Linear Algebra and Matrices. *3(3 0) . Preq: MA 241. Coreq: MA 242. Credit is not allowed for both MA 305 and MA 405.* Linear equations operations with matrices, row echelon form, determinants, vector spaces, linear independence, bases, dimension, orthogonality, eigenvalues, reduction of matrices to diagonal forms, applications to differential equations and quadratic forms.

MA 407 Introduction to Modern Algebra for Mathematics Majors. *3(3-0) . Preq: MA 225. Credit is not allowed for both MA 403 and MA 407.* Elementary number theory, equivalence relations, groups, homomorphisms, cosets, Cayley's Theorem, symmetric groups, rings, polynomial rings, quotient fields, principal ideal domains, Euclidean domains.

MA 408 Foundations of Euclidean Geometry. *3(3-0) . F,S. Coreq: MA 403 or MA 407.* An examination of Euclidean geometry from a modern perspective. The axiomatic approach with alternative possibilities explored using models.

MA 410 Theory of Numbers. *3(3 0) . Preq: One year of calculus.* Arithmetic properties of integers. Congruences, arithmetic functions, diophantine equations. Other topics chosen from quadratic residues, the quadratic reciprocity Law of Gauss, primitive roots, and algebraic number fields.

MA 414 Introduction to Differential Geometry. *3(3-0) . S. Preq: MA 242 and MA 405.* Introduction to the geometry of curves in space, arc length, curvature, and torsion of curves; introduction to the geometry of surfaces in space; calculus of functions on surfaces, covariant derivatives, shape operators, metrics, curvatures of surfaces, geodesics, holonomy and other geometrical properties. Applications in the physical sciences and/or projects using computer algebra.

MA (CSC) 416 Introduction to Combinatorics. *3(3-0) . S, Alt. Yrs. Preq: MA 242 or CSC (MA) 224, and proficiency in a programming language.* Basic principles of counting: addition and multiplication principles, generating functions, recursive methods, inclusion-exclusion, pigeonhole principle; basic concepts of graph theory: graphs, digraphs, connectedness, trees; additional topics from: Polya theory of counting, Ramsey theory; combinatorial optimization - matching and covering, minimum spanning trees, minimum distance, maximum flow; sieves; mobius inversion; partitions; Gaussian numbers and q-analogues; bijections and involutions; partially ordered sets.

MA 421 Introduction to Probability. *3(3-0) . Preq: MA 242 or MA 231. Credit for both MA 421 and MA 314 is not allowed.* Axioms of probability, conditional probability and independence, basic combinatorics, discrete and continuous random variables, joint densities and mass functions, expectation, central, limit theorem, simple stochastic processes.

MA 422 Actuarial Risk Theory. *3(3-0) . Preq: MA 421 or equivalent.* Probabilistic models for insurance systems. The economics of insurance, individual and collective risk models, and applications of risk theory. Utility of wealth functions applied to insurance decisions, distributions for insurance claims, and theruin model for the claims process.

MA 425 Mathematical Analysis I. *3(3-0) . Preq: MA 225 (MA 407 desirable).* Real number system, functions and limits, topology on the real line, continuity, differential and integral calculus for functions of one variable. Infinite series, uniform convergence.

MA 426 Mathematical Analysis II. *3(3-0) . Preq: MA 425 and 405.* Calculus of several variables, topology in n-dimensions, limits, continuity, differentiability, implicit functions, integration.

MA (CSC) 427 Introduction to Numerical Analysis I. *3(3-0) . Preq: MA 341 or 301 and programming language efficiency.* Theory and practice of computational procedures including approximation of functions by interpolating polynomials, numerical differentiation and integration, and solution of ordinary differential equations including both initial value and boundary value problems. Computer applications and techniques.

MA (CSC) 428 Introduction to Numerical Analysis II. *3(3 0) . Preq: MA 405 and programming language proficiency. MA (CSC) 427 is not a prerequisite.* Computational procedures including direct and iterative solution of linear and nonlinear equations, matrices and eigenvalue calculations, function approximation by least squares, smoothing functions, and minimax approximations.

MA 430 Mathematical Models in the Physical Sciences. *3(3-0) . Preq: MA 341 or 301; and MA 405.* Application of mathematical techniques to topics in the physical sciences. Problems from such areas as conservative and dissipative dynamics, calculus of variations, control theory, and crystallography.

MA 432 Mathematical Models in Life and Social Sciences. *3(3-0) . Preq: MA 301 or 341, 305 or 405., programming language proficiency. Coreq: MA 421 or ST 371.* Topics from differential and difference equations, probability, and matrix algebra applied to formulation and analysis of mathematical models in biological and social science (e.g., population growth).

MA 433 History of Mathematics. *3(3-0) . Preq: One year of calculus.* Development of mathematical thought and evolution of mathematical ideas examined in a historical setting. Biographical and historical content supplemented and reinforced by study of techniques and procedures used in earlier eras.

MA 435 Major Topics in the Development of Mathematics. *3(3-0) Preq: MA 242. Coreq: MA 403 or MA 407 or MA 425.* Great themes in mathematics, in their cultural and historical framework from an advanced undergraduate mathematical viewpoint. Biographical/mathematical snapshots of famous mathematicians.

MA 437 Applications of Algebra. *3(3 0) . Preq: MA 403 or 407, MA 405.* Error correcting codes, cryptography, crystallography, enumeration techniques, exact solutions of linear equations, and block designs.

MA 491 Reading in Honors Mathematics. *Preq: Membership in honors program, consent of department.* A reading (independent study) course available as an elective for students participating in the mathematics honors program.

MA 493 Special Topics in Mathematics. *Preq: Consent of department.* Directed individual study or experimental course offerings.

MA 501 Advanced Mathematics For Engineers and Scientists I. *3(3-0) . F,S,Sum. Preq: MA 341. Credit for this course and MA 401 is not allowed.* Survey of mathematical methods for engineers and scientists. Ordinary differential equations and Green's functions; partial differential equations and separation of variables; special functions, Fourier series. Applications to engineering and science. Not for credit by mathematics majors.

MA 502 Advanced Mathematics For Engineers and Scientists II. *3(3-0) . F,S,Sum. Preq: MA 341. Any student receiving credit for MA 502 may receive credit for, at most, one of the following: MA 405, MA 512, MA 513.* Determinants and matrices; line and surface integrals, integral theorems; complex integrals and residues; distribution functions of probability. Not for credit by mathematics majors.

MA (OR) 504 Introduction To Mathematical Programming. *3(3-0) . S. Preq: MA 242, MA 405.* Basic concepts of linear, nonlinear and dynamic programming theory. Not for majors in OR at Ph.D. level.

MA (IE, OR) 505 Linear Programming. *3(3-0) F,S Preq: MA 405.* Mathematical methods applied to problems of planning. Linear programming covered in detail. For those who desiring an in-depth and detailed study. Provision for rigorous and complete development of theoretical and computational aspects of this technique as well as a discussion of a number of applications.

MA 507 Analysis For Secondary Teachers. *3(3-0) . F,Sum. Alt. yrs. Preq: Grad. standing.* A course to update and broaden secondary teacher's capability and point-of-view with respect to topics in analysis. Historical development, logical refinement and applications of concepts such as limits, continuity, differentiation and integration. May be taken for graduate credit for certificate renewal by secondary school teachers. Credit towards graduate degree may be allowed only for students in mathematics education.

MA 508 Geometry For Secondary Teachers. *3(3-0) S,Sum Alt. Yrs Preq: Grad. standing.* Topics in geometry of concern to secondary teachers in their work and provision for background and enrichment. Various approaches to study of geometry, including vector geometry, transformational geometry and axiomatics. Course may be taken for graduate credit and for certificate renewal by secondary school teachers. Credit towards a graduate degree may be allowed only for students in mathematics education.

MA 509 Abstract Algebra For Secondary Teachers. *3(3-0) . F,Sum Alt. yrs. Preq: Grad. standing* From advanced viewpoint, an investigation of topics in algebra from high school curriculum. Theory of equations, polynomial rings, rational functions and elementary number theory. Course may be taken for graduate credit for certificate renewal by secondary school teachers. Credit towards a graduate degree may be allowed only for students in mathematics education.

MA 510 Selected Topics In Mathematics For Secondary Teachers. *3(3-0) . S,Sum. Alt. yrs. Preq: Grad. standing.* Coverage of various topics in mathematics of concern to secondary teachers. Topics selected from areas such as mathematics of finance, probability, statistics, linear programming and theory of games, intuitive topology, recreational math, computers and applications of mathematics. Course may be taken for graduate credit for certification renewal by secondary school teachers. Credit towards a graduate degree may be allowed only for students in mathematics education.

MA 511 Advanced Calculus I. *3(3-0) . F,S,Sum. Preq: MA 301. Credit for both MA 425 and MA 511 is not allowed.* Fundamental theorems on continuous functions; convergence theory of sequences, series and integrals; the Riemann integral.

MA 512 Advanced Calculus II. *3(3-0) . F,S,Sum. Preq: MA 301. Credit for both MA 426 and MA 512 is not allowed.* General theorems of partial differentiation; implicit function theorems; vector calculus in 3-space; line and surface integrals; classical integral theorems.

MA 513 Introduction To Complex Variables. *3(3-0) . F,S,Sum. Preq: MA 242.* Operations with complex numbers, derivatives, analytic functions, integrals, definitions and properties of elementary functions, multivalued functions, power series, residue theory and applications, conformal mapping.

MA 515 Analysis I. *3(3 0) . F S. Preq: MA 426* Metric spaces: contraction mapping principle, Tietze extension theorem, Ascoli-Arzela lemma, Baire category theorem, Stone-Weierstrass theorem, LP spaces, Banach spaces: linear operators, Hahn-Banach theorem, open mapping and closed graph theorems. Hilbert spaces: projection theorem, Riesz representation theorem. Lax-Milgram theorem, complete orthonormal sets.

MA 518 Introduction To Manifold Theory. *3(3 0) Preq: MA 426 or MA 512* Theory of differentiable manifold. Definitions and examples; tangent vectors and tangent spaces; maps between manifolds submanifolds, submersions, immersions, product and quotient manifolds; cotangent vectors and cotangent spaces: differentials forms; vector fields on a manifold, integral curves and flows of vector fields, and Lie derivatives; tangent and cotangent bundles.

MA 520 Linear Algebra. *3(3-0) . F. Preq: MA 405.* Vector spaces, Bases and dimension. Changes of basis. Linear transformations and their matrices. Linear functionals. Simultaneous triangularization and diagonalization. Rational and Jordan canonical forms. Bilinear forms.

MA 521 Abstract Algebra I. *3(3 0) . F,S. Preq: MA 405 and MA 407.* Groups, normal subgroups, quotient groups, Cayley's theorem, Sylow's theorem. Rings, ideals and quotient rings, polynomial rings. Elements of field theory.

MA 522 Computer Algebra. *3(3-0) . S. Preq: MA 407 or MA 521 and MA 405 or MA 520.* Basic techniques and algorithms of computer algebra. Integer arithmetic, primality tests and factorization of integers, polynomial arithmetic, polynomial factorization. Groebner bases, integration in finite terms.

MA 523 Linear Transformations and Matrix Theory. *3(3-0) . F. Preq: MA 405.* Vector spaces, linear transformations and matrices, orthogonality, orthogonal transformations with emphasis on rotations and reflections, matrix norms, projectors, least squares, generalized inverses, definite matrices, singular values.

MA (CSC) 530 Numerical Analysis II. *3(3-0) Preq: MA 380.* Approximation and interpolation, Fast Fourier Transform, numerical differentiation and integration, numerical solution of initial value problems for ordinary differential equations.

MA (E, OR) 531 Dynamic Systems and Multivariable Control I. *3(3-0) F. Preq: MA 341, MA 405* Introduction to modeling, analysis and control of linear discrete-time and continuous-time dynamical systems. State space representations and transfer methods. Controllability and observability. Realization. Applications to biological, chemical, economic, electrical, mechanical and sociological systems.

MA 532 Ordinary Differential Equations I. *3(3-0) . F,S. Preq: MA 341, 405, 425 or 511. Coreq: MA 426 or 512.* Existence and uniqueness theorems, systems of linear equations, fundamental matrices, matrix exponential, nonlinear systems, plane autonomous systems, stability theory.

MA 534 Introduction To Partial Differential Equations. *3(3-0) . F Preq: MA 425 or MA 511, MA 341. Coreq: MA 426 or 512.* Linear first order equations, method of characteristics. Classification of second order equations. Solution techniques for the heat equation, wave equation and Laplace's equation. Maximum principles. Green's functions and fundamental solutions.

MA 535 Stability and Time Optimal Control Of Hereditary Systems. *3(3-0) F. Preq: MA 341, MA 425 or MA 511.* Theory of stability and of time optimal control of hereditary systems. Lyapunov stability theory, time optimal, minimum fuel and effort control synthesis of systems. Applications: spread of epidemics, growth of global economy, automatic steering of aircraft, control of wind tunnels, and of flexible structures.

MA 537 Nonlinear Dynamics and Chaos. *3(3-0) . S. Preq: MA 341 and MA 405.* Usage of computer experiments for demonstration of nonlinear dynamics and chaos and motivation of mathematical definitions and concepts. Examples from finance and ecology as well as traditional science and engineering. Difference equations and iteration of functions as nonlinear dynamical systems. Fixed points, periodic points and general orbits. Bifurcations and transition to chaos. Symbolic dynamics, chaos, Sarkovskii's Theorem, Schwarzian derivative, Newton's method and fractals.

MA 544 Computer Experiments In Mathematical Probability. *3(3-0) . S. Preq: MA 421.* Exposure of student to practice of performing mathematical experiments on computer, with emphasis on probability. Programming in an interactive language such as APL, MATLAB or Mathematica. Mathematical treatment of random number generation and application of these tools to mathematical topics in Monte Carlo method, limit theorems and stochastic processes for purpose of gaining mathematical insight.

MA (ST) 546 Theory Of Probability I. *3(3-0) . F Sum. Preq: MA 425 or 511.* Axioms, combinatorial analysis, conditional probability, independence, random variables, expectation, special discrete and continuous distributions, probability and moment generating functions, central limit theorem, laws of large numbers, branching processes, recurrent events, random walk.

MA 551 Introduction To Topology. *3(3-0) . F. Preq: MA 426.* Set theory, topological spaces, metric spaces, continuous functions, separation, cardinality properties, product and quotient topologies, compactness, connectedness.

MA 555 Introduction To Manifold Theory. *3(3-0) . F. Preq: MA 426 or MA 512.* Theory of differentiable manifold. Definitions and examples; tangent vectors and tangent spaces; maps between manifolds submanifolds, submersions, immersions, product and quotient manifolds; cotangent vectors and cotangent spaces; differentials forms; vector fields on a manifold, integral curves and flows of vector fields, and Lie derivatives; tangent and cotangent bundles.

MA 561 Set Theory and Foundations Of Mathematics. *3(3-0) . S. Preq: MA 407.* Logic and axiomatic approach, the Zermelo-Fraenkel axioms and other systems, algebra of sets and order relations equivalents of the Axiom of Choice, one-to-one correspondences, cardinal and ordinal numbers, the Continuum Hypothesis.

MA (CSC, OR) 565 Graph Theory. *3(3-0) . F. Preq: CSC 224 or MA 351.* Basic concepts of graph theory, including: paths and connectivity, Euler tours and Hamilton cycles, matchings and independence, graph coloring, planarity, directed graphs and network flows, vector spaces associated with a graph, and applications with emphasis on organizing problems for computer solution.

MA (BMA) 573 Mathematical & Experimental Modeling of Physical Processes I. *3(3-0) . F. Preq: MA 341, MA 405, knowledge of high-level programg. lang.* In-depth treatment of case studies in application of mathematics to problems currently under investigation in industrial and governmental laboratories. Background information for each case study; development of mathematical models; analytical and computational methods appropriate to models; model validation using experimental data collected during field trips to laboratories. Case studies involve problems in mechanics, thermodynamics, and hydrodynamics.

MA (BMA) 574 Mathematical & Experimental Modeling of Physical Processes II. *3(3-0) . S. Preq: MA 341, MA 405, knowledge of high-level programg. lang.* In-depth treatment of case studies in the application of mathematics to problems currently under investigation in industrial and governmental laboratories. Background information for each case study; development of mathematical models; analytical and computational methods appropriate to the models; model validation using experimental data collected during field trips to the laboratories. Problems in biology & electromagnetism.

MA (PY) 575 Mathematical Introduction To Celestial Mechanics. *3(3-0) . F. Preq: MA 301.* Central orbits, N-body problem, 3-body problem, Hamilton-Jacobi theory, perturbation theory, applications to motion of celestial bodies.

MA (PY) 576 Orbital Mechanics. *3(3-0) . S. Preq: MA 341, 405, knowledge of elementary mechanics and computer programming.* Keplerian motion, iterative solutions, numerical integration, differential corrections and space navigation, elements of probability, least squares, sequential estimation, Kalman filter.

MA (CSC) 580 Numerical Analysis I. *3(3-0) . F,S. Preq: MA 405; MA 425 or MA 511; high-level computer language.* Algorithm behavior and applicability. Effect of roundoff errors, systems of linear equations and direct methods, least squares via Givens and Householder transformations, stationary and Krylov iterative methods, the conjugate gradient and GMRES methods, convergence of method.

MA 584 Numerical Solution Of Partial Differential Equations--Finite Difference Methods. *3(3-0) . F. Preq: MA 501; knowledge of a high level programming language.* Survey of finite difference methods for partial differential equations including elliptic, parabolic and hyperbolic PDE's. Consideration of both linear and nonlinear problems. Theoretical foundations described; however, emphasis on algorithm design and implementation.

MA 587 Numerical Solution Of Partial Differential Equations--Finite Element Method. *3(3-0) . S. Preq: MA 501; knowledge of a high level programming language.* Introduction to finite element method. Applications to both linear and nonlinear elliptic and parabolic partial differential equations. Theoretical foundations described: however, emphasis on algorithm design and implementation.

MA 591 Special Topics. *1-6. F,S. Preq: Consent of department.*

MA 676 Master's Project. *3(3-0) . F,S,Sum.* Investigation of some topic in mathematics to a deeper and broader extent than typically done in a classroom situation. For the applied mathematics student the topic usually consists of a realistic application of mathematics to student's minor area. A written and oral report on the project required.

MA 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

MA 690 Master's Examination. *1-6. F,S,Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

MA 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

MA 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's Student.* Thesis Research

MA 699 Master's Thesis Preparation. *1 3. F,S,Sum. Preq. Master's Student. Credits Arranged.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

MA (OR, ST) 706 Nonlinear Programming. *3(3-0) . S. Preq: OR(IE,MA) 505 and MA 425 or equivalent.* An advanced mathematical treatment of analytical and algorithmic aspects of finite dimensional nonlinear programming. Including an examination of structure and effectiveness of computational methods for unconstrained and constrained minimization. Special attention directed toward current research and recent developments in the field.

MA (OR) 708 Integer Programming. *3(3-0) . S. Alt. yrs. Preq: MA 405, OR (MA,IE) 505. Coreq: Some familiarity with computers (e.g., CSC 112).* General integer programming problems and principal methods of solving them. Emphasis on intuitive presentation of ideas underlying various algorithms rather than detailed description of computer codes. Students have some "hands on" computing experience that should enable them to adapt ideas presented in course to integer programming problems they may encounter.

MA 711 Analytic Function Theory I. *3(3-0) . F. Preq: MA 426.* Rigorous introduction to theory of functions of a complex variable. Complex plane, functions, Mobius transformations, exponential and logarithmic functions, trigonometric functions, infinite series, integration in the complex plane, Cauchy's theorem and its consequences.

MA 712 Analytic Function Theory II. *3(3-0) . S. Preq: MA 711* A continuation of MA 611. Taylor and Laurent series. The residue theorem, the argument principle, harmonic functions and the Dirichlet problem, analytic continuation and the monodromy theorem, entire and meromorphic functions, the Weierstrass product representation and the Mittag-Leffler partial fraction representation, special functions, conformal mapping and the Picard theorem.

MA 713 Techniques of Complex Analysis. *3(3-0) . S. Preq: MA 313 or 711.* Applications of complex analysis to mathematical problems in physical science in the setting of potential equation and other partial differential equations: contour integrals, special functions of mathematical physics from line integral point of view, solution of problems in potential theory, asymptotic methods including WKB and Wiener-Hopf techniques.

MA 715 Analysis II. *3(3-0) . S. Preq: MA 515.* Integration: Lebesgue measure and integration, Lebesgue-dominated convergence and monotone convergence theorems, Fubini's theorem, extension of the fundamental theorem of calculus. Banach spaces: Lp spaces, weak convergence, adjoint operators, compact linear operators, Fredholm-Fiesz Schauder theory and spectral theorem.

MA 716 Advanced Functional Analysis. *3(3-0) . F, Alt. yrs. Preq: MA 715.* Advanced topics in functional analysis such as linear topological spaces; Banach algebra, spectral theory and abstract measure theory and integration.

MA (OR) 719 Vector Space Methods in System Optimization. *3(3-0) . F. Preq: MA 405, 511 or equivalent.* Introduction to algebraic and function-analytic concepts used in system modeling and optimization: vector space, linear mappings, spectral decomposition, adjoints, orthogonal projection, quality, fixed points and differentials. Emphasis on geometricinsight. Topics include least square optimization of linear systems, minimum norm problems in Banach space, linearization in Hilbert space, iterative solution of system equations and optimization problems. Broad range of applications in operations research and system engineering including control theory, mathematical programming, econometrics, statistical estimation, circuit theory and numerical analysis.

MA 720 Lie Algebras. *3(3-0) . S. Preq: MA 520, MA 521.* Definition of Lie algebras and examples. Nilpotent, solvable and semisimple Lie algebras. Engel's theorem, Lie's Theorem, Killing form and Cartan's criterion. Weyl's theorem on complete reducibility. Representations of s1(2,C). Root space decomposition of semisimple Lie algebras. Root system and Weyl group.

MA 721 Abstract Algebra II. *3(3-0) . S. Preq: MA 521.* Field extensions, Galois theory, modules, tensor products, exterior products.

MA 723 Theory Of Matrices and Applications. *3(3-0) . S. Preq: MA 520 or 523.* Canonical forms, functions of matrices, variational methods, perturbation theory, numerical methods, nonnegative matrices, applications to differential equations, Markov chains.

MA (E, OR) 731 Dynamic Systems and Multivariable Control II. *3(3-0) . S. Preq: MA 531.* Stability of equilibrium points for nonlinear systems. Liapunov functions. Unconstrained and constrained optimal control problems. Pontryagin's maximum principle and dynamic programming. Computation with gradient methods and Newton methods. Multidisciplinary applications.

MA 732 Ordinary Differential Equations II. *3(3-0) . S. Preq: MA 532. Coreq: MA 515.* Existence-uniqueness theory, periodic solutions, invariant manifolds, bifurcations, Fredholm's alternative.

MA 734 Partial Differential Equations. *3(3-0) . S. Preq: MA 534. Coreq: MA 515.* Linear second order parabolic, elliptic and hyperbolic equations. Initial value problems and boundary value problems. Iterative and variational methods. Existence, uniqueness and regularity. Nonlinear equations and systems.

MA 735 Stability and Time Optimal Control of Hereditary Systems II. *3(3-0) . S. Preq: MA 535.* Topics: time optimal control of linear delay systems; minimum fuel control synthesis; nonlinear controllability theory; stability of large-scale systems and applications to growth of the national/global economy.

MA (ST) 746 Introduction to Stochastic Processes. *3(3 0) . S. Preq: MA 405 and MA(ST) 546 or ST 521.* Markov chains and Markov processes, Poisson process, birth and death processes, queuing theory, renewal theory, stationary processes, Brownian motion.

MA 751 Topology. *3(3-0) . S. Preq: MA 551.* Separation and cardinalty properties, countable and sequential compactness, compactification, paracompactness and normality, metrization and metrizability theorems.

MA 753 Algebraic Topology. *3(3-0) . S, Alt. yrs. Preq: MA 551* Homotopy, fundamental group, covering spaces, classification of surfaces, homology and cohomology.

MA 755 Introduction to Riemannian Geometry. *3(3 0) . S, Alt. yrs. Preq: MA 555.* Tensor algebra on vector spaces and tensor fields on manifolds; Koszul connections; parallel transport; torsion and curvature of connections; the Bianchi identities; metric tensor fields; metric and Levi-Civita connections; the Riemannian curvature,Ricci and Einstein tensors. Special topics: general relativity, embedding theory, integration on manifolds, the Gauss-Bonnet theorem, De Rahm cohomology.

MA 756 Geometrical Structures on Fiber Bundles. *3(3-0) F Alt. yrs Preq: MA 755.* Principal fiber bundles, subbundles, associated bundles; Frobenius theory of distributions; the frame bundle LM of a manifold, the soldering 1-form, linear connections, curvature and torsion forms on LM, the Bianchi identities, reduction of connections; affine frame bundle and generalized affine connections. Special topics: Yang-Mills theory, electro-weak theory, magnetic monopoles, geometric quantization.

MA (IE, OR) 766 Network Flows. *3(2-2) . S. Preq: OR(IE MA) 505 or equivalent.* Study of problems of flows in networks. These problems include the determination of shortest chain, maximal flow and minimal cost flow in networks. Relationship between network flows and linear programming developed as well as problems with nonlinear cost functions, multi-commodity flows and problem of network synthesis.

MA (BMA, ST) 771 Biomathematics I. *3(3-0) . F. Preq: Advanced calculus, reasonable background in biology or Consent of Instructor.* Role of theory construction and model building in development of experimental science. Historical development of mathematical theories and models for growth of one-species populations (logistic and off-shoots), including considerations of age distributions (matrix models, Leslie and Lopez; continuous theory, renewal equation). Some of the more elementary theories on the growth of organisms (von Bertalanffy and others; allometric theories; cultures grown in a chemostat). Mathematical theories of two and more species systems (predator-prey, competition, symbosis; leading up to present-day research) and discussion of some similar models for chemical kinetics. Much emphasis on scrutiny of biological concepts as well as of mathematical structure of models in order to uncover both weak and strong points of models discussed. Mathematical treatment of differential equations in models stressing qualitative and graphical aspects, as well as certain aspects of discretization. Difference equation models.

MA (BMA, ST) 772 Biomathematics II. *3(3-0) S Preq: BMA 771 elementary probability theory.* Continuation of topics of BMA 771. Some more advanced mathematical techniques concerning nonlinear differential equations of types encountered in BMA 771: several concepts of stability, asymptotic directions, Liapunov functions; different time-scales. Comparison of deterministic and stochastic models for several biological problems including birth and death processes. Discussion of various other applications of mathematics to biology, some recent research.

MA (BMA, OR, ST) 773 Stochastic Modeling. *3(3 0) . S,Alt. Yrs. Preq. BMA 772 or ST (MA) 546.* Survey of modeling approaches and analysis methods for data from continuous state random processes. Emphasis on differential and difference equations with noisy input. Doob Meyer decomposition of process into its signal and noise components. Examples from biological and physical sciences, and engineering. Student project.

MA (BMA, OR) 774 Partial Differential Equation Modeling in Biology. *3(3 0) S. Preq: BMA 771 or MA/OR 731, BMA 772 or MA 401 or MA 501.* Modeling with and analysis of partial differential equations as applied to real problems in biology. Review of diffusion and conservation laws. Waves and pattern formation. Chemotaxis and other forms of cell and organism movement. Introduction to solid and fluid mechanics/dynamics. Introductory numerical methods. Scaling. Perturbations, Asymptotics. Cartesian, polar and spherical geometries. Case studies.

MA 775 Mathematical Methods in the Physical Sciences I. *3(3-0) . F. Preq MA 405, 511 and either MA 401 or 501* Green's functions and two-point boundary value problems; elementary theory of distributions; generalized Green's functions. Finite and infinite dimensional inner product spaces; Hilbert spaces; completely continuous operators; integral equations; the Fredholm alternative; eigenfunction expansions; applications to potential theory. Nonsingular and singular Sturm-Liouville problems; Weil's theorem.

MA 776 Mathematical Methods in the Physical Sciences II. *3(3-0) S Preq: MA 775.* Distribution theory in n-space; Fourier transforms; partial differential equations, generalized solutions, fundamental solutions, Cauchy problem, wave and heat equations, well-set problems. Laplace's equations, the Dirichlet and Neumann problems, integral equations of potential theory. Green's functions, Eigen function expansions.

MA (NE) 777 Exact and Approximate Solutions in Particle Transport Theory. *3(3-0) . S. Preq: MA 501 or MA 511.* Method of elementary solutions used to solve exactly basic problems in neutron-transport theory and related topics. In addition, development and usage of FN method to establish concise approximate solutions in the realm of particle transport theory.

MA (ST) 778 Measure Theory and Advanced Probability. *3(3-0) . F,S. Preq: MA 426; ST 521 or MA(ST) 546 or equivalent.* Modern measure and integration theory in abstract spaces. Probability measures, random variables, expectations. Distributions and characteristic functions. Modes of convergence. Independence, zero-one laws, laws of large numbers, three-series theorem. Central limit problem. Conditional expectations, martingales and martingale convergence theorems.

MA (ST) 779 Measure Theory and Advanced Probability. *3(3-0) . F,S. Preq: ST 778.* Modern measure and integration theory in abstract spaces. Probability measures, random variables, expectations. Distributions and characteristic functions. Modes of convergence. Independence, zero-one laws, laws of large numbers, three-series theorem. Central limit problem. Conditional expectations, martingales and martingale convergence theorems.

MA (CSC) 780 Numerical Analysis II. *3(3-0) . S. Preq: MA 580.* Approximation and interpolation. Fast Fourier Transform, numerical differentiation and integration, numerical solution of initial value problems for ordinary differential equations.

MA 782 Advanced Numerical Linear Algebra. *3(3-0) . S. Preq: MA 580.* Mathematical and numerical investigation of direct, iterative and semi-iterative methods for solution of linear systems. Singular algebraic systems and least squares computations. Methods for calculation of eigenvalues and eigenvectors. Careful mathematical analysis of these techniques.

MA (CSC) 783 Parallel Algorithms and Scientific Computation. *3(3-0) . F. Preq: MA 580.* Multiprocessing and supercomputer architectures including Alliant FX/8, IBM 3090 VF-600, CRAY XMP-48, Intel iPCS and BBN Butterfly. The implementation of standard numerical linear algebra algorithms on vector and multiprocessing computers. Portability of codes from one computer to another. Typical applications to science and engineering.

MA 784 Nonlinear Equations and Unconstrained Optimization. *3(3 0) . S, Alt. yrs. Preq: MA 580.* Newton's method and Quasi-Newton methods for nonlinear equations and optimization problems, globally convergent extensions, methods for sparse problems, applications to differential equations, integral equations and general minimization problems. Methods appropriate for boundary value problems.

MA 785 Numerical Solution of Ordinary Differential Equations. *3(3-0) . S. Preq: MA 511 or 512.* Numerical methods for initial value problems including predictor-corrector, Runge-Kutta, hybrid and extrapolation methods; stiff systems; shooting methods for two-point boundary value problems; weak, absolute and relative stability results.

MA 788 Numerical Nonlinear Partial Differential Equations. *3(3-0) . S, Alt. yrs. Preq: MA 405 or 520 and MA 501 or 534; knowledge of a high level programming language.* Nonlinear discrete equations; Newton and monotone methods for nonlinear equations; computational algorithms and applications; finite difference method-convergence, stability and error estimates; multiplicity of solutions and bifurcation; asymptotic behavior of solutions; and coupled systems of equations.

MA (IE, OR) 790 Advanced Special Topics System Optimization. *1-3. F,S.* Advanced topics in some phase of system optimization using traditional course format. Identification of various specific topics and prerequisities for each section from term to term.

MA 791 Special Topics In Real Analysis. *1-6. F,S.*

MA 792 Special Topics In Algebra. *1-6. F,S.*

MA 793 Special Topics In Differential Equations. *1-6.*

MA 795 Special Topics In Topology. *1-6.*

MA 796 Special Topics In Combinatorial Analysis. *1-6.*

MA 797 Special Topics In Applied Mathematics.

MA 798 Special Topics In Numerical Analysis. *1-6.*

MA (IE, OR) 812 Special Topics In Mathematical Programming. *S. Alt. yrs. Preq: IE(MA,OR) 505.* Study of special advanced topics in area of mathematical programming. Discussion of new techniques and current research in this area. The faculty responsible for this course select areas to be covered during semester according to their preference and interest. This course not necessarily taught by an individual faculty member but can, on occasion, be joint effort of several faculty members from this university as well as visiting faculty from other institutions. To date, a course of Theory of Networks and another on Integer Programming offered under the umbrella of this course. Anticipation that these two topics will be repeated in future together with other topics.

MA (IE, OR) 816 Advanced Special Topics System Optimization. *1-3. F,S.* Advanced topics in some phase of system optimization. Identification of various specific topics and prerequisite for each section from term to term.

MA 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq: Doctoral Student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

MA 890 Doctoral Preliminary Examination. *1-9. F,S Sum. Preq: Doctoral Student.* For students who are preparing for and taking written and/or oral preliminary exams.

MA 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq: Doctoral Student* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

MA 895 Doctoral Dissertation Research. *1-9 F,S,Sum. Preq. Doctoral Student.* Dissertation Research

MA 899 Doctoral Dissertation Preparation. *1-3 F,S,Sum. Preq: Doctoral Student* For students who have completed all credit hour requirements, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

MECHANICAL AND AEROSPACE ENGINEERING

MAE 206 Engineering Statics. *3(3-0) . Preq: PY 205. Coreq: MA 242.* Basic concepts of forces in equilibrium. Distributed forces, frictional forces. Inertial properties. Application to machines, structures, and systems.

MAE 208 Engineering Dynamics. *3(3-0) . Preq: MAE 206 with a grade of C or better, MA 242.* Kinematics and kinetics of particles in rectangular, cylindrical, and curvilinear coordinate systems; energy and momentum methods for particles; kinetics of systems of particles; kinematics and kinetics of rigid bodies in two and three dimensions; motion relative to rotating coordinate systems.

MAE 261 Aerospace Vehicle Performance. *3(3-0) . Preq: CSC 112, MA 241, PY 205.* Introduction to the problem of performance analysis in aerospace engineering. Aircraft performance in gliding, climbing, level, and turning flight. Calculation of vehicle take-off and landing distance, range and endurance. Elementary performance design problems.

MAE 301 Engineering Thermodynamics I. *3(3-0) . Preq: MA 242, PY 208 or 202.* Introduction to the concept of energy and the laws governing the transfers and transformations of energy. Emphasis on thermodynamic properties and the First and Second Law analysis of systems and control volumes. Integration of these concepts into the analysis of basic power cycles is introduced.

MAE 302 Engineering Thermodynamics II. *3(3 0) Preq. C or better in MAE 301 and CSC 112* Continuation of Engineering Thermodynamics I with emphasis on the analysis of power and refrigeration cycles and the application of basic principles to engineering problems with systems involving mixtures of ideal gases, psychrometrics, nonideal gases, chemical reactions, combustion, chemical equilibrium cycle analysis, and one-dimensional compressible flow.

MAE 305 Mechanical Engineering Laboratory I. *1(0-3) . Preq. Junior standing in ME.* Theory and practice of measurement and experimental data collection. Laboratory evaluation and demonstration of components of the generalized measurement system and their effects on the final result. Applications of basic methods of data analysis as well as basic instrumentation for sensing, conditioning and displaying experimental qualities. (Instruction and practice in technical report writing.)

MAE 306 Mechanical Engineering Laboratory II. *1(0-3) . Preq. MAE 305* Continuation of MAE 305 into specific types of measurements. Students evaluate and compare different types of instrumentation for measuring the same physical quantity on the basis of cost, time required, accuracy, etc. (Oral and written presentation of technical material).

MAE 308 Fluid Mechanics. *3(3-0) . Preq: MA 242; MAE 208 with a grade of C or better or CE 215 or CE 213; CSC 112. Coreq: MA 341, MAE 301.* Development of the basic equations of fluid mechanics in general and specialized form. Application to a variety of topics including fluid statics; inviscid, incompressible fluid flow; design of Fluid dynamic system.

MAE 310 Conduction and Radiation Heat Transfer. *3(3-0) . Preq: CSC 112, MA 341, C or better in MAE 301.* Analysis of steady state and transient one and multidimensional heat transfer by conduction, employing both analytical methods and numerical techniques. Heat transfer by the mechanism of radiation.

MAE 314 Solid Mechanics. *3(3-0) . Preq: MAE 206 with a grade of C or better, MA 242. Coreq: MAT 201.* Concepts and theories of internal force, stress, strain, and strength of structural element under static loading conditions. Constitutive behavior for linear elastic structures. Deflection and stress analysis procedures for bars, beams, and shafts. Introduction to matrix analysis of structures.

MAE 315 Dynamics of Machines. *3(3-0) . Preq: MAE 208 with a grade of C or better, CSC 112 the analysis and design of machine and mechanical components. Coreq: MA 341; and a ME, AE major.* Application of dynamics to the analysis and design of machine and mechanical components. Motions resulting from applied loads, and the forces required to produce specified motions. Introduction to mechanical vibration, free and forced response of discrete and continuous systems.

MAE 316 Strength of Mechanical Components. *3(3-0) . Preq: MAE 314 with a grade of C or better, CSC 112. Coreq: MA 341; and a ME, AE, NE major.* Analysis and design of mechanical components based on deflection, material, static strength and fatigue requirements. Typical components include beams, shafts, pressure vessels and bolted and welded joints. Classical and modern analysis and design techniques. Computer analysis using the finite element method. Material and manufacturing considerations in design.

MAE 355 Aerodynamics I. *3(3-0) . Preq: MAE 261, MA 341.* Fundamentals of perfect fluid theory with applications to incompressible flows over airfoils, wings, and flight vehicle configurations.

MAE 356 Aerodynamics II. *3(3-0) . Preq: MAE 355 and a grade of C or better in MAE 301.* Concepts of thermodynamics, compressible fluid flow, and shock waves with application to computing the aerodynamic characteristics of airfoils, wings and flight configurations at high speed.

MAE 357 Experimental Aerodynamics I. *1(0-3) . Preq: MAE 261, MA 341. Coreq: MAE 355.* Subsonic wind tunnel, instrumentation, data acquisition techniques, technical report preparation. Experiments involve pressure and force/moment measurements of various aerospace vehicle components with supplemental flow visualization.

MAE 358 Experimental Aerodynamics II. *1(0-3) . Preq: MAE 357. Coreq: MAE 356.* Advanced stability and control experiments in the subsonic wind tunnel and external compressible flow experiments in the supersonic wind tunnel.

MAE 365 Propulsion I. *3(3-0) . Preq: MAE 355 and a grade of C or better in MAE 301.* One dimensional internal flow of compressible fluids including: isentropic flow, normal shocks, flow with friction, simple heat addition. Applications to air-breathing aircraft propulsion systems and overall performance of air-breathing engines.

MAE 371 Aerospace Structures I. *3(3-0) . Preq: MAE 261, MAE 314 with a grade of C or better.* Determination of appropriate analysis techniques for Aerospace Structures. Introduction of governing equations and selected solutions for typical structures. Use of these concepts in the design of a representative structural component.

MAE 403 Air Conditioning. *3(3-0) . S. Preq: MAE 302, MAE 310 MAE 308* Design of a complete air conditioning system for a building. Introduction, Design Objectives - Building Description, Review of Psychrometrics and Air Conditioning Processes, Cooling and Heating Load Calculation, Space Air diffusion, Duct Lay-out and Design, Equipment Selection, Pipe Sizing, Life-cycle Cost Analysis.

MAE 404 Refrigeration. *3(3 0) . Preq: MAE 302.* Thermodynamic analysis of the vapor compression cycle; optimization of multiple evaporator and multiple compressor systems; commercial refrigeration load calculations; desirable properties of refrigerants and brines, piping arrangement and sizing.

MAE 405 Mechanical Engineering Laboratory III. *1(0-3) . Preq: MAE 306.* Final undergraduate course in mechanical engineering laboratory sequence. Experimental investigation of measurement problems involving typical mechanical engineering equipment systems. Design and application of a measurement system to a specific problem.

MAE 406 Energy Conservation in Industry. *3(3-0) . F. Preq: MAE 302, MAE 310, IE 311.* Application of energy conservation principles to a broad range of industrial situations with emphasis on typical equipment encountered as well as the effect of recent environmental regulations. Topics covered include: steam generators, pollution control, work minimization, heat recovery, steam traps, industrial ventilation, electrical energy management, and economics. Field trip to conduct tests and evaluate operation at three NCSU steam plants.

MAE 407 Steam and Gas Turbines. *3(3-0) . Preq: MAE 302; MAE 308 or MAE 355.* Fundamental analysis of the theory and design of turbomachinery flow passages; control and performance of turbomachinery; gas-turbine engine processes.

MAE 408 Internal Combustion Engine Fundamentals. *3(3-0) . Preq: MAE 302.* Fundamentals common to internal combustion engine cycles of operation. Otto engine: carburetion, combustion, knock, exhaust emissions and engine characteristics. Diesel engine: fuel metering, combustion, knock, and performance. Conventional and alternative fuels used in internal combustion engines.

MAE 410 Convective Heat Transfer and Fluid Flow. *3(3-0) . Preq: MAE 301, MAE 308. Coreq: MAE 310.* Integration of principles and concepts of thermodynamics, fluid mechanics, and heat transfer to the development of practical convective heat transfer and mass transport relations relevant to mechanical engineering. Typical applications include boilers, condensors, piping, pumps, and heat exchangers.

MAE 411 Machine Component Design. *3(3-0) . Preq: MAE 315, MAE 316.* Application of the principles of solid mechanics and material science to the analysis and design of specific machine components including screws, bearings, gears, transmission devices, brakes, clutches, couplings, fly wheels, cams, etc.

MAE 412 Analysis and Design of Energy Systems. *3(3-0) . Preq: MAE 302, MAE 310 and senior standing in MAE. Coreq: MAE 410.* Applications of thermodynamics, fluid mechanics, and heat transfer to energy systems with emphasis on design and computer modeling. Analyses of compressible flow and combustion. Design of heat exchangers and other power system components. Economic analyses and design optimization. Operating characteristics of gas turbines, diesel engines, and central power stations. Environmental impact of power generation. Nuclear fuels and nuclear plant components.

MAE 415 Analysis for Mechanical Engineering Design. *3(3-0) . Preq: MAE 302, 308, 310, 315, 316, ECE 331, and senior standing in ME.* Integration of the physical sciences, mathematics, and engineering to solve real-world design problems. Emphasis on open-ended problems which contain superfluous information and/or insufficient data. Solution techniques focus on problem definition, reduction to a solvable system, and development of a design response. Formal written communication of results.

MAE 416 Mechanical Engineering Design. *4(3-2) . Preq: MAE 415.* Application of engineering principles to design and construction of a prototype by a team of students in response to a specific need. Emphasis on the design process: problem definition, establishment of objectives, generation of alternatives, preliminary design, detailed design, fabrication and testing of the prototype in the shop. Oral and written report of the project.

MAE 421 Design of Solar Thermal Systems. *3(3-0) . Preq: MAE 308, MAE 310. Coreq: MAE 410.* Analysis and design of active and passive solar thermal systems for residential and small commercial buildings. Solar insolation, flat plate collectors, thermal storage, heat exchanges, controls, design, performance calculations, economics. Site evaluation, shading, suncharts, types of passive systems. Heating load analysis. Overview of photovoltaics. On-site evaluation of NCSU Solar House.

MAE 435 Principles of Automatic Control. *3(3-0) . Preq: MA 341.* Study of linear feedback control systems using transfer functions. Transient and steady state responses. Stability and dynamic analyses using time response and frequency response techniques. Compensation methods. Classical control theory techniques for determination and modification of the dynamic response of a system. Synthesis and design applications to typical mechanical engineering control systems. Introduction to modern control theory.

MAE 442 Automotive Engineering. *3(3-0) . Preq: Senior in MAE.* Fundamental aspects of automotive engineering. Examines various automotive systems (engine, brakes, etc.) as well as their interactions in such areas as safety and performance. Current practices and development for the future.

MAE 452 Aerodynamics of V/STOL Vehicles. *3(3-0) . Preq: MAE 356.* Introduction to the aerodynamics and performance of vertical and short take-off and landing vehicles. Aerodynamics of propellers and rotors. High lift devices.

MAE 453 Introduction to Space Flight. *3(3-0) . Preq: PY 205; MA 341 or MA 303.* Fundamental aspects of space flight including launch vehicle performance and design, spacecraft characteristics, two-body orbital mechanics, earth satellites, interplanetary trajectories, atmospheric entry, and atmospheric heating.

MAE 455 Boundary Layer Theory. *3(3-0) . Preq: MAE 355.* Introduction to the Navier-Stokes Equations and boundary layer approximations for incompressible flow. Calculation techniques for laminar and turbulent boundary layer parameters which affect lift, drag, and heat transfer on aerospace vehicles. Discussions of compressible flows.

MAE 456 Computational Methods in Aerodynamics. *3(3-0) . Preq: MAE 356. Coreq: MAE 455.* Introduction to computational methods for solving exact fluid equations. Emphasis on development of the fundamentals of finite difference methods and their application to viscous and inviscid flows.

MAE 461 Dynamics & Controls. *3(3-0) . Preq: MA 341, MAE 208 with a grade of C or better.* Dynamics and linear feedback control of aerospace and mechanical systems. Concepts from linear system theory, kinematics, particle dynamics, first- and second-order systems, system dynamics, vibrations, and computational techniques. Feedback control by root-locus, Nyquist, Bode plots, servo-mechanisms, gain and phase margin, and compensation. Control system design emphasized.

MAE 462 Flight Vehicle Stability and Control. *3(3-0) . Preq: MAE 261, 461.* Longitudinal, directional and lateral static stability and control of aerospace vehicles. Lineralized dynamic analysis of the motion of a six degree-of-freedom flight vehicle in response to control inputs and disturbance through use of the transfer function concept. Control of static and dynamic behavior by vehicle design (stability derivatives) and/or flight control systems.

MAE 465 Propulsion II. *3(3-0) . Preq: MAE 365.* Performance analysis and design of components and complete air-breathing propulsion systems.

MAE 466 Experimental Aerodynamics III. *1(0-3) . Preq: MAE 358. Coreq: MAE 455, MAE 475.* Laboratory experiments in internal compressible flow and boundary layers in conjunction with MAE 455 and MAE 475. Topics include nozzle flows, constant area duct flows, component/overall performance of a gas turbine, and boundary layer analysis.

MAE 469 Controls Laboratory. *1(0-2) . Coreq: MAE 461 or MAE 435.* Laboratory experiments demonstrate the essential features of classical and modern control theory for single-input and single-output systems.

MAE 472 Aerospace Structures II. *3(3-0) . Preq: MAE 371.* A continuation of MAE 371; deflection of structures, indeterminate structures, minimum weight design fatigue analysis and use of matrix methods in structural analysis. Selection of materials for aircraft construction based on mechanical, physical, and chemical properties.

MAE 473 Aerospace Vehicle Structures II Lab. *1(0-3) . Preq: MAE 371. Coreq: MAE 472.* Demonstration and application of the concepts that have been presented in MAE 371 and MAE 472. Fabrication techniques and the design and construction of a structural component will be emphasized.

MAE 475 Propulsion I. *3(3-0) . Preq: MAE 356 and MAE 301.* One-dimensional, internal, compressible flow including: isentropic flow, normal shocks, flow with friction and simple heat addition. Applications to air-breathing aircraft propulsion systems. Performance, analysis and design of components and overall performance of air-breathing engines.

MAE 478 Aerospace Vehicle Design I. *2(1-3) . Preq: MAE 356, 472. Coreq: MAE 462, 465. Available only to seniors in the Aerospace Engineering Curriculum.* A synthesis of previously acquired theoretical and empirical knowledge and application to the design of practical aerospace vehicle systems.

MAE 479 Aerospace Vehicle Design II. *3(1-6) . Preq: MAE 478. A continuation of MAE 478.* Designs are refined and the vehicles constructed and instrumented by the students. A flight test program is designed and carried out in cooperation with MAE 525 students.

MAE 495 Special Topics in Mechanical and Aerospace Engineering. *1-3. Preq: Consent of instructor.* Offered as needed to present new or special MAE subject matter.

MAE 503 Advanced Power Plants. *3(3 0) . F. Preq: MAE 412.* Critical analysis of energy balance of thermal power plants, thermodynamics and economic evaluation of alternate schemes of development; study of recent development in production of power.

MAE 510 Effects of Noise and Vibration on Man. *3(3-0) . F. Preq: MA 301.* Study of effects of noise and vibration and design criteria available to establish acceptability of environments. Study of auditory and non-auditory response to noise and models available for predicting responses. Presentation of guidelines for designing equipment and environments to meet existing ANSI, ISO, ASTM and HVAC standards. Practical experience in using noise-vibration equipment.

MAE 514 Noise and Vibration Control. *3(3-0) . S. Preq: MAE 315.* Discussion of noise and vibration design criteria. Presentation of noise and vibration survey procedures. Discussion of noise and vibration control model. Review of most common equipment noise sources and ways to achieve adequate control. Topics include room acoustics, acoustics of walls, enclosures, vibration isolation and use of scale models.

MAE 517 Instrumentation in Sound and Vibration Engineering. *3(3-0) . S. Preq: ECE 331. Coreq: MAE 713.* A presentation of measurement techniques and theory and operation of transducers and amplifiers. Introduction to signal analysis techniques such as power spectral density and correlation.

MAE 524 Principles of Mechantronic Control. *3(3-0) . F. Preq: MAE 315.* Principles of mechantronic control beginning with single and two-degree of freedom systems. Linear feedback, disturbance rejection, state estimation, and filtering. Applications to civil, robotic, automotive, aircraft, space systems. "Hands on" experiments in linear feedback control and filtering.

MAE (WPS) 534 Mechantronics Design. *3(2-2) . F. Preq: Structured Programming Experience, Senior/Graduate Standing in WPS/MAE or Permission of Instructor.* Principles of Mechatronics Design, review of logic gates, microprocessor architecture, sensors and actuators, A/D and D/A conversion techniques, real-time multi-tasking programming concepts, direct digital control implementation. "Hands-on" experience through several laboratory assignments and final team project.

MAE 540 Advanced Air Conditioning Design. *3(3-0) . S. Preq: MAE 403, 404.* Psychrometric process representations. Heating and cooling coil design. Heat pump design. Air washer design. Direct contact heat and mass transfer systems. Ventilation requirements, air dilution calculations. Cooling load calculations; CLTD, CLF and transfer functions methods. Room air distribution.

MAE 545 Metrology For Precision Manufacturing. *3(2-1) . S. Preq: Sr. status in MAE or BS in other curriculum.* Foundations of dimensional metrology and error analysis as applied to accuracy and repeatability in machine design. Plane, length, angle, and roundness metrology. Design of precision systems, Abbe' principle, error analysis, measurement, and compensation. Precision instruments and operating principles. Hands-on experience with measurement instruments and techniques.

MAE 586 Project Work In Mechanical Engineering. *1-6. F,S.* Individual or small group investigation of a problem stemming from a mutual student-faculty interest. Emphasis on providing a situation for exploiting student curiosity.

MAE 589 Special Topics In Mechanical Engineering. *3(3-0) . F,S. Preq: Advanced undergrad. or grad. standing.* Faculty and student discussions of special topics in mechanical engineering.

MAE 601 Seminar. *1(1-0) S. Preq: MAE 701.* Analysis and establishment of conclusions of classical thermodynamics from the microscopic viewpoint. Topics include: ensemble methods, partition functions, translational, rotational and vibrational energy modes of an ideal gas, chemical equilibrium, imperfect gases, dense fluids, critical-point theories, mean free path concepts, Boltzmann equation, hydrodynamic equations from kinetic theory and properties of disordered composite media.

MAE 685 Master's Supervised Teaching. *1 3. F,S,Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

MAE 690 Master's Examination. *1-6. F,S,Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

MAE 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

MAE 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's Student.* Thesis Research

MAE 699 Mechanical Engineering Research. *1-3. F,S. Preq: Grad. standing in mechanical engineering, consent of adviser.* Individual research in the field of mechanical engineering.

MAE 701 Advanced Engineering Thermodynamics. *3(3-0) . F Preq: MAE 302, MA 401 or MA 511.* Classical thermodynamics of a general reactive system; conservation of energy and principles of increase of entropy; fundamental relation of thermodynamics; Legendre transformations; phase transitions and critical phenomena; equilibrium and stability criteria in different representation; irreversible thermodynamics. Introduction to statistical thermodynamics.

MAE 702 Statistical Thermodynamics. *3(3-0) . S. Preq: MAE 701.* Analysis and establishment of conclusions of classical thermodynamics from the microscopic viewpoint. Topics include: ensemble methods, partition functions, translational, rotational and vibrational energy modes of an ideal gas, chemical equilibrium, imperfect gases, dense fluids, critical-point theories, mean free path concepts, Boltzmann equation, hydrodynamic equations from kinetic theory and properties of disordered composite media.

MAE 703 Dynamics of Internal Fluid Flow. *3(3-0) . F. Preq: MAE 356 or MAE 308.* A general development of governing equations of fluid motion with subsequent restriction to incompressible flow. Exact and approximate solutions of Navier-Stokes equations for internal laminar flow and elementary boundary layer theory. Applications include: hydrodynamic lubrication, converging-diverging channel flows, entrance flows and turbulent internal flow.

MAE 704 Fluid Dynamics of Combustion I. *3(3-0) . F. Preq: MAE 301, MAE 355 or MAE 308.* Gas-phase thermochemistry including chemical equilibrium and introductory chemical kinetics. Homogeneous reaction phenomena. Subsonic and supersonic combustion waves in premixed reactants (deflagration and detonation). Effects of turbulence. Introduction to diffusion flame theory.

MAE 705 Fluid Dynamics of Combustion II. *3(3-0) . S. Preq: MAE 704.* Advanced theory of detonation and deflagration. Ignition criteria. Direct initiation of detonation including blast-wave theory. Transition from deflagration to detonation. Combustion wave structure and stability. Liquid droplet and solid particle combustion.

MAE 706 Heat Transfer Theory and Applications. *3(3-0) . F. Preq: MAE 410 or equivalent.* Development of basic equations for steady and transient heat and mass transfer processes. Emphasis on application of basic equations to engineering problems in areas of conduction, convection, mass transfer and thermal radiation.

MAE 707 Advanced Conductive Heat Transfer. *3(3 0) . S. Preq: MAE 706 or MA 501.* Comprehensive, unified treatment of methodologies for solving multidimensional transient and steady heat conduction. Approximate and exact methods of solving nonlinear problems, including phase and temperature-dependent thermal properties. nonlinearboundary conditions. Heat conduction in composite media and anisotropic solids. Use of finite integral transform and Green's function techniques.

MAE 708 Advanced Convective Heat Transfer. *3(3-0) . S. Preq: MAE 703* Advanced topics in steady and transient, natural and forced convective heat transfer for laminar and turbulent flow through conduits and over surfaces. Mass transfer in laminar and turbulent flow. Inclusion of topics on compressible flow with heat and mass transfer.

MAE 709 Advanced Radiative Heat Transfer. *3(3-0) F Preq: MAE 706.* Comprehensive and unified treatment of basic theories; exact and approximate methods of solution of radiative heat transfer and the interaction of radiation with conductive and convective modes of heat transfer in participating and non-participating media.

MAE 713 Principles Of Structural Vibration. *3(3-0) . F. Preq. MAE 315* Principles of structural vibration beginning from single and multi-degree of freedom systems and extending to distributed systems. Forced system response, vibration of strings, bars, shafts and beams and an introduction to approximate methods.

MAE 714 Analytical Methods In Structural Vibration. *3(3-0) S. Preq: MAE 713.* Classical problems in structural vibration for which analytical solutions are available. Shock response, energy formulations and applications to continuous and discretized systems including curved beams, membranes, plates, shells, cylinders, spheres and cones.

MAE 715 Nonlinear Vibrations. *3(3 0) . S. Alt. yrs. Preq: MAE 713.* A study of free and forced vibrations of non-linear systems with non-linear restoring forces and self-sustained oscillations. Development and usage of various analytical and phase plane methods in obtaining actual solutions. Emphasis on understanding properties unique to non-linear systems.

MAE 716 Random Vibration. *3(3-0) . F. Alt. yrs. Preq: MAE 713.* Mathematical description of stochastic processes. The stationary and ergodic assumptions and response analysis of mechanical systems to random excitation. Simulation of and failure due to random environments.

MAE (ECE, TE) 717 Multivariable Linear Systems Theory. *3(3-0) . S. Alt. yrs.(even). Preq: ECE 716 or MAE 721.* Advanced theory of control to linear systems with application to textile processing systems. Transfer matrices, controllability/observability, LQR. Algebraic treatment of feedback systems, coprime factorization. Analytic and harmonic functions, H– design.

MAE 718 Acoustic Radiation I. *3(3-0) . F. Preq: MA 301 and MAE 308 or MAE 356.* Introduction to principles of acoustic radiation from vibrating bodies and their related fields. The radiation of simple sources, propagation of sound waves in confined spaces and transmission through different media.

MAE 719 Acoustic Radiation II. *3(3-0) . S. Preq: MAE 718.* Advanced treatment of the theory of sound generation and transmission. Topics include: techniques for solution of the wave equation, radiation from spheres, cylinders and plates, sound propagation in ducts, scattering.

MAE (IE) 720 Industrial Robotics. *3(3-0) . F. Preq: IE 351; MA 301 or MA 303.* Development, structure, specifications and capabilities of industrial robots. Robot control fundamentals. Kinematics of manipulators. Applications, selection, economics and implementation of robotic systems. Safety considerations, end-of-arm tooling and design of robotic workplace. Acutators, sensors including vision and tactile sensory systems for robots.

MAE 721 Linear Control and Design for Mimo Systems. *3(3-0) . F. Preq: MAE 435 or equivalent; MA 341.* Linear Multivariable control and design for multibody engineering systems (robotics) and aircraft controls and navigation. Emphasis on multi-input and multi-output (MIMO) system analysis and design using frequency-based approach. Controllability and observability, transmission zeroes and pole-zero cancellation, eigenstructures, singular value decomposition in frequency domain, stability and performance robustness of MIMO systems.

MAE 722 Real Time Digital Filtering and Control. *3(3-0) . S Preq: MAE 721.* Development of microprocessor hardware and special purpose chips for real-time processing. Classical algorithms for digital filtering and control. Recursive and non-recursive filters, deadbeat algorithms, PID and model matching techniques, state space algorithms. Sensors and actuators. Applications including inertial guidance, engine control, aircraft and spacecraft maneuver control.

MAE 723 Mechanics of Machinery. *3(3-0) . S. Alt. yrs. Preq: MAE 315, MA 512.* Advanced applications of dynamics to the design and response analysis of dynamic behavior of machines and mechanical devices. Emphasis on developing competence in transforming real problems in dynamics into appropriate mathematical models whose analysis permits performance predictions of engineering value.

MAE (MEA) 725 Geophysical Fluid Mechanics. *3(3-0) . F. Alt. yrs. Preq: MAE 701 or equivalent.* The principles of fluid mechanics applied to geophysical systems. Special emphasis placed on those features of these systems, such as almost rigid rotation and stable stratification, which produce unique and important effects. The effects of almost rigid rotations on homogeneous and stratified flows examined in detail.

MAE (MEA) 726 Advanced Geophysical Fluid Mechanics. *3(3-0) . S. Alt. yrs. Preq: MAE 725 or equivalent.* Principles of fluid mechanics applied to geophysical systems. Special emphasis on role of stable stratification on the flows in these systems. Detailed study of generation, interaction, propagation and dissipation of internal gravity waves. Study of other geophysically important flows.

MAE 727 Computational Methods in Structural Vibration. *3(3-0) . S. Preq: CE 722 or MAE 713.* Development of computational methods to analyze the field problems in structural vibration for which closed-form solutions generally unavailable. Aimed primarily at linear systems, topics include: linearization and stability, computational methods for the eigensolutions and discretization by local function, global function and hybrid approaches, applications to undampled, damped and spinning assemblages of beams, rods, strings, shafts, membranes and plates.

MAE 730 Modem Plasticity. *3(3-0) . F. Alt. yrs.(even). Preq: Grad. course in elasticity or strength of materials.* Classical theories of plasticity and solutions pertaining to rate-independent and -dependent deformations modes in metals, geomaterials and concrete. Ductile failure modes, i.e., shear-strain localization and other failure modes associated with large deformation modes. Inelastic wave propagation, crystalline constitutive formulations and computational aspects of quasi-static and dynamic plasticity.

MAE (MAT) 731 Materials Processing by Deformation. *3(3-0) . F. Preq: Six hrs. of solid mechanics and/or materials.* Presentation of mechanical and metallurgical fundamentals of materials processing by deformation. Principles of metal working, friction, forging, rolling, extrusion, drawing, high energy rate forming, chipless forming techniques, manufacturing system concept in production.

MAE (MAT) 732 Fundamentals of Metal Machining Theory. *3(3-0) . S. Preq: Six hrs of solid mechanics and/or materials.* Presentation of mechanical and metallurgical fundamentals of metal machining. Mechanics of machining, temperatures generated, tool life and tool wear, lubrication, grinding process, electrical machining processes, surface integrity, economics, nomenclature of cutting tools.

MAE 733 Finite Element Analysis I. *3(3-0) . F. Preq: MAE 316 or MAE 472.* Fundamental concepts of the finite element method for linear stress and deformation analysis of mechanical components. Development of truss, beam, frame, plane stress, plane strain, axisymmetric and solid elements. Isoparametric formulations. Introduction to structural dynamics. Practical modeling techniques and use of general-purpose codes for solving practical stress analysis problems.

MAE 734 Finite Element Analysis II. *3(3-0) . S. Preq: MAE 733.* Advanced treatment of finite element analysis for non-linear mechanics problems, including most recent developments in efficient solution procedures. Plate bending and shell elements, computational plasticity and viscoplastic materials, large deformation formulations, initial stability and buckling, structural vibrations, incompressible elasticity, contact problems, flow in incompressible media, weighted residuals and field problems. Development of efficient algorithms for practical application.

MAE 736 Photoelasticity. *3(2-3) . S. Alt. yrs. Preq: MAE 316 or 371.* Theory and experimental techniques of two- and three-dimensional photoelasticity including photoelastic coatings, photoplasticity and an application of photoelastic methods to determination of stress-strain distributions in loaded members. Laboratory includes an investigation and complete report of a problem chosen by student under guidance of instructor.

MAE 737 Mechanics Of Composite Structures. *3(3-0) . F. Preq: MAE 316 or MAE 472.* Manufacturing techniques with emphasis on selection of those producing most favorable end result. Classical plate theory, materials properties and failure theories. Micromechanics, repair, plate solutions and elasticity solutions covered as required to meet special interests of students.

MAE 740 Advanced Machine Design I. *3(3-0) . F. Preq: MAE 416.* Advanced treatment of stress analysis and mechanics of materials devoted to analytical methods of predicting the life of mechanical components. Development of governing differential equations of elasticity. Analyses of beams, stress concentrations, pressurized pipes, rotating disks and contact stresses. Usage of energy approach to elasticity problems also as well as a brief introduction to plastic failure criteria.

MAE 741 Advanced Machine Design II. *3(3-0) . S. Preq: MAE 740.* Continuation of MAE 541. Problems related to torsion, curved and nonsymmetric beams, rings, plates and shells, and a brief introduction to fracture mechanics.

MAE 742 Mechanical Design for Automated Assembly. *3(3-0) . F. Preq: Grad. standing or PBS status in engineering.* Mechanical design principles important in high volume production using modern automated assembly technology. Production and component design for ease of assembly as dictated by part handling, feeding, orientation, insertion and fastening requirements. Existing product evaluation and redesign for improved assemblage.

MAE 743 Fracture Mechanics. *3(3-0) . S. Preq: MAE 316.* Concept of elastic stress intensity factor, Griffith energy balance, determination of the elastic field at a sharp crack tip via eigenfunction expansion methods, J integrals analysis, experimental determination of fracture toughness, fatigue crack growth, elastic-plastic crack tip fields. Emphasis on modern numerical methods for determination of stress intensity factors, critical crack sizes and fatigue crack propagation rate predictions.

MAE 744 Real Time Robotics. *3(3-0) . F Preq: Pascal, C, FORTRAN or Assembly language experience.* Real-time programming for servo control using an embedded controller. Software and hardware interfacing for control of a D.C. servo device. Introduction of multi-tasking to establish concurrent control of several processes, transforming servo loop into a process executing concurrently on single board computer. Provision for hands-on development systems and software emulators.

MAE 745 Advanced Flight Vehicle Stability and Control. *3(3-0) . F. Preq: MAE 462.* Preliminary analysis and design of flight control systems to include autopilots and stability augmentation systems. Study of effects of inertial cross-coupling and nonrigid bodies on vehicle dynamics.

MAE 746 Inertial Navigation Analysis and Design. *3(3-0) . S. Preq: MAE 435 or 462.* Performance analysis and engineering design of inertial navigation components, subsystems and systems. Development of transfer functions and application of linear system techniques to determine stability, transient response and errors of gyroscopes, accelerometers, stable platforms and inertial alignment systems. Error analysis and its significance. Preliminary analysis and design of typical inertial navigation systems for aircraft and marine vehicles.

MAE 750 Foundations of Fluid Dynamics. *3(3-0) . F. Preq: MAE 301, MAE 355 or MAE 308.* Review of basic thermodynamics pertinent to gas dynamics. Detailed development of general equations governing fluid motion in both differential and integral forms. Simplification of the equations to those for specialized flow regimes. Similarity parameters. Applications to simple problems in various flow regimes.

MAE 751 Airfoil Theory. *3(3-0) . S. Preq: MAE 355.* Development of fundamental aerodynamic theory. Emphasis upon mathematical analysis and derivation of equations of motion, airfoil theory and comparison with experimental results. Introduction to super sonic flow theory.

MAE 752 Transonic Aerodynamics. *3(3-0) . S. Preq: MAE 356.* Detailed study of latest theoretical and experimental findings in transonic aerodynamics, including two-dimensional and axisymmetric flows.

MAE 753 Compressible Fluid Flow. *3(3-0) . F. Alt. yrs. Preq: MAE 356.* Equations of motion in supersonic flow; unsteady wave motion, velocity potential equation; linearized flow; conical flow. Slender body theory. Methods of characteristics. Shockwave/ boundary layer interactions.

MAE 754 Hypersonic Aerodynamics. *3(3-0) . S. Preq: MAE 753.* Fundamentals of inviscid and viscous hypersonic flowfields. Classical and modern techniques for calculating shock wave shapes, expansions, surface pressures, heat transfer and skin friction. Applications to high speed aircraft, rockets and spacecraft.

MAE 755 Aerodynamic Heating. *3(3-0) . F. Preq: MAE 356.* Detailed study of latest theoretical and experimental findings of compressible laminar and turbulent boundary layers with special attention to aerodynamic heating problem. Application of theory in analysis and design of aerospace hardware.

MAE 756 Mechanics Of Ideal Fluids. *3(3-0) . S. Preq: MAE 355 or MAE 308.* Mass, momentum and energy conservation laws, flow kinematics and special forms of the governing equations (e.g., Euler equations and Bernoulli's equation). Solutions of Laplace's equation for the velocity potential. Applications of complex analysis for two-dimensional potential flows. Study of three-dimensional potential flows. Introduction to the effects of viscosity.

MAE 760 Computational Fluid Mechanics and Heat Transfer. *3(3-0) . S. Preq: MA 501 or MA 512, MAE 750 or MAE 703, proficiency in the FORTRAN programming language is required.* Introduction to integration of the governing partial differential equations of fluid flow and heat transfer by numerical finite difference and finite volume means. Methods for parabolic, hyper-bolic and elliptical equations and application to model equations. Error analysis and physical considerations.

MAE 761 Wing Theory. *3(3-0) . S. Alt. yrs. Preq: MAE 751.* Discussion of inviscid flow fields over wings in subsonic flow. Vortex lattice methods, lifting surface theories and panel methods developed for wings with attached flow and leading-edge separation. Calculation of aerodynamic characteristics and determination of effects of planform and airfoil shapes.

MAE 762 Physical Gas Dynamics. *3(3-0) . F. Preq. MAE "50.* Introduction to kinetic theory, statistical mechanics and chemical thermodynamics. Law of Action. Vibrational and chemical rate processes. Application to equilibrium and nonequilibrium flows.

MAE 766 Computational Fluid Dynamics. *3(3-0) . F Preq: MAE "60; proficiency in the FORTRAN programming language is required.* Advanced computational methods for integrating, by use of finite differences, and finite volume discretizations, non linear governing equations of fluid flow; the Euler equations and the Navier-Stokes equations. Topics from current literature.

MAE (MEA) 768 Perturbation Method in Fluid Mechanics I. *3(3 0) . F,S Preq: MA 401, MAE 308.* Basic theory and application of perturbation methods in fluid mechanics including: regular and singular perturbations, matching principles, method of strained coordinate, two variable expansion and applications to partial differential equations.

MAE (MEA) 769 Perturbation Method in Fluid Mechanics II. *3(3-0) . F,S. Preq: MA 401, MAE 308.* Basic theory and application of perturbation methods in fluid mechanics including: regular and singular perturbations, matching principles, method of strained coordinate, two variable expansion and applications to partial differential equations

MAE 770 Computation of Reacting Flows. *3(3-0) . S. Preq: MAE 760, MAE 766.* Development of governing equations for chemically and thermally nonequilibrium flows. Numerical formulation with application to planetary entry flows and supersonic combustion. Numerical examples. Computational problems.

MAE 773 Hydrodynamic Stability and Transition. *3(3-0) . S. Alt. yrs. Preq: MAE 750 or MAE 703.* Conceptual framework and development of hydrodynamic stability theory. Application of the theory to two-dimensional incompressible and compressible subsonic, transonic, supersonic and hypersonic flows. Results for three-dimensional flows. Introduction of mechanisms of transition and discussion of transition models in numerical methods.

MAE 774 Dynamics of Real Fluids I. *3(3-0) . S. Preq: MAE 750 or 703.* Exact solutions to the Navier-Stokes equations. Approximate solutions for low Reynolds numbers. Approximate solutions for high Reynolds numbers--incompressible boundary layer theory. Laminar and turbulent boundary layers in theory and experiment. Flow separation.

MAE 775 Dynamics of Real Fluids II. *3(3-0) . F. Preq: MAE 774.* A continuation of MAE 654. Compressible laminar and turbulent boundary layers. Laminar and turbulent jets. Stability of laminar boundary layers with respect to small disturbances, transition from laminar to turbulent flow.

MAE 776 Turbulence. *3(3 0) . S. Preq: MAE 750.* Development of basic concepts and governing equations for turbulence and turbulent field motion. Formulations of various correlation tensors and energy spectra for isotropic and nonisotropic turbulence. Introduction to turbulent transport processes, free turbulence, and wall turbulence.

MAE 777 Experimental Methods in Fluid Mechanics. *3(3-1) . Preq. MAE 750 or MAE 703.* Principles and practices of fluid dynamic measurement. Application of instruments and measuring techniques. One, two and three component thermal anemometry. Differential and unsteady pressures, LDV, Shadowgraph, Schlieren and interferometer techniques. Optimization and choice of instrument selection. Limitations of data acquisition and analysis. Limited hands-on experience.

MAE 778 Molecular Gas Dynamics I. *3(3-0) . F. Preq: MAE 750.* Statistical mechanics as applied to the derivation of the equations of gas dynamics from the microscopic view point. Collision processes, treatments of viscosity, heat conduction and electrical conductivity.

MAE 779 Molecular Gas Dynamics II. *3(3-0) . S. Preq: MAE 778, 702.* A continuation of MAE 778. Approximate methods of solution to the Boltzmann equation. Modeling of the Boltzmann equation. Results obtained by various methods of analysis.

MAE 789 Advanced Topics in Mechanical Engineering. *1-3. F,S. Preq: Grad. standing.* Faculty and graduate student discussions of advanced topics in contemporary mechanical engineering.

MAE 801 Mechanical Engineering Seminar. *1(1-0) . F,S.* Faculty and graduate student discussions centered around current research problems and advanced engineering theories.

MAE 885 Doctoral Supervised Teaching. *1-3. F,S,Sum. Preq: Doctoral Student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

MAE 890 Doctoral Preliminary Examination. *1-9. F,S,Sum. Preq: Doctoral Student.* For students who are preparing for and taking written and/or oral preliminary exams.

MAE 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq: Doctoral Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

MAE 895 Doctoral Dissertation Research. *1-9. F,S,Sum. Preq: Doctoral Student.* Dissertation Research

MAE 899 Doctoral Dissertation Preparation. *1-3. F,S,Sum.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

MATERIALS SCIENCE AND ENGINEERING

MAT 200 Mechanical Properties of Structural Materials. *3(2-3) . Preq: CH 101 and the first course in engineering mechanics. Not for Materials majors.* An introduction to the atomic and grain structure of structural materials and their properties with emphasis on mechanical properties of metals; plastic deformation, cold and hot working and heat treatment of metals and alloys; residual stresses, fatigue, creep and corrosion phenomena; structural polymers and composites; physical examination and nondestructive testing of materials and structural components.

MAT 201 Structure and Properties of Engineering Materials. *3(3-0) . Preq: CH 101.* Introduction to the fundamental physical principles governing the structure and constitution of metallic and nonmetallic materials and the relationships among these principles and the mechanical, physical and chemical properties of engineering materials.

MAT 210 Materials Characterization Laboratory. *2(1-3) . Coreq: MAT 201.* Concepts and applications of basic materials characterization techniques, including diffraction, microscopy (optical and electron), thermal analysis, mechanical testing techniques, and spectroscopic analysis of materials.

MAT 225 Chemistry of Polymeric Materials. *2(2-0) . Preq: CH 201.* Bonding in molecular solids, structure and nomenclature of organic compounds relevant to polymers, nomenclature of polymers, polymerization of reactions and mechanisms for step growth polymerization, chain polymerization, copolymerization, and coordination polymerization.

MAT 301 Equilibrium and Rate Processes. *3(3-0) . Preq: 241. Coreq: MAT 201.* Review of classical thermodynamics and thermodynamic relationships. Use of statistical methods of describe entropy and other thermodynamic properties. Description of vapor-, liquid-, and solid-phase equilibrium in unary and other multicomponent material systems. Treatment of ideal and nonideal solution behavior in inorganic alloys and organic polymers. Application of gas-phase reaction kinetics and identification of the criteria required for reaction equilbria.

MAT 310 Computer Applications for Materials Engineering. *2(1 3) .* Computer applications for processing and analyzing materials data and performing materials design and modeling calculations.

MAT 321 Phase Transformations and Diffusion. *3(3-0) . Preq: MAT 330.* Types. mechanisms, and kinetics of solid state phase transformations are presented with selected applications of solid state transformations. Mechanisms of diffusion and techniques for diffusion calculations.

MAT 324 Polymer Characterization Laboratory. *1(0.50 1.50) . Coreq: MAT 425 for MTE majors.* Laboratory experiments designed to illustrate the preparation and characterization of polymer materials, including: polymer synthesis, molecular weight measurement, microscopic examination, thermal properties, mechanical properties, and permeability.

MAT 330 Crystal Chemistry and Phase Equilibria. *3(3-0) . Preq: MAT 301.* Structure of engineering materials from electronic to atomic and crystallographic considerations. Structural imperfections and their effects on properties. Applications of thermodynamic principles to the construction and use of phase diagrams in materials systems. Development of and correlation of microstructure with phase diagrams.

MAT 331 Electronic Properties of Materials. *3(3-0) . Preq: MAT 330. Coreq: MAT 333.* Treatment of the role of electrons and electron energy (band) structures in determining the fundamental properties of materials- electrical, magnetic, optical, and thermal. Introduction to quantum mechanics; Brillouin zones; band structures. Theoretical and phenomenological basis of each property as manifested in various classes of materials; examples and demonstrations of technological applications.

MAT 333 Electronic Properties Laboratory. *1(0-3) . Preq: MAT 330.* Laboratory experiments demonstrating major electronic properties of all classes of materials; electrical conduction (temperature and defect dependence); characterization of semiconductors; optical measurements and characterization; magnetic behavior and properties; electron beam techniques used to characterize devices.

MAT 350 Mechanical Properties of Materials I. *3(3-0) . Preq: MAT 201, MA 341.* Covers fundamental topics in stress analysis and mechanics of materials including statics and structures, elasticity, plasticity, fracture, fatigue, testing methods, and engineering applications.

MAT (NE) 409 Nuclear Materials. *3(3-0) . Preq: MAT 201.* Properties and selection of materials for optimum design of nuclear steam systems. Implications of radiation damage to reactor materials and material problems in nuclear engineering. Overview of nuclear steam systems, crystal structure and defects, dislocation theory, mechanical properties, radiation damage, hardening and embrittlement due to radiation exposure and problems concerned with fission and fusion materials.

MAT 423 Introduction to Materials Engineering Design. *3(3-0) . Preq: MAT 435, 434, 450 and senior standing in MTE. Coreq: MAT 431, MAT 430.* Materials selection in engineering design involving lecture, cooperative and problem based learning techniques. Course stresses creative thinking, problem solving methodology, interdependence of design with analysis and evaluation, teamwork and sharpening of communication skills. Real industrial problems are introduced later which are analyzed by student teams. Well developed proposals are submitted to sponsors which define future work under MAT 424.

MAT 424 Materials Science and Engineering Design Project. *3(1-6) . Preq: MAT 423, 430, 431, 435, 434, 450 and senior standing.* Design project in materials science and engineering requiring problem definition and analysis, synthesis, and presentation of a designed solution. Students work in groups with a faculty adviser on problems submitted by local industrial sponsors or emerging research issues that represent the major specialty areas including ceramics, metals, polymers, or electronic materials.

MAT 425 Introduction to Polymeric Materials. *3(3-0) Preq: MAT 225 MAT 301 Coreq: MAT 324.* Covers fundamental concepts in polymer science, engineering and design including molecular weight distributions, polymer physical structure, morphology, crystalline and amorphous polymers, structure-property relationships, viscoelasticity, and rubber elasticity.

MAT 430 Physical Metallurgy Laboratory. *1(0-3) . Coreq: MAT 431.* Selected microstructures in ferrous and non-ferrous metals are examined using optical and scanning electron microscopy and interpreted. Mechanical properties measurements are made on some of the same alloys in order to develop structure-property relationships.

MAT 431 Physical Metallurgy I. *3(3-0) . Preq: MAT 321, 450. Coreq: MAT 430.* Application and design of selected metals and alloys in a theoretical and practical context. Relationships between mechanical behavior and alloy chemistry, microstructure, and processing. Corrosion resistance; fatigue failure; creep; brittle fracture. Design of specific microstructures.

MAT 434 Ceramic Engineering Laboratory. *1(0-3) . Coreq: MAT 435.* Ceramics are processed and examined in the laboratory. Topics include sintering, grain growth, mechanical properties and design using brittle materials and various characterization techniques relating processing to the development of microstructures and properties.

MAT 435 Physical Ceramics. *3(3-0) . Preq: MAT 201, MAT 210. Coreq: MAT 321, MAT 434.* Physical and chemical nature of classical and modern ceramic materials. Emphasis on crystal structures, defect structures and microstructures, and their collective effects on thermal, mechanical and electrical properties.

MAT 440 Processing of Metallic Materials. *3(3-0) . Preq: MAT 321, MAT 450. Coreq: MAT 431.* Fundamental concepts of solidification and their application to foundry and welding practices; metal forming concepts applied to forging, rolling, extrusion, drawing, and sheet forming operations; machining mechanisms and methods; powder metallurgy; advanced processing methods including rapid solidification and mechanical alloying.

MAT 445 Ceramic Processing. *3(2-3) . Preq: MAT 434, 435* Ceramic processing of powders includes powder synthesis, characterization, mixing, and size reduction. Theoretical aspects include particle packing, particles in suspension, and some aspects of surface chemistry. Forming methods include compaction, casting, and extrusion. Firing and sintering are examined.

MAT 450 Mechanical Properties of Materials II. *3(3-0) . Preq: MAT 350.* Plastic flow, fracture and/or failure phenomenon in solids are treated in terms of fundamental deformation mechanisms with emphasis on the role of crystal defects and microstructure. Tensile, creep and fatigue modes of deformation are included, along with design considerations and applications in-practice

MAT 460 Microelectronic Materials. *3(3-0) . Preq: MAT 331.* Processes and characterization techniques relevant to microelectronic materials science and technology. Boule growth, wafer preparation, oxidation, epitaxial growth, doping techniques, metallization, and device applications of elemental and compound semiconductors. Electrical, structural and chemical characterization of semiconductors is included as well as materials considerations relevant to device fabrication.

MAT 475 Polymer Technology and Engineering. *3(3-0) . Preq. MAT 425.* Covers classes of commercially important polymers, advanced topics in the phase behavior, viscoelasticity, fracture and ultimate properties of polymers. polymer rheology, processing and permeability; and the design of polymeric materials.

MAT 490 Special Topics in Materials Engineering. *1-4 Preq. Permission of Instructor.* Offered as needed for the development of new courses in materials engineering, including areas such as metals. ceramics, polymers, or microelectronic materials.

MAT 491 Materials Engineering Seminar. *1(1-0) . Preq: Sr. standing.* Survey of topics relevant to job placement for seniors including: resumes, career opportunities, writing and speaking skills, and interview skills. Written and oral presentations by students, presentations by faculty and guests, practice interviews,and critiques.

MAT 495 MAT 495 Materials Engineering Projects. *1-6. Preq: Jr. or Sr standing.* Application of engineering principles to a specific materials engineering project by a student or small group of students under supervision of a faculty member. A written report required.

MAT 500 Modern Concepts In Materials Science. *3(3-0) . Preq: Grad. standing.* Fundamentals of structure, structure modification and properties of materials with emphasis on structure-property relationships and modern theory of solids.

MAT 531 Physical Metallurgy. *3(3-0) . F. Preq: MAT 321, MAT 450. Coreq: MAT 430. Credit for both MAT 431 and MAT 531 is not allowed.* Application and design of selected metals and alloys in a theoretical and practical context. Relationships between mechanical behavior, and alloy chemistry, microstructure, and processing. Corrosion resistance; fatigue failure; creep; brittle fracture Design of specific microstructures.

MAT 540 Processing of Metallic Materials. *3(3-0) . F. Preq. MAT 321, MAT 450. Coreq: MAT 431. Credit for both MAT 440 and MAT 540 is not allowed.* Fundamental concepts of solidification and their application to foundry and welding practices; metal forming concepts applied to forging, rolling, drawing, and sheet forming operations, machining mechanisms and methods; powder metallurgy; advanced processing methods including rapid solidification and mechanical alloying.

MAT 545 Ceramic Processing. *3(2-1) . F. Preq: MAT 434, MAT 435 Credit for both MAT 445 and MAT 545 is not allowed.* Powder synthesis, characterization, colloidal processing, forming method, theory of sintering, aspects of microstructural control.

MAT 556 Composite Materials. *3(3-0) . F. Preq: MAT 450.* Basic principles underlying properties of composite materials as related to properties of individual constituents and their interactions. Emphasis on design of composite systems to yield desired combinations of properties.

MAT 560 Microelectronic Materials Science and Technology. *3(2-1) . S Preq. MAT 331. Coreq: MAT 431. Credit for both MAT 460 and MAT 560 is not allowed* Processes and characterization techniques relevant to microelectronic materials science and technology. Boule growth, water preparation, oxidation, epitaxial growth, doping techniques, metallization, and device applications of elemental and compound semiconductors. Electrical, structural and chemical characterization of semiconductors as well as materials considerations relevant to device fabrication.

MAT (TC) 561 Organic Chemistry Of Polymers. *3(3-0) . S.* Principles of step reaction and addition polymerizations; copolymerization; emulsion polymerization; ionic polymerization; characterization of polymers; molecular structure and properties.

MAT 575 Polymer Technology and engineering. *3(3-0) . F. Preq: MAT 424 or equivalent. Credit for both MAT 475 and MAT 575 is not allowed.* Classes of commercially important polymers, advanced topics in phase behavior, viscoelasticity, fracture and ultimate properties of polymers; polymer rheology, processing and permeability; design of polymeric materials.

MAT (BUS) 576 Technology Evaluation and Commercialization Concepts. *3(3-0) S. Preq: Grad. standing.* Commercialization potential of new technologies, products and processes. Marketing, organizational, financial, operational and manufacturing issues. Strategic assessment and planning. Innovation management. Entrepreneurial transfer mechanisms including spinoffs, licensing and high-technology start-ups. Practical application with project and team management skills development.

MAT (BUS) 577 Technology Evaluation and Strategy. *3(3-0) . F Preq: BUS 576* Theoretical and practical team-based application of systematic evaluation techniques for assessing commercial potential of technologies, products and processes. Prioritization and selection based on technology strategy.

MAT (BUS) 578 High Technology Entrepreneurship. *3(3-0) Every yr. Preq: BUS 577.* Development of strategies to commercialize technology based on prioritized assessments. Investigation of various commercialization approaches. Business plan development. Practical application of technology management skills to actual cases with commercial potential.

MAT 601 Seminar. *1(1-0) . F, S.* Reports and discussion of special topics in materials science and engineering and allied fields.

MAT 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

MAT 690 Master's Examination. *1-6. F, S, Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

MAT 693 Master's Supervised Research. *1-9. F, S, Sum. Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

MAT 695 Master's Thesis Research. *1-9. F, S, Sum. Preq: Master's Student.* Thesis Research

MAT 699 Master's Thesis Preparation. *1-3. F, S, Sum. Preq: Master's Student. Credits Arranged.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

MAT 700 Modern Concepts in Materials Science. *3(3-0) . F. Preq: Grad. standing.* Fundamentals of structure, structure modification and properties of materials with emphasis on structure-property relationships and modern theory of solids.

MAT 701 Diffusion and Mass Transport Processes in Solids. *3(3-0) . F. Preq: Consent of Instructor.* Interatomic forces and crystal structure, basic concepts in diffusion theory, diffusion and mass transport in metals and alloys, semiconductors, ionic crystals (ceramics) and amorphous materials. Diffusion along dislocations and grain boundaries, surface and interface diffusion, electromigration and thermomigration, concentration-enhanced diffusion, transient diffusion, stress-induced diffusion, mass and heat transport during rapid solidification, radiation damage and defect diffusion.

MAT 702 Defects in Solids. *3(3-0) . S Preq. Consent of Instructor.*

MAT 704 Electrical, Optical and Magnetic Properties Of Materials. *3(3 0) . S. Preq: MAT "00. "10.* Electron theory of materials, band theory; electrical behavior of metals, semiconductors, dielectrics and noncrystalline materials; theory of optical behavior and applications; foundations of magnetic properties and applications of ferrites and permanent magnetic materials.

MAT 705 Mechanical Behavior of Engineering Materials. *3(3-0) . F. Preq: MAT 450, MAT 702.* Coverage of both fundamental and engineering aspects of mechanical behavior of materials. Elasticity, plasticity and dislocation theory concepts used to describe phenomenological behavior and micro-mechanical mechanisms. Strengthening mechanisms in crystals, high-temperature deformation, fracture mechanics, fracture toughening mechanisms and cyclic deformation.

MAT 706 Phase Transformations and Kinetics. *3(3-0) . S. Preq: MAT 700, 710.* Homogeneous and heterogeneous nucleation, spinodal decomposition, interface and diffusion-controlled growth, formal theory of transformation kinetics, precipitation, coarsening, order-disorder, and martensitic transformations.

MAT (CH) 707 Chemical Concepts In Materials Science and Engineering. *3(3-0) . F. Preq: Consent of Instructor.* Structure, symmetry and chemical bonding; spectroscopic methods and their utilization in trace analysis and pollution control; phase equilibria, crystal growth and materials purification; vapor phase equilibria and kinetics of chemical reactions andtransport; electrochemical thermodynamics and kinetics with applications to batteries, solar cells, electrorefinement, plating and corrosion processes.

MAT 708 Thermodynamics Of Materials. *3(3-0) . F. Preq: MAT 301 or equivalent.* Review of first and second laws of thermodynamics, equilibrium and irreversible processes, open and closed systems, partition functions and particle distribution functions. Applications include extension of thermodynamic potentials to situations where electrical, magnetic and stress fields present, heat capacity of crystals, electron gas in metals, solution models, binary phase diagrams and rubber elasticity in polymers.

MAT 710 Elements Of Crystallography and Diffraction. *3(3-0) . F.* Crystal symmetry, lattices and space groups; elementary diffraction by crystalline matter; experimental methods of x-ray diffraction.

MAT 711 Stereology and Image Analysis. *3(3-0) . S. Alt Yrs. Preq: Grad. standing.* Development of principles and their practical application to measurement of images from microscopy (primarily materials) to describe three-dimensional structure of specimens viewed in transverse sections or projection. Basic statistics, manual and automatic (computerized) image analysis methods. Basic stereological parameters (volume fraction, surface density, curvature) plus object size and shape parameters, fractal and stereoscopic description of surfaces.

MAT 712 Scanning Electron Microscopy. *3(3-0) . F. Preq: Grad. standing.* Electron optics, sources and detectors. Beam specimen interactions, secondary and backscattered electrons. EDS and WDS. Resolution limits, experimental conditions, related techniques, beam-induced damage and materials modification.

MAT 715 Fundamentals Of Transmission Electron Microscopy. *4(3-3) . S. Preq: MAT 710 or equivalent. Laboratory enrollment limited to twelve, but laboratory may be waived with consent of instructor..* Electron optics, electron-solid interactions, electron diffraction, image contrast, defect characterization, analytical and high resolution microscopy. Parallel laboratory demonstrations and exercises.

MAT 720 Advanced Crystallography and Diffraction. *3(3-0) . F. Preq: MAT 710.* Symmetry in crystals and space group determination. Kinematic and dynamical scattering theories. Experimental methods involving single crystals. Image formation in x-ray topography and electron microscopy. Disorder and defects. Methods of crystal structure analysis. Residual stresses and preferred orientation in polycrystals.

MAT 721 Theory and Structure Of Amorphous Materials. *3(3-0) . S. Preq: MAT 700.* Bond types and structure of amorphous solids, relations of bond types and structure to flow mechanisms, electrical, optical and thermal properties.

MAT 722 Advanced Scanning Electron Microscopy and Surface Analysis. *3(3 0) . S, Alt. Yrs. Preq: MAT 712 or equivalent.* Beam specimen interactions, voltage contrast, electron spectrometers, stroboscopy, EBIC, cathodoluminescence, channeling, backscattering, magnetic contrast, vacuum science, instrumentation, ion sputtering, Auger electron spectroscopy, SIMS, quantitative EDS, ESCA, FIM, STM.

MAT 723 Theory and Structure Of Metallic Materials. *3(3-0) . F. Preq: MAT 700.* The metallic state, its atomic and electronic structure. Electron theory of metals and alloys. Advanced methods of determining electronic structure in metallic materials. Solid solutions and intermediate phases, superconducting and magnetic alloys.

MAT (NE) 725 Nuclear Materials. *3(3-0) . F. Preq: NE 409 or MAT 201, Consent of Instructor.* Properties and selection of materials for nuclear steam systems and radiation effects on materials. Implications of radiation damage to reactor materials and material problems in nuclear engineering. An overview of nuclear steam systems, crystal structure and defects, dislocation theory, mechanical properties, radiation damage, hardening and embrittlement due to radiation exposure and problems concerned with fission and fusion materials.

MAT (MAE) 731 Materials Processing By Deformation. *3(3-0) . F. Preq: Six hrs. of solid mechanics and/or materials.* Presentation of mechanical and metallurgical fundamentals of materials processing by deformation. Principles of metal working, friction, forging, rolling, extrusion, drawing, high energy rate forming, chipless forming techniques, manufacturing system concept in production.

MAT (MAE) 732 Fundamentals Of Metal Machining Theory. *3(3-0) . S. Preq: Six hrs. of solid mechanics and/or materials.* Presentation of mechanical and metallurgical fundamentals of metal machining. Mechanics of machining, temperatures generated, tool life and tool wear, lubrication, grinding process, electrical machining processes, surface integrity, economics, nomenclature of cutting tools.

MAT 733 Advanced Ceramic Engineering Design. *3(2-3) F.* Advanced studies in analysis and design of ceramic products, processes and systems leading to original solutions of current industrial problems and development of new concepts of manufacturing.

MAT 741 Principles of Corrosion. *3(2-3) . F. Preq: MAT 201 and CH 431 or MAT 301.* Fundamentals of metallic corrosion and passivity. Electro-chemical nature of corrosive attack, basic forms of corrosion, corrosion rate factors, methods of corrosion protection. Laboratory work included.

MAT 751 Thin Film and Coating Science and Technology I. *3(3-0) . F. Preq: MAT 700.* Vacuum science and technology including gas kinetics, gas flow calculations, system design and use of various pumps, materials and components. Atomistics of solid surfaces. Nucleation and growth of films and coatings.

MAT 752 Thin Film and Coating Science and Technology II. *3(3-0) S.Alt Yrs. Preq: MAT 751.* Techniques for thin films and coatings deposition and their applications. Interfaces, adhesion and surface modification. Artificially structured and chemically modulated layered materials. Pseudomorphic structures. Characterization of thin films and coatings.

MAT 753 Advanced Mechanical Properties of Materials. *3(3-0) . F.* Theories of yield strength, work hardening, creep, fracture and fatigue of crystalline materials developed in terms of dislocation theory.

MAT 760 Materials Science In Processing of Semiconductor Devices. *3(3 0) . S Alt Yrs. Preq: MAT 460.* Ion implantation and doping for advanced semiconductor devices, thin films and epitaxy, silicides, ohmic contacts and interconnection metallurgy, oxidation and nitridation, gettering of impurities and dopant segregation phenomena, electromigration, electronic packaging materials science and advanced device concepts.

MAT (CHE) 761 Polymer Blends and Alloys. *3(3-0) . F, Alt. Yr(odd). Preq: CHE 316 or MAT 301.* Thermodynamics, morphological characteristics and properties of multiphase polymer systems composed of homopolymers or copolymers. Interfacial characteristics and modification of multicomponent polymer blends through emulsification and reactive blending. Microphase ordering in block copolymers, and emerging technolgies employing these nanostructured materials. Conformational properties and dynamics of macromolecules constrained near an interface.

MAT (CH, TC) 762 Physical Chemistry of High Polymers-Bulk Properties. *3(3-0) F. Alt Yrs. Preq: CH 220 or TC 203, CH 431.* Molecular weight description; states of aggregation and their interconversion; rubbery, glassy and crystalline states; rubber elasticity; diffusion properties.

MAT (FPS, TMS) 763 Characterization of Structure of Fiber Forming Polymers. *3(3-0). F. Preq: MA 301, PY 208.* Theories, experimental evidence and characterization methods of the molecular fine structure of fiber forming polymers in the solid state. Characterization methods include X-ray diffraction, microscopy, infrared, thermal and magnetic resonance. An introduction to nucleation theory of polymer systems.

MAT 770 Defects, Diffusion and Ion Implantation in Semiconductors. *3(3-0) . F, Alt. Yrs. Preq: MAT 701 or equivalent.* Thermodynamics of vacancies and interstitials, defect complexes, electronic defects, defect annealing processes, self diffusion, dopant and impurity diffusion, substitutional/interstitial diffusion, diffusion in amorphous solids, electro transport, fundamentals of ion-solid interactions, semiconductor doping atomic structure of defects, damage annealing processes, supersaturated alloys, laser annealing, ion beam mixing phenomena, ion implantation and rapid thermal annealing processes, shallow junctions and devices.

MAT (CH, TC) 772 Physical Chemistry of High Polymers--Solution Properties. *3(3-0) . S, Alt Yrs. Preq: CH 433, TC (CH, MAT) 762.* Thermodynamics of polymer solutions; phase equilibria; determination of molecular weight.

MAT (NE) 773 Computer Experiments in Materials and Nuclear Engineering. *3(3-0) . S. Preq: Advanced undergrad. standing.* Monte Carlo and dynamical computer experiments covered from standpoint of how to design and use them in materials and nuclear engineering work.

MAT 775 Structure of Semicrystalline Polymers. *3(3-0) . S. Alt Yrs. Preq: MAT 425 or equivalent.* Structure and organization of semicrystalline polymers, from molecular scale to bulk state, including chain configuration, unit cell geometries, polymer crystallography, single crystals, spherulites, epitaxial crystallization, morphology, crystal defects, annealing and deformation mechanisms. Emphasis on analysis of x-ray diffraction, electron diffraction and electron microscopy data for structural characterization.

MAT 791 Advanced Topics in Materials Science and Engineering. *1-3. F, S, Sum. Preq: Grad. standing.* Special studies of advanced topics in materials science and engineering.

MAT 792 Advanced Topics in Materials Science and Engineering. *1-3. F S, Sum. Preq: Grad. standing.* Special studies of advanced topics in materials science and engineering.

MAT 795 Advanced Materials Experiments. *1-3. F, S, Sum. Preq: Sr. or grad. standing.* Advanced engineering principles applied to a specific experimental project dealing with materials. A seminar period provided; required written report.

MAT 801 Seminar. *1(1-0) . F, S, Sum.* Reports and discussion of special topics in materials science and engineering and allied fields.

MAT 885 Doctoral Supervised Teaching. *1-3. F, S, Sum. Preq: Doctoral Student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

MAT 890 Doctoral Preliminary Exam. *1-9. F, S, Sum. Preq: Doctoral Student.* For students who are preparing for and taking written and/or oral preliminary exams.

MAT 893 Doctoral Supervised Research. *1-9. F, S, Sum. Preq: Doctoral Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

MAT 895 Doctoral Dissertation Research. *1-9. F, S, Sum. Preq: Doctoral Student.* Dissertation Research

MAT 899 Doctoral Dissertation Preparation. *1-3. F, S, Sum. Preq: Doctoral Student.* For students who have completed all credit hour requirements, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

MICROBIOLOGY

MB 200 Microbiology and World Affairs. *3(3-0) .* An integrated and comprehensive study of the microbial world and its influence on global events and human affairs.

MB 351 General Microbiology. *3(3-0) . F,S,Sum. Preq: One biology course: (BIO 125,BIO 181, 183 or ZO 150) and one organic chemistry course: (CH 221 or CH 220).* Rigorous introduction to basic principles of microbiology for students in biological and agricultural sciences and for all students planning to take further courses in microbiology.

MB 352 General Microbiology Laboratory. *1(0-3) . F,S,Sum. Coreq: MB 351.* Laboratory experience in general microbiology. Aseptic technique, isolation and identification of bacteria, staining and microscopy. Enumeration of bacteria and viruses.

MB (FS) 405 Food Microbiology. *3(3-0) . Preq: MB 351.* Microorganisms of importance in foods and their metabolic activities. Source of microbial contamination during food production, processing and storage. Microbial spoilage; foods as vectors of human pathogens. Physical and chemical destruction of microorganisms in foods and the kinetics involved. Conversions of raw foods by microorganisms into food products. Microbiological standards for regulatory and trade purposes.

MB (FS) 406 Food Microbiology Lab. *1(0-2) . Coreq: FS (MB) 405.* Laboratory experience to complement FS/MB 405. Skills in detecting and quantitating microorganisms and their toxins in foods. Application of colony and direct microscopic counts, most probable numbers, enzyme immunoassays, nucleic acid probes and computer modeling are used to understand the numbers and types of microorganisms or microbial end products in foods. Laboratory safety and oral and written reports are emphasized.

MB 409 Microbial Diversity. *3(2-3) . S. Preq: MB 351.* Molecular, biochemical and evolutionary diversity of the microbial world, including Bacteria (a.k.a. eubacteria), Archaea (archaebacteria), and unicellular Eucarya (eucaryotes). Evolutionary perspective on microbial relationships, molecular methods of study, and classical and modern biotechnological methods utilizing this genetic diversity to meet the needs of our own species.

MB 411 Medical Microbiology. *3(3-0) . F. Preq: MB 351.* Comprehensive study of microbial pathogenesis and mammalian host resistance. Diagnosis, prevention, and therapy of common human diseases of microbial origin.

MB 412 Medical Microbiology Laboratory. *1(0-3) . F. Preq: MB 351.* Laboratory experience to complement MB 411. Techniques of detection, growth and identification of bacteria and viruses relevant in clinical microbiology laboratories. Good laboratory practices (GLP) and safety stressed.

MB 414 Microbial Metabolic Regulation. *3(3-0) . Preq: MB 351, BCH 451.* An integrative perspective on bacterial physiology and metabolism through an analysis of metabolic regulatory functions.

MB 455 Microbial Biotechnology. *3(3 0) . S. Preq: MB 351, GN 411.* Introduction to industrial microbiology with focus on biotechnology including developments employing recombinant nucleic acid and monoclonal antibody techniques. Bioremediation, industrial enzymes, transgenic plants, biopesticides, medical diagnostics, recombinant vaccines production of important secondary metabolites, and other topics. Field trips to local biotechnology companies.

MB 461 Introduction to Molecular Virology. *3(3-0) . S. Preq: MB 351, MB 411.* Introduction to principles of molecular virology. Overview of classification and nomenclature, virus structure, interaction of viruses with cells, organisms (immunology, pathology), and populations (epidemiology). Detailed case studies from major groups of viruses; picornaviruses, togaviruses, orthomyxoviruses, retroviruses, polyomaviruses, and herpesviruses.

MB 490 Seminar in Microbiology. *1(1-0) . F,S. Preq: MB 351 and senior standing.* Library research on current topics in all areas of microbiology. Presentation of research results orally and in the form of a major term paper.

MB 492 External Learning Experience. *1-6. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

MB 493 Special Problems in Microbiology. *1-6. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes campus facilities and resources. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

MB 495 Special Topics in Microbiology. *1 3. F,S,Sum.* Offered as needed to present materials not normally available in regular course offerings or for offering of new courses on a trial basis.

MB (BO, PP) 501 Fungi and Their Interaction with Plants. *3(3-0) . F Preq: PP 315 or equivalent.* Biology, physiology and molecular interactions between plant pathogenic fungi and their host plants. Basic introduction to fungal biology and evolutionary relationships, fungal development and life cycles, and genetic variability in fungi. In-depth coverage of fungal pathogenesis mechanisms, physiology of diseased plants, physiology, genetics, and molecular biology of plant defense reactions, and genetic engineering of plants for disease resistance.

MB (PP) 503 Bacteria and Their Interactions with Plants. *2(1 2) . F.* Major groups of plant-associated bacteria and current status of research on important bacterial plant pathogens and symbionts. Genetics, physiology, molecular biology and ecology of plant-associated bacteria, epidemiology and control of bacterial plant diseases, and host-pathogen interactions associated with bacterial pathogens and symbionts.

MB (SSC) 532 Soil Microbiology. *4(3-3) . Preq: MB 351: CH 220 or Consent of Instructor.* Soil as a medium for microbial growth, the relation of microbes to important mineral transformations in soil, the importance of biological equilibrium and significance of soil microbes to environmental quality.

MB (ZO) 555 Protozoology. *4(2-6) . S. Preq: Consent of Instructor.* The biology of the Protozoa: lectures including morphology, physiology, ecology, genetics, reproduction, evolution, systematics and life-cycles of both free-living and parasitic taxa; laboratory stressing recognition of selected forms and demonstrate techniques used to prepare specimens for microscopic examination.

MB (BO, PP) 575 Introduction to Mycology. *4(3-3) . F, Alt. Yr(even). Preq: BIO 125 or BS 181 & 183 or BO 200 or PP 315 or PP 318.* A survey of the fungal kingdom in context of phyla and classes. Systematics, ecology, biology and utilization. Illustrative material, cultural techniques in laboratories. Collection and paper required.

MB 590 Topical Problems. *Preq: Grad. standing, Consent of Instructor.*

MB 601 Seminar. *1(1-0) . F, S.*

MB 610 Special Topics Microbiology. *F,S,Sum.*

MB 620 Special Problems. *F, S, Sum.*

MB 624 Topical Problems. *F, S. Preq: Grad. standing, Consent of Instructor.*

MB 670 Laboratory Research Methods. *F, S. Preq: Consent of Instructor.* Directed research of microbiology graduate students in departmental laboratories prior to selecting thesis research topic. Selection of a minimum of three laboratories for research experience lasting 3 to 5 weeks. Acquisition of research methods relevant to each laboratory. Microbiology graduate students only.

MB 680 Microbiology Research Presentations. *1(1-0) . F, S.* Essential elements of structure, delivery, data presentation and use of media in scientific research seminars. Presentation and evaluation of student seminars. Coverage of topical material in microbiology as determined by instructor. Microbiology graduate students only.

MB 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

MB 686 Teaching Experience. *1(1-0) . F, S, Sum.* Faculty mentoring in didactic and methodological aspects of teaching, including instructional technology as well as design and grading of assessment instruments. Provision of individual performance evaluations to encourage enhancement of teaching skills. Microbiology graduate students only.

MB 690 Master's Examination. *1-6. F, S, Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

MB 693 Master's Supervised Research. *1-9. F, S, Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

MB 695 Master's Thesis Research. *1-9. F, S, Sum. Preq: Master's student.* Thesis research.

MB 699 Master's Thesis Preparation. *1-3. F, S, Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

MB 703 Microbial Diversity. *2(2-0) . S. Alt. Yrs. Preq: MB 351.* Introduction to theory and practice of bacterial taxonomy. Historical view of significant developments; classification into phrenetic and phylogenetic; modern approaches of chemotaxonomy and numerical taxonomy; identification methods; interactions and biotechnology, ecology, genetics and pathology. The role of microbial culture collections.

MB 705 Biological Scanning Electron Microscopy. *2(1-2) . Preq: Grad. standing with some biological background.* On demand. Theory and application of scanning electron microscopy, including specimen preparation, microscope alignment and operation, performance evaluation, interpretation of problems and darkroom technique. (Limited to 8 students with prior approval of instructor.)

MB 710 Biological Transmission Electron Microscopy. *3(2-3) . Preq: Grad. standing with some biological background.* On demand. Theoretical and practical aspects of transmission electron microscopy, including microscope alignment and use, performance evaluation, interpretation of problems and darkroom techniques. (Limited to 8 students with prior approval of instructor.)

MB 711 Ultramicrotomy for Life Sciences. *2(1-4) . Preq: MB 710, grad. standing.* On demand. An intensive laboratory course covering sample preparative techniques for transmission electron microscopy, including tissue preparation, thick sectioning, staining and ultramicrotomy. (Limited to 8 students with prior approval of instructor.)

MB 714 Microbial Metabolic Regulation. *3(3-0) . F. Preq: MB 351, BCH 451. Credit in both MB 414 and MB 714 is not allowed.* An integrative perspective on bacterial physiology and metabolism through analysis of metabolic regulatory functions.

MB 718 Introductory Virology. *3(3-0) . S. Preq: BCH 451 or GN 411 or MB 351.* Introduction to principles of virology including: classification and nomenclature, epidemiology, structure, genome replication, gene expression strategies and cellular infection cycle. Major groups of viruses including those with DNA genomes and positive-sense or negative-sense RNA genomes.

MB (FS) 725 Fermentation Microbiology. *3(3-0) . S Alt. Yrs.* Fermentation bioprocessing and characteristics, function and ecology of responsible microorganisms. Fermentative activities, growth responses and culture interactions related to metabolism, physiology and genetics of lactic acid bacteria and selected yeasts and molds. Current developments in starter culture technology and genetics; application to food and industrial fermentations.

MB (BO, GN, PP) 730 Fungal Genetics and Physiology. *3(2 3) . S Alt. Yrs. Preq: BCH 451, BO 775, GN 411 or PP 501.* Basic concepts of genetics and physiology of fungi, with emphasis on saprophytic and plant pathogenic mycelial fungi. Current literature on evolution, cell structure, growth and development, gene expression, metabolism, sexual and asexual reproduction and incompatibility systems. Laboratory exercises on mutant isolation, sexual and parasexual analysis, genetic transformation, and RFLP and isozyme analysis.

MB (IMM) 751 Immunology. *3(3-0) . S. Preq: BCH 451, GN 411 MB 351.* Introduction to mechanisms of immunity in man and animals. Emphasis on interactions between cells of the immune system in production of immune responses and the molecules in control of these interactions.

MB (CBS, IMM, PHY. PO) 756 Immunogenetics. *3(2-2) F, Alt. Yrs . Preq: MB 501C or MB 751 or Consent of Instructor* Basic concepts of the immune system. Genetic basis of the immune response including immunoglobulin genetics, major histocompatibility complexes and their role in the immune response, the molecular basis of the immune system and effector mechanisms.

MB (GN) 758 Prokaryotic Molecular Genetics. *3(3-0) . S. Preq: BCH 451 or GN 411.* Structure and function in prokaryotic molecular genetics, with emphasis on mutations and mutagenic pathways, transcriptional and translational regulation, RNA processing, DNA replication and recombination and characterization of recombinant DNA molecules. Applications of genetic and recombinant DNA techniques to microbial processes, including strain construction and enhancement of gene expression.

MB (GN) 760 Experimental Microbial Genetics. *4(2-6) . S. Preq: BCH 761, GN 411, MB 351.* Laboratory-oriented presentation of current methodologies and concepts in molecular microbial genetics and their application to strain construction, plasmid and phage manipulations, mutagenesis, cloning and genetic engineering of microorganisms.

MB 771 Molecular Virology Of Animal Viruses. *3(3-0) . F.* Animal virus replication. Selected examples from each virus group illustrate principles underlying lytic, persistent and tumor-inducing viral infection.

MB (BO) 774 Phycology. *3(1-4) . S.* Introduction to taxonomy, morphology, reproduction and ecological importance of organisms which may be included in the algae. Attention to local freshwater flow and physiology of selected species in relation to algal blooms, water quality and nutrient loading in aquatic habitats.

MB (BO) 775 The Fungi. *3(3-0) . F. Preq: BO 200 or equivalent.* Overview of the fungi within framework of a survey of major classes.

MB (BO) 776 The Fungi - Lab. *1(0-3) . F. Coreq: MB 775.* Illustrative material of fungal assemblages discussed in MB 775.

MB (CBS, IMM) 783 Advanced Immunology. *3(3-0) . F Alt Yrs. Preq: CBS 753 or VMM 815 or MB 751 or equivalent or Consent of Instructor.* The ontogeny and phylogeny of self and non-self recognition. Emphasis on basic mechanisms evolved during the evolution of the species. Speciality areas such as immunology of reproduction and genetic regulation of the immune response.

MB 790 Topical Problems. *F,S,Sum.*

MB 801 Seminar. *1(1-0) . F, S.*

MB 810 Special Topics Microbiology. *F,S,Sum.*

MB 820 Special Problems. *F S, Sum*

MB 824 Topical Problems. *F S. Preq. Grad. standing, Consent of Instructor.*

MB 870 Doctoral Lab Rotations. *F, S* Essential elements of structure, delivery, data presentation and use of media in scientific research seminars. Presentation and evaluation of student seminars. Coverage of topical material in microbiology as determined by instructor. Microbiology graduate students only.

MB 880 Doctoral Microbiology Research Presentations. *1(1 0) . F, S. Preq: Consent of Instructor.* Directed research of microbiology graduate students in departmental laboratories prior to selecting thesis research topic. Selection of a minimum of three laboratories for research experience lasting 3 to 5 weeks. Acquisition of research methods relevant to each laboratory. Microbiology graduate students only.

MB 885 Doctoral Supervised Teaching. *1-3. F, S. Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

MB 886 Teaching Experience. *1(1-0) . F, S, Sum.* Faculty mentoring in didactic and methodological aspects of teaching, including instructional technology as well as design and grading of assessment instruments. Provision of individual performance evaluations to encourage enhancement of teaching skills. Microbiology graduate students only.

MB 890 Doctoral Preliminary Examination. *1-9. F, S, Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

MB 893 Doctoral Supervised Research. *1-9. F, S. Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

MB 895 Doctoral Dissertation Research. *1-9. F, S, Sum. Preq: Doctoral student.* Dissertation research.

MB 899 Doctoral Dissertation Preparation. *1-3. F, S, Sum. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

MULTIDISCIPLINARY STUDIES

MDS 101 Introduction to University Education I. *1(1-1) . F.* Developmental and academic topics to assist students in making rational decisions about majors: including issues between high school and college, learning styles, career decision making, assessing motivation and values, overview of university majors and diversity.

MDS 102 Introduction to University Education II. *1(1-1) . S. Preq: MDS 101.* Continuation of MDS 101

MDS 103 Images of the Future. *3(3-0) .* Basic principles of futures studies; history, problems, limitations, and methods of forecasting; questions of change, quality of life, complexity, technology, and values.

MDS 104 The Experience and Interpretations of Freedom. *3(3-0) .* Interdisciplinary introduction to freedom as a basic theme in history, culture, and personal life. Focus on interplay between the experience of freedom and its various interpretations.

MDS 105 A Systems Approach to the Universe. *3(3-0)* Systems approaches to problems in physical, social, and behavioral sciences and technology. Concepts of general systems (interactions between systems functioning). Emphasis in interdisciplinary problem-solving methods and critical questioning.

MDS (WGS) 200 Introduction to Women's and Gender Studies. *3(3-0) . F.* Introduction to women's and gender studies as an interdisciplinary field spanning the humanities, social sciences, and natural sciences. Study of historical perspectives and contemporary understanding of women and gender. Theory, systematic analysis, and experimental accounts used to explore complexities of gender, and other identity determinants, mechanisms of power and privilege, and avenues for social change.

MDS 201 Environmental Ethics. *3(3-0) .* Interdisciplinary consideration of ways in which field of study coupled with personal/cultural values contribute towards either solving or compounding environmental problems; provides framework for process of making ethical decisions.

MDS 210 Women and Gender in Science and Technology. *3(3-0) . F.* Interdisciplinary introduction to the reciprocal relationships between scientific/technological research and contemporary understanding of gender. Special emphasis on social factors influencing scientists and engineers in their professions.

MDS 214 Technology and Values. *3(3-0) .* Introduction to the relations of technology and society. Emphasis placed upon the nature of technology, contrasting attitudes towards technology, technology's relation to the individual and to values, and to the future relations of technology and society.

MDS 220 Coastal and Ocean Frontiers. *3(3-0) .* Interdisciplinary approach to current issues, scientific concepts, management strategies and future trends concerning the coasts and the oceans. Required weekend field trip.

MDS 240 African Civilization. *3(3-0) .* An interdisciplinary study of centers of African civilization from antiquity to the 1960s. Such centers include ancient Egypt, Nubia, Axum, Ghana, Mali, Songhai, Kilwa, Malinda, Sofola, Zinzibar and Monomotapa.

MDS 241 Introduction to African-American Studies II. *3(3-0) .* Second in a two semesters sequence in the interdisciplinary study of sub-Saharan Africa, its arts, culture, and people, and the African-American experience.

MDS 251 The Arts of a World Capital: London. *3(3-0) .* Multidisciplinary course introducing students to the architecture and museums and the musical, dance, and theatrical performances of London. Historical and social context of these works of art. The infrastructure in London that makes its unusual artistic vitality and quality possible. Taught in London.

MDS 252 Vienna in 1900. *3(3 0) .* Interdisciplinary study of art, architecture, music and theater in turn-of-the-century Vienna and of the political and scientific thinking that surrounded these arts. Taught in Vienna.

MDS 257 Technology in the Arts. *3(3-0) .* The interaction between technology and the arts with an emphasis on developments in Western art of the twentieth century. Historical and emerging issues include: sound and film recordings, the addition of sound to films, the impact of films and television on theater, the impact of radio, computer applications to music, the visual arts, and literature.

MDS 258 Mathematics and Models in Music. *3(3-0) .* Use of mathematics and models in the composition of western music of various time periods with an emphasis on the twentieth century. Critical analysis of trivial and non-trivial uses of mathematics; differentiation between mathematics as an analytical tool and mathematics as a compositional tool. Survey of models including geographical, grammatical, and graphic.

MDS 259 The Arts and Politics. *3(3-0)* . Interactions between the arts and politics. Specific instances and types of political art from the past and the present. Patronage, censorship, propaganda, art in times of war, the artist's options and powers, aesthetics and criticism.

MDS 295 Special Topics in Multidisciplinary Studies. *1-6. F,S,Sum.* Detailed investigation of an interdisciplinary topic. Topic and mode of study to be determined by faculty member and/or teach team.

MDS 301 Science and Civilization. *3(3-0) . Preq: Soph. standing.* An inquiry into the scientific achievement and cultural impact of three different, but interrelated, models (or paradigms) of understanding the world and man's place in it; the Ancient-Medieval model of Aristotle, Ptolemy and Aquinas; the 17th century model of Newtonian physics; and the emerging, but fragmentary, 20th century model based upon the new physics of Einstein, Planck and Heisenberg.

MDS 302 Contemporary Science, Technology and Human Values. *3(3-0) Preq: Soph. standing.* Interdisciplinary evaluation of recent and potential influences of current scientific and technological developments on society. Emerging social, ethical, and intellectual issues include: The adequacy of contemporary scientific frameworks; the relations among science, technology, and society; the social consequences of scientific and technological applications, and human prospects and possibilities.

MDS 303 Humans and the Environment. *3(3 0)* . Interactions among human populations in the biophysical system and the environment. Emphasis on current issues, ecological principles and their relationships to basic biophysical processes; considers food, population dynamics, public land and common resources, renewable natural resources, pollution, water resources, energy and non-renewable resources.

MDS 304 Ethical Dimensions of Progress. *3(3-0)* . Multidisciplinary examination of traditional western notion of progress, focusing on ethical issues raised by concept of progress, and connections between science, technology and society. Places relationships such as engineering and social responsibility within the context of present day redefinitions of the notion of progress.

MDS 305 Peace in the Global Village. *3(3-0) . F.* Examination of peace in multidisciplinary terms-anthropological, psychological, political, philosophical, environmental and religious; consideration of human propensity for cooperation as well as aggressiveness; dialogue-lectures, case studies, workshops and round table presentations on past and present human groupings that succeeded in attaining peace; possibilities for peace in the future.

MDS (MUS) 306 Music Composition with Computers. *3(3-0) . Preq: Some knowledge of music or computer science (e.g. CSC 200) or consent of instructor* Survey of the theory and history of computer music, compositional algorithms, digital synthesis techniques, composition of at least one computer music work - a computer-assisted composition for traditional instruments, a piece for computer music on tape, a real-time piece, or a piece that combines tape and instrument(s).

MDS (WGS) 310 Women's and Gender Studies Internship. *3(3-0) F S.* Internship program. Introduction to careers that deal specifically with women's issues. Ten-hours-per-week work at a nonprofit or governmental organization. Contextualization of that experience through additional academic requirements.

MDS 320 Ethics in Engineering. *3(3-0) S. Preq: Junior standing* Engineering in American culture and the emerging ethical issues confronting the profession: corporate responsibility, personal rights, whistle blowing, conflicts of interest, professional autonomy, risk assessment, sustainable development, and the place and purpose of Engineering codes of ethics.

MDS 322 Technological Catastrophes. *3(3-0) Preq. Sophomore standing* Interdisciplinary examination of the human, organizational and technical factors contributing to the causes and impacts of recent technological accidents such as the Bhopal chemical leak, the space shuttle Challenger explosion, the Chernobyl nuclear accident, and the Exxon Valdez oil spill. Evaluation of risk assessment, risk perception and risk communication strategies. Consideration of options for living with complex technological systems.

MDS 323 World Population and Food Prospects. *3(3-0)* Examination of the dynamics of population size and food needs, production, distribution and utilization. Consequences of inadequate nutrition and food choices, efforts to increase the compatability of effective food production systems and alternate crops and cropping systems examined.

MDS 324 Alternative Futures. *3(3-0)* . Perspectives on possible alternative futures as well as the cutting edge of the present. Nature and likelihood of various alternatives. Methodology and limitations of forecasting, selected futurist issues and interactions between present and possible future technologies and human values.

MDS 325 Bio-Medical Ethics: An Interdisciplinary Inquiry. *3(3-0) . F.S.* Interdisciplinary examination and appraisal of emerging ethical and social issues resulting from recent advances in the biological and medical sciences. Abortion, euthanasia, physician-assisted suicide, compromised infants, aids, reproductive technologies, and health care. Focus on factual details and value questions, fact-value questions, fact-value interplay, and questions of impact assessment and policy formulation.

MDS 326 Technology Assessment. *3(3-0)* . Impacts of technologies as they are applied in society. Description and forecasting of effects, interactions, and potential irreversibilities.

MDS 327 Modern Art-Modern Literature: 1880-1980. *3(3-0)* . Interrelationship of art and literature, 1880-1980, from classic Modern movements to contemporary Post-modern movements; major figures, such as Picasso, Ernst, Magritte, De Kooning, Warhol, and Kiefer in art and O'Neill, Woolf, Faulkner, Beckett, Sartre, and Vonnegut in literature.

MDS 328 Sexuality and Values. *3(3-0)* . Interdisciplinary examination of value issues related to sexual behavior and identity, pornography, homosexuality, and abuse.

MDS 330 Black Popular Culture. *3(3-0)* . A multidisciplinary examination of contemporary black cultural expression in film, music, art, and the media. Emphasis on race, class, gender, and political discourse.

MDS (HI) 340 Perspectives in Agricultural History. *3(3-0)* . Historical topics related to the heritage of agriculture, the biological sciences, and the relationship among agriculture, technology, science and society.

MDS 351 Arts, Ideas and Values. *3(3-0)* . An examination of the way works of art embody a particular understanding of what is real and what is worthwhile and shape their viewers' ideas and values. Case studies approach.

MDS 352 Dress, Style, and Change. *3(3-0)* . *Preq: Junior standing.* Interdisciplinary course focusing on historical and cultural principles of style as related to dress and fashion. Examination of fashion and stylistic trends in cycles of dress.

MDS 401 The Contemporary City: Problems and Prospects. *3(3-0)* . *Preq: Sophomore standing.* Interdisciplinary examination of the social and physical characteristics of the contemporary city and problems which cities face. Topics include urban design, social relationships, education, transportation, crime and violence, and urban psychology. Alternative solutions to various urban problems examined.

MDS 402 Peace and War in the Nuclear Age. *3(3-0)* . An interdisciplinary examination of contemporary wars and international conflict, arms, races, nuclear strategy and defense policy, arms control, theories and strategies of peace.

MDS 403 Seminar in Technology and Society. *3(3-0)* . *Preq. Sophomore standing.* Exploration of the phenomenon of technology in society. The nature of technology, policy issues, the question of values, technological forecasting, and the implications of future technologies.

MDS 406 Conservation of Biological Diversity. *3(3-0)* . *Preq: Junior standing and one year of Biological Science.* Population biology concepts fundamental to understanding the properties of the objects of conservation. Genetic diversity in agriculture, forestry, and animal breeding; the ethical and international policy issues in preservation and management.

MDS 410 Toxic Substances and Society. *3(3-0)* . *Preq: Junior standing.* Interdisciplinary evaluation of past, present and future effects of toxic substances in the environment. Addresses various dimensions of toxic substances; special emphasis on ways to minimize adverse effects in contemporary and future societies.

MDS 412 Entering the 21st Century. *3(3-0)* . *S, Alt. Yrs.(odd).* Systems approach to predictions about the world in the 21st century from the perspectives of agricultural and environmental studies. Attention to food production, fisheries, forests, water, energy, material resources for fuel, climate, and population. Guest lectures and class projects.

MDS (TAM) 414 Textiles and Society. *3(3-0)* . *Alt. yrs. Sophomore standing.* Historical and sociological study of the textile and apparel industries since the Middle Ages with emphasis on 1850-present. Changes in industry composition, corporate structure, production technology, work organization, and labor-management relations. Impact on communities, workers, and the environment. Long range trends and implications.

MDS (HI) 485 History of American Technology. *3(3-0)* . *Preq: 3 hours of history.* Technology in American history: the ideological, social, economic, and institutional contexts of technological change from the 1760 s to the present. Impacts of new technological systems.

MDS 490 Issues in Science, Technology, and Society. *3(3-0)* . *F,S,Sum. Preq. Junior standing.* Examination of a significant issue, method, or historical episode in the area of science, technology, and society

MDS (WGS) 492 Theoretical Issues in Women's and Gender Studies. *3(3-0)* . *S. Preq. MDS 200.* Examination of feminist theory. Study of formative texts in modern feminism, drawn from various disciplines within the humanities, social sciences, and natural sciences. In-depth exploration of feminist perspectives on issues of race, class, gender, sexuality, work and mothering, among others. Analysis of local and global cultural practices using feminist theoretical frameworks.

MDS (WGS) 493 Special Topics in Women's and Gender Studies. *3(3-0)* . *F.* Examination of varying topics on women and/or gender from a multidisciplinary perspective.

MDS 494 Topics in Arts Studies. *3(3-0) . Preq: Junior standing and 15 hours in either dance, design, film studies, music, theater, or visual arts.* Multi-arts course focusing on selected works of art in various media, related by theme, place or date. Capstone course for students with an extensive background in one of the arts. Topics may vary.

MDS 495 Special Topics in Multidisciplinary Studies. *1-6.* Examination of selected topics of an interdisciplinary nature.

MDS 496 Topics in Film and Interdisciplinary Studies. *3(3-0)* . Detailed examination of film within interdisciplinary contexts. Specific topics will vary from semester to semester.

MDS 497 Topics in African-American Studies. *3(3-0) . Preq: MDS 240.* Multidisciplinary examination of selected topics in African-American studies.

MDS 498 Independent Study in Multidisciplinary Studies. *1-3. Preq: Permission of instructor.* Independent investigation and discussion of a selected topic of an interdisciplinary nature.

MDS 595 Special Topics in Multidisciplinary Studies. *1-3 F, S, Sum. Preq: Grad. standing or Consent of Instructor*

MDS 610 Special Topics in Multidisciplinary Studies. *F, S, Sum.*

MDS 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

MARINE, EARTH, AND ATMOSPHERIC SCIENCES

MEA 100 Earth System Science: Exploring the Connections. *4(3-2) . S. Preq: Competence in high school algebra and chemistry.* An introduction to the processes of and linkages among major components of planet Earth. Geosphere, hydrosphere, atmosphere, biosphere as dynamic and interdependent systems. Influence of human activity on earth systems. Optional weekend field trip.

MEA 101 Geology I: Physical. *3(3-0) . Preq: Recommended that MEA 110 be taken concurrently.* Systematic consideration of processes operating on and below the earth's surface and the resulting features of landscape, earth structures, and earth materials. Occurrences and utilization of the earth's physical resources.

MEA 102 Geology II: Historical. *3(3-0) . Preq: MEA 101. Recommended that MEA 111 be taken concurrently.* The second semester of the basic introductory sequence in geology. Utilization of the principles of geology to reconstruct and understand the earth's history. Geologic events that cause modification of the earth's crust, emphasizing North America. History of life and the environmental significance of changes in animal and plant life through geologic time.

MEA 110 Geology I Laboratory. *1(0-3) . Coreq: MEA 101.* Scientific methodology applied to the study of common rock-forming minerals, common rocks, topographic maps, geologic structures and geological maps. Field trips.

MEA 111 Geology II Laboratory. *1(0-2) . Coreq: MEA 102.* Reconstruction and interpretation of events in the history of the earth. Interpretation of sedimentary rocks, construction and interpretation of geological maps, identification of fossil organisms and utilization of fossils in the reconstruction of earth history.

MEA 120 The Dinosaurian World. *3(3-0) . S, Alt. Yrs.(even).* Evolution and ecology of dinosaurs related to broader features of Earth history, including plate tectonics, paleoclimatology, mass extinction and the long-term effects of natural selection.

MEA 121 The Dinosaurian World Lab. *1(0-2) . S, Alt. Yrs.(even) Coreq. MEA 120.* Companion to lecture course on "The Dinosaurian World." Adaptive significance of osteological characteristics, ecological correlates of body weight and physical environmental variables, and concepts relating to natural selection, fitness, biodiversity and changes in the planetary environment on various time scales. Discussion, specimen demonstrations and problem solving.

MEA 130 Introduction to Weather and Climate. *3(3-0) Preq: For non-majors only.* Explores the structure, physical causes, and climatology of weather systems including the jet streams, mid-latitude cyclones, hurricanes, thunderstorms, and tornadoes. Clouds and precipitation, air pollution, climate modification, optical effects (rainbows, halos) and weather instruments. Weather systems and forecasting techniques are illustrated through daily weather map discussions.

MEA 135 Introduction to Weather and Climate Laboratory. *1(0-2) Coreq MEA 130.* Experiments include effects of air pressure change on temperature and density (gas law); measurement of atmospheric moisture; formation of clouds and hail; effects of variable solar heating. Graphical display and interpretation of data; weather instruments and observations; weather map analysis; forecasting principles.

MEA 140 Natural Hazards and Global Change. *3(3-0)* The science of natural hazards and global change: the impact on human civilization of events in the lithosphere, atmosphere, biosphere, and hydrosphere (e.g., earthquakes, hurricanes, red tides, and floods), and the impact of humans on the global environment (e.g., global warming).

MEA 200 Introduction to Oceanography. *3(3-0) . Preq: High school physics, chemistry, algebra, trigonometry and biology or equivalent.* The ocean as a part of our environment including interactions between atmosphere and ocean, ocean circulation, physical and chemical properties of sea water, marine geology and marine biology.

MEA 210 Oceanography Lab. *1(0-2) . Coreq: MEA 200.* Complements the lecture course in Oceanography. Numerous demonstrations and resource materials visualize basic oceanographic concepts such as geological processes operating in the marine realm, the chemical properties of seawater, oceanic circulation, tides and waves, as well as processes affecting the biology of the oceans.

MEA 213 Fundamentals of Meteorology. *2(1-2) . F. Coreq: MA 141.* Introduction to the discipline of and opportunities in meterology, atmospheric vertical structure, motion, and pressure systems, jet streams; global circulation; air masses and fronts: mid-latitude cyclone structure and evolution.

MEA 214 Fundamentals of Meteorology II. *2(1-2) . S. Preq: MEA 213.* Introduction to moisture variables, adiabatic processes, thermodynamic diagrams, stability, clouds and precipitation, thunderstorms, tornadoes, and hurricanes, air pollution, global climate change, ozone hole.

MEA (ZO) 220 Marine Biology. *3(3-0) . Preq: MEA 200 or BIO 125.* Introduction to marine plants and animals, their adaptations to life in the sea and ecological interactions in selected marine environments (e.g. coral reefs, deep sea, salt marshes). Interactions of man with the sea: food from the seas, biology of diving. Optional trip.

MEA 250 Introduction to Coastal Environments. *3(3-0) . Preq: MEA 200/210 or MEA 101/110.* A global survey of coastal habitats, the processes that shape these dynamic environments, and the physicochemical controls that regulate their indigenous biological communities.

MEA 251 Introduction to Coastal Environments Laboratory. *1(0-2) . Coreq: MEA 250.* Complements the lecture course Introduction to Coastal Environments (MEA 250). Experiments involving the physical, chemical and biological processes that shape a variety of coastal environments.

MEA 268 Marine Paleontology. *4(3-2) . F. Preq: BIO 125, MEA 102.* Evolution of marine life traced through geologic time, accenting the functional significance of adaptations and the history of marine escosystems. Required field trips.

MEA 300 Environmental Geology. *3(3-0) . Preq: MEA 101 or MEA 140, or SSC 200.* Geologic aspects of the environment; man's effect upon and interaction with the various geologic processes; geologic considerations in land-use planning, waste disposal, and effective use of the earth's natural resources; geologic risks and hazards. Required field trip.

MEA 311 The Global Atmosphere. *3(3-0) . F. Preq: PY 205 or 211 & MA 141. Coreq: MEA 213 & 313.* Physical basis for weather and climate. Regional and global climate change; earth-sun relationships; solar energy incident to and modified by the atmosphere; terrestrial radiation; transports of heat and water vapor; surface and global energy balance; general circulation of the atmosphere; climate classification.

MEA 312 Atmospheric Thermodynamics. *3(3-0) . S. Preq: PY 208; MEA 311. Coreq: MA 241. MEA 214 & 314.* Atmospheric thermodynamics: equation of state for mixture of gases; first and second laws of thermodynamics; diabatic and adiabatic processes for dry and moist air; measurement and phase changes of water vapor. Atmospheric statics: static stabilityof moist air; vertical acceleration.

MEA 313 Weather Measurements and Analysis I. *1(0-3) . F. Coreq: MEA 213 & 311.* A laboratory course supplementing material in MEA 311. Solar and terrestrial radiation; atmospheric attenuation; surface energy balance; general circulation and transport of heat and water vapor; climate classification.

MEA 314 Weather Measurements and Analysis II. *1(0-3) . S. Preq: MEA 311. Coreq: MEA 214 & 312.* A laboratory course supplementing material in MEA 312. Meteorological data fields and their mathematical expression; objective analysis; measurement and calculation of moisture variables: moist and dry adiabatic processes; static stability; effects of radiation and vertical motion; vertical cross sections.

MEA (CH) 323 Earth System Chemistry. *3(3-0) . Preq: CH 201. Coreq: BIO 125 or any MEA course.* Chemistry of the earth with an emphasis on the interactions of the biosphere, geosphere and atmosphere. The origin and chemical evolution of the solar system, chemical cycles in the environment, and the impact of man on biogeochemical processes.

MEA 330 Mineralogy and Optical Mineralogy. *5(3-6) . Preq: MEA 101. Coreq: CH 101,102, MEA 110.* Fundamentals of crystallography, crystal chemistry, and crystal physics. Introduction to minerals as naturally occurring solid state materials. Characterization and identification of minerals on the basis of crystallographic features, physical and chemical properties, geologic occurrence, phase relations, and uses. Determination of the optical properties of non-opaque minerals, with emphasis on petrographic thin sections. Systematic review of rock-forming minerals. Required weekend field trip.

MEA 369 Terrestrial Paleontology. *4(3-2) . S, Alt. Yrs.(odd). Preq: BIO 125, MEA 102.* Evolution of terrestrial life traced through geologic time, accenting the functional significance of adaptations and the history of terrestrial ecosystems. Required field trips.

MEA 384 Paleoecology. *3(3-0) . F, Alt. Yrs.(odd). Preq: MEA 268 and MEA 369.* Methodologies in paleoecology. Effects of preservational bias, interpretations of the dynamics of ancient communities, and comparisons with living communities. Required field trips.

MEA 400 Earth Systems Simulation Modeling. *4(3-3) S Preq Senior standing ES,NR MEA curricula.* Conceptual ecosystems modeling, dynamics, parameterization, boundary conditions, data integration, validation, interactions between sub-systems, and anthropogenic-coupling. Construction of simulation models using programmable blocks for quantitative simulations. Develop modeling skills and illustrate simulations of science and management questions through focus on a watershed-river-coastal system (Neuse River-Pamlico Sound)

MEA 405 Climatological Data Analysis. *3(3 0) . Preq. MEA 311 and ST 380.* Probability and statistics applied to climatology and meteorology. Discrete and continuous probability distributions of meteorological variables examined. Regression analysis applied to weather forecasting. Forecast verification. Smoothing and filtering processes. Introduction to time series analysis. Elementary decision theory.

MEA 410 Introduction to Geologic Materials. *4(3-3) . Preq: MEA 101; CH 101,102.* Basic principles of mineralogy and petrology. Common rock-forming and ore-forming minerals. Introduction to igneous, metamorpic, and sedimentary environments and rocks. Description and classification of common rocks and minerals. Required field trips.

MEA 411 Marine Sediment Transport. *3(3-0) . Preq: MEA 101 or MEA 200, MA 241, PY 201 or PY 205. Credit not allowed for both MEA 411 and MEA 562.* Quantitative study of sediment transport in the marine environment including an introduction to fluid mechanics and sediment transport theory. Discussion of the processes and products of sediment transport in specific marine environments from estuaries to the deep sea and interpretation of sediment transport processes from sedimentary structures.

MEA 412 Atmospheric Physics. *3(3-0) . Preq: MA 242, PY 208 or equivalent.* Physical and analytical descriptions of atmospheric aerosols, clouds/fogs, and precipitation processes; size distribution and sources of atmospheric aerosols; impact of aerosols on visibility and climate; microstructure of warm and cold clouds and their interaction with solar and terrestrial radiation; collision-coalescence and ice phase mechanisms of precipitation formation; atmospheric electricity; planned and inadvertent weather modification; weather radar; atmospheric optics.

MEA 415 Geology of Economic Mineral Deposits. *3(2-3) . Preq: MEA 330; MEA 440 and 450 recommended.* The nature, geologic setting and geographic distribution of economic mineral deposits. Topics include both metallic and industrial minerals and the various geologic processes that work to produce them. Laboratory work with economic mineral suites from famous mining districts of the world. Two to three weekend field trips required.

MEA 417 Geology of Fossil Fuel Deposits. *3(3-0) Preq. MEA 410 or MEA 430 MEA 451 PY 211 or PY 205.* Introduction to applications of geological and geophysical principles in the exploration, evaluation and exploitation of the earth's fossil energy resources.

MEA 421 Atmospheric Dynamics I. *3(3 1) . F. Preq: MA 242, PY 208, MEA 312 314.* Meteorological applications of fluid kinematics: divergence, vorticity, deformation, advection, mass continuity and vertical motion. Atmospheric dynamics: the equation of motion on a rotating earth; component equations in Cartesian, polar-sphericaland pressure coordinates. Scale analysis and simplifications. Cases of horizontal flow: geostrophic and gradient wind, ageostrophy and acceleration; thermal wind and vorticity.

MEA 422 Atmospheric Dynamics II. *3(3 1) . Preq: MEA 421* Vorticity and potential vorticity equations; dynamics of synoptic-scale motions; quasi-geostrophic theory; atmospheric waves including shallow water, internal gravity, inertia-gravity, and Rossby waves; finite difference methods; numerical weather prediction; atmospheric instabilities including static, Kelvin-Helmholtz, inertial, symmetric, barotropic, and baroclinic instabilities.

MEA 430 Scientific Concepts and Global Problems. *3(3 0) . Preq: Sophomore standing.* Major problems facing human population caused by conflict between its growth, its consumption and the earth's finite environment. Focus on scientific concepts and dynamics governing these problems, their interrelationships, their causes, and their consequences. Participatory learning through group discussions and student-initiated research.

MEA (CE) 435 Engineering Geology. *3(3-0) . Preq: MEA 101 and Junior Standing in colleges of Agriculture and Life Sciences, Engineering, Forest Resources, Physical and Mathematical Sciences or Textiles* Application of both geology and geotechnical engineering to engineering projects. Illustrations of relevant materials properties and techniques utilized in describing subsurface conditions.

MEA 440 Igneous and Metamorphic Petrology. *4(3-3) . Preq: MEA 330.* The study of rocks formed by the crystallization of magmas (igneous) and by the recrystallization of existing rocks (metamorphic), with emphasis on whole-rock and mineral compositions, classification, petrography, hand-sample and thin section identification, and the rock origins in terms of magma genesis and emplacement and tectonics. Field trips are required.

MEA 443 Weather Analysis and Forecasting I. *3(1-6) . Preq. MEA 421.* Analysis and forecasting of mid-latitude weather systems with emphasis on simplified models and methods. Barotropic model, Rossby waves; baroclinic structure, upper-level wave evolution, forecasting; surface cyclone evolution, Sutcliffe-Pettersen model. Numerical computation methods; numerical weather prediction and operational models, subjective and objective analysis of meteorological fields.

MEA 444 Weather Analysis and Forecasting II. *3(1-6) . Preq: MEA 443.* Analysis and forecasting of mid-latitude weather systems with emphasis on scale interaction and case studies. Quasi-geostrophic theory, omega equation; cyclogenesis climatology and processes; isentropic analysis, three-dimensional airflow, cloud patterns; explosive cyclogenesis. Structure and dynamics of fronts and jet streams. Severe weather processes, thunderstorms, microbursts, tornadoes. Mesoscale dynamics, analysis techniques, forecast problems; precipitation bands; multi-scale interaction.

MEA 450 Introductory Sedimentary Petrology/Stratigraphy. *4(3-3) . Preq: MEA 330.* Properties, classification, geologic occurrences, and origin of minerals and rocks formed by physical, chemical, and biologic processes at and near the earth's surface. Principles of division of stratified terrains into natural units, correlation of strata, interpretation of depositional environments and facies. Required field trips.

MEA 451 Structural Geology. *4(3-3) . S. Preq: MEA 330 or MEA 410.* Basic principles of geometric, kinematic and dynamic analysis as applied to fractures, shear zones, folds, and fabrics of deformed rock bodies. Considers both brittle and ductile realms of the crust from misroscale to regional tectonics. Required overnight field trips.

MEA 455 Micrometeorology. *3(3-0) . Preq: MEA 422 or MAE 308.* Energy budget near the earth's surface; soil temperatures and heat transfer; air temperature, humidity, and wind distribution in the planetary boundary layer; fundamentals of viscous flows and turbulence; semiempirical theories of turbulence; exchanges of momentum, heat and moisture in the atmospheric surface layer; air modification due to changes in surface properties; agricultural and forest micrometeorology.

MEA (CE) 456 Air Quality. *3(3-0) . Preq: MEA 411; or CE 384; or 280 plus CE 382.* Introduction to air quality engineering and meterology. Air quality management, air quality meterology, atmospheric emissions and dispersion modeling, and control technology principles.

MEA 459 Field Investigation of Coastal Processes. *5(3-5) . Preq: MEA 250 and 251.* Coastal zone processes and dynamics with emphasis on the forcing factors that regulate changing coastal landforms, the ecology and physicochemical character of coastal ocean water-masses, seabed morphologies, landscape academes, etc. Field observations and field techniques will be emphasized in tidal-freshwater coastal wetlands, estuaries, barrier island, tidal inlets, continental shelves and shelf-margin habitats. Additional feeds required.

MEA 460 Principles of Physical Oceanography. *3(3-0) . Preq: MA 242. Coreq: PY 203 or PY 208. Credit is not allowed for both MEA 460 and MEA 560.* Introduction to principles and practices of physical oceanography. Equation of state of seawater; energy transfer to the ocean by thermal, radiative and mechanical processes; the heat budget; oceanic density distribution; oceanic boundary conditions; conservations equation; air-sea interaction; global fluxes and general description of major ocean currents.

MEA 462 Observational Methods and Data Analysis in Marine Physics. *3(2-2) . Preq: MEA 460.* Practical experience in the observational techniques used by physical oceanographers. Basic instrumentation described, emphasizing principles rather than detailed descriptions. Both direct and indirect techniques used to define the three-dimensional circulation of the ocean as a function of time.

MEA (PY) 463 Fluid Physics. *3(3-1) . Preq: MA 341 and PY 208. Credit is not allowed for both MEA 463 and MEA 700.* Derivation of the basic equations governing fluid motion in a rotating coordinate system. Equations include conservation of mass or the continuity equation, the momentum equations, the thermodynamic energy equation, and the vorticity equation. Application to simplified oceanic flows which include surface gravity waves, inertial motion, geostrophic motion, Ekman dynamics, and vorticity dynamics.

MEA 464 Ocean Circulation Systems. *3(3-0) . Preq: PY(MEA) 463.* Dynamical processes governing ocean circulation. Driving of ocean currents by the atmosphere, currents on a rotating spherical earth. Mid-ocean gyre, western boundary currents, equatorial current systems, and polar circulation. Currents in coastal regions and shallow-water processes.

MEA 465 Geologic Field Camp I. *3(3-0) . Preq: MEA 440, 450, 451. First part of six weeks out-of-state summer field camp. Both MEA 465 and MEA 466 must be taken in the same summer.* Geological field instruments and techniques. Geological field mapping of various geologic structures and terrains within areas of little deformed sedimentary strata. Additional fees required.

MEA 466 Geologic Field Camp II. *3(3-0) . Preq: MEA 465. Second part of six weeks out-of-state summer field camp. Both MEA 465 and MEA 466 must be taken in the same summer.* Advanced geologic field techniques. Geologic field mapping in areas of complexly deformed rocks. Areas of volcanic, plutonic, or metamorphic rocks commonly mapped. Regional field trips between field stations. Additional fees required.

MEA 467 Marine Meteorology. *3(3-0) . Preq: MEA 422 or MEA 460.* Basic equation and concepts. Review of ocean and atmospheric circulations. Ocean mixed layer, air-sea interaction and coastal ocean and meteorological processes, marine boundary layer and cloud processes.

MEA 468 Invertebrate Paleontology and Biostratigraphy. *4(3-3) . Preq: MEA 102 and MEA 111, or ZO 402* Study of fossil invertebrates and their applications to problems and concepts of paleoecology, correlation of strata, evolution and broader concepts of earth history. Required field trips.

MEA 469 Ecology of Coastal Resources. *3(3-0) . S Preq: MEA 250; MEA 220.* Anthropogenic impacts on estuarine and coastal marine ecosystems. Survey of basic biological, physical, chemical and geological mechanisms underlying habitat-specific functioning, followed by discussion, in-class presentation, and critique of real and hypothetical case studies involving anthropogenic impacts.

MEA 470 Introduction to Geophysics. *3(3-0) . Preq: PY 208 or 212.* Structure of the earth, a dynamic and evolving entity, as inferred from seismology, gravity, magnetism and heat flow. Geodynamic processes responsible for continental drift; plate tectonic theory; regional geophysics of selected areas.

MEA 471 Exploration and Engineering Geophysics. *3(3-0) . Preq. PY 208. Credit may not be received for both MEA 471 and MEA 570.* Geophysical methods applied to exploring the earth's shallow sub-surface. Principles of gravity, magnetic, electrical, and seismic exploration surveys. Planning, conducting, and interpreting geophysical surveys.

MEA (CH) 473 Principles of Chemical Oceanography. *3(3-0) . Preq: CH 201/202, MEA 200. Credit is not allowed for both MEA 473 and MEA 560.* Chemical processes that control the composition of the oceans including discussions of chemical equilibria, biological cycling of nutrients, tracers of ocean circulation, minor and trace element distributions, and the chemical history of the marine environment.

MEA 481 Principles of Geomorphology. *3(2-2) . Preq: MEA 101 and MEA 110.* Landforms and the processes responsible for their origin. Emphasis on the geologic principles involved in interpreting the origin and evolution of various landforms, and discussion of North American geomorphic process.

MEA 491 Seminar on Selected Geologic Topics. *2(2-0) . Preq: Senior standing in GYS, GYA, or GPY.* Study and discussion of selected topics from the geological literature. Preparation of a major library research paper.

MEA 493 Special Topics in MEAS. *1-6. Preq: Consent of department.* Directed individual study or experimental course offering.

MEA 510 Air Pollution Meteorology. *3(3-0) . S. Preq: MAE 308 or MEA 455 or MEA 700 or equivalent.* Wind structure in atmospheric surface layer and planetary boundary layer; temperature structure and stability; mixed layer and inversions; turbulence intensity and scale; meteorological factors affecting dispersion of pollutants; diffusion theories and models; diffusion and transport experiments; plume rise, fumigation and trapping; removal processes; effects of buildings and hills; effects of local winds.

MEA 512 Satellite Meteorology. *3(3-0) . S, Alt Yrs. Preq. MA 241. Coreq: MEA 443.* Basic background in satellite orbits, coordinate systems and image navigation; description of sensors and techniques for quantitative measurement of atmospheric variables. Applications of satellite data in analysis of weather systems; evolution of convective systems, tropical disturbances and mid-latitude cyclones as revealed by visible and infrared imagery; current research in satellite applications.

MEA 513 Radar Meteorology. *3(3-0) . S. Preq: MEA 412, MEA 422· CSC 112, ST 380.* Principles of radar operations and analysis. Application of radar to observing stormy and clear weather. Conventional weather radar; Doppler, polarimetric and wind profiling radars. Precipitation estimation, hydrometeor identification, air motion analysis using radar. Practical radar imagery interpretation using computer-based learning and case studies. Radar observations and analyses of thunderstorms, mesocylones, tornadoes, fronts, hurricanes, boundary layer phenomena.

MEA 514 Advanced Physical Meteorology. *3(3-0) F Preq MEA 412, 421.* Fundamental laws and concepts of thermodynamics and electromagnetic radiative transfer considered in an atmospheric context. Application of these principles to a number of meteorological problems, including radiative climate models, the global energy balance, atmospheric aerosols, lidar radar backscatter and remotely sensed temperature fields.

MEA 540 Principles of Physical Oceanography. *3(3-0) . S Preq: MA 231 and PY 212 or equivalent.* Introduction to principles and practice of physical oceanography. The equation of state of seawater; energy transfer to the ocean by thermal, radiative and mechanical processes; the heat budget; oceanic boundary conditions; geographical distribution of oceanic properties; observational methods; conservation equations; simple waves and tides; physical oceanography of North Carolina coastal zone. Application of Fourier analysis techniques to interpretation of low-frequency motions in ocean and atmosphere. Review of Fourier method. Filtering of tidal signals. Spectral estimates and calculation of current ellipses. Identification of coherent motions and their empirical orthogonal modes. Data from field experiments used in lectures and homework assignments.

MEA (ZO) 550 Principles of Biological Oceanography. *3(3-0) . S. Preq: BIO 125 and either BO 360 or ZO 260 or grad. standing.* Biological productivity and tropic relationships in Plankton, Nekton and Benthos; community ecology of selected habitats (estuaries, intertidal zones, coral reefs, deep sea) and adaptation of organisms to marine environment.

MEA 551 Marine Physical-Biological Interactions. *3(3-0) . S, Alt yr(even). Preq: MEA 540 and MEA 550.* Space-time relationships between physics and biology; influence of Reynolds number on aquatic life style; aspects of physical and biological mathematical modeling; influence of biology on physical phenomena; influence of static physical/chemical properties on biology; influence of dynamic physical phenomena (turbulence, waves and advection) on biology within water column and at its boundaries.

MEA 560 Chemical Oceanography. *3(3-0) . F. Preq: CH 201 or equivalent.* Chemical processes controlling the composition of oceans, including discussions of chemical equilibria, biological cycling of nutrients and use of chemical tracers in marine environment; consideration of origin and chemical history of oceans.

MEA 562 Marine Sediment Transport. *3(3-0) . F. Preq: MEA 101 or MEA 200, MA 241, PY 201 or PY 205.* Quantitative study of sediment transportation in the marine environment including introduction to fluid mechanics and sediment transportation theory. Processes and products of sediment transportation in specific marine environments from estuaries to deep sea and the interpretation of sediment transport processes from sedimentary structures.

MEA 570 Geological Oceanography. *3(3-0) . F.* A comprehensive overview of the geological aspects of oceanography. Topics include: a) marine geophysics and the evolution of ocean basins, b) sedimentological processes and the formation of marine deposits, c) marine geochemistry and authigenic sedimentation, d) paleoceanography and the interpretation of marine stratigraphy.

MEA 574 Advanced Igneous Petrology. *3(3-0) . S Alt Yrs. Preq: MEA 440.* Physicochemical principles related to igneous petrogenesis. General principles and specific problems including origin, differentiation and emplacement of magmas and the possible relationships of igneous processes to global tectonics.

MEA 575 Advanced Metamorphic Petrology. *3(2-2) . Alt Spring. Preq: MEA 440.* Petrogenesis of metamorphic rocks including conditions of metamorphism, metamorphic facies and facies series, the petrogenetic grid, contact and regional metamorphism, metamorphism and plate tectonics. Heterogeneous chemical equilibrium and application of Gibbs Phase Rule to metamorphic rocks. Thermodynamically valid algebraic and graphical analysis of equilibrium mineral assemblages. Chemical zoning. Petrographic studies of selected metamorphic suites.

MEA 576 Applied Sedimentary Analysis. *3(3-1) . F Alt. Yrs. Preq: MEA 450, ST 361.* Extension of MEA 450, with emphasis on coarser grained clastic sedimentary rocks. Sampling of sedimentary population, critical study of assumptions underlying standard measurement techniques; treatment, testing and evaluation of sedimentary data; application to problems in sedimentology.

MEA 577 Electron Microprobe Analysis of Geologic Material. *2(2-1) . F, Alt. Yrs. (Even). Preq: MEA 330 or equivalent.* Theory of quantitative analysis of geologic material by electron beam application; laboratory operation of electron microprobe to acquire chemical composition and x-ray images of geologic material.

MEA 578 Depositional Environments and Lithostratigraphy. *3(2-3) . S. Preq: MEA 450 or grad. standing.* Fabric of large sedimentary basins in terms of spatial distribution of component major rock facies; current litho-genetic models based upon comparison with recent equivalents; field trips.

MEA 585 Hydrogeology. *3(3-0) . S Alt Yrs. Preq: MEA 450.* Occurrence and sources of surface and subsurface water. Relationships of surface water to subsurface water. Rock properties affecting infiltration, movement, lateral and vertical distribution and quality of ground water. Determination of permeability, capacity, specific yield and other hydraulic characteristics of aquifers. Principles of well design, legal aspects of water supplies.

MEA 591 Special Topics in Marine Science. *1-3. F, S, Sum. Preq: Consent of Instructor.* Opportunity for advanced undergraduate and graduate students to study timely special problem areas in Marine Science and Engineering.

MEA 592 Special Topics in Earth Sciences. *1-6. F, S, Sum. Preq: Consent of Instructor.* Special topics in earth sciences, provided to groups or to individuals.

MEA 593 Special Topics in Atmospheric Science. *1-3. F, S, Sum. Preq: Consent of Instructor.* Special topics in atmospheric science, provided to groups or to individuals.

MEA 599 Regional Geology of North America. *1-6. F, S. Preq: MEA 101 or 120, Sr. standing.* Field study of classic geologic localities and geomorphic processes not indigenous to North Carolina. Typical areas: New England and adjacent Canada, northern Mexico and southwestern United States and Pacific Northwest. Representative subjects include Canadian Shield, Precambrian mineral deposits, San Andreas fault, desert geomorphology, Grand Canyon stratigraphy, modern and ancient reefs and glaciated volcanoes. Mineral, rock and fossil collecting. Required student reports.

MEA 601 Seminar. *1(1-0) . F, S. Preq: Grad. standing.* Presentation by each student of one seminar on his/her current research.

MEA 611 Special Topics in Marine Sciences. *1-6. F, S, Sum. Preq: Consent of Instructor.* Special topics in earth sciences, provided to groups or to individuals.

MEA 612 Special Topics in Earth Sciences. *1-3. F, S, Sum. Preq: Consent of Instructor.* Special topics in atmospheric science, provided to groups or to individuals.

MEA 613 Special Topics Atmospheric Sciences. *F,S.*

MEA 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

MEA 690 Master's Examination. *1-6. F, S, Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

MEA 693 Master's Supervised Research. *1-9. F, S, Sum. Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

MEA 695 Master's Thesis Research. *1-9. F, S, Sum. Preq: Master's Student.* Thesis Research

MEA 699 Master's Thesis Preparation. *1-3. F, S, Sum. Preq: Master's Student. Credits Arranged.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

MEA 700 Environmental Fluid Mechanics. *3(3-1) . F. Preq: MA 241, PY 208.* Basic concepts and laws governing motion of atmosphere and oceans developed from first principles, including approximations valid for environmental flows, kinematics, dynamics and thermodynamics of fluid flows as well as introduction to environmental turbulence.

MEA 702 Advanced Cloud and Precipitation Physics. *3(3-0) . F Alt. Yrs. Preq: MEA 421 or MEA 412.* Analysis of microstructure of warm and cold clouds and precipitation, cloud microphysics-dynamics interactions, formation of cloud droplets, growth of cloud droplets by condensation, initiation of rain in nonfreezing clouds, formation and growth of ice crystals, precipitation theories, planned and inadvertent weather modification, and the problem of acid rain.

MEA 703 Atmospheric Aerosols. *3(3-0) . S Alt Yrs. Preq: CH 201 and PY 205 or 211. Coreq. MEA 412.* An understanding of aerosols as primary air pollutants, indoor versus outdoor pollution, transformation processes, prediction of atmospheric concentrations, scavenging of aerosols, transport of air pollutants on a regional scale, discussion of national experiments to characterize and study impact of urban-industrial pollution, tropospheric aerosol and weather, stratospheric aerosol, effect of aerosols on atmospheric warming and cooling and air-quality models.

MEA 705 Dynamic Meteorology. *3(3-0) . F. Preq: MEA 422 or equivalent.* Brief review of classical and physical hydrodynamics; scale analysis of dynamic equations; atmospheric instabilities; dynamics of tropical convections; perturbation theory and approximations for atmospheric wave motions.

MEA 706 Meterology of the Biosphere. *3(3-0) . F Alt. Yrs. Preq: PY 205 or 211; CH 201; MA 101 or 111.* For graduate students in the life sciences, presenting physical principles governing the states and processes of atmosphere in contact with earth's surface of land, water and life. Exchanges of heat, mass and momentum analyzed for various conditions of atmosphere and surface and as function of season, time and geographic location.

MEA 707 Planetary Boundary Layer. *3(3-0) . F, S Alt. Yrs. Preq: MEA 455 or MEA 721 or Consent of Instructor.* Review of basic equations and concepts of planetary boundary layers. The closure problem and semi-empirical theories of turbulence, buoyancy effects on mean flow and turbulence, instrumentation and observational platforms for PBL experiments, observed characteristics of atmospheric boundary layers, numerical and physical modeling of PBL and its parameterization in large-scale atmospheric circulation models.

MEA 708 Atmospheric Turbulence. *3(3-0) . S, Alt. Yrs. Preq: MAE 550 or MEA 700 or MEA 707 or equivalent.* Statistical description of turbulence, including probability, correlation and spectrum functions. Statistical theory of homogeneous turbulence, spectral dynamics and Kolmogorov's local similarity hypotheses. Effects of shear, thermal stratification and earth's rotation. Observed structure and scales of turbulence in PBL and free atmosphere. Higher-order closure models and large eddy simulations of atmospheric turbulence.

MEA 710 Atmospheric Dispersion. *3(3 0) . F, Alt Yrs. Preq: MAE 550 or MEA 700 or MEA 510.* Lagrangian vs. Eulerian descriptions of turbulence and diffusion. Statistical theories of absolute and relative diffusion from continuous and instantaneous releases. Effects of shear, thermal stratification and earth's rotation on atmospheric dispersion. Lagrangian similarity theories of diffusion in the surface layer and mixed layer. Random walk, Monte Carlo and large eddy simulations of atmospheric dispersion. Urban and regional dispersion models.

MEA 712 Mesoscale Modeling. *3(3 0) . F, Alt. Yrs Preq: MEA 705.* Modeling mesoscale weather phenomena including midlatitude cyclones, mesoscale convective complexes and squall lines. Application of finite difference, spectral and implicit methods and coordinate transforms to these problems. Utilization of explicit representations of moist processes. Development of parameterizations of convective clouds, planetary boundary layer and moist processes.

MEA 713 Mesoscale Dynamics. *3(3-0) . F, Alt. Yrs. Preq: MEA 700 and MEA 705 or equivalent.* Inertia-gravity waves. Mechanical and thermally forced waves. Generation, circulation and maintenance of mesoscale convective storms and systems. Symmetric instability. Wave-CISK, quasi-geostrophic and semi-geostrophic fronts and fronto-genesis. Meso-B/Y frontogenesis. Lee and coastal cyclogenesis.

MEA 714 Atmospheric Convection. *3(3-0) . F, Alt. Yrs. (Odd). Preq: MEA 412, MEA 700, MEA 705.* Structure, physics and dynamics of convective clouds and cloud systems; fundamental equations for modeling convection; microphysical parameterization schemes; influence of instabilities on convective cloud systems; severe thunderstorms dynamics; tornadogenesis theories; mesoscale convective systems; upscale feedback effects of convection; cumulus parameterization schemes.

MEA 715 Dynamics of Mesoscale Precipitation System. *3(3-0) . F, (Alt. yrs.)even. Preq: MEA 444.* Frontogenesis theory; inertial and conditional symmetric instability; mesoscale gravity waves and wave-CISK; conveyor belts; seeder-feeder processes and precipitation generating cells; classification and dynamics of precipitation band types.

MEA 716 Numerical Weather Prediction. *3(3-0) . F, S Alt Yrs. Preq: MEA 705. CSC (MA) 427 or equivalent and some FORTRAN programming experience.* Physical and mathematical basis of numerical weather prediction with computer experiments to demonstrate principles and techniques. Derivation of sets of prediction equations consistent with scale analysis and dynamical constraints; atmospheric waves and filtered equations; numerical methods and computational instabilities; filtered and primitive equation models; NWS operational models.

MEA 717 Advanced Weather Analysis. *3(2 2) . F, Alt. Yrs. Preq: MEA 444, MEA 705.* Evolution of physical and dynamic structure of synoptic and sesoscale storm systems occurring in middle and high latitudes. Recent advances in understanding these storm systems through intensive field experiments and computer modeling. Introduction to contemporary analysis techniques through laboratory exercises shedding light on storm structure, dynamics and scale interaction.

MEA 719 Climate Modeling. *3(3-0) . F, Alt. Yrs. Preq: MEA 705.* Climate system. Fundamental equations and time scales. Atmosphere, ocean, biosphere, cryosphere, lithosphere and hydrosphere subsystems. Computational numerical methods. Physical processes; atmosphere-ocean coupling, role of radiation, clouds and land surface processes. Climate anomalies due to changes in atmospheric composition, boundary conditions and extra-terrestrial forcing. Model validation, climate change detection, past climates and future climate scenarios.

MEA 720 Coastal Meteorology. *3(3-0) . Alt. Yrs. Preq: MEA 455.* Importance and complexity of coastal meteorological processes; modification induced by surface inhomogeneities; development of internal boundary layers; thermally induced internal boundary layers; coastal fumigation processes; structure and development of sea and land breezes; analytical and numerical modeling of sea breezes; coastal fronts; storm surges; prediction models for storm surges; cold air outbreaks; baroclinic boundary layer processes near coastal areas.

MEA 721 Air-Sea Interaction. *3(3-0) . S, Alt. Yrs. Preq: MEA 422 or MEA 560 or Consent of Instructor.* Review of basic equations and concepts of turbulent transfer in geophysical flows, air-sea interaction processes and their importance to man's activities, theory and observation of wind-generated ocean surface waves, turbulent transfers in planetary boundary layer of marine atmosphere, oceanic mixed layer, development of thermocline and inversion.

MEA (MAE) 725 Geophysical Fluid Mechanics. *3(3-0) . F, Alt. Yrs. Preq: MAE 701 or equivalent.* The principles of fluid mechanics applied to geophysical systems. Special emphasis placed on those features of these systems, such as almost rigid rotation and stable stratification, which produce unique and important effects. The effects of almost rigid rotations on homogeneous and stratified flows examined in detail.

MEA (MAE) 726 Advanced Geophysical Fluid Mechanics. *3(3-0) . S Alt Yrs. Preq: MAE 725 or equivalent.* Principles of fluid mechanics applied to geophysical systems. Special emphasis on role of stable stratification on the flows in these systems. Detailed study of generation, interaction, propagation and dissipation of internal gravity waves. Study of other geophysically important flows.

MEA 735 Fourier Analysis of Geophysical Data. *3(3-0) . S, Alt. Yrs. Preq: MA 341 and ST 511.* Application of Fourier analysis to interpretation of low-frequency motions in ocean and atmosphere. Review of Fourier method. Filtering of tidal signals. Spectral estimates and calculation of current ellipses. Identification of coherent motions and their empirical orthogonal modes. Data from field experiments used in lectures and homework assignments.

MEA 741 Synpotic Physical Oceanography. *3(3 0) . S, Alt. Yrs. Preq: MEA 560.* Basic discussion of the techniques and terminology of synoptic physical oceanography; focus on water characteristics and their relationship to currents in the individual oceans; a systematic quantitative description of the character of ocean waters and their movements.

MEA 742 Gravity Wave Theory I. *3(3-0) . S. Preq: MAE 308, PY 411 or MEA 700.* Classical gravity wave theory with emphasis on basic mechanics of wave motions, mass transport induced by waves and various conservation laws with their applications in wave study.

MEA 743 Ocean Circulation. *3(3-0) . F. Preq: MEA 700 or PY 411.* Basic study of mechanics of ocean circulation with emphasis on various simple models of circulation systems.

MEA 744 Dynamics of Shelf Circulation. *3(3-0) . F Alt Yrs. Preq: MEA 700.* Description and models of dynamic processes on the shelf, including seiches and tides in gulfs, propagation of tides and storm surges, wind-induced coastal upwelling, continental shelf waves and coastally trapped waves. Steady circulation driven by winds, river plumes and density forcing, formation of shelf-break fronts; and influence from deep-ocean currents.

MEA 745 The Physical Dynamics of Estuaries. *3(3-0) . S Alt Yrs. Preq: MA 121 or 212; PY 208 or Consent of Instructor.* Physical/dynamical description of estuaries and estuarine processes occurring as a function of tides, atmospheric forcing, river runoff and topography. Classification schemes; development of salt, heat energy and momentum balances; a discussion of biological modeling and sediment transport processes as a function of physical dynamics; conservative and non-conservative pollution dispersion prediction; and theoretical, mathematical modeling of estuaries, including those in North Carolina.

MEA (ZO) 750 Marine Benthic Ecology. *3(3-0) . F. Preq: ZO 402, ZO 509 or ZO 760 or MEA (ZO) 550.* Marine benthic systems in deep sea and in shallow waters, focusing upon abiotic and biotic processes regulating density, diversity and taxonomic and functional composition. Discussions of benthic-pelagic coupling, predation, interspecific competition, biogeography, sampling problems, evolutionary trends, trophic structure and community organization.

MEA 752 Marine Plankton Ecology. *3(3-0) . F Alt Yrs. Preq: BCH 451 and MA 121 and ZO 419 or equivalents.* Examination of worldwide relationships between physical-chemical environment and planktonic organisms. Organism descriptions: effects of light, temperature, salinity, density, water motion and chemical constituents on organisms; interactions among different organisms emphasizing competition and predation; community structure, distribution and succession; and mathematics models of distribution, production and interaction.

MEA (ZO) 754 Advances in Marine Community Ecology. *3(3-0) . S, Alt. Yrs. Preq: ZO 402 or ZO 760 or MEA(ZO) 750.* Current research and biological and physical processes structuring shallow and deep water benthic communities. Recent research on competition, predation, disturbance, succession, animal-sediment-flow interactions, life history tactics and experimental design in marine benthic biology. Student discussion of current issues and critique of recent papers.

MEA (ZO) 756 Ecology of Fishes. *3(3 0) . F. Preq: BO 360 or ZO 260 or 760 or equivalent.* Physiological ecology of fishes emphasizing energetics, production and adaptations to aquatic mediums. Ecological classification of fishes and theory of resource partitioning in freshwater, estuarine and marine realms.

MEA 758 Laboratory and Field Methods for Investigation of the Seabed. *3(2-3) S, Alt. Yrs.* An initial lecture and laboratory phase acquaints the student with the use of advanced techniques and instrumentation for chemical and geological oceanographic investigations. A field project in the coastal waters of North Carolina and then allows application of these tools to a specific marine problem.

MEA 759 Organic Geochemistry. *3(3-0) . F, Alt Yrs.* Sources and fates of organic material in the geochemical environment. Microbial transformations of organic compounds. The use of biomarkers to study depositional environments. Petroleum, natural gas and coal formation. Extraterrestrial organic geochemistry.

MEA 760 Biogeochemistry. *3(3-0) . F, Alt. Yrs.* Processes involved in the biogeochemical cycling of C, N, S and related biogenic elements. Stable isotopic and other geochemical signatures of biological processes. Introduction to modeling chemical distributions in sediments. The impact of biogeochemical processes on atmospheric chemistry.

MEA 762 Marine Geochemistry. *3(3-0) . S, Alt. Yrs. Preq: CH 331, MEA 560 or equivalent.* Detailed examination of chemical processes occurring in marine environment. Chemical evolution of the oceans, continental and submarine weathering, particle scavenging of reactive elements from water, column, formation of biogenic and metalliferous deposits, sediment diagenesis and marine geochronology.

MEA 763 Geochemistry. *3(3-0) . F Alt Yrs. Preq: CH 331 or 431.* Quantitative distribution of elements in earth's crust, hydrosphere and atmosphere. Application of laws of chemical equilibrium and resultant chemical reactions to natural earth systems. Geochemical application of Eh-pH diagrams. Geochemical cycles.Isotope geochemistry.

MEA 764 Sedimentary Geochemistry. *3(3-0) . S, Alt. Yrs. Preq: CH 331 or CH 431 or MEA 763 or equivalent background.* Application of thermodynamic data to the calculation of reactions in natural waters at or near the earth's surface. Weathering to form clay minerals, precipitation of economic minerals and carbonate sedimentology.

MEA 767 Continental Margin Sedimentation. *3(3-0) . S, Alt. Yrs. Preq: MEA 510.* Detailed examination of processes and sedimentation active along continental margins. Examination of specific environments of continental shelf, slope and rise.

MEA (MAE) 768 Perturbation Method in Fluid Mechanics I. *3(3 0) . F, S Alt Yrs. Preq: MA 401, MAE 308.* Basic theory and application of perturbation methods in fluid mechanics including: regular and singular perturbations, matching principles, method of strained coordinate, two variable expansion and applications to partial differential equations.

MEA (MAE) 769 Perturbation Method in Fluid Mechanics II. *3(3 0) . F, S Alt Yrs. Preq: MA 401, MAE 308.* Basic theory and application of perturbation methods in fluid mechanics including: regular and singular perturbations, matching principles, method of strained coordinate, two variable expansion and applications to partial differential equations.

MEA 785 Hydrogeology of Groundwater Pollution and Protection. *3(3-0) . S Alt Yrs. Preq: MEA 585 or CE 584 or equivalent.* Hydrogeologic factors associated with protection of groundwater; use of geologic principles and materials to protect groundwater quality; geologic evaluation and monitoring of waste disposal sites, including appropriate models.

MEA 788 Advanced Structural Geology. *3(2-3) . F, Alt. Yrs. Preq: MEA 451.* Principles of rock mechanics and their application in solving geologic problems; finite strain analysis of deformed rocks; advanced techniques of structural analysis; petrofabrics; development of various geologic structures. Emphasis upon application of principles and techniques in the field.

MEA 789 Topics In Appalachian Geology. *3(3-0) . F, Alt. Yrs. Preq: MEA 440, 450 and 451.* Examination of geology of areas within Appalachian orogenic belt. Lectures, discussions, reading and review of current literature and consideration of ideas concerning geological evolution of region. Required field trips.

MEA 790 Geotectonics. *3(3-0) . F Alt Yrs. Preq: MEA 440, 450, 451.* In-depth examination of current ideas in plate tectonic theory. Plate tectonic controls on orogeny, orogenic belts, magmatism and metallogeny.

MEA 791 Advanced Special Topics in Marine Science. *1-3. F, S, Sum. Preq: Consent of Instructor* Opportunity for advanced undergraduate and graduate students to study timely special problem areas in Marine Science and Engineering

MEA 792 Advanced Special Topics in Earth Sciences. *1-3. F, S, Sum. Preq: Consent of Instructor.* Special topics in earth sciences, provided to groups or to individuals.

MEA 793 Advanced Special Topics in Atmospheric Science. *1-3. F, S, Sum. Preq: Consent of Instructor* Special topics in atmospheric science, provided to groups or to individuals.

MEA 794 Regional Tectonics. *3(3 0) . S, Alt Yrs Preq: MEA 440, 450, 451.* Methods of study of tectonic history of major geologic regions in North America and other areas of world through the application of stratigraphy, petrology and structural geology. Synthesizing regional tectonic patterns and events.

MEA 795 Photogeology and Remote Sensing. *3(2 3) S Preq: MEA 101 or 120, MEA 481 or equivalent* Study and interpretation of aerial photographs and other remotely sensed data for geological information relating to mineral resource exploration and evaluation and geological controls on environmental problems.

MEA 796 Exploration And Engineering Geophysics. *3(3-0) . S. Preq: MEA 470 or PY 208. Credit in both MEA 470 and MEA 570 is not allowed.*. Geophysical methods as applies to exploring the earth's mineral and energy resources and to investigating subsurface geological structure and physical properties. Principles, measurements, analyses, and interpretations of gravity, magnetic, electric, electromagnetic, seismic methods. Required research paper.

MEA 801 Seminar. *1(1-0) . F, S. Preq: Grad. standing.* Presentation by each student of one seminar on his/her current research.

MEA 810 Special Topics. *F,S,Sum.*

MEA 811 Special Topics in Marine Sciences. *F, S, Sum. Preq: Consent of Instructor.* Special topics in earth sciences, provided to groups or to individuals.

MEA 812 Special Topics in Earth Sciences. *1-3. F, S, Sum. Preq: Consent of Instructor.* Special topics in atmospheric science, provided to groups or to individuals.

MEA 813 Special Topics in Atmospheric Sciences. *F, S, Sum. Preq: Consent of Instructor.* Special topics in earth sciences, provided to groups or to individuals.

MEA 885 Doctoral Supervised Teaching. *1-3. F, S, Sum. Preq: Doctoral Student.* Teaching experience under the mentorship of faculty who assist the student in planing for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

MEA 893 Doctoral Supervised Research. *1-9. F, S, Sum. Preq: Doctoral Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

MEA 895 Doctoral Dissertation Research. *1-9. F, S, Sum.* Dissertation Research

MEA 899 Doctoral Dissertation Preparation. *1-3. F, S, Sum. Preq: Doctoral Student.* For students who have completed all credit hour requirements, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

MASTER OF INTERNATIONAL STUDIES PROGRAM

MIS 501 Colloquium In International Development. *3(3 0) . Preq: Grad standing or Consent of Instructor.* An interdisciplinary survey of process and institutions of international development. Systematic review of comparisons and contrasts of selected countries and regions. Specific topics drawn from technological and institutional innovations in development contexts.

MIS 598 Topical Problems in International Development. *1-6. Preq: MTID standing.* Investigation of topics of particular interest to advanced students under faculty direction on a tutorial basis. Credits and content vary with student/faculty discretion and needs.

MIS 630 Topical Problems in International Development. *1-6. F, S, Sum. Preq: MTID standing.* Investigation of topics of particular interest to advanced students under faculty direction on a tutorial basis. Credits and content vary with student/faculty discretion and needs.

MIS 651 Internship in International Development. *1-6. F, S, Sum. Preq: MTID standing.* Exposure of student to value systems and technological environment of cultures other than his/her own through a supervised work experience. Application of technological knowledge to development problems. Required technical paper summarizing and analyzing this experience.

MIS 685 Master's Supervised Teaching. *1-3. F,S. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

MIS 690 Master's Examination. *1-5. F,S. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

LIBERAL STUDIES

MLS 501 Seminar in Liberal Studies. *3(3-0) . F, S, Sum. Preq: Admission to M.A. in liberal studies.* Intensive study of an interdisciplinary issue or area. Seminars, varying each semester, address such topics as arts studies, history and literature, sociobiology and social sciences, world trade and world conflict, and technology and social change.

MLS 630 Independent Study. *1-6. F, S, Sum. Preq: Admission to M.A. in liberal studies.* Advanced independent study of an interdisciplinary topic under supervision of a faculty member.

MLS 676 Independent Project. *3(3-0) . F, S, Sum. Preq: Admission to M.A. in liberal studies.* Advanced independent research on an interdisciplinary project under supervision of a faculty member.

MLS 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

MLS 690 Master's Examination. *1-6. F, S, Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

MLS 717 Independent Study. *1-6 Preq: Admission to M.A. in liberal studies.* Advanced independent study of an interdisciplinary topic under supervision of a faculty member.

MILITARY SCIENCE

MS 101 Introduction to ROTC and the Army. *1(1-1) Enrollment limited to freshman and sophomore students only.* The mission, organization, traditions, and role in society of the U.S. Army, and an introduction to ROTC. Advantages, opportunities, and benefits of becoming an Army officer. Introduction to leadership with emphasis on improving oral communicationskills.

MS 106 Map Reading. *1(1-1) . Enrollment limited to freshman and sophomore students only.* Basic map reading techniques: determination of present location through the use of intersection and resection procedures; information for outdoor activities, ranging from competitive orienteering to occasional backpacking.

MS 201 Basic Military Leadership. *2(2-1) . Preq: MS 101 and 106.* Instruction in fundamentals of military leadership, team development, interpersonal communication skills, the military decision-making process and military briefing skills. Students also receive instruction on map reading, first aid, weapons familiarization, and physical conditioning.

MS 202 Small Unit Tactics. *2(2-1) . Preq: MS 101.* Principles of small unit (squad level) tactics and their application. Emphasis on briefing tactical operations orders (OPORD), and developing the individual leadership skills necessary to control soldiers in the tactical environment. Student leadership laboratory sessions apply tactical principles.

MS 301 Military Leadership and Training Management. *3(2-3) . Preq: ROTC advanced course cadets.* Organizational leadership and process in the Army; leadership activities and key management functions. Management and conduct of group training activities. Leader development through hands-on, practical situations.

MS 302 Intermediate Small Unit Tactics. *3(2-3) . Preq: MS 301 (Grade of C or higher)* Planning, organizing and executing military operations at the squad and platoon level. Focus on the leader's actions, map reading, land navigation, marksmanship, and other essential skills. Continued leader development through planning and execution of group activities under structured evaluation.

MS 401 Advanced Military Science - Leadership and Systems Management. *3(3-2) Preq: MS 301, MS 302.* A course designed to familiarize the student with the fundamentals of staff operations and procedures, military correspondence, and the U.S. Army training management system. Also included are the Officer Personnel Management and Officer Evaluation Report systems (OPMS/OER), the Army logistics system, mobilization and deployment, and intelligence/electronic warfare.

MS 402 Advanced Military Science - Military Justice, Ethics and Professionalism. *3(3-2) . Preq: MS 401.* The role of military justice, the Uniform Code of Military Justice (UCMJ) and the procedures for accomplishing certain legal actions. Ethics and professionalism of the officer corps. Also included are counseling techniques and continued preparation for the transition from cadet to commissioned officer. Emphasis on student interaction and small group exercise practical application.

MUSIC

MUS 100 Instrumental Music. *1(0-3) . F.S. Preq: Satisfactorily passing audition.* The study and performance of instrumental music. Repertoire dependent upon instrument and level of interest and accomplishment.

MUS 101 Beginning Class Piano I. *1(0-3) F,S.* Introductory course for students with no previous piano experience. Music notation, chord formation, keyboard techniques, and ensemble playing. Reading and playing developed through folk, popular, and classical repertoire.

MUS 102 Beginning Class Piano II. *1(0-3) . F.S. Preq: Consent of instructor* A continuation of MUS 101. Further development through the study of more advanced repertoire.

MUS 110 Choral Music. *1(0-4) Preq: Satisfactorily passing audition.* Study and performance of choral music by participation in Varsity Men's Glee Club (male chorus), Women's Choir, New Horizons Choir (mixed chorus), or Chamber Singers.

MUS 120 Rudiments of Music. *3(3-0)* . Students with limited musical experience learn to read and notate music as well as sing and play a variety of melodies on the piano with simple chordal accompaniment. Repertoire includes music from classical, folk, and popular traditions.

MUS 150 Vocal Techniques. *1(0 2)* . Development and practice of vocal techniques suitable to solo and ensemble singing in a variety of musical styles, both historical and contemporary.

MUS 160 Basic Conducting. *1(2-0) . Preq: Ability to read music.* Development and practice of skills and techniques necessary for conducting all types of musical ensembles. Emphases include use of baton, basic and complex conducting patterns, left hand independence and expressivity, and score study. Opportunity to conduct student ensembles.

MUS 180 Introduction to Musical Experiences. *3(3 0) . F,S.* Examination of western musical materials, forms, styles and history through the primary musical experiences of composing, performing, and listening. Course designed for students with no formal musical training.

MUS 200 Understanding Music. *3(3-0)* . Introduction to the art of music for the general student. Elements, formal principles, repertoires, compositional techniques, and survey of western stylistic periods from medieval to modern. Prior musical experiences (high school band, church choir, etc) recommended.

MUS 201 Introduction to Music Literature I. *3(3-0)* . Survey of Western art music from antiquity to end of eighteenth century. Includes examination of the art of music through discourses of philosophy (aesthetics) and anthropology (ethnomusicology). Core requirement for music minor.

MUS 202 Introduction to Music Literature II. *3(3-0)* . Survey of Western art music from end of eighteenth century through end of twentieth century. Includes examination of contemporary popular genres and impact of media and technology on music production and consumption. Core requirement for music minor.

MUS 230 Introduction to African-American Music. *3(3-0) . F.* Comprehensive survey of African-American music in the United States from Colonial times to the, with emphasis on its unique features and contributions to American culture.

MUS 260 History of Jazz. *3(3-0)* . History of jazz and the contributions of major artists. Emphasis of the various styles that have contributed to this American art form. Investigation of structural forms in the jazz idiom.

MUS 300 Chamber Music Performance. *1(0-4) . Preq: Satisfactorily passing audition.* Performance of chamber music. Emphasis on chamber literature from the sixteen through the twentieth centuries written for a wide variety of combinations ranging from string quartets to pieces written for specific instruments and voices.

MUS 301 Basic Music Theory I. *3(3-0) . F,S. Preq: Ability to read music.* Introduction to Music Theory for students with no academic musical background. Basic elements of music through exercises in notation, ear training, written harmony, and formal analysis. Application through study of selected compositions from the musical literature and through creation of an original composition written by each student.

MUS 302 Basic Music Theory II. *3(3-0) . S. Preq: MUS 301.* Second course in Music Theory. Musical analysis of representative works. Further study of chordal functions and orchestration technics through written exercises. Compositions, written by students.

MUS 305 Music Composition. *3(3-0) . Preq: MUS 301, MUS 302.* Study and creation of musical works. Emphasis on writing original music and works imitative of conventional and contemporary musical styles.

MUS (MDS) 306 Music Composition with Computers. *3(3-0) . Preq: Some knowledge of music or computer science (eg. CSC 200) or consent of instructor.* Survey of the theory and history of computer music, compositional algorithms, digital synthesis techniques, composition of at least one computer music work -- a computer-assisted composition for traditional instruments, a piece for computer music ontape, a real-time piece, or a piece that combines tape and instrument(s).

MUS 310 Music of the 17th and 18th Centuries. *3(3-0) .* Evolution of European music from 1600 to 1820, with emphasis on characteristics of Baroque and Classical form and style. Examination of major composers and representative works in light of social, political and cultural influences.

MUS 315 Music of 19th Century Europe. *3(3-0) .* A survey of 19th century European music, including analysis of its texts, forms and composers, and its relations to other art forms of the period.

MUS 320 Music of the Twentieth Century. *3(3-0) . Preq: MUS 200 or 202 or 301.* Study of Western Art Music from 1900 to present, emphasizing significant composers, repertoire, and compositional procedures and trends, including traditional, atonal, serial, aleatoric, electronic and computer music.

MUS 330 Music Drama. *3(3-0) .* Survey of staged musical works spanning four centuries. Emphasis on large-scale dramatic works in the genres of opera, operetta, and musical theater. Designed for students with musical and/or theatrical experience.

MUS 335 Choral Literature. *3(3-0) .* Survey of choral literature spanning five centuries. Emphasis on large-scale choral/orchestral masterworks in the genres of oratorio, passion, cantata, mass and requiem.

MUS 340 The Symphony Orchestra and Its Music. *3(3-0) . Preq: Any 200-level music course.* Development of the symphony orchestra as a performing medium through study of significant works composed during the 18th, 19th, and 20th centuries. Emphasis on contemporary role of conductor.

MUS 345 Keyboard History and Literature. *3(3-0) .* Survey of keyboard history and literature from the Renaissance through the Twentieth Century. Emphasis on significant composers, performers, social issues, aesthetics and criticism.

MUS 350 World Music I: Music of Asia. *3(3-0) . F. Preq: No previous formal training in music required.* Examination of music from a variety of Asian traditions including India and Pakistan, Japan and Korea, Thailand and Indonesia. Emphasis place on philosophical, social and religious contexts from which music emerges and in which it is experienced by native performers and listeners. No previous formal training in music in required.

MUS 351 World Music II: Music of Africa and the Americas. *3(3 0) . S Preq. No previous formal training in music required.* Examination of music of sub-Saharan Africa, the African Diaspora in the New World, and Native American traditions. Emphasis placed both on traditional forms of musical expression and such contemporary developments as "Afri-pop" and "World Beat."

MUS (WGS) 360 Women In Music. *3(3-0) . S.* The role of women in music as patrons, teachers, composers, and performers, placing them within the social, economic, and political framework to which they belong. Emphasis on Western Art Music and the role of women in popular music. No previous formal training in music is required.

MUS 390 Applied Music. *1(1-0) . F,S. Preq: Restricted to students enrolled in Music Minor program. Department approval required.* Individual instruction in voice or instrumental performance. Includes development of technique basic to voice or instrument, as well as advancement of artistry, musicianship, and repertoire.

MUS 495 Special Topics in Music. *3(3-0) . F,S.* Examination of selected topics in music.

MUS 498 Independent Study in Music. *Preq: Departmental approval required.* Directed independent study of selected topics for students with specialized interests in music and/or advanced musical ability. Credit and content determined by faculty member in consultation with Director of Music.

NUCLEAR ENGINEERING

NE 201 Introduction to Nuclear Engineering. *2(2-0) . F. Preq: MA 241, PY 205.* An introduction to the concepts, systems and application of nuclear processes. Topics include radioactivity, fission, fusion, reactor concepts, biological effects of radiation, nuclear propulsion, and radioactive waste disposal. Designed to give students a broad perspective of nuclear engineering and an introduction to fundamentals and applications of nuclear energy.

NE 202 Fundamentals of Nuclear Energy. *4(3-2) . S,Sum. Preq: PY 208. Coreq: PY 407.* Introduction to nuclear energy. Topics include radioactivity, radiation detection, interaction of radiation with matter, nuclear reactions, fission, fusion, nuclear reactors, radiation safety and protection, and laboratory measurement of nuclear radiation.

NE 301 Fundamentals of Nuclear Engineering. *4(3-2) . F. Preq: MA 341 (or equivalent), C or better in NE 202.* Introductory course in nuclear engineering. Neutron physics, reactor operation, and reactor dynamics. Basic principles underlying the design and operation of nuclear systems, facilities and applications. Laboratory sessions include neutron detection and measurement, reactor instrumentation, and reactivity measurements.

NE 302 Nuclear Reactor Energy Conversion. *4(3-2) . S. Preq: MAE 301 and a C or better in NE 301. Coreq: 308.* Introduction to the concepts and principles of heat generation and removal in reactor systems. Power cycles, reactor heat sources, analytic and numerical solutions to conduction problems in reactor components and fuel elements, heat transfer in reactor fuel bundles and heat exchangers. Problem sets emphasize design principles. Heat transfer lab included.

NE 401 Reactor Analysis and Design. *4(3-2) . S. Preq: C or better in NE 301. Coreq: MA 401.* Elements of nuclear reactor theory for reactor core design and operation. Includes one-group neutron transport and multigroup diffusion models, analytical and numerical criticality search, and flux distribution and calculations for homogeneous and heterogeneous reactors, slowing down and thermalization models and transient isotopics. Laboratory observations and correlation of reactor measurements with theory.

NE 402 Reactor Engineering. *4(3-2) . F. Preq: MAE 308, NE 302, NE 401.* A course in thermal-hydraulic design and analysis of nuclear systems. Single and two-phase flow, boiling heat transfer, modeling of fluid systems. Design constraints imposed by thermal-hydraulic considerations are discussed. A thermal-hydraulics laboratory included.

NE 403 Nuclear Engineering Design Projects. *3(2-3) . S. Preq: NE 401, NE 402.* Projects in design of practical nuclear engineering systems. Preliminary designs developed by teams with advice by faculty as needed, with reports presented in oral and written form. Current and future systems emphasized, and use of computers encouraged.

NE 404 Radiation Safety and Shielding. *3(3-0) . F. Preq: NE 301 with a grade of C or better or NE 419.* Radiation safety and environmental aspects of nuclear power generation. Radiation interaction, photon attenuation, shielding theory and design project, external and internal dose evaluation, reactor effluents and release of radioactivity into the environment, transportation and disposal of radioactive waste; and environmental impact of nuclear power plants.

NE 405 Reactor Systems. *3(3-0) . F. Preq: NE 401. Coreq: NE 402.* Nuclear power plant systems: design criteria, design parameters, and economics. Topics covered include: PWR, BWR, core design, primary loops, auxiliary and emergency systems; containment, reactor control and protection systems, accident and transient behaviors.

NE 412 Nuclear Fuel Cycles. *3(3-0) . S. Preq: NE 401 and NE 402.* Processing of nuclear fuel with descriptions of mining, milling, conversion, enrichment, fabrication, irradiation, reprocessing, and waste disposal. Incore and out-of-core nuclear fuel management design, including objectives, constraints, decisions and methodologies. Nuclear power plant and fuel cycle economics.

NE (PY) 414 Electromagnetism I. *3(3-0) . F. Preq: PY 203 or 208, MA 341.* First semester of a two-semester sequence. An intermediate course in electromagnetic theory using the methods of vector calculus. Electrostatic field and potential, dielectrics, solution to Laplace's and Poisson's equations, magnetic fields of steady currents

NE (PY) 415 Electromagnetism II. *3(3-0) . S. Preq: PY 414.* A continuation of PY 414. Electromagnetic induction, magnetic fields in matter, Maxwell's equations, wave guides, radiation.

NE 418 Nuclear Power Plant Instrumentation. *3(3-0) . F. Preq: ECE 221 or ECE 331.* Instrumentation and supporting systems required for control and protection of a nuclear power plant. Radiation measurement, process measurement, and reactor operating principles used to develop instrumentation requirements and characteristics. Requirements and implementations of instrumentation, control and protection systems for pressurized and boiling water reactors. Design and implementation issues include power supplies, signal transmission, redundancy and diversity, response time, and reliability.

NE 419 Introduction to Nuclear Engineering. *3(3-0) . S. Preq: PY 202 or PY 208. Not open to majors in Nuclear Engineering.* Electrical power generation from nuclear fission, fundamental aspects of fission chain reaction, and reactor design. Reactor types, their static and dynamic characteristics and instrumentation. Reactor operation and safety. Nuclear fusion and fusion reactor development.

NE (CHE) 485 Management of Hazardous Chemical and Radioactive Wastes. *1(1-0) . F. Junior Standing. Credit will not be given for both NE 485 and 585.* Seminar series designed to provide an introduction to the management of both hazardous chemical and radioactive wastes. Topics include: hazardous waste treatment and disposal, pollution prevention, radioactive waste management, Superfund policy, state and federal regulations and risk assessment.

NE 491 Special Topics in Nuclear Engineering. *1-4. Preq: Consent of Instructor.* Detailed coverage of special topics.

NE 504 Radiation Safety and Shielding. *3(3-0) . F. Preq: NE 401 or NE 520.*

NE 505 Reactor Systems. *3(3-0) . F Preq. NE 401 or equivalent. Credit for both NE 405 and NE 505 is not allowed.* Nuclear power plant systems: PWR, BWR and advanced concepts. Design criteria, design parameters, economics, primary and secondary loops, safety systems, reactor control and protection systems, containment, accident and transient behaviors, core design, and reactivity control mechanisms. Term-long project.

NE (MAT) 509 Nuclear Materials. *3(3-0) . F. Preq. MAT 201. Credit for both NE 409 and NE(MAT) 509 is not allowed.* Properties and selection of materials for nuclear steam systems and radiation effects on materials. Implications of radiation damage to reactor materials and material problems in nuclear engineering. Overview of nuclear steam systems, crystal structure and defects, dislocation theory, mechanical properties, radiation damage, hardening and embrittlement due to radiation exposure and problems concerned with fission and fusion materials. Term-long project.

NE 511 Nuclear Physics for Engineers. *3(3-0) . F* The properties of atomic nuclei, of nuclear radiations and of interaction of nuclear radiation with matter. Emphasis on principles of modern equipment and techniques of nuclear measurement and their application to practical problems.

NE 512 Nuclear Fuel Cycles. *3(3-0) . S Preq: NE 401 or equivalent. Credit for both NE 412 and NE 512 is not allowed.* Processing of nuclear fuel with description of mining, milling, conversion, enrichment, fabrication, irradiation, shipping, reprocessing and waste disposal. Fuel cycle economics and fuel cost calculation. In-core and out-of-core nuclear fuel management, engineering concepts and methodology. Term-long project.

NE 520 Radiation and Reactor Fundamentals. *2(2-0) . F. Preq: MA 401 and NE 401 or equivalent.*

NE (PY) 528 Introduction to Plasma Physics and Fusion Energy. *3(3-0) . F. Preq: MA 401 and PY 208 or equivalent.* Concepts in plasma physics, basics of thermonuclear reactions; charged particle collisions, single particle motions and drifts, radiation from plasmas and plasma waves, fluid theory of plasmas, formation and heating of plasmas, plasma confinement, fusion devices and other plasma applications.

NE (CHE) 585 Management of Hazardous Chemical and Radioactive Wastes. *1(1-0) . F. Credit for both CHE 485 and CHE(NE) 585 is not allowed.* Seminar series to provide introduction to management of both hazardous chemical and radioactive wastes. Hazardous waste treatment and disposal, pollution prevention, radioactive waste management, Superfund policy, state and federal regulations and risk assessment.

NE 591 Special Topics in Nuclear Engineering I. *3(3-0) . F,S. Preq: Consent of Instructor.*

NE 592 Special Topics in Nuclear Engineering II. *3(3-0) . F,S. Preq: Consent of Instructor.*

NE 601 Seminar. *1(1-0) . F,S.* Discussion of selected topics in nuclear engineering.

NE 685 Master's Supervised Teaching. *1-3. F, S. Sum. Preq. Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment

NE 690 Master's Examination. *1-3. F, S, Sum. Preq: Master's student* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

NE 693 Master's Supervised Research. *1-9. F, S, Sum Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

NE 695 Master's Thesis Research. *1-9 F, S, Sum. Preq: Master's student* Thesis research.

NE 699 Master's Thesis Preparation. *1-3 F, S, Sum Preq: Master's student* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

NE 721 Nuclear Laboratory Fundamentals. *2(1 3) . F Preq: MA 401 and NE 401 or equivalent.* Introduction to nuclear instrumentation and experimental techniques used in nuclear engineering research. Topics include radiation detection and spectroscopy, neutron instrumentation, statistical analysis, use of microcomputers and nuclear reactor operations.

NE 722 Reactor Dynamics and Control. *3(3-0) . F Preq: NE 401 or NE 520.* Methods of describing and analyzing dynamic behavior of systems. These methods applied to reactor systems and the effects of feedbacks studies. Methods of measuring the behavior of reactor systems and development of logic systems for control and safety.

NE 723 Reactor Analysis. *3(3-0) . F. Preq: NE 401 or NE 520.* Basic models of neutron motion and methods of calculating neutron flux distributions in nuclear reactors. Emphasis on multigroup diffusion theory. Criticality search, neutron slowing down models, resonance absorption, thermalization and heterogeneous cell calculations. Objective is to enable students to read literature and perform relevant analysis in reactor physics.

NE 724 Reactor Heat Transfer. *3(3-0) . S. Preq: NE 402 and NE 401 or NE 520.* Consideration of heat generation and transfer in nuclear power reactors. Topics include reactor heat generation, steady-state and transient heat combustion in reactor fuel elements, boiling heat transfer and single and two-phase flow.

NE (MAT) 725 Nuclear Materials. *3(3-0) . F. Preq: NE 409 or MAT 201, Consent of Instructor.* Properties and selection of materials for nuclear steam systems and radiation effects on materials. Implications of radiation damage to reactor materials and material problems in nuclear engineering. An overview of nuclear steam systems, crystal structure and defects, dislocation theory, mechanical properties, radiation damage, hardening and embrittlement due to radiation exposure and problems concerned with fission and fusion materials.

NE 726 Radioisotopes Measurement Applications. *3(3-0) . S. Preq: NE 401 or 520.* Introduction the student to measurement applications using radioisotopes and radiation. Discussion of all major tracing, gauging and analyzer principles and treatment of several specific applications in detail. Objective is to familiarize student with design and analysis of industrial measurement systems using radioisotopes and/or radiation.

NE 727 Nuclear Engineering Analysis. *3(3-0) . S. Preq: NE 401 or NE 520.* Fundamental material on: (1) numerical methods for solving the partial differential equations pertinent to nuclear engineering problems, (2) Monte Carlo simulation of radiation transport and (3) data and error analysis techniques including estimation of linear and nonlinear model parameters from experimental data.

NE 729 Reactor Theory and Analys. *3(3 0) . S Alt. yrs. Preq: NE 723,72".* Theoretical aspects of neutron diffusion and transport related to the design computation and performance analysis of nuclear reactors. Principal topics: a unified view of the neutron cycle including slowing down, resonance capture and thermalization; reactor dynamics and control; fuel cycle studies; and neutron transport methods. Background provided for research in power and test reactor analysis.

NE 732 Principles of Industrial Plasmas. *3(3-0) S. Preq. NE/PY 528.* Theory and fundamental physical principles of industrial plasmas. Applications in plasma processing, plasma manufacturing technology, arcs and torches, plasma sprayers, high-voltage high-current switching devices, plasma-driven devices and plasma-aided technology. Emphasis on particle transport and plasma flow.

NE 740 Laboratory Projects in Nuclear Engineering. *3(3-0) . F. Preq: NE 721.* Enhancement of laboratory skills pertinent to nuclear engineering research through projects that requiring student to design the experiment, assemble equipment, carry out the measurements and analyze and interpret data. Students work in groups of two and perform to completion two laboratory projects.

NE 745 Plasma Laboratory. *3(2-3) . F. Alt. Yrs. Preq: NE 528 or PY 508 or PY 509.* Experimental plasma generation and plasma diagnostic techniques. Lecture topics include high vacuum techniques, perturbing and non-perturbing probe techniques, and laser and emission spectroscopy. Laboratories utilize various methods of measuring plasma parameters discussed in lectures.

NE 746 Fusion Energy Engineering. *3(3-0) . F. Alt. Yrs. Preq: NE 528.* Description and analysis of the technologies of devices necessary to produce fusion energy including vacuum technology, plasma heating and fueling, magnetics, special energy conversion, neutronics, materials, environment and safety. Stress upon design integration and ensuing technological constraints.

NE 751 Nuclear Reactor Design Calculations. *3(3-0) . S. Alt. yrs. Preq: NE 723.* Application of digital computer to problems in reactor core nuclear design. Study and exercise of available reactor core physics computer modules. Description of systems and programs used by industry for power reactor core design and core follow. A review of relevant analytic and numerical methods facilitates computer program development by students.

NE 752 Thermal Hydraulic Design Calculations. *3(3-0) . F. Alt. yrs. Preq: NE 724* Advanced presentation of thermal-hydraulic analysis of nuclear power systems. Topics including development of single phase and two-phase fluid flow equations, subchannel analysis, interphase phenomena and numerical solution methods relevant to design and safety analysis codes.

NE 753 Reactor Kinetics and Control. *3(3-0) . S. Preq: NE 722.* The control of nuclear reactor systems. Development of basic control theory including the use of Bode, Nyquist and S plane diagrams and state-variable methods. Analysis of reactor and reactor systems by these methods and development of control methods and optimum-control methods. Discussion of models of reactors and reactor-associated units, such as heat exchangers. Presentation of effects of nonlinearities.

NE 755 Reactor Theory and Analysis. *3(3-0) . S. Alt. yrs. Preq: NE 723, 727.* Theoretical aspects of neutron diffusion and transport related to the design computation and performance analysis of nuclear reactors. Principal topics: a unified view of the neutron cycle including slowing down, resonance capture and thermalization; reactor dynamics and control; fuel cycle studies; and neutron transport methods. Background provided for research in power and test reactor analysis.

NE 757 Radiation Effects on Materials. *3(3-0) . F. Preq: NE 509.* Interactions of radiation with matter, with emphasis on physical effects. Discussion of current theories and experimental techniques. Annealing of defects, radiation induced changes in physical properties and effects in reactor materials.

NE 761 Radiation Detection. *3(3-0) . F. Preq: NE 726.* Advanced aspects of radiation detection such as computer methods applied to gamma-ray spectroscopy, absolute detector efficiencies by experimental and Monte Carlo techniques, the use and theory of solid state detectors, time-of-flight detection experiments and M÷ssbauer and other resonance phenomena.

NE 762 Radioisotope Applications. *3(3-0) . F. Preq: NE 726.* Presentation of advanced principles and techniques of radioisotope applications. Topics include radiotracer principles; radiotracer applications to engineering processes; radioisotope gauging principles; charged particle, gamma ray and neutron radioisotope gauges.

NE 770 Nuclear Radiation Attenuation. *3(3-0) . F. Alt. yrs. Preq: NE 727.* Physical theory and mathematical analysis of the penetration of neutrons, gamma-rays and charged particles. Analytical techniques including point kernels, transport theory, Monte Carlo and numerical methods. Digital computers employed in the solution of practical problems.

NE (MAT) 773 Computer Experiments in Materials and Nuclear Engineering. *3(3-0) S.* Monte Carlo and dynamical computer experiments covered from standpoint of how to design and use them in materials and nuclear engineering work.

NE (MA) 777 Exact and Approximate Solutions in Particle Transport Theory. *3(3-0) . S. Preq: MA 501 or MA 511.* Method of elementary solutions used to solve exactly basic problems in neutron-transport theory and related topics. In addition, development and usage of FN method to establish concise approximate solutions in the realm of particle transport theory.

NE 780 Magnetohydrodynamics & Transport in Plasmas. *3(3-0) F, Alt. Yrs. (Odd). Preq: NE 528, NE/PY 414 and 415.* Advanced fluid description of plasmas for magnetic fusion, space and industrial plasmas, and other applications. Emphasis on a first principles approach to transport, equilibria, and stability.

NE 781 Kinetic Theory, Waves, & Non-Linear Effects in Plasmas. *3(3-0) . F, Alt. Yrs. (even). Preq: NE 528, NE/PY 414 and 415. Coreq: MA 775.* Kinetic theory, waves, and non-linear phenomena in magnetized plasmas. First principles approach to the treatment of instabilities and other collective effects.

NE 795 Advanced Topics in Nuclear Engineering I. *F,S. Preq: Consent of Instructor.* A study of recent developments in nuclear engineering theory and practice.

NE 796 Advanced Topics in Nuclear Engineering II. *F,S. Preq: Consent of Instructor.* A study of recent developments in nuclear engineering theory and practice.

NE 801 Seminar. *1(1-0) . F,S.* Discussion of selected topics in nuclear engineering.

NE 885 Doctoral Supervised Teaching. *1-3. F, S, Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

NE 890 Doctoral Preliminary Examination. *1-9. F, S, Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

NE 893 Doctoral Supervised Research. *1-9. F, S, Sum. Preq: Doctoral student* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

NE 895 Doctoral Dissertation Research. *1-9 F, S, Sum. Preq. Doctoral student* Dissertation research.

NE 899 Doctoral Dissertation Preparation. *1-3. F, S, Sum. Preq: Doctoral student* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

NATURAL RESOURCES

NR 100 Introduction to Natural Resources. *2(1-3) . F Open to Natural Resources. Forest Management and University Undesignated students only* Orientation to natural resources management. Case study of a current natural resource management issue including biophysical, economic, social and political dimensions. Field experience with local natural resources issues. Career orientation and counseling.

NR 300 Natural Resource Measurements. *4(2 6) . S Preq: BO 360 365. CH 201/202, MA 231, PY 211, SSC 200, ST 311.* Theory and practice of measuring, analyzing, and describing the characteristics of natural ecosystems. Surveying and mapping, inventory of vegetation, soils, wildlife habitat, and hydrology. Sampling, data analysis, and presentation of data. Use of geographic information systems to store, analyze, and present environmental data. Intensive instruction and practice in communication of technical information

NR 400 Natural Resource Management. *4(3-3) . S. Preq: ARE 336 and either ST 311 or ST 350; and senior standing.* Theory and practice of integrated natural resource management. Quantitative optimization, economics of multiple-use, compounding and discounting, optimal rotations, linear programming. Public and private management case studies and team projects.

NR (FOR) 420 Watershed and Wetlands Hydrology. *4(3-3) . F. Preq: SSC 200, BO 360. Credit will not be given for both FOR(NR)420 and FOR(NR)520..* Principles of hydrologic science; classification and assessment of watersheds and stream networks; hydrologic, erosion, and water quality processes in natural and managed watersheds; wetlands hydrology; hydrologic measurements and data analysis; applications of hydrology and water quality management for forest agriculture, and urban ecosystems; watershed restoration. Emphasis field study of watersheds and hydrologic measurements. Two weekend field trips are required.

NR 484 Environmental Impact Assessment. *4(2-0) . F. Preq: FOR 212 or BO 405, NR 300 or FOR 274. Coreq: FOR 353 or FOR 554.* Impact assessment principles, practices, and their evolution. Lectures and field practicums concerning problems addressed by environmental assessment practitioners. Practical implications of current regulatory requirements, especially endangered species and wetlands.

NR (FOR) 491 Special Topics in Forestry and Related Natural Resources. *1-4. F,S. Preq: Consent of Instructor.* Independent (or group) study or research of a forestry or related natural resources topic with a faculty supervisor of the student's choice. Also courses offered on a trial basis.

NR 500 Natural Resource Management. *3(3-3) . S. Preq: ARE 336 and either ST 311 or ST 350; graduate standing. Credit will not be allowed for both NR 400 and NR 500.* Theory and practice of integrated natural resource management. Quantitative optimization, economics of multiple-use, compounding and discounting, optimal rotations, linear programming. Public and private management case studies and team projects.Graduate students expected to provide more in-depth critique of planning process.

NR (FOR) 520 Watershed and Wetlands Hydrology. *4(3-4) . F. Preq: SSC 200 BO 360 Credit for both FOR(NR) 420 and FOR(NR) 520 is not allowed..* Principles of hydrologic science; classification and assessment of watersheds and stream networks; hydrologic, erosion, and water quality processes in natural and managed watersheds; wetlands hydrology; hydrologic measurements and data analysis; applications of hydrology and water quality management for forest, agriculture, and urban ecosystems; watershed restoration. Field study of watersheds and hydrologic measurements. Two weekend field trips required.

NR 521 Wetland Assessment, Delineation, and Regulation. *3(2-3) . S. Preq: SSC 200, BO 360. FOR 212 or BO 405, and FOR 420.* Wetland definitions and systems of classification and functional assessment; methods for assessing ecological functions of wetlands; identification and delineation of jurisdictional wetlands in accordance with US Army Corps of Engineers procedures; application of federal and state regulatory programs. Two required weekend field trips.

NR 571 Current Issues in Natural Resource Policy. *3(3-0) . S.* Seminar providing an overview of current natural resource issues for the world and the U.S. Population, sustainable development, food and agriculture, forests, rangelands, biodiversity, energy resources, water resources, atmosphere and climate, international policies and instructions.

NAVAL SCIENCE

NS 100 Midshipman 4/C Naval Science Laboratory. *0(0-1) . F,S.* Military drill, courtesies and honors, elements of unit leadership, physical fitness and professional development of the prospective Naval/Marine Corps Officer. Required of Midshipmen 4/C.

NS 110 An Introduction to Naval Science. *2(2-0) . F.* Fundamental orientation to the Naval Service emphasizing the mission, organization, regulations, customs and traditions, broad warfare components of Navy and the major challenges facing today's Navy and Marine Officers.

NS 200 Midshipman 3/C Naval Science Laboratory. *0(0-1) . F,S.* Continuation of NS 100. Required of Midshipmen 3/C.

NS 210 Leadership and Management. *3(3-0) . F.* Assists students in acquiring knowledge and developing the cognitive processes necessary to make decisions in the practice of management. The student will learn the traditional foundations of management while developing decision skills to apply this knowledge in a real-world setting. The major focus is centered upon global management, ethics and social responsibility, total quality management, and cultural diversity.

NS 220 Naval Ships Engineering Systems. *3(3 0) . S.* Introduction to the application of engineering principles in the research, development, design, construction, and operation of ships, weapons systems, and ocean structures, with emphasis on thermodynamic processes and energy conversions.

NS 300 Midshipman 2/C Naval Science Laboratory. *0(0-1) . F,S. Preq: Junior standing.* Continuation of NS 200. Required of Midshipmen 2/C.

NS 310 Navigation. *4(3 2) . F.* A comprehensive study of the theory, principles and procedures of ship navigation, movements and employment. Course includes mathematical analysis, spherical triangulations and practical work involving sight reduction, sextant, publications and report logs.

NS 320 Naval Operations. *4(3-2) . S. Preq: Junior standing.* Components of general naval operations, including concepts and application of tactical formations and dispositions, relative motion, maneuvering board and tactical plots, rules of the road and naval communications.

NS 330 Evolution of Warfare. *3(3-0) . Preq: Junior Standing.* A survey of the evolution of warfare through the study of selected campaigns and classic battles with special emphasis on the principles of war, the military impact of leadership, and the evolution of tactics, weapons, and weaponry.

NS 400 Midshipman 1/C Naval Science Laboratory. *0(0-1) . F,S. Preq: Senior standing.* Continuation of NS 300. Required of Midshipmen 1/C.

NS 410 Naval Weapon Systems. *3(3-0) . F.* An introduction to the concepts and properties of electronic, physical, electromagnetic and mechanical systems to foster an understanding of the theory and principles of operation of shipboard weapons systems, emphasizing types of weapons and fire control systems, capabilities and limitations, theory of target acquisition, identification and tracking, trajectory principles, and basics of ordnance.

NS 420 Naval Leadership and Management II. *3(3-0) . S. Preq: Senior standing.* Skills and abilities needed for competence as a commissioned officer in the area of human resources management, naval personnel management, material management, and the administration of discipline.

NS 430 Amphibious Warfare. *3(3-0) . S. Alt. yrs. Preq: Senior standing.* A survey of the projection of sea power ashore with special emphasis on the evolution of and innovation in amphibious warfare in the 20th Century through the study of historical amphibious landings and campaigns.

NUTRITION

NTR (ANS, FS) 301 Introduction to Modern Nutrition. *3(3-0) . F,S,Sum. Preq: Sophomore standing. Food science majors may use as a free elective only.* Functions, dietary sources and deficiencies of essential nutrients in humans; a balanced diet; role of nutrients in heart disease, cancer, hypertension, osteoporosis; weight control and eating disorders; vegetarianism; food safety; dietary supplements; government regulation of food supply; food quackery.

NTR (FS) 400 Principles of Human Nutrition. *3(3-0) . F. Preq: CH 220 or 221.* Functions of nutrients in the human body; sources and properties of nutrients; relationship of food industry practices to nutrition.

NTR (ANS, PO) 415 Comparative Nutrition. *3(3-0) . F. Preq: Preq: CH 220 or both 221 and 223.* Principles of nutrition, including the classification of nutrients and the nutrient requirements of and species for health, growth, maintenance and productive functions.

NTR (ANS) 419 Human Nutrition in Health and Disease. *3(3-0) . S. Preq: ANS 230, ANS/FS/NTR 301 or FS/NTR 400 or ANS/NTR/PO 415.* Current concepts and physiological bases of the roles of nutrition in the maintenance of health during the different stages in the life cycle and in the prevention and therapy of specific disease states in humans.

NTR 490 Nutrition Seminar. *1(1-0) . S. Preq: Junior standing.* Location of recent literature in the library and discussion of current topics in nutrition. Guest lectures on career opportunities and jobs available in the fields of human and animal nutrition. Use of computer databases to conduct a literature search on the chosen topic. Preparation and presentation of a final oral report, including an abstract and effective visual aids.

NTR 492 External Learning Experience. *F, S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience

NTR 493 Special Problems in Nutrition. *F,S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes campus facilities and resources. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

NTR 495 Special Topics in Nutrition. *F,S,Sum.* Offered as needed to present materials not normally available in regular course offerings or for offering of new courses on a trial basis.

NTR (ANS, FS) 554 Lactation, Milk, and Nutrition. *3(2-2) . S. Alt. yrs.(even). Preq: ANS 230 or FS/NTR 400; BCH 451 or ZO 421. Credit will not be given for both ANS 454 and 554.* Nutritional properties of milk as a high-quality food with nutritional diversity. Principles of physiology, biochemistry and cell biology in the mammary gland. Procedures of milk production and milk collection for milk quality and nutrition. Human lactation vs. that of domestic animals. Impacts of biotechnology and food safety on dairy production.

NTR 560 Nutrition and Biotechnology. *3(3-0) .*

NTR 594 Special Topics in Nutrition. *F,S,Sum.*

NTR 597 Master's Seminar. *1(1-0) . F,S.*

NTR 601 Master's Seminar. *F,S.*

NTR 624 Topical Problems in Nutrition. *1-6. F,S. Preq: Grad. or Sr. standing.* Analysis of current problems in nutrition. Also entails the scientific appraisal and solution of a selected problem designed to provide training and experience in research.

NTR 625 Advanced Special Problems in Nutrition. *1-6. F,S. Preq: Grad. standing.* Directed research in a specialized phase of nutrition designed to provide experience in research methodology and philosophy.

NTR 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

NTR 690 Advanced Special Problems in Nutrition. *1-6. F,S. Preq: Grad. standing.* Directed research in a specialized phase of nutrition designed to provide experience in research methodology and philosophy.

NTR 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

NTR 695 Master's Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research

NTR 699 Research in Nutrition. *F,S. Preq: Grad. standing.* Original research preparatory to the thesis for Master of Science or Doctor of Philosophy degree.

NTR 701 Protein and Amino Acid Metabolism. *3(3-0) . S. Preq: BCH 453, ZO 421, a 400-level nutrition course* Study of protein and amino acid metabolism, regulation, dietary requirements and techniques for their investigation in human and other animals.

NTR (FS) 706 Vitamin Metabolism. *2(2-0) . F. Preq: ANS(NTR,PO) 415 and BCH 453.* Structures, chemical and physical properties, functions, deficiency symptoms, distribution, absorption, transport, metabolism, storage, excretion and toxicity of vitamins in humans and domestic animals. Nutritional significance of essential fatty acids and metabolism of prostaglandins, prostacyclins and leucotrienes.

NTR 708 Energy Metabolism. *3(3-0) . F. Preq: BCH 453 and an introductory NTR course.* Relationship of biochemical and physiological events within the cell, tissue, organ and system with the nutrient needs as sources of energy for productive animal life. Digestion, absorption and metabolism of energy sources. Presentation of processes of energy transformations within living structures in relation to energetics, biological oxidations, coupled reactions, anabolic and catabolic systems, metabolic control, partitioning and efficiency.

NTR 709 Energy Metabolism. *3(3-0) . Preq: BCH 553.* Relationship of biochemical and physiological events within cell, tissue, organ and system with nutrient needs as sources of energy for productive animal life. Digestion, absorption and metabolism of energy sources. Processes of energy transformations within the body in relation to energetics, biological oxidation, anabolic and catabolic systems, metabolic control, partitioning and efficiency.

NTR (FS) 730 Human Nutrition. *3(3-0) . S. Alt. yrs.. Preq: FS 400 or NTR 415 or 419; BCH 451.* Biochemical and physiological bases of nutrition. Human nutrient requirements, assessment of nutritional status, clinical and subclinical disorders resulting from nutrient deficiencies or inadequacies.

NTR (ANS, CBS, PHY) 764 Comparative Physiology of the Digestive System. *3(3-0) . Every Yr. Preq: Course in general or comparative physiology. Coreq: Consent of Instructor. (FORMERLY NTR 632).* Discussion of major functions of vertebrate digestive systems and structural and functional adaptations to diet, environment and other characteristics of the animals.

NTR (ANS, PO) 775 Mineral Metabolism. *3(3-0) . F. Preq: ANS(NTR,PO) 415 or BCH 451 and ZO 421.* Requirements, function, distribution, absorption, excretion and toxicity of minerals in humans and domestic animals. Interactions between minerals and other factors affecting mineral metabolism or availability. Emphasis on mechanisms associated with mineral functions and the metabolic bases for the development of signs of deficiency.

NTR 794 Special Topics in Nutrition. *F,S,Sum.*

NTR 797 Doctoral Seminar. *1(1-0) . F,S.*

NTR 801 Doctoral Seminar. *F, S, Sum.*

NTR 824 Topical Problems in Nutrition. *1-6. F,S. Preq: Grad. or Sr. standing.* Analysis of current problems in nutrition. Also entails the scientific appraisal and solution of a selected problem designed to provide training and experience in research.

NTR 825 Advanced Special Problems in Nutrition. *1-6. F,S. Preq: Grad. standing.* Directed research in a specialized phase of nutrition designed to provide experience in research methodology and philosophy.

NTR 885 Doctoral Supervised Teaching. *1-3. F, S, Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

NTR 890 Doctoral Preliminary Examination. *1-9. F, S, Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

NTR 893 Doctoral Dissertation Research. *1-9. F, S, Sum Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

NTR 895 Doctoral Dissertation Research. *1-9. F, S, Sum. Preq: Doctoral student.* Dissertation research.

NTR 899 Doctoral Dissertation Preparation. *1-3. F, S, Sum. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

OPERATION RESEARCH

OR 501 Introduction to Operations Research. *3(3-0) . F,S. Preq: MA 421 or ST 421 or ST 371 and ST 372.* OR Approach: modeling, constraints, objective and criterion. Problems of multiple criteria, optimization, model validation and systems design. OR Methodology: mathematical programming; optimum seeking; simulation, gaming; heuristic programming. Examples, OR Applications: theory of inventory; economic ordering under deterministic and stochastic demand. Production smoothing problem; linear and quadratic cost functions. Waiting line problems: single and multiple servers with Poisson input and output. Theory of games for two-person competitive situations. Project management through PERT-CPM.

OR 502 Introduction to Systems Theory. *3(3-0) . F. Preq. CSC 322, MA 341, ST 371.* Modeling of systems and their dynamics in variety of contexts: systems identification, controllability and observability; operational methods and their use in modeling; analysis and synthesis of systems; optimization.

OR (MA) 504 Introduction to Mathematical Programming. *3(3-0) . S. Preq: MA 242, MA 405.* Basic concepts of linear, nonlinear and dynamic programming theory. Not for majors in OR at Ph.D. level.

OR (IE, MA) 505 Linear Programming. *3(3-0) . F,S. Preq: MA 405.* Introduction including: applications to economics and engineering; the simplex and interior-point methods; parametric programming and post-optimality analysis; duality matrix games, linear systems solvability theory and linear systems duality theory; polyhedral sets and cones, including their convexity and separation properties and dual representations; equilibrium prices, Lagrange multipliers, subgradients and sensitivity analysis.

OR 506 Algorithmic Methods in Nonlinear Programming. *3(3 0) . S. Preq. MA 301, MA 405, knowledge of computer language, such as FORTRAN or PL/I.* Introduction to methods for obtaining approximate solutions to unconstrained and constrained minimization problems of moderate size. Emphasis on geometrical interpretation and actual coordinate descent, steepest descent, Newton and quasi-Newton methods, conjugate gradient search, gradient projection and penalty function methods for constrained problems. Specialized problems and algorithms treated as time permits.

OR (CHE) 527 Optimization of Engineering Processes. *3(3-0) F. Preq: CHE 451 or OR 501, FORTRAN programming.* Formulation and solution of process optimization problems, with emphasis on nonlinear programming techniques. Computer implementation of optimization algorithms and structuring of process models to increase computational efficiency.

OR (E, MA) 531 Dynamic Systems and Multivariable Control I. *3(3 0) . F. Preq: MA 341, MA 405.* Introduction to modeling, analysis and control of linear discrete-time and continuous-time dynamical systems. State space representations and transfer methods. Controllability and observability. Realization. Applications to biological, chemical, economic, electrical, mechanical and sociological systems.

OR (CSC, MA) 565 Graph Theory. *3(3-0) . F. Preq. MA 231 or 405.* Basic concepts of graph theory. Trees and forests. Vector spaces associated with a graph. Representation of graphs by binary matrices and list structures. Traversability. Connectivity. Matchings and assignment problems. Planar graphs. Colorability. Directed graphs. Applications of graph theory with emphasis on organizing problems in a form suitable for computer solution.

OR (CSC, ECE) 579 Introduction to Computer Performance Modeling. *3(3-0) F. Preq: CSC 312 and MA 421. Coreq. CSC 501.* Workload characterization, collection and analysis of performance data, instrumentation, tuning, analytic models including queuing network models and operational analysis, economic considerations.

OR 591 Special Topics in Operations Research. *1-3. F,S,Sum. Preq. Consent of Instructor.* Individual or small group studies of special areas of OR which fit into students' programs of study and which may not be covered by other OR courses. Furthermore, course serves as a vehicle for introducing new or specialized topics at introductory graduate level.

OR 601 Seminar in Operations Research. *1(1-0) . F,S. Preq: Enrollment in OR as a major or minor.* Seminar discussion of operations research problems. Case analyses and reports. Graduate students with minors or majors in operations research expected to attend throughout period of their residence.

OR 610 Special Topics in Operations Research. *1-3. F,S,Sum. Preq: Consent of Instructor.* Individual or small group studies of special areas of OR which fit into students' programs of study and which may not be covered by other OR courses. Furthermore, course serves as a vehicle for introducing new or specialized topics at introductory graduate level.

OR 615 Advanced Special Topics in Operations Research. *3(3-0) . F,S,Sum. Preq: OR 501, OR(IE,MA) 505.* Course allows individual students or small groups of students to take on studies of special areas in OR which fit into their particular program and which may not be covered by other OR courses. The work directed by a qualified faculty member and in some instances by visiting professors. The subject matter in any year dependent on students and faculty members.

OR 652 Practicum in Operations Research. *1-3. F,S. Preq: OR 501, OR 505, OR 709 and OR 761.* Practicum in problem solving in industry applying applicable OR methodologies. Practical experience in diagnosing and solving problems in operational systems at either an industrial site or at NC State.

OR 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

OR 690 Master's Examination. *1-6. F,S,Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

OR 693 Master's Supervised Research. *1-9 F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

OR 695 Master's Thesis Research. *1-9. F,S Preq: Master's student.* Thesis research.

OR 699 Master's Thesis Preparation. *1-3 F,S,Sum. Preq: Master's student.* For student who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

OR 705 Large Scale Linear Programming Systems. *3(3-0) . Alt. S. Preq: OR 505 and FORTRAN programming experience.* Specialized algorithms for efficient solution of large scale LP problems. Parametric programming, bounded variable algorithms, generalized upper bounding, decomposition, matrix factorization and sparse matrix techniques. Emphasis on gaining firsthand practical experience with current computer codes and computational procedures.

OR (MA, ST) 706 Nonlinear Programming. *3(3-0) . Preq: OR(IE,MA) 505 and MA 425 or equivalent.* An advanced mathematical treatment of analytical and algorithmic aspects of finite dimensional nonlinear programming. Including an examination of structure and effectiveness of computational methods for unconstrained and constrained minimization. Special attention directed toward current research and recent developments in the field.

OR (MA) 708 Integer Programming. *3(3-0) . S. Alt. yrs. Preq: MA 405, OR (MA,IE) 505. Coreq: Some familiarity with computers (e.g., CSC 112).* General integer programming problems and principal methods of solving them. Emphasis on intuitive presentation of ideas underlying various algorithms rather than detailed description of computer codes. Students have some $hands on$ computing experience that should enable them to adapt ideas presented in course to integer programming problems they may encounter.

OR (IE) 709 Dynamic Programming. *3(3-0) . S. Preq: MA 405, ST 421.* Introduction to theory and computational aspects of dynamic programming and its application to sequential decision problems.

OR 710 Advanced Dynamic Programming. *3(3-0) . F. Alt. yrs. Preq: OR 709, MA 546.* Introduction to measure theoretic concepts, review of finite state Markov processes, theory of Markovian programming, discrete decision processes, continuous time dynamic programming, relation to calculus of variation and the Maximum Principle. Emphasis throughout on recent theoretical development in the field.

OR (MA) 719 Vector Space Methods in System Optimization. *3(3-0) . F. Preq: MA 405, 511 or equivalent.* Introduction to algebraic and function-analytic concepts used in system modeling and optimization: vector space, linear mappings, spectral decomposition, adjoints, orthogonal projection, quality, fixed points and differentials. Emphasis on geometric insight. Topics include least square optimization of linear systems, minimum norm problems in Banach space, linearization in Hilbert space, iterative solution of system equations and optimization problems. Broad range of applications in operations research and system engineering including control theory, mathematical programming, econometrics, statistical estimation, circuit theory and numerical analysis.

OR (BMA, ST) 722 Decision Analytic Modeling. *4(3-2) . F Alt Yrs. Preq: MA 421 or ST 421 plus ST 511or ST 516.* Analysis of decision problems involving risk and uncertainty. Modeling decision process; Bayesian probability analysis, use of information, and subjective probability; utility theory and multiattribute utility assessment; dynamics of interacting with decision makers and subject matter specialists; decision trees, influence diagrams and other tools to assist in modeling decision problems. Laboratory develops skill in implementing methodology.

OR (IE) 726 Theory of Activity Networks. *3(3-0) . S. Alt. yrs. Preq: OR 501, OR(IE,MA) 505.* Introduction to graph theory and network theory. In-depth discussion of theory underlying (1) deterministic activity networks (CPM): optimal time-cost trade offs; the problem of scarce resources; (2) probabilistic activity networks (PERT): critical evaluation of underlying assumptions; (3) generalized activity networks (GERT, GAN): applications of signal flow graphs and semi-Markov process to probabilistic branching; relation to the theory of scheduling.

OR (E, MA) 731 Dynamic Systems and Multivariable Control II. *3(3-0) . S. Alt. yrs. Preq: OR(E,MA) 531.* Stability of equilibrium points for nonlinear systems. Liapunov functions. Unconstrained and constrained optimal control problems. Pontryagin's maximum principle and dynamic programming. Computation with gradient methods and Newton methods. Multidisciplinary applications.

OR (IE) 761 Queues and Stochastic Service Systems. *3(3 0) . F.* Introduction of general concepts of stochastic processes. Poisson processes, Markov processes and renewal theory. Usage of these in analysis of queues, from with a completely memoryless queue to one with general parameters. Applications to many engineering problems.

OR (CSC, IE) 762 Computer Simulation Techniques. *3(3-0) . F.* Basic discrete event simulation methodology: random number generators, simulation designs, validation, analysis of simulation output. Applications to various areas of scientific modeling. Simulation language such as SLAM and GPSS. Computer assignments and projects.

OR (IE, MA) 766 Network Flows. *3(2-2) . S. Alt. yrs. Preq: OR(IE,MA) 505 or equivalent.* Study of problems of flows in networks. These problems include the determination of shortest chain, maximal flow and minimal cost flow in networks. Relationship between network flows and linear programming developed as well as problems with nonlinear cost functions, multi-commodity flows and problem of network synthesis.

OR (IE) 772 Stochastic Simulation Design and Analysis. *3(3-0) . S. Preq: (CSC,ECE,IE,OR) 762 and ST 516.* Advanced topics in stochastic system simulation, including random variate generation, output estimation for stationary and nonstationary models, performance optimization techniques, variance reduction approaches. Student application of these techniques to actual simulations. A current topic research paper required.

OR (BMA, MA, ST) 773 Stochastic Modeling. *3(3 0) . S,Alt. Yrs.. Preq. BMA 772 or ST (MA) 746.* Survey of modeling approaches and analysis methods for data from continuous state random processes. Emphasis on differential and difference equations with noisy input. Doob-Meyer decomposition of process into its signal and noise components. Examples from biological and physical sciences, and engineering. Student project.

OR (BMA, MA) 774 Partial Differential Equation Modeling in Biology. *3(3 0) . S. Preq: BMA 771 or MA/OR 731; BMA 772 or MA 401 or MA 501.* Modeling with and analysis of partial differential equations as applied to real problems in biology. Review of diffusion and conservation laws. Waves and pattern formation. Chemotaxis and other forms of cell and organism movement. Introduction to solid and fluid mechanics/dynamics. Introductory numerical methods. Scaling. Perturbations, Asymptotics, Cartesian, polar and spherical geometries. Case studies.

OR (IE, MA) 790 Advanced Special Topics System Optimization. *1-3. F,S.* Advanced topics in some phase of system optimization using traditional course format. Identification of various specific topics and prerequisites for each section from term to term.

OR 791 Advanced Special Topics. *F,S.*

OR 801 Seminar in Operations Research. *1(1-0) . F,S. Preq: Enrollment in OR as a major or minor.* Seminar discussion of operations research problems. Case analyses and reports. Graduate students with minors or majors in operations research expected to attend throughout period of their residence.

OR 810 Special Topics in Operations Research. *1 3. F,S,Sum Preq: Consent of Instructor.* Individual or small group studies of special areas of OR which fit into students' programs of study and which may not be covered by other OR courses. Furthermore, course serves as a vehicle for introducing new or specialized topics at introductory graduate level.

OR (IE, MA) 812 Special Topics in Mathematical Programming. *S. Alt. yrs. Preq: IE(MA,OR) 505.* Study of special advanced topics in area of mathematical programming. Discussion of new techniques and current research in this area. The faculty responsible for this course select areas to be covered during semester according to their preference and interest. This course not necessarily taught by an individual faculty member but can, on occasion, be joint effort of several faculty members from this university as well as visiting faculty from other institutions. To date, a course of Theory of Networks and another on Integer Programming offered under the umbrella of this course. Anticipation that these two topics will be repeated in future together with other topics.

OR 815 Special Topics in Operations Research. *3(3-0). F,S,Sum.. Preq: OR 501 OR(IE,MA) 505. Credits Arranged.* Course allows individual students or small groups of students to take on studies of special areas in OR which fit into their particular program and which may not be covered by other OR courses. The work directed by a qualified faculty member and in some instances by visiting professors. The subject matter in any year dependent on students and faculty members.

OR (IE, MA) 816 Advanced Special Topics Sys Opt. *1-3. F,S.* Advanced topics in some phase of system optimization. Identification of various specific topics and prerequisite for each section from term to term.

OR 852 Practicum in Operations Research. *1 3. F,S. Preq. OR 501 OR 505. OR 709 and OR 761* Practicum in problem solving in industry applying applicable OR methodologies. Practical experience in diagnosing and solving problems in operational systems at either an industrial site or at NC State.

OR (IE) 862 Scheduling and Routing. *3(3-0). S. Alt yrs Preq. IE 723 OR 501 OR(MA) 504.* In-depth study of analytical models of problems arising in the scheduling of single and parallel processors, flow shops and job shops and in routing and scheduling of delivery vehicles. Emphasis on analysis, solution methodologies and underlying theory. Discussion of recent trends and outstanding problems from both theoretical and applied points of view.

OR 885 Doctoral Supervised Teaching. *1 3. F,S,Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

OR 890 Doctoral Preliminary Examination. *1-9. F,S,Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

OR 893 Doctoral Supervised Research. *1-9. F,S,Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

OR 895 Doctoral Dissertation Research. *1 9. F,S,Sum. Preq Doctoral student* Dissertation research.

OR 899 Doctoral Dissertation Preparation. *1 3. F,S,Sum. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

PUBLIC ADMINISTRATION

PA 501 Effective Writing for Public Managers. *1(1-0). F, Alt. Yrs.* Focus on professional writing and emphasis on the types of documents most frequently written by public managers. Drafting, editing, audience assessment, and persuasive writing. Student composition of memos, position papers, proposals and instructions.

PA 510 Ethics and Professional Practice. *1(1-0). F,S. Preq: Grad. standing or PBS status.* Workshop on ethical responsibilities of public administrators and codes of ethics used by professional organizations in the field. Knowledge and problem-solving skills to assess ethical challenges encountered in professional practice of public administration.

PA 511 Public Policy Analysis. *3(3-0). F,S,Sum. Preq. Advanced undergrad. standing including 12 hrs. in PS, grad. standing or PBS status.* Methods and techniques of analyzing, developing and evaluating public policies and programs. Emphasis given to benefit-cost and cost-effectiveness analysis and concepts of economic efficiency, equity and distribution. Methods include problem solving, decision making and case studies. Examples used in human resource, environmental and regulatory policy.

PA 512 The Budgetary Process. *3(3-0). F,S Preq: Grad. standing or Management Development Certificate Prog. and 6 hrs. of 500-level course work.* Examination of generalized budgetary process used at all levels of government in the U. S. Understanding of the process based upon comprehension of institutions involved, roles of politicians and professionals and the objectives of budgetary systems. Focus also upon budgetary reforms and on Planning-Programming-Budgetary and Zero-Based Budgeting as management tools.

PA 513 Public Organization Behavior. *3(3-0). F,S. Preq: Grad. standing or PBS status.* Major conceptual frameworks developed to understand organization behavior. Motivation, leadership, group dynamics, communication, socio-technical systems, work design and organizational learning. Application of theories and concepts to public sector organizations.

PA 514 Management Systems. *3(3-0). F,S. Preq: Six hrs. of grad. PA course work* Use of management systems by public organizations to monitor and manage their programs. Particular focus on management by objectives (MBO) systems, quality management systems and performance monitoring systems. Techniques of goal setting and output/outcome measurement. How information produced by systems is used for decisions about budgets, individual and group rewards, and structures. Connecting systems to PERT/CPM and strategic planning.

PA 515 Research Methods and Analysis. *3(3-0) . F,S. Preq: Advanced undergrad.* A focus on behavioral approach to study of political and administrative behavior. Topics including philosophy of social science; experimental, quasi and non-experimental research design: data collection techniques; basic statistical analysis with computer applications.

PA 520 Seminar in Urban Management. *3(3-0) . S. Preq: Grad. standing or Management Development Certificate Prog. and 6 hrs. of 500-level course work* A seminar focusing on analytical techniques and managerial principles required for policy formation and implementation in a complex urban governmental environment Specific topics including urban planning and community development, housing, intergovernmental relations, organizational roles and decision making, budgeting and selected urban services (for example: police, transportation).

PA 521 Government and Planning. *3(3-0) Alt S. Preq: Grad. standing or Management Development Certificate Prog. and 6 hrs. of 500-level course work.* The planning function at all levels of government in the U. S., with particular attention to problems posed for planning by rapid growth of metropolitan areas. Overview of community development, urban spatial structure, housing economics and land use planning.

PA 522 Intergovernmental Relations in the United States. *3(3-0) . F. Preq: Grad. standing or occasionally Management Development Certificate Prog. and 6 hrs. of 500-level course work.* Examination of distinctive features of intergovernmental relations in the U. S. Topics stressed including historical adaptations of federalism, emerging role of the administrator, contemporary trends in intergovernmental relations and assessment of contemporary trends from federal, state and local perspectives.

PA 525 Organization Design. *3(3-0) . S. Preq: Advanced undergrad. standing including 12 hrs. of PS. grad. standing or PBS status.* An examination of contemporary approaches to organization design, including organization development, sociotechnical systems analysis and various forms of organizational participation ranging from human relations to self-management models. Emphasis on issues in personnel administration in relation to public management and government structure.

PA 530 Financial Management in the Public Sector. *3(3-0) . Alt. S (odd). Preq: Graduate standing or PBS status.* Survey of financial practices and concepts in the public sector. Topics including public sector accounting, financial information systems, revenue projections, cash management and debt management. Emphasis upon case-based applications.

PA 531 Seminar in Public Personnel Management. *3(3-0) . F,S. Preq: Grad. standing or Management Development Certificate Prog. and 6 hrs. of 500-level course work.* Examination of major issues in public sector personnel management. Among topics considered: staffing, position classification, compensation, affirmative action, performance review and appraisal, patronage, training, career development, employee assistance, unionization and rights of public employees.

PA 535 Team Building for Public Managers. *3(3-0) . S. Preq: PA 513 or Consent of Instructor.* Effective utilization of public management practices, especially those taught in PA 513 Group problem solving, goal setting, team development, conflict resolution and action planning. Employment of experiential learning methods through involvement of students in team projects for public and not-for-profit organizations

PA 537 Association Management. *3(3-0) Alt S Preq: Grad. standing or PBS status* Survey of association management. Application of public management to specific association management concerns Topics including history of associations, legal aspects, public relations, budgeting and financial management, membership development and politics of associations.

PA 540 Computer Applications in Public Affairs. *3(3-0) . F,S.* Methodology, data analysis techniques and computer-based skills necessary to conduct and manage applied research. Focus on analysis and processing of data through medium of conventional computer software frequently used in the field, i.e., SPSS. SAS.

PA 541 Geographic Information Systems for Public Administration. *3(3-0) . S. Graduate standing, PBS status, advanced undergraduate standing with 12 hours in PS* Introduction to management of spatial data in relation to public administration databases. including preparation of maps, tables, and data graphics related to geographic information systems in the public sector. Use of ArcView and a variety of other GIS computer applications.

PA 545 Administrative Law. *3(3-0) . Occasionally. Preq: Grad. standing or PBS status.* Case law of exercise of administrative power, judicial and legislative control of administrative action, legal rights of public employers and legal procedures of administrative tribunals.

PA 550 Environmental Policy. *3(3-0) . F,S. Preq: Advanced undergrad. standing including 12 hrs. of PS, grad. standing or PBS status.* Focus on formation and impact of environmental policy in the U. S. Examination on decision-making processes at all levels of government. Comparisons between political, economic, social and technological policy alternatives. Emphasis upon application of policy analysis in environmental assessment and consideration on theoretical perspectives on nature of the environmental crisis.

PA 555 Administration of Criminal Justice. *3(3-0) . F,S. Preq: PS 311 or graduate standing. Credit for both PS 555 and PA 555 is not allowed.* Politics and administration in American criminal justice system. Emphasis upon interrelationships between ideology, organization and policy outputs in analysis of major problems confronting the system today. Topics including intergovernmental relations, discretionary justice, impact of judicial decisions on criminal justice administration and management trends in criminal justice bureaucracies.

PA 580 Independent Study. *1-6. F,S,Sum. Preq: Grad. standing or PBS.* Independent research or readings by graduate students under direct supervision of individual faculty members. Students' work evaluated, based on reports, papers and exams.

PA 598 Special Topics in Public Administration. *1-6. F,S,Sum. Preq: Advanced undergrad. standing including 12 hrs. in PS, grad. standing or PBS status.* Detailed investigation of contemporary topics in fields of public administration. Topic and mode of study determined by program faculty.

PA 602 Oral Presentations for Public Managers. *1(1-0) . F,S.* Focus on professional presentations common to public managers. Persuasive presentations, analyzing the audience, using visual aids, handling question and answer sessions. Techniques for dealing with media and holding effective meetings.

PA 610 Special Topics in Public Administration. *1-6. F,S,Sum. Preq: Advanced undergrad. standing including 12 hrs. in PS, grad. standing or PBS status.* Detailed investigation of contemporary topics in fields of public administration. Topic and mode of study determined by program faculty.

PA 635 Readings and Research. *1-3. F,S,Sum. Preq: Grad. standing.* To enable graduate students to pursue a subject of particular interest to them by doing extensive readings or research in that subject under direct, individual faculty supervision.

PA 640 Grantwriting. *1(1-0) . F.* Survey of funding environment; how to identify foundations, corporation and government funding sources, wirte proposals, and evaluate proposals.

PA 650 Internship in Public Affairs. *1-6. F,S,Sum. Preq: Minimum 9 hrs. graduate work.* Exposure of the student to environment and value systems of the public organization through a supervised work experience. Involving application of substantive knowledge and analytical skills to organizational problems. Credit will vary with nature of the work experience.

PA 651 Internship in Public Affairs. *1-6. F,S,Sum. Preq: Minimum 9 hrs. graduate work.* Exposure of the student to environment and value systems of the public organization through a supervised work experience. Involving application of substantive knowledge and analytical skills to organizational problems. Credit will vary with nature of the work experience.

PA 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

PA 701 Politics and Ethics of Public Administration. *3(3-0) . F. Preq: Grad. standing.* The linkage of public administration to politics occasionally and policy process in local, state and national government and relationship of public administrators to the agency, government and public. Accountability in public sector, legal and professional responsibilities of public administrators, ethical issues in public administration and codes of ethics.

PA 716 Seminar in Program Evaluation. *3(3-0) . F. Preq: Grad. standing or Management Development Certificate Prog. and 6 hrs. of 500-level course work.* Combination of seminar and field research techniques to study evaluation of public programs. Focus on political and administrative problems associated with program evaluation. Examination of availability and appropriateness of various quantitative methodologies. Seminar concepts applied through evaluative projects conducted for public agencies.

PA 721 Environmental Administration. *3(3-0) . Alt.S. Preq: Grad. standing or Management Development Certificate Prog. and 6 hrs. of 500-level course work.* A review and investigation of major environmental management systems utilized in planning, developing and implementing environmental programs.

PA 732 Collective Negotiations in the Public Service. *3(3-0) . Occasionally. Preq: Grad. standing or Management Development Certificate Prog. and 6 hrs. of 500-level course work.* Occasionally. Intensive consideration of the background of collective negotiations movement; analysis of key policy issues, such as bargaining rights and use of strike weapons; framework for collective negotiations; scope and conduct of negotiations; impasse resolution; grievance procedure.

PA 761 Foundation of Public Administration. *3(3-0) . F.* Intellectual foundation of public administration and its development as a discipline. Boundaries between public administration and large political process, external political control, factors producing administrative influence and the bases of administrative ethics.

PA 762 Public Organization Theory. *3(3 0) . S, Alt. Yrs.* Examination of fundamental questions guiding organization research in public administration with emphasis on reconciling democracy and organization. Analysis of classical bureaucratic systems, rational choice, cognitive and organizational economic, and nonlinear and chaos theories.

PA 763 Public Policy Process. *3(3-0) . F, Alt. Yrs* Examination of public policy process at federal level in the United States. Analysis of constitutional foundations of this process and the role of governmental institutions, political culture, parties, interest groups, and public opinion in policy making. Case studies of policy making and implementation in selected policy areas.

PA 764 Budgeting and Financial Management. *3(3-0) . S, Alt. Yrs. Preq. PA 512 or equiv.*. Examination of budgetary and financial management processes in governmental and nonprofit agencies. Budgetary and financial management theory, practice, and unanswered research questions.

PA 765 Quantitative Research in Public Administration. *3(3 0) . S. Preq: PA 515 or equiv.; ST 507 or equiv.*. Review of quantitative procedures commonly applied in public administration with emphasis on applications found in leading journals in the discipline. Exploration of data acquisition, appropriate research design, selection of procedures, data assumptions of procedures, and common errors in the research process and in statistical analysis.

PA 766 Advanced Research Methodology. *3(3-0) . S. Preq: PA 765. Required of all doctoral students.*. This course is designed to prepare doctoral students to conduct independent research. Students will present a research prospectus that will serve as the basis for their dissertation.

PA 770 Contemporary Public Management. *3(3-0) . S, Alt. Yrs. Preq: PA 514.* Current public management practices, including evaluation of their underlying theoretical assumptions and of empirical evidence about their effectiveness. Causes of recent shifts in public management theory; political implications of management choices; privatization in theory and practice; managerial use of performance measurement systems; customer feedback systems; worker incentive structures.

PA 780 Independent Study. *1-6. F,S,Sum. Preq: Grad. standing or PBS.* Independent research or readings by graduate students under direct supervision of individual faculty members. Students' work evaluated, based on reports, papers and exams.

PA 810 Special Topics in Public Administration. *1-6. F,S,Sum. Preq: Advanced undergrad. standing including 12 hrs. in PS, grad. standing or PBS status.* Detailed investigation of contemporary topics in fields of public administration. Topic and mode of study determined by program faculty.

PA 835 Readings and Research. *1 3 F,S,Sum. Preq. Grad. standing.* To enable graduate students to pursue a subject of particular interest to them by doing extensive readings or research in that subject under direct, individual faculty supervision.

PA 850 Internship in Public Affairs. *1-6. F,S,Sum. Preq: Minimum 9 hrs graduate work.* Exposure of the student to environment and value systems of the public organization through a supervised work experience. Involving application of substantive knowledge and analytical skills to organizational problems. Credit will vary with nature of the work experience.

PA 860 Public Management Computing Lab. *1(1-0) . F,S Preq. Grad. standing* Introduction to managerial computing in the public sector. Budgeting and database management applications including tracking departmental expenditures, fund balance calculations, tracking personnel, sensitivity analysis, forecasting and graphical display of financial and management reports. Employment of spreadsheet and database management software used in budgeting and other management activities.

PA 880 Directed Study.

PA 885 Doctoral Supervised Teaching. *1 3. F,S,Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

PA 890 Doctoral Preliminary Examination. *1-9. F,S,Sum Preq: Doctoral student* For students who are preparing for and taking written and/or oral preliminary exams.

PA 893 Doctoral Supervised Research. *1 9. F,S,Sum Preq: Doctoral student* Instruction in research and research under the mentorship of a member of the Graduate faculty.

PA 895 Doctoral Dissertation Research. *1 9. F,S,Sum. Preq: Doctoral student.* Dissertation research.

PA 899 Doctoral Dissertation Preparation. *1-3 F,S Sum. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

PHYSICAL EDUCATION

PE 101 Fitness and Wellness. *1(0-2) . F,S,Sum.* Benefits and development of a personal fitness and wellness program; training principles and guidelines for cardio respiratory activities and weight training, fitness and wellness components and misconceptions, nutrition, weight control, stress management, and contemporary health issues. Satisfies the Fitness and Wellness one hour requirement for graduation.

PE 102 Fitness Walking. *1(0-2) . F,S,Sum.* Benefits and development of a personal physical fitness and wellness program. Knowledge, attitudes, and skills necessary for participation in a lifelong fitness walking program as an activity to improve health and fitness. For people of any age, gender, background and skill level. Satisfies the Fitness and Wellness one hour requirement for graduation.

PE 103 Water Aerobics. *1(0-2) . F,S, Sum. Individual under medical care must have prior approval from physician before registering for the course.* Benefits and development of a personal physical fitness and wellness program. Individually paced water exercise program designed to increase cardiovascular endurance, muscular strength, muscular endurance, and flexibility. Satisfies the Fitness and Wellness 1 hour requirement for graduation.

PE 104 Swim Conditioning. *1(0-2) . F,S, Sum. Preq: PE 215 or equivalent skills.* Benefits and development of a personal physical fitness and wellness program. Swim techniques that maximize fitness gains and minimize injuries. Variety of training methods including all levels of intensity. Satisfies the fitness & wellness one hour requirement for graduation.

PE 105 Aerobics and Body Conditioning. *1(0-2) . F,S,Sum.* Benefits and development of a personal fitness and wellness program. Exercise prescription, safety precautions, proper cardiorespiratory exercise technique, muscular strength, muscular endurance, flexibility and body composition. Lectures and discussions on nutrition, weight control, and stress management. Satisfies the Fitness and Wellness one hour requirement for graduation.

PE 106 Triathlon. *1(0-2) . F,S. Preq: PE 221 or equivalent skill.* Benefits and development of a personal physical fitness and wellness program. Swim, cycle and run techniques that maximize fitness gains and minimize injuries. Bicycles and ANSI approved helmets need to be provided by the students. Satisfies the fitness and wellness one hour requirement for graduation.

PE 107 Run Conditioning. *1(0-2) . F,S,Sum.* Benefits and development of a personal fitness and wellness program. Emphasis on a variety of training techniques, including all levels of intensity. Satisfies the Fitness and Wellness one hour requirement for graduation.

PE 214 Beginning Swimming. *1(0-2) . F,S,Sum.* Swimming skills for the non-swimmer that are essential for survival in the water.

PE 215 Advanced Beginning Swimming. *1(0-2) . F,S. Preq: PE 214 or equivalent skills.* Continuation of Beginning Swimming: development of basic strokes, learning new strokes, and survival skills.

PE 216 Soccer. *1(0-2) . F,S.Sum.* Soccer with emphasis on skills development, playing strategies, and rules of the game.

PE 218 Adapted Physical Education. *1(0-2) . F,S. Preq: Documentation of medical restriction. For students with medical problems who are unable to take regular Physical Education classes.* Designed for students with physical or medical problems, accommodating individual needs and limitations. Repeatable up to four semesters.

PE 219 Gymnastics. *1(0-2) . F,S.* Fundamentals of gymnastics for men and women. Coed: tumbling and vaulting; men's events: parallel bars and pommel horse; women's events: balance beam and uneven parallel bars. Safety and spotting.

PE 221 Intermediate Swimming. *1(0-2) . F,S,Sum. Preq: PE 214 or equivalent skill.* Emphasis on five swim strokes: Freestyle (front crawl), breaststroke, elementary backstroke, backstroke (back crawl), sidestroke. Deep water skill development (dives, treads, underwater swims). Emphasis on increased cardiovascular fitness.

PE 223 Lifeguard Training. *1(0-2) . F,S. Preq: PE 221 or equivalent skills.* Advanced techniques of Lifeguard Training with American Red Cross certification upon completion of course requirements. Optional fee assessed for certification.

PE 224 Water Safety Instructor. *1(0-2) . F,S. Preq: Current certification in Lifeguard Training or Emergency Water Safety.* Designed to qualify students for a Red Cross Water Safety Instructor's rating. Optional fee assessed for certification

PE 226 Skin and Scuba Diving I. *2(1-2) . F,S,Sum. Preq: PE 221 or equivalent skills.* Basic theory and skills related to skin and scuba diving. Emphasis on equipment, diving maladies, safety and physical conditioning for diving. Additional fee assessed for the open water experience and certification.

PE 227 Scuba Diving II. *2(0-1) . F,S. Preq: PE 226 or basic scuba diving certification.* Scuba skills development, first aid, CPR and openwater rescues.

PE 228 Springboard Diving. *1(0-2) . F,S. Preq: PE 215 or deep water tread for 10 minutes and swim 5 laps(250 yds).* Development of the fundamental skills of one-meter springboard diving.

PE 229 Skin & Scuba Diving Open Water Training. *1(0-2) . F,S,Sum. Coreq: PE 226.* Instruction and supervision in transfer of Skin and Scuba Diving skills and knowledge from the pool and classroom to the open water environment. Out-of-class fieldtrips required. Additional fees ranging between $110 to $275 depending upon dive location.

PE 230 Step Aerobics. *1(0-2) F,S,Sum.* Fitness through use of basic information, skills and techniques of a safe step aerobic program.

PE 231 Water Step Aerobics. *1(0 2) . F,S, Sum. Preq. PE 214 or equivalent skills.* An individually-paced water exercise program designed to increase cardiovascular endurance, muscular strength and endurance, and flexibility. Conducted in chest-deep water on aquatic steps.

PE 232 Track & Field. *1(0-2) . F.* Develops knowledge, skill and interest in track and field events.

PE 233 Clogging. *1(0-2) . F,S.* An entry level dance course stressing the fundamentals of traditional and precision clogging. Emphasis on basic foot movements, combinations and individual freestyle.

PE 234 Country and Square Dance. *1(0-2) . F,S.* Mountain Square Dance, Western Square Dance, and American Country Dances.

PE 235 Beginning Karate. *1(0-2) . F,S.* Introduction to traditional Japanese karate: kihon (basic punching, striking, blocking, and kicking techniques); kata (formal drills); yakusoku kumite (pre-arranged sparring); and demonstration of ji-yu-kumite (controlled free sparring). Karate uniform required.

PE 236 Advanced Karate. *1(0-2) . F,S,Sum. Preq: PE 235 or equivalent.* Advanced training in Wado-ryu Japanese Karate. Emphasis on instruction in advanced striking, blocking, and kicking techniques. Three additional Pinan Katas. Introduction to multiple-step pre-arranged Kumite.

PE 237 Weight Training. *1(0-2) . F,S,Sum.* Provides essential knowledge of the Principles of Muscular Strength development and an opportunity to acquire skill in a variety of progressive resistance exercises.

PE 238 Wrestling. *1(0-2) . F,S.* Wrestling skills, safety considerations, and conditioning factors necessary for moderate competition in a combative sport-beginning skills through more advanced techniques

PE 239 Self Defense. *1(0-2) . F,S.* Basic self defense skills and techniques. Skills covered include falls, kicks, punches, and escapes; plus psychology of physical and sexual assault. Physical contact between students and instructor.

PE 240 Social Dance. *1(0-2) . F,S,Sum.* Basic steps and fundamentals of leading and following in the Fox Trot, Waltz, Cha-Cha, Shag, and one other current popular dance form

PE 242 Badminton. *1(0-2) . F,S,Sum.* Skills development, strategies and rules of singles and doubles play.

PE 243 Bowling. *1(0 2) . F S.Sum* Instruction in ball selection, grip, stance, approach, delivery, bowling etiquette, safety precautions, rules, scoring, terminology, and general theory of spare coverage. Additional fee assessed.

PE 244 Fencing. *1(0 2) . F,S.* Development of offensive and defensive skills; emphasis on rules, courtesy, and strategy of bouting.

PE 245 Golf. *1(0 2) . F,S,Sum.* Fundamentals of golf: grip, stance, alignment, swing. Rules and etiquette on the course.

PE 246 Handball. *1(0-2) . F,S.* Skills development, rules and strategies for singles, cut-throat, and doubles play of four wall handball

PE 247 Roller Skating. *1(0-2) . F S.* Fundamental and intermediate skills of skating: starting, turning, stopping. Emphasis on balance, coordination, and endurance skating.

PE 248 Squash. *1(0 2) . F,S.* Skill development and strategies of play. Equipment selection, safety, history, and rules.

PE 249 Tennis I. *1(0-2) . F,S,Sum.* Basic tennis skills on grips, footwork, ground strokes, service. Rules and basic strategy for singles play. Introduction to volleys, lobs, overheads, and doubles.

PE 250 Tennis II. *1(0-2) . F,S, Sum. Preq: PE 249 or equivalent experience.* Review basic tennis skills on grips, footwork, ground strokes, and service. Stroke production involved in more aggressive/offensive style of play: approach and volley, spin serve and kick serve. Emphasis on half-volleys, lobs, overheads, and supplemental shots. Active drills and point play situations for aggressive singles and doubles play

PE 251 Target Archery. *1(0-2) . F,S,Sum.* Shooting fundamentals, safety, selection, and care of equipment.

PE 252 Downhill Skiing. *1(0-2) . S.* Skills and techniques in downhill skiing. Emphasis on safety control, and proper equipment selection. On slope instruction held at selected ski site during semester break. Four classroom sessions on campus prior to trip. Additional cost to student approximately $200.00.

PE 253 Orienteering. *1(0-2) . F,S.* Navigating on foot from defined point to defined point, with use of map and compass in the shortest possible time.

PE 254 Beginning Equitation. *1(0-2) . F,S.* Hunt seat equitation, care of horse and tack, and control skills at the walk, trot and canter. Meets off campus once a week. Additional fee assessed.

PE 255 Basic Canoeing. *1(0-2) . F,S. Preq: Preq: PE 214 or equivalent skills.* Instruction and experience in flatwater canoe skills; emphasizing paddling skills, safety, flat and moving water travel techniques and proper equipment selection. Plan and participate in a required weekend fieldtrip costing approximately $25.

PE 256 Racquetball. *1(0-2) . F,S,Sum.* Skill development, strategies and rules of singles, doubles and cutthroat play.

PE 257 Backpacking. *1(0-2) . F,S.* Designed for students with little or no backpacking experience. Safe and environmentally-sound camping practices. Equipment/clothing, first aid and safety management agencies, land navigation, and trip planning. Two weekend field trips required.

PE 258 Basic Rock Climbing. *1(0-2) . F,S,Sum.* Instruction and direct experience for the beginning rock climber. Emphasis on safe rope systems for belaying and basic movement on rock.

PE 259 Intermediate Rock Climbing. *1(0-2) F,S. Preq. PE 258* Development of intermediate rock climbing skills and practices including: climbing safety, belaying techniques, anchor systems, partner and self-rescue, rappelling and ascending techniques, minimal impact climbing, and climbing hazards.

PE 260 Intermediate Equitation. *1(0-2) . F,S. Preq: Beginning Equitation or equivalent.* Advanced techniques, theories and performance in equitation. Additional fee assessed

PE 261 Basketball. *1(0-2) . F,S.* Offensive and defensive skills development and systems of team work. Coverage of strategies, history and rules of the sport.

PE 262 Introduction to Whitewater Canoeing. *1(0-2) . F,S. Preq. PE 255 or equivalent; ability to pass swim test.* Instruction and direct experience in fundamental whitewater canoeing skills. Basic paddling strokes and maneuvers for use on whitewater, river safety, basic river rescue, equipment selection and care, and environmental ethics. Additional fee assessed.

PE 263 Tap Dance. *1(0-2) . F,S.* Entry level dance course stressing fundamental movements of tap. Emphasis on foundation skill movements, rhythmic exercises, and the relationship of movement to music.

PE (DAN) 264 Ballet. *1(0-2) . F,S.* Beginning level ballet technique course. Fundamental ballet concepts and vocabulary introduced through barre and center exercises and combinations.

PE 265 Softball. *1(0-2) . F,S,Sum.* Basic skills, rules, and strategies for playing softball.

PE 266 Ultimate Frisbee. *1(0-2) . F,S.* Emphasis on skill development, aerobic fitness and spirit of competition. Includes flight dynamics, various throwing and catching techniques, offensive skills, defensive skills, equipment, strategies, and rules of the game.

PE 267 Flag Football. *1(0-2) . F,S.* An introduction to the skills, history, rules and strategy of flag football.

PE 268 Advanced Clogging. *1(0-2) . F,S. Preq: PE 233 or equivalent.* Experience in advanced Appalachian clogging techniques.

PE 269 Volleyball I. *1(0-2) . F,S Sum.* Volleyball fundamentals: setting, passing, serving, spiking, court movement, and game strategy.

PE 270 Volleyball II. *1(0-2) . F,S. Preq: PE 269 or equivalent.* Advanced techniques, theories and strategies of volleyball.

PE 271 Varsity Sports. *1(0-2) . F,S. Preq. 1 hr. of P.E. credit. For student athletes on a team sponsored by the Athletic Department for one hour of Physical Education.* For students on a team sponsored by the Athletic Department. Course not repeatable.

PE 273 Jazz Dance. *1(0-2) . F,S.* Beginning level jazz dance technique course covering basic jazz skills in warm-up exercises, combinations, and compositions. Concentration on learning and performing combinations in jazz styles.

PE (DAN) 274 Modern Dance I. *1(0-2) . F,S.* Introduction of movement and dance concepts and techniques through theory and analysis, improvisation and composition, structured dance exercises combinations.

PE (DAN) 275 Modern Dance II. *1(0-2) . F,S. Preq: PE/DAN 274 (or permission of instructor).* Continuation of Modern Dance I. Emphasis on design of body in space, movement qualities and musicality through structured technical exercises and combinations.

PE 276 Whitewater Rafting. *1(0-2) . F,S,Sum. Preq: Pass swim test.* Whitewater rafting skills and practices emphasizing safe river travel, minimal impact river camping techniques, and trip planning. Additional fee assessed.

PE 277 Mountain Biking. *1(0-2) . F,S,Sum.* Bike handling, minimal impact trail riding skills, safety, fitness, basic maintenance and repair, and equipment selection. Students provide their own bike, helmet, protective equipment, and clothing.

PE 282 Advanced Aerobics and Leadership. *1(0-2) . F,S. Preq: PE 231 or PE 230.* Safe and effective high-low impact aerobics program with emphasis on student choreography and leadership, development of individual exercise prescription, and related health topics

PE 283 Mountaineering. *1(0-1) . S. Preq: PE 258 or equivalent skills.* Instruction and experience in alpine climbing skills emphasizing snow and ice travel, safety, land navigation, winter hazard evaluation, minimal impact camping skills, and equipment selection. Three full-day classroom sessions before the trip required. Planning and participating in a twelve-day field trip required. Approximate cost of $190 will be assessed.

PE 295 Special Topics in Physical Education. *1(0-2) . F,S.* Examination of selected topics of physical education.

PHYSICAL EDUCATION - COACHING

PEC 201 Coaching Baseball/Softball. *2(2-0) . S.* Theories, techniques, and strategies of coaching baseball/softball.

PEC 202 Coaching Basketball. *2(2-0) . F.* Theories, techniques, and strategies of coaching basketball.

PEC 203 Coaching Football. *2(2-0) . F.* Theories, techniques, and strategies of coaching football.

PEC 204 Coaching Golf. *2(2-0) . S.* Theories, techniques, and strategies of coaching golf.

PEC 205 Coaching Soccer. *2(2-0) . F.* Theories, techniques, and strategies of coaching soccer.

PEC 206 Coaching Swimming and Diving. *2(2-0) . S.* Theories, techniques and strategies of coaching swimming and diving.

PEC 207 Coaching Tennis. *2(2-0) . S.* Theories, techniques, and strategies of coaching tennis.

PEC 208 Coaching Track & Field/Cross-Country. *2(2-0) . S.* Theories, techniques, and strategies of coaching track and field and cross-country.

PEC 209 Coaching Volleyball. *2(2-0) . F.* Theories, techniques, and strategies of coaching volleyball.

PEC 211 Strength Training and Conditioning. *2(1-2) . F, S This course does not constitute credit toward meeting the minimum university Physical Education requirements.* Knowledge and skills necessary for designing and implementing strength and conditioning programs.

PEC 301 Coaching Practicum. *1(0-4) . F,S. Preq. 15 hours of PE.* A seven-week practical coaching experience in a junior high school or high school setting. Specific placement will depend upon the various playing seasons for the sports involved.

PEC 381 Athletic Training. *3(2 1) . F.S,Sum Preq. PEH 280 or PEH 281 or CPR/First aid Certification.* Incidence, causes, prevention and treatment of sports-related injuries. Conditioning for sports, injury recognition and evaluation, taping techniques, first aid care, treatment and reconditioning.

PEC 477 Coaching Concepts. *3(2-1) . F,S Sum This course does not constitute credit toward meeting Physical Education requirements* Practical and theoretical concepts essential to the preparation of coaches.

PEC 478 Principles of Sports Science. *3(3-0) . F,S Sum.* Basic principles of human anatomy, physiology, and biomechanics and their relationship to athletic coaching.

PEC 479 Sport Management. *3(3-0) . F,S,Sum.* Planning, organizing, leading, and evaluating within a sport context; fundamentals of accounting, budgeting, economics, marketing, strategic planning, ethics, and their use in sport settings; techniques of personnel, facility, and sporting event management.

PHYSICAL EDUCATION - FITNESS

PEF 303 Fitness Practicum. *1(2-0) . F,S. Preq: Permission of Instructor. This course does not constitute credit toward meeting the physical education requirement..* A 10 week practical fitness specialist experience in a fitness specific setting within the triangle area.

PEF 334 Principles of Exercise Programming. *3(3-0) . F,S,Sum. Preq: PEC 478. This course does not constitute credit toward meeting the Physical Education requirement..* Fundamentals and scientific principles necessary to plan, design, implement, and evaluate individual exercise programs.

PHYSICAL EDUCATION – HEALTH STUDIES

PEH 212 Alcohol, Drugs and Tobacco. *2(2-0) . F,S.* Overview of physiological and psychosocial aspects of dug use and abuse in modern society. Emphasis placed on practical application of course material to promote healthy lifestyle changes. Trends in drug education/prevention/treatment explored.

PEH 213 Human Sexuality. *2(2-0) . F,S,Sum.* Physiological and psychosocial aspects of human sexuality. Emphasis placed on health-related topics of birth control, pregnancy, childbirth, abortion and sexually-transmitted diseases. Concepts of gender acquisition, sexual values, and sexual morality discussed as related to the promotion of healthy lifestyles within contemporary American culture.

PEH 280 Responding to Emergencies. *2(2-0) . F,S,Sum. Does not satisfy the physical education requirement.* Information necessary to evaluate vital signs and bodily functions as related to emergency response; training to evaluate and react correctly to most emergency situations which might arise, and to perform temporary medical care and the follow-up action as indicated. Optional fee assessed for certification.

PEH 281 First Responder. *3(2-1) . F,S,Sum.* Knowledge and skills necessary to respond appropriately in an emergency. Advanced skills in first aid and CPR (adult, child, and infant, pocket masks and oxygen use) fulfills requirements for First Responder (depending on local protocol).

PEH 285 Personal Health. *2(2-0) . F,S. This course does not constitute credit toward meeting the Physical Education GER requirement.* Behavior change, wellness, stress management, cardiovascular diseases, alcohol and tobacco use, cancer, infectious diseases, arthritis, human sexual response, sexual assault, contraception, and sexually transmitted diseases.

PEH 286 Nutrition, Exercise and Weight Control. *2(1-2) . F,S. Constitutes credit toward meeting one PE hour of the Fitness & Wellness requirement if approved by instructor. Student must supply necessary medical request.* Weight control and management program emphasizing nutritional requirements for healthy lifestyles; appropriate eating habits and exercise prescription. Individual lifestyle changes stressed along with weight loss or gain where indicated.

PEH 287 Stress Management. *2(2-0) . F,S. This course does not constitute credit toward meeting the Physical Education GER requirement.* Impact of stress upon the psychological and physiological function of the body. Exploration and interaction with stress management techniques.

PHYSICAL EDUCATION - OUTDOORS

PEO (PRT) 214 Introduction to Adventure Education. *2(2-0) . F.* Topics related to adventure education: history and philosophy, social psychology of adventure, theories and concepts, benefits, wilderness and urban settings, staff and clientele, trends and issues, research and evaluation, and model programs.

PEO (PRT) 215 Principles and Practices of Outdoor Leadership. *2(2-0) . S.* Principles and practices of leadership in adventure education/recreation programs. Topics: group management, trip planning, staffing, group dynamics, health and safety issues, risk management, selected outdoor activities, and other relevant topics.

PEO 216 Backcountry Skills and Techniques. *2(2-0) . Sum.* Skills for backcountry travel and camping. Techniques for planning, organizing and leading backcountry trips. Course will be conducted between spring and summer session. To include an 8 day outing. Approximate cost to student: $150.00.

PEO 217 Challenge Course Programming. *2(1-2) . F,S.* Participants learn about ropes and group initiative courses; variety of adventure activities including New Games, initiatives and high and low ropes course events. Safety and risk management issues and facilitiation techniques presented and discussed.

PEO 302 Practicum Experience in Outdoor Programs. *2(0-4) . F,S,Sum. Preq: PEO 214, PEO 215, PEO 216, PEH 280 or equivalent.* Short-term, supervised opportunity for students to participate in leading an outdoor activity course or program. Integration of academic preparation with its application in a field setting.

PHYSICAL EDUCATION - SPORTS

PES 291 Officiating Basketball. *1(1-0) . S.* Rules, interpretations, signals and mechanics of officiating basketball. Out-of-class officiating required.

PHILOSOPHY

PHI 205 Problems and Types of Philosophy. *3(3-0) .* Introduction to selected problems of enduring philosophical importance, including such topics as the nature of morality, knowledge, human freedom, and the existence of God. Content varies with different sections.

PHI 250 Practical Reasoning. *3(3-0)* . Analysis and criticism of both deductive and inductive argument. Deduction validity and soundness in deductive arguments; definition and the clarification of meaning; disproof by counter-example; common fallacies. Inductive arguments: polls and samples; correlations and causal connection. Conceptual and empirical theories and hypotheses. Arguments discussed with a minimum of formalization.

PHI 275 Ethics. *3(3-0)* . Examination of traditional questions of philosophical ethics: What are the principles of moral conduct? What sort of life is worthy of a human being? Includes both classic and contemporary literature.

PHI 298 Special Topics in Philosophy. *3(3-0)* . Selected studies in philosophy that do not appear regularly in the curriculum. Topics will be announced for each semester in which the course is offered.

PHI 300 Ancient and Medieval Philosophy. *3(3-0)* . Western philosophy of the ancient world and Middle Ages, with special emphasis on Plato and Aristotle.

PHI 301 Early Modern Philosophy. *3(3-0)* . Western philosophy of the 17th and 18th centuries, including such philosophers as Descartes, Hobbes, Leibniz, Locke, Berkeley, Hume, and Kant.

PHI 305 Philosophy of Religion. *3(3-0)* . The existence and nature of God, including such topics as traditional proofs of God, skeptical challenges to religious belief, miracles, the problem of evil, faith and reason, and religious experience.

PHI 306 Philosophy of Art. *3(3-0) . Preq: One philosophy course other than LOG or LOG 335: or one course in visual and performing arts.* Analysis of the concepts and theories encountered in discussion of art in such a way as to illuminate the nature of works of art, esthetic experiences, and art criticism.

PHI 309 Contemporary Political Philosophy. *3(3-0) . Preq: One philosophy course or PS 361.* Current theories about basic concepts in political philosophy, such as liberty, equality, justice, natural rights, and democracy, with special attention to disputes concerning the nature of a just social order.

PHI 311 Philosophical Issues in Medical Ethics. *3(3-0) . Preq: One of the following: PHI 275, 309, 312, 313, 321, 322, or 325.* Such issues as the morality of abortion, suicide, and euthanasia; the meaning and function of the concepts of health, illness, and death; psychological intervention; paternalism in medicine; consent and medical experimentation; and the allocation ofscarce medical resources. Consideration of individual rights and fairness. Emphasis on conceptual clarity and the assessment of moral principles.

PHI 312 Philosophy of Law. *3(3-0) . F.* Fundamental legal issues such as what constitutes a law or legal system. Justifications of legal interference with individual liberty. Philosophical legal issues illustrated by specific legal cases.

PHI 313 Ethical Problems in the Law. *3(3-0) . Preq: PHI 275 or 321.* Explores uses of the legal system, including such topics as the death penalty, plea bargaining, legalizing euthanasia, censorship, Good Samaritan laws, the insanity defense, civil disobedience, preferential treatment.

PHI 314 Issues in Business Ethics. *3(3-0)* . An analysis and evaluation of major issues in business ethics. Topics include the social responsibility of business; social justice and free enterprise; the rights and duties of employers, employees, manufacturers, and consumers; duties to the environment, the world's poor, future generations, and the victims of past injustices; the moral status of the corporation; and the ethics of advertising.

PHI 321 Contemporary Moral Issues. *3(3 0)* Philosophical analysis and theory applied to a broad range of contemporary moral issues, including euthanasia, suicide, capital punishment, abortion, war, famine relief, and environmental concerns.

PHI 322 Philosophical Issues in Environmental Ethics. *3(3-0) . Preq. One of the following: PHI 275, 309, 311, 312, 313, 321, or 325.* Arguments and principles surrounding moral questions about the environment: whether non-humans have moral standing; duties to future generations; policy regarding population, common resources, pollution; preserving biodiversity, forests; property rights; efficiency and equity considerations; decision-making associated with global risk-taking, e.g., global warming.

PHI 325 Theories of Human Nature. *3(3-0)* . Philosophical and scientific theories of human nature, with special attention to "nature/nurture" controversies. Detailed treatment of one of two contemporary issues, such as IQ, sociobiology, gender differences, or abortion, in which the question "what is a human being?" plays a central role.

PHI 330 Metaphysics. *3(3-0) Preq: LOG 201 or 335.* Metaphysical problems: distinction between appearance and reality, nature of space and time, free will and determinism, mind and body, nature of identity.

PHI 331 Philosophy of Language. *3(3-0) . Preq: LOG 201 or 335.* Introduction to traditional and modern accounts of the relations between language and reality, the nature of truth, problems of intentionality and propositional attitudes.

PHI 332 Philosophy of Psychology. *3(3-0) . Preq: LOG 201 or 335.* Problems and controversies that overlap the boundary between philosophy and psychology: the mind/body problem, behaviorism vs. cognitivism, the prospects for artificial intelligence, and language and the questions of innate knowledge.

PHI 333 Theory of Knowledge. *3(3-0) . Preq: LOG 201 or LOG 335.* Analysis of such central concepts as knowledge, belief, and truth, and the investigation of the principles by which claims to knowledge may be justified.

PHI 340 Philosophy of Science. *3(3-0) . F. S, Sum.* Nature of science highlighted by differences between science and pseudoscience, relationships between science and religion, and roles of purpose-directed (teleological explanation) and causal explanation in physical life and social sciences.

PHI (PSY) 425 Introduction to Cognitive Science. *3(3-0) . Preq: One upper-level course in either PHI, PSY, CSC or Linguistics. Credit cannot be given for both PHI/PSY 425 and PHI/PSY 525.* Philosophical foundations and empirical fundamentals of cognitive science, an interdisciplinary approach to human cognition. Topics include: the computational model of mind, mental representation, cognitive architecture, the acquisition and use of language.

PHI 440 The Scientific Method. *3(3-0) . S. Preq: One upper-level course in philosophy. Credit cannot be given for both PHI 440 and PHI 540.* Detailed examination of core issues in the philosophy of science: the confirmation of scientific theories, falsification, projectibility, the nature of scientific explanation, laws of nature, and causation.

PHI 494 Writing in Ethics. *1(1-2) . Preq: LOG 201 or 335, and one other philosophy course not PHI 250. Coreq: One of PHI 275, 298, 306, 309, 311, 313, 321, 322, 325, or 498.* A substantial paper in ethics, assigned by the instructor of the corequisite.

PHI 495 Writing in History of Philosophy. *1(1-2) . F,S. Preq: lOG 201 or 335, and one other philosophy course not = PHI 250. Coreq: One of PHI 298, 300, 301 or 498.* A substantial paper in history of philosophy, assigned by the instructor of the corequisite.

PHI 496 Writing in Contemporary Philosophy. *1(1-2) . Preq: LOG 201 or 335, and one other philosophy course not PHI 250. Coreq: One of PHI 298, 305, 306, 325. 330, 331, 332, 333, 340, 425, 498.* A substantial paper in contemporary philosophy, assigned by the instructor of the corequisite.

PHI 497 Writing and Research Seminar in Philosophy. *3(3-0) . Preq: One of PHI 494, 495, 496. Coreq: Another PHI 494, 495, 496. Philosophy majors only. Students strongly encouraged to take seminar in junior year.* Intensive training in writing and research in philosophy. Topic chosen by instructor. Requires at least one oral presentation and one substantial paper, in addition to other writing assignments.

PHI 498 Special Topics in Philosophy. *1-6. Preq: Six credits in PHI.* Detailed investigation of selected topics in philosophy. Topics determined by faculty members in consultation with head of the department. Course may be used for individualized study.

PHI (PSY) 525 Introduction to Cognitive Science. *3(3-0) . F. Preq: Grad. standing or Consent of Instructor. Credit for both PHI(PSY) 425 and PHI(PSY) 525 is not allowed.* Philosophical foundations and empirical fundamentals of cognitive science, an interdisciplinary approach to human cognition. The computational model of mind, mental representation, cognitive architecture, the acquisition and use of language.

PHI 540 The Scientific Method. *3(3-0) . S. Preq: Graduate standing or permission of instructor. Credit cannot be given for both PHI 440 and PHI 540.* Detailed examination of core issues in philosophy of science: confirmation of scientific theories, falsification, projectibility, nature of scientific explanation, laws of nature, and causation.

PHI 598 Special Topics in Philosophy. *3(3-0) . F,S.*

PHI 635 Advanced Independent Study in Philosophy. *1-6. F,S.* Independent study of advanced topic in philosophy under supervision of a faculty member.

PHI 798 Advanced Topics in Philosophy. *3(3-0) . Preq: Must have grad. standing.* Detailed investigation of selected advanced topics in philosophy. Topics determined by faculty members in consultation with head of department.

PHYSIOLOGY

PHY (ZO) 503 General Physiology I. *3(3-0) . F. Preq: Sr. or grad. standing; the following courses are recommended: ZO 421 or equivalent, BCH 451 or equivalent, a yr. of physics.* Discussion of general principles of homeostasis, emphasizing importance of integrative action. Following systems studied: muscular, cardiovascular and nervous systems.

PHY (ZO) 504 General Physiology II. *3(3-0) . S. Preq: PHY (ZO) 503.* Discussion of general principles of homeostasis, emphasizing importance of integrative action. Following systems studied: alimentary, renal, respiratory and endocrine systems.

PHY (ZO) 513 Comparative Physiology. *3(3-0) . F. Odd yrs.. Preq: ZO 421 or Consent of Instructor.* Comparative study of the organ systems of vertebrates and physiological processes involved in maintaining homeostatic state. Various compensatory mechanisms employed during environmental stress included.

PHY (PO, ZO) 524 Comparative Endocrinology. *4(3-3) . S. Preq: ZO 421 or equivalent.* Basic concepts of endocrinology, including functions of major endocrine glands involved in processes of growth, metabolism and reproduction.

PHY 595 Special Topics in Physiology.

PHY 601 Physiology Seminar. *1(1-0) . F,S. Preq: Grad. standing.*

PHY (ANS, CBS, ZO) 602 Seminar In Biology of Reproduction. *2(2-0) . S. Preq: ANS(PHY) 702 or Consent of Instructor.* Current topics in animal reproduction presented by reproductive physiologists from various Research Triangle institutions. Student presentations of research projects or library projects in area of animal reproduction.

PHY 610 Special Topics in Physiology. *1-4. F, S, Sum. Preq: Grad. standing.*

PHY 620 Special Problems in Physiology. *F, S, Sum. Preq: Grad. standing, Consent of Instructor. Credits Arranged.*

PHY 685 Master's Supervised Teaching. *1-3 F, S, Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

PHY 690 Master's Examination. *1 6. S. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

PHY 693 Master's Supervised Research. *1-9. F, S, Sum. Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

PHY 695 Master's Thesis Research. *1-9. F, S, Sum. Preq: Master's Student.* Thesis Research

PHY 699 Master's Thesis Preparation. *1-3. F,S. Preq: Master's Student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

PHY (ANS) 702 Reproductive Physiology of Mammals. *3(3-0) . F. Preq: ZO 421.* Survey of reproductive strategies among vertebrates; in-depth coverage of mammalian reproductive physiology; gametogenesis, fertilization, embryonic and fetal development, parturition, puberty, neuroendrocrine control mechanisms in male and female mammals.

PHY (CBS, IMM, MB, PO) 756 Immunogenetics. *3(2 2) . F Alt. yrs.. Preq: MB 501C or MB 751 or Consent of Instructor.* Basic concepts of the immune system. Genetic basis of the immune response including immunoglobulin genetics, major histocompatibility complexes and their role in the immune response, the molecular basis of the immune system and effector mechanisms.

PHY (ANS, CBS, NTR) 764 Comparative Physiology of the Digestive System. *3(3-0) . Every Yr. Preq: Course in general or comparative physiology. Coreq: Consent of Instructor.* Discussion of major functions of vertebrate digestive systems and structural and functional adaptations to diet, environment and other characteristics of the animals.

PHY (ANS) 780 Mammalian Endocrinology. *3(3-0) . S, Alt. Sum. Preq: BCH 451, ZO 421.* Mammalian endocrine system with emphasis on ontogeny and anatomy of key organs; synthesis and action of hormones. Role of hormones in regulation of physiological processes such as metabolism, exocrine function, digestion, ion balance, behavior, lactation, growth and reproduction.

PHY 795 Special Topics in Physiology. *F,S.*

PHY 801 Physiology Seminar. *1(1 0) . F, S, Sum. Preq: Grad standing.*

PHY (ANS, CBS, ZO) 802 Seminar in Biology of Reproduction. *2(2 0) . S Preq. ANS(PHY) 702 or Consent of Instructor.* Current topics in animal reproduction presented by reproductive physiologists from various Research Triangle institutions. Student presentations of research projects or library projects in area of animal reproduction.

PHY 810 Speical Topics in Physiology. *1-4. F, S Sum. Preq. Grad standing.*

PHY 820 Special Problems in Physiology. *F,S. Preq. Grad. standing, Consent of Instructor. Credits Arranged.*

PHY 885 Doctoral Supervised Teaching. *1-3. F, S, Sum. Preq: Doctoral Student.* Teaching experience under the mentorship of faculty who assist the student in planing for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

PHY 890 Doctoral Preliminary Examination. *1-9. F, S, Sum. Preq: Doctoral Student.* For students who are preparing for and taking written and/or oral preliminary exams.

PHY 893 Doctoral Supervised Research. *1-9. F, S, Sum. Preq: Doctoral Student* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

PHY 895 Doctoral Dissertation Research. *1-9. F, S, Sum. Preq. Doctoral Student.* Dissertation Research

PHY 899 Doctoral Dissertation Preparation. *1-3. F, S, Sum Preq: Doctoral Student.* For students who have completed all credit hour requirements, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

PHYSICAL AND MATHEMATICAL SCIENCES

PMS 100 Perspectives on Learning. *1(1-1) . F.* Undergraduates in College of Physical and Mathematical Sciences. The campus computing and information environment; levels of learning; recognition and application of good reasoning; academic and career resources and opportunities.

PMS 295 Special Topics in Physical and Mathematical Sciences. *1-3. F,S,Sum. Preq: Consent of Associate Dean.* Special topics in physical and mathematical sciences at the early undergraduate level. Available as directed individual or group study.

POULTRY SCIENCE

PO 201 Poultry Science and Production. *4(3-3) . F,S. Preq: BIO 125.* Fundamental principles of broiler, turkey and egg production including poultry physiology, breeding, incubation, housing, nutrition, disease control, management and marketing.

PO 290 Poultry Seminar. *1(1-0) . F. Preq: Sophomore standing.* Exploration of topics related with current and future potential to influence the poultry industry. Guest lectures from industry representatives will include: vertically integrated poultry production, primary breeders, marketing, animal health, veterinary medicine as it relates to poultry, allied equipment manufacturers, and management of poultry companies. Special emphasis on summer internships and career services.

PO 301 Evaluation of Live Poultry. *2(1-3) . S. Preq: PO 201.* Experience in evaluating live poultry for production and breeder stock potential. Emphasis on techniques and criteria used in selecting poultry for use in commercial production units.

PO (ANS, FS) 322 Muscle Foods and Eggs. *3(2-3) . F. Preq: BIO 125.* Processing and preserving fresh poultry, red meats, seafood, and eggs. Ante- and post-mortem events as they affect quality, yield, and compositional characteristics of muscle foods. Principles and procedures involved in the production of processedmeat items.

PO 351 Grading and Evaluation of Poultry Products. *2(1-2) . F. Preq. PO 201.* Principles of grading and evaluation of poultry products such as dressed broilers, turkeys, shell eggs, candled eggs and broken-out eggs according to USDA guidelines.

PO 405 Avian Physiology. *4(3-3) . F. Preq: CH 220.* Principles of avian physiology integrating physiological functions and anatomical structures of organs and organ systems. Practical problems associated with poultry production. The importance of maximizing growth and productivity via exploitation of environmental influences on physiological systems.

PO 410 Production and Management of Game Birds in Confinement. *3(2-3) . Preq: PO 201.* Management principles associated with the successful propagation and rearing of game birds, ornamental birds and waterfowl in confinement. Housing and pen requirements, nutrition, disease control and regulatory issues included.

PO (ANS, NTR) 415 Comparative Nutrition. *3(3-0) . F. Preq: CH 220 or 221 and 223.* Principles of nutrition, including the classification of nutrients and the nutrient requirements of and metabolism by different species for health, growth, maintenance and productive functions.

PO 420 Turkey Production. *2(1-2) . S. Preq: PO 201.* Principles and current practices of turkey production.

PO 421 Commercial Egg Production. *2(1-2) . F,S. Preq: PO 201.* Principles and current practices of commercial egg production.

PO 422 Incubation and Hatchery Management. *2(1-2) . F. Preq: PO 201.* Principles and current practices of hatching egg production, incubation, and hatchery management, beginning with the placement of broiler breeder chicks on the breeder farm and ending with the placement of chicks at the brooding facility.

PO 423 Broiler Production. *2(1-2) . F. Preq: PO 201.* Principles and current practices of broiler production; encompassing nutrition, management, poultry health and related area.

PO (ANS) 425 Feed Mill Management and Feed Formulation. *3(2-3) . S. Preq: PO(ANS.NTR) 415 or ANS 230; CH 220 or 221.* Feed mill management, feed ingredient purchasing, inventory, storage, and quality evaluation, computerized feed formulation, feeding programs for poultry and swine, feed mill design, equipment, maintenance, operation, safety, state and federal regulations pertaining to feed manufacture.

PO 430 Poultry Breeding. *3(2-2) . S. Preq: PO 201.* Application of reproductive and genetic principles to the reproduction of poultry breeding stocks.

PO 492 External Learning Experience. *1-6. F,S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

PO 493 Special Problems in Poultry Science. *1-6. F,S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes campus facilities and resources. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

PO 495 Special Topics in Poultry Science. *1-3. F,S,Sum.* Offered as needed to present materials not normally available in regular course offerings or for offering of new courses on a trial basis.

PO 505 Physiological Aspects of Poultry Management. *3(3-0) . S. Preq: PO 201, PO 405 or grad. standing.* Application of physiological principles to modern poultry management. Poultry physiology related to management topics including nutrition, housing, ventilation, disease, heat stress and lighting programs.

PO (PHY, ZO) 524 Comparative Endocrinology. *4(3-3) . S. Preq: ZO 421 or equivalent.* Basic concepts of endocrinology, including functions of major endocrine glands involved in processes of growth, metabolism and reproduction.

PO 601 Seminar. *1(1-0) . F, S, Sum.* Preparation for research, research perspectives, rising concerns in poultry production, orientation for graduate studies in poultry science. Required of all graduate students in the Department of Poultry Science.

PO 620 Special Problems. *1-6. F, S, Sum. Preq: Grad. standing.* Specific problems of study assigned in various phases of poultry science.

PO 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq. Master's students* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

PO 690 Master's Examination. *1-6. F,S. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

PO 693 Master's Supervised Research. *1-9. F, S, Sum. Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

PO 695 Master's Thesis Research. *1-9. F, S, Sum. Preq Master's Student.* Thesis Research

PO 699 Master's Thesis Preparation. *1-3. F,S. Preq: Master's Student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

PO 702 Biotechniques in Avian Biology. *4(1-8) . S Alt Yrs (Odd). Preq: BCH 552 or BIT 810, or BCH 553 and Consent of Instructor.* Applications to avian system of cellular and molecular techniques including embryo staging, in vitro and in ovo embryo culture, genetic analysis, sex determination, avian cell culture and chimeras in transgenesis and developmental biology.

PO 705 Physiological Aspects of Poultry Management. *3(3-0) . S. Preq: PO 201, PO 405 or grad. standing.* Application of physiological principles to modern poultry management. Poultry physiology related to management topics including nutrition, housing, ventilation, disease, heat stress and lighting programs.

PO (CBS, IMM, MB, PHY) 756 Immunogenetics. *3(2-2) . F Alt. yrs.. Preq: MB 501 or MB 751 or Consent of Instructor.* Basic concepts of the immune system. Genetic basis of the immune response including immunoglobulin genetics, major histocompatibility complexes and their role in the immune response, the molecular basis of the immune system and effector mechanisms.

PO (IMM) 757 Avian Immunology. *2(1-2) . F Alt Yrs (Odd). Preq: MB 751. PO 756 or Consent of Instructor* Specific features of the avian immune system based on its organization, functions and comparison with its mammalian counterparts. Laboratory immunological techniques using the chicken as an animal model.

PO (ANS, NTR) 775 Mineral Metabolism. *3(3 0) . F. Preq. ANS(NTR,PO) 415 or BCH 451 and ZO 421.* Requirements, function, distribution, absorption, excretion and toxicity of minerals in humans and domestic animals. Interactions between minerals and other factors affecting mineral metabolism or availability. Emphasis on mechanisms associated with mineral functions and the metabolic bases for the development of signs of deficiency.

PO 801 Graduate Seminar in Poultry Science. *1(1-0) . F.* Preparation for research, research perspectives, rising concerns in poultry production, orientation for graduate studies in poultry science. Required of all graduate students in the Department of Poultry Science.

PO 820 Special Problems in Poultry Science. *1-6. F,S. Preq. Grad. standing.* Specific problems of study assigned in various phases of poultry science.

PO 885 Doctoral Supervised Teaching. *1-3. F, S, Sum. Preq: Doctoral Student.* Teaching experience under the mentorship of faculty who assist the student in planing for the teaching assignment, observe and provide feedback to the student during the teaching assignment and evaluate the student upon completion of the assignment.

PO 890 Doctoral Preliminary Examination. *1-9. F, S, Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

PO 893 Doctoral Supervised Research. *1-9. F, S, Sum. Preq: Doctoral Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

PO 895 Doctoral Dissertation Research. *1-9. F, S, Sum. Preq: Doctoral Student.* Dissertation Research

PO 899 Doctoral Dissertation Preparation. *1-3. F, S, Sum. Preq: Doctoral Student.* For students who have completed all credit hour requirements, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

PLANT PATHOLOGY

PP 315 Principles of Plant Pathology. *4(3-3) . F. Preq: BIO 125.* Fundamental principles of plant pathology with emphasis on disease etiology, nature of pathogenesis, ecology of host/parasite interaction, epidemiology of plant diseases, current strategies and practices for integrated disease control.

PP (FOR) 318 Forest Pathology. *3(2-2) . S. Preq: BIO 125 or BO 200.* Major diseases of forest trees and deterioration of wood products emphasizing principles of plant pathology; diagnosis; nature, physiology, ecology, and dissemination of disease-causing agents; mechanisms of pathogenesis; epidemiology and environmental influences; principles and practices of control.

PP 492 External Learning Experience. *1-6. F,S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

PP 493 Special Problems in Plant Pathology. *1-6. F,S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes campus facilities and resources. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

PP 495 Special Topics in Plant Pathology. *1-3. F,S,Sum.* Offered as needed to present materials not normally available in regular course offerings or for offering of new courses on a trial basis.

PP 500 Plant Disease: Principles, Diagnosis and Management. *4(15-15) . Preq: B.S. degree in plant sciences.* Principles of plant pathology for diagnosis and control of plant diseases, principally for county agents and non-plant pathology graduate students. Taught as a special, three-week summer session course or as needed.

PP (BO, MB) 501 Fungi and Their Interaction with Plants. *3(3-0) . F. Preq: PP 315 or equivalent.* Biology, physiology and molecular interactions between plant pathogenic fungi and their host plants. Basic introduction to fungal biology and evolutionary relationships, fungal development and life cycles, and genetic variability in fungi. In-depth coverage of fungal pathogenesis mechanisms, physiology of diseased plants, physiology, genetics, and molecular biology of plant defense reactions, and genetic engineering of plants for disease resistance.

PP (CS, HS) 502 Plant Disease: Methods & Diagnosis. *2(0-6) . F. Preq: PP 315.* Introduction to the basic principles of disease causality in plants and the methodology for the study and diagnosis of plant diseases caused by fungi. Identification of plant-pathogenic fungi. Research project, disease profiles and field trips are required.

PP (MB) 503 Bacteria and their Interactions with Plants. *3(2-2) . S Alt. yrs..* Major groups of plant-associated bacteria and current status of research on important bacterial plant pathogens and symbionts. Genetics, physiology, molecular biology and ecology of plant-associated bacteria, epidemiology and control of bacterial plant diseases, and host-pathogen interactions associated with bacterial pathogens and symbionts.

PP 504 Plant Nematology. *3(2-3) . S, Alt. yrs. Preq: PP 315 or equivalent or Consent of Instructor.* Principles and concepts of nematode biology, plant parasitism and disease, genetics and physiology, plant-nematode interactions, ecology and epidemiology, diagnosis and management of nematode diseases in agroecosystems, classical and contemporary research techniques in nematology.

PP 505 Introductory Plant Virology. *3(3-0) . S, Alt. yrs. Preq: PP 315, GN 411, MB 351.* Viruses as plant pathogens: concepts in contemporary diagnostic aids, spread of these pathogens and their control. Extensive use of case studies illustrating principles.

PP 506 Epidemiology and Plant Disease Control. *3(3-0) . S. Preq: PP 315 or PP 318.* Consideration of fundamental concepts and principles of epidemiology as applied to modern strategies of plant disease control. Special consideration given to evaluation of current techniques for control of fungal, bacterial, viral and nematode pathogens in an integrated crop protection system.

PP (BO, MB) 575 Introduction to Mycology. *4(3-3) . F, Alt. Yr(even) Preq: BS 125 or BS 181 & 182 or BO 200 or PP 315 or PP 318.* A survey of the fungal kingdom in context of phyla and classes. Systematics, ecology, biology and utilization. Illustrative material, cultural techniques in laboratories. Collection and paper required.

PP 590 Special Topics. *F, S, Sum.*

PP 601 Seminar. *1(1-0). F, S, Sum. Preq: Consent of seminar chair.* Discussion of assigned phytopathological topics.

PP 610 Special Topics. *F, S, Sum.*

PP 615 Advanced Special Topics in Plant Pathology. *1-3. F,S,Sum. Preq. PP 501, 502 or Consent of Instructor. Coreq: ST 511* Offered as needed to present materials not normally available in regular course offerings or for offering of new courses on a trial basis.

PP 620 Special Problems. *1-6. F, S, Sum. Preq: Consent of Instructor.* Investigation of special problems in plant pathology not related to thesis problem. Investigations may consist of original research and/or literature survey.

PP 685 Master's Supervised Teaching. *1-3. F,S,Sum Preq Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment and evaluate the student upon completion of the assignment.

PP 690 Master's Examination. *1-3. F,S. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

PP 693 Master's Supervised Research. *1-9 F,S. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

PP 695 Master's Thesis Research. *1-9. F,S. Preq: Master's student.* Thesis research.

PP 699 Research in Plant Pathology. *F, S, Sum. Preq: Grad. standing, Consent of Instructor.* Original research in plant pathology.

PP 708 History of Phytopathology. *1(1-0). F, Alt Yrs. Preq: PP 315, Consent of Instructor.* Development of the science of phytopathology from its early beginnings to early part of the 20th century.

PP 720 Morphology and Taxonomy of Nematodes. *3(1-6). S Alt Yrs. Preq PP 504, Consent of Instructor.* Morphology, anatomy and taxonomy of nematodes with emphasis on identification of important plant-parasitic genera. Exercises include preparation of semipermanent and permanent nematode mounts.

PP 724 Advanced Plant Nematology. *4(3-3). F, Alt yrs. Preq: PP 720.* Nematode biology, genetics, physiology, molecular biology, ecology, embryogenesis, post-embryonic development, gametogenesis, cytology, reproduction, sexuality, evolution, behavior, host-parasite relationships, mechanisms of pathogenesis and resistance, interactions with other pathogens and impacts on crop performance. Laboratory exercises, research projects and techniques.

PP 725 Molecular Biology of Plant Viruses. *3(3-0) S. Alt. Yrs (even). Preq: PP 505, BCH 451 or 551.* Current status of molecular biology of plant infecting viruses. Recognition, infection, replication, regulation, expression, genome organization, encapsidation, resistance, silencing and transmission. Molecular approaches to virus disease control and development of plant viral vector and expression systems.

PP 726 Botanical Epidemiology. *4(2-6). S. Alt. Yrs. Preq. PP 501, 502 or Consent of Instructor. Coreq: ST 511.* Advanced study of the dynamics of plant disease epidemics in relation to agricultural crop production and forestry systems. Emphasis upon epidemiological concepts and principles, pathogen and host dynamics, disease forecasting, geographic distribution of pathogens, crop-loss assessment and the development of theoretical and practical disease-management strategies.

PP 728 Soilborne Plant Pathogens. *3(2-3) F, Alt. Yrs.. Preq: PP 501, 502.* In-depth study of ecology of soilborne fungal and bacterial pathogens inducing root and wilt diseases in plants. Concepts and principles including but not limited to the rhizosphere, inoculum potential, soil fungistasis, survival, root disease models and biological control.

PP 729 Plant Pathogenesis. *3(2-3). F, Alt. Yrs. Preq. PP 501, BO 551, Consent of Instructor.* Advanced study of the biochemical nature of the weapons utilized by pathogens in pathogenic attack and defensive mechanisms employed by the hosts in resisting attack and resultant dynamic interactions of the host and pathogen.

PP (BO, GN, MB) 730 Fungal Genetics and Physiology. *3(2-3). S. Alt. Yrs Preq: BCH 451, BO 775, GN 411 or PP 501.* Basic concepts of genetics and physiology of fungi, with emphasis on saprophytic and plant pathogenic mycelial fungi. Current literature on evolution, cell structure, growth and development, gene expression, metabolism, sexual and asexual reproduction and incompatibility systems. Laboratory exercises on mutant isolation, sexual and parasexual analysis, genetic transformation, and RFLP and isozyme analysis.

PP 732 Genetics of Host-Parasite Interactions. *2(1-3) F, Alt Yrs Preq BCH 451 GN 411, MB 351 or Consent of Instructor.* Concept-oriented approach to an understanding of host-parasite genetic interactions from molecular through population levels. In-depth consideration of gene action, gene for-gene interactions, co-evolution pathogen virulence, host defense, gene flow in populations and other current topics.

PP (CS, GN, HS) 748 Breeding for Pest Resistance. *2(2-0) . F, Alt. yrs. Preq: CS(GN, HS) 741, PP 315, ST 701.* Theory and principles of breeding for pest resistance. Experimental approaches for examining genetics of host-parasite interactions, expression and stability of pest resistance and breeding strategies for developing pest-resistant cultivars.

PP 790 Special Topics.

PP 795 Advanced Special Topics.

PP 801 Seminar in Plant Pathology. *1(1-0) . F,S. Preq: Consent of seminar chair.* Discussion of assigned phytopathological topics.

PP 809 Colloquium in Plant Pathology. *1(1-0) . S. Preq: PP 501, 502.* Exploration of institutional operations in universities, research laboratories, international centers and industry through group discussions and individual presentations. Examination of sources of funding through appropriations, research grants and industry cooperators. Consideration of criteria for evaluating the performance of professional employees, the role of scientific journals and professional societies, as well as public responsibilities.

PP 810 Special Topics. *F, S, Sum.*

PP 815 Advanced Special Topics. *F, S, Sum.*

PP 820 Special Problems in Plant Pathology. *1-6. F, S, Sum. Preq: Consent of Instructor.* Investigation of special problems in plant pathology not related to thesis problem. Investigations may consist of original research and/or literature survey.

PP 885 Doctoral Supervised Teaching. *1 3. F, S, Sum. Preq: Doctoral Student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

PP 890 Doctoral Preliminary Examination. *1-9. F, S, Sum. Preq: Doctoral Student.* For students who are preparing for and taking written and/or oral preliminary exams.

PP 893 Doctoral Supervised Research. *1-9. F, S, Sum. Preq: Doctoral Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

PP 895 Doctoral Dissertation Research. *1-9. F, S, Sum. Preq: Doctoral Student.* Dissertation Research

PP 899 Doctoral Dissertation Preparation. *1-3. F, S, Sum. Preq: Doctoral Student.* For students who have completed all credit hour requirements, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

PARKS, RECREATION AND TOURISM MANAGEMENT

PRT 150 Parks, Recreation and Tourism Management Orientation. *3(3-0) . F,S,Sum. Coreq: PRT 152.* Introduction to PRTM Department, programs and facilities, the profession and opportunities in the delivery of park, recreation and tourism services. Students will complete a 30 hour field experience.

PRT 152 Introduction to Parks, Recreation and Tourism. *3(3-0) . F,S,Sum. Coreq: PRT 150.* Introduction to the professional field of recreation by presenting the basic principles, fundamentals and concepts of recreation as related to such factors as recreation history and objectives, sociological and economic aspects of recreation, leadership qualities and facility provision; and settings for organized recreation in modern society.

PRT 200 Leisure Behavior, Health and Wellness. *3(3-0) . F,S,Sum.* Leisure as a lifelong resource for human satisfaction and fulfillment; its potential for physical, mental, social and emotional growth and emotional growth and development of the individual. Leisure opportunity areas presented and evaluated.

PRT (PEO) 214 Introduction to Adventure Education. *3(3-0) . F.* Topics related to adventure education: history and philosophy, social psychology of adventure, theories and concepts, benefits, populations served, risk-taking, trends and issues, research and evaluation and model programs.

PRT (PEO) 215 Principles and Pratices of Outdoor Leadership. *3(3-0) . S.* Principles and practices of leadership in adventure education and recreation programs. Topics: group management, trip planning, staffing, group dynamics, health and safety issues, risk management, selected outdoor activities and other relevant topics.

PRT 220 Commercial Recreation and Tourism Management. *3(3-0) . F. Preq: PRT 152.* Commercial recreation and the tourism industry, including its origin, present characteristics, behavioral foundations and societal impacts. Emphasis on recreation administration in the commercial sector.

PRT 238 Inclusive Recreation. *3(3-0) . F. Preq: PRT 152.* Knowledge, attitude awareness, and resources needed to include people with disabilities or challenges in parks, recreation and tourism programs and services. Current legislation, issues and trends.

PRT 250 Management of Park and Recreation Facilities. *3(2-2) . F,S. Preq: PRT 152.* Management principles applied to park, recreation, sport areas and facilities. Emphasis on operational efficiency, quality service, fiscal responsibility and maintenance management. Laboratory provides for application of management and maintenance principles.

PRT 266 Introduction to Sport Management. *3(3-0) . F.* Introduction to concepts and practices of effective sport programming and management at the professional, collegiate and community levels. Overview of various program delivery systems such as fitness, instructional sport, informal sport, and intramural sport. Examination of management elements of sport programming, including planning, personnel, finance, facilities, risk and liability and marketing.

PRT 315 Organization and Administration of Adventure Programs. *3(3 0) . S Alt. yrs(odd). Preq: PRT 152.* Overview of the organizational and administration of adventure programs and services, professional standards, programming, management, staffing, budgeting, public relations, liability and risk management.

PRT 320 Convention and Visitor Services. *3(3-0) . F. Preq: PRT 152.* An examination of the programmatic issues of providing visitor services for conventions, meetings, group tours, and special events. The focus is on the planning and delivery of visitor service programs designed to enhance visitor experiences in a community.

PRT 350 Outdoor Recreation Management. *3(2 3) . F. Preq. PRT 152.* Concepts and methods of outdoor recreation planning and management explored with emphasis on the public sector. Current issues relative to recreation provision identified and debated.

PRT 358 The Recreation Program. *3(2-3) . F,S. Preq: PRT 152.* Theoretical and applied approaches to the recreation program planning process. Basic elements of programming using a variety of recreational settings and diversity of practical experience.

PRT 359 Leadership and Supervision in Recreation. *3(2-2) . F,S. Preq: PRT 250.* Systematic principles for managing human resource component of parks, recreation and tourism organizations. Leadership, group dynamics, human resources planning and organizing, employee recruitment, selection, and supervision.

PRT 365 Arts Management in Recreation. *3(2-2) . F. Preq: Junior standing.* Introduction to arts management in recreation programs; emphasis on the importance and benefits of arts to the individual and community. Understanding and appreciation of the role of the arts in a comprehensive recreation program plan. Emphasis on arts management principles including philosophy, fiscal, technical and physical community resources.

PRT 375 Internship Orientation. *1(0-1) . F Preq. PRT 152 and departmental approval.* Preparation for recreation and park internship. Resume writing, interviewing skills, cover letters and internship search techniques and resources.

PRT 380 Analysis and Evaluation in Parks, Recreation. *3(2-2) F,S. Preq: 300-level Statistics course; CFR 134; PRT 359.* Examination of the steps involved in analyzing and estimating the impact of recreation and parks services. Includes relevant issues and useful approaches for systematic analysis. Emphasis is placed on an understanding and development of various types of systematic evaluation designs. Activities leading to the analysis and development of performance reports to assess and improve managerial operational efficiency are covered.

PRT (BUS) 406 Sports Law. *3(3-0) . F. Preq. Junior standing* Fundamental principles of law, especially tort and contract law, applied to sports situations. Analysis of liability of sports personnel in various roles including participant, coach, promoter, trainer and official. Analysis of common law court decisions in sports contexts well as key state and federal statutory legislation such as civil rights and antitrust.

PRT 420 Resort Planning and Management. *3(3-0) S. Preq: PRT 152* Theory and practical applications of planning, accommodations management, food and beverage operations, recreation programs and management in the resort industry.

PRT 442 Recreation and Park Interpretive Services. *3(2-3) . F. Preq. Junior standing.* The principles and practices of environmental and historical interpretation. Personal (attended) and non-personal (unattended) interpretive communication techniques. Comprehensive planning and implementation of interpretive programs, and equipment and facilities used in environmental and historical interpretation. One overnight field trip required.

PRT 451 Principles of Recreation Planning and Facility Development. *3(2-3) . S. Preq: PRT 358.* Planning activities analyzed as decision-making processes. Identification, interpretation, evaluation and utilization of data and resources necessary for recreation planning. Planning principles applied in the analysis of proposed and existing recreation sites.

PRT 453 Administrative Processes of Recreation/Park Organizations. *3(3-0) F. Preq: PRT 359.* Basic administrative processes; the internal organization of the recreation/park department; board and executive relationships; legal foundations and legal liability considerations; personnel practices and policies; and public relations administration.

PRT 454 Parks and Recreation Finance and Administration. *3(3-0) . S. Preq: PRT 359.* Recreation and park fiscal administration, sources of finance for operating and capital expenditures, revenue activities, financial planning, budgeting, expenditure policies, auditing and planning for recreation and park services, decision-making tools, legal aspects of administration.

PRT 455 Personnel and Administrative Practices for Zoos and Aquariums. *3(3-0) F.* Personnel and administrative practices identified with zoos and acquariums. Administrative philosophy and application, organizational structure, personnel management, fiscal procedures, communications, specific administrative problems.

PRT 462 Introduction to Geographic Information Systems. *3(3-0) . F,S. Preq: CFR 134.* Overview of the operations and functions of computerized spatial display and map analysis processes (Geographic Information Systems), production of effective computer-generated maps and spatial displays, concepts for spatial modeling. Extensive independent learning and computer experiences including on-line virtual laboratory sessions.

PRT 475 Recreation and Park Internship. *8(0-27) . F,S,Sum. Preq: PRT 350, PRT 358, PRT 359, PRT 375, PRT 380.* Provides prospective park, recreation and leisure service professionals a 400-hour (ten week) learning experience in a selected agency or organization, under the joint supervision of a qualified manager and a university internship supervisor.

PRT 476 Post-Internship Seminar. *1(0-2) . F,Sum. Preq: PRT 475.* Identification and analysis of current management practices, challenges and issues common to leisure delivery systems.

PRT 477 Park, Recreation and Tourism Management. *3(3-0) . F,S. Preq: Senior standing. Must be taken during student's last semester of coursework.* Integration of knowledge, theory and methods from coursework and experience; development and presentation of comprehensive operational and management problems and plans. Designed to encourage students to function as professionals and to relate areas of specialty to the broader Parks, Recreation and Tourism Management profession.

PRT 491 Special Topics in Recreation. *1-3. F,S.Sum. Preq: Consent of department.* Investigation and analysis of a problem associated with recreation resources.

PRT 500 Theories of Leisure and Recreation. *3(3 0) . F.* Analysis of leisure and recreation and a study of their origin and development as revealed by behavioral patterns. Interpretation of influence and social significance of leisure and recreation concepts on contemporary American culture and their implications on future recreation thought and action.

PRT 501 Research Methods in Recreation. *3(3-0) . S. Preq: Grad. level statistics.* Examination and understanding of advanced scientific investigative methods in their application toward explaining recreation and leisure behavioral phenomena and for resolution of recreation management problems.

PRT (ECG) 503 Economics of Recreation. *3(3-0) . F. Preq: EC 301 or 401.* Principal emphasis on identity and importance of economic information for planning. Examination of market mechanism and government as they affect and interact to affect allocation of resources to recreation, distribution of recreation services and behavior of recreationists. Other topics including demand analysis, economics of planning, cost/benefit analysis, secondary economic impacts, public decision making, externalities, public finance and supply considerations in urban and rural recreation situations.

PRT 504 Recreation and Park Data Systems. *3(3-0) . S. Preq: CSC 200, ST 311.* The analysis of such topics as identification of maintenance, operation and service delivery work areas in recreation and park agencies for system applications; development of reporting structures; recreation and maintenance activity scheduling; system monitoring; system implementation evaluation.

PRT 505 Quantitative Techniques for Recreation and Natural Resource Management. *3(3-0) . S. Preq: CSC 200, ST 311.* Review of application of specific management science techniques to recreation and natural resource management. Gravity, optimization, simulation and other modeling procedures discussed through a case study approach. Primary emphasis on exposure to techniques and problem formulation rather than development of theoretical bases or computational methodologies.

PRT 510 Theories of Sport and Fitness Program Management. *3(3-0) . Every 3rd semester. Preq: PRT 358.* The development of a theoretical basis for sport and physical fitness program management. Study of sociological, psychological, political and economic considerations of sport and fitness. Stress on values and motivation of sport and fitness.

PRT 511 Foundations for Sport, Exercise and Fitness Program Management. *3(3-0) . Every 3rd semester. Preq: PRT 358* The development of a scientific basis for sport, exercise and fitness program development. Characteristics of human growth, development and aging as they relate to participation in physical activity. Emphasis on physical fitness evaluation and program development.

PRT 512 Recreational Sport Management. *3(3-0) . Every 3rd semester. Preq: PRT 358.* Overview and analysis of key managerial concerns of the sports enterprise. Stress on problems and issues unique to sports-oriented service or business. Emphasis on recreational sports settings.

PRT 520 Concepts of Travel and Tourism. *3(3-0) . S. Preq: Grad. standing.* Theory and research in travel and tourism, including conceptual foundations, research problems and methods and the application of research results to strategic tourism development and marketing.

PRT 550 Outdoor Recreation Behavior. *3(3-0) . F. Preq: PRT 501.* An understanding of outdoor recreation behavior in natural resource-oriented areas such as state and national parks and national forests. Nature of resource-based recreation experience, influencing factors and implications of this behavior for park management.

PRT 562 Principles of Geographic Information Systems. *3(3-0) . S. Preq: PRT 462.* Exploration of theoretical underpinnings of Geographic Information Systems (GIS); focus on spatial analysis and modeling with extensive programming experiences in a GIS language; required major project and detailed computer homework exercises.

PRT 563 Technical Issues in Geographic Information Systems. *3(3-0) . F. Preq: PRT 562.* A generic understanding of GIS algorithms, data structures and analysis of error in context of natural resource management applications. Student development of simple problems to perform overlays, intersections and area measurements and learn to identify sources of error, appropriate methods for spatial data management and advanced GIS application techniques.

PRT 580 Current Issues in Recreation Resources. *1-3. F,S. Preq: Grad. standing, Consent of Instructor.* Examination of current issues in recreation resources. Course content varies as changing conditions require new approaches to emerging problems.

PRT 595 Special Topics in Recreation Resources. *1-3. F,S. Preq: Grad. standing, Consent of Instructor.* Special topics in various aspects of recreation resources developed under direction of a graduate faculty member on a tutorial basis. Subjects offered under this course listing also used to test and develop new courses.

PRT 601 Seminar in Recreation Research. *1(1-0) . S. Preq: PRT 501.* Research studies, scientific articles and progress reports on research effects presented and critically evaluated. Each student pursuing a graduate degree expected to take this offering twice for one hour of credit each time.

PRT 602 Recreation Management Seminar I. *2(2-0) . F. Preq: PRT 500, 501.* Research and theories of (1) marketing, (2) case law and liability and (3) personnel practices as they relate to the management of recreation resources.

PRT 603 Recreation Management Seminar II. *2(2-0) . S. Preq: PRT 500, PRT 501.* Research and theories of (1) planning and development, (2) financing and (3) maintenance management of recreation resources.

PRT 610 Special Topics in Recreation Resources. *1-3. F, S. Preq: Grad. standing, Consent of Instructor.* Special topics in various aspects of recreation resources developed under direction of a graduate faculty member on a tutorial basis. Subjects offered under this course listing also used to test and develop new courses.

PRT 620 Recreation Resources Problems. *1-4. F, S. Preq: Advanced undergrad or grad. status.* Assigned or selected problems in field of recreation administration, planning, supervision, maintenance, operations, financing or program. Special research problems selected on basis of interest of students and supervised by members of graduate faculty.

PRT 625 Advanced Problems in Recreation. *F, S. Preq: Twelve hrs of PRT courses. Credits Arranged.* Directed research in a specialized phase of recreation other than a thesis problem.

PRT 660 Field Studies in Recreation. *1-4. F, S, Sum. Preq. Minimum of nine hrs of grad. credit.* Experience in applying analytical methods to administrative, managerial and planning problems in providing recreation and park opportunities. Required completion of an evaluation project or analytical study for the practicum agency.

PRT 685 Master's Supervised Teaching. *1 3 F, S, Sum. Preq. Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

PRT 690 Master's Examination. *1 6. F. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

PRT 693 Master's Supervised Research. *1-9. F, S, Sum Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

PRT 695 Master's Thesis Research. *1-9. F, S, Sum. Preq: Master's Student.* Thesis Research

PRT 699 Master's Thesis Preparation. *1-3. F,S. Preq: Master's Student Credits Arranged.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

PRT 763 Application Issues in Geographic Information Systems. *3(3-0) . S. Preq: PRT 563.* Operation and management issues related to GIS use in natural resource organizations. Issues in proposing and implementing GIS through case study analyses and experimental project planning including social and legal impacts, cost and benefit assessments, institutional constraints to implementation, benchmarks, proposal development, education concerns, and planning for technological advances.

PRT 764 Advanced Study in Geographic Information Systems. *3(3-0) . S Alt Yrs. Preq: PRT 563.* Research and application activities in GIS. Individualized study of a major topic related to student's primary field of study of these topics utilizing GIS capabilities with special emphasis on complex spatial analyses. Projects must benefit significantly from use of GIS methods. Development of sophisticated skills, approaches and strategies directly relevant to their field. Oral presentations and written report required.

PRT 885 Doctoral Supervised Teaching. *1-3. F,S. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

PRT 890 Doctoral Preliminary Exam. *1-9. F,S. Preq. Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

PRT 893 Doctoral Supervised Research. *1-9. F,S. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

PRT 895 Doctoral Dissertation Research. *1-9. F,S. Preq: Doctoral student.* Dissertation research.

PRT 899 Doctoral Dissertation Preparation. *1-3. F,S. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

POLITICAL SCIENCE

PS 101 Internet Research. *1(0-2) . F,S,Sum.* Tools and Techniques for conducting Internet research and electronic literature reviews. Documentation and ethics of using and citing information sources.

PS 102 Data Analysis. *1(0-2) . F,S,Sum.* Statistical Analysis of governmental and survey data. Introduction to data sets and collecting, computerizing and analyzing political and social data.

PS 103 Designing Political Web Pages. *1(0-2) . F,S,Sum.* Principles of effective Internet communication in political professions, for constituency contact and grassroots mobilization, and use of Web documents by politicans and political organizations. Design of Web page documents and creation of Internet directories.

PS 200 Workshop in Political Science. *1(1-0) . F,S. Restricted to Political Science Majors.* Core questions in political science using current political issues, events and debates as examples. Emphasis on methods of investigating political questions and the role of values in political debates.

PS 201 American Politics and Government. *3(3-0) . F,S,Sum.* Analysis of American political institutions and processes, including the Constitution, political culture, campaigns and elections, political parties, interest groups, the media, the president, Congress, the federal courts, and public policy. Discussion of contemporary and controversial issues in American Politics. Emphasis on placing current issues in comparative and historical perspective where relevant.

PS 202 State and Local Government. *3(3-0) . F,S, Sum.* State and local governments within the context of the American federal system. Special emphasis on federalism, the constitutional/legal relationships between state and local governments, and the institutions, organizational forms, and political processes in American state and local government.

PS 204 Problems of American Democracy. *3(3-0) . F.* Political problems in America from the perspective of political theory. Democracy, economics and politics, racial and sexual equality, civil disobedience, and individual freedom.

PS 205 Law and Justice. *3(3-0) . F,S,Sum.* Role of law from practical, political and theoretical perspective; linkages between law and justice in addressing social problems, such as gun control; drug legalization; civil disobedience; gender equality; and property rights; the impact of media on public perceptions of law and justice.

PS 231 Introduction to International Relations. *3(3-0) . F,S,Sum.* Evolution of relations among nations and of the roles of the United Nations and other international institutions, including changes in the world political system since the end of the Cold War.

PS 236 Issues in Global Politics. *3(3-0) . F, S.* Selected problems facing the world community, related political issues, and international responses to them, including international trade, economic development, wars, arms control, terrorism, ethnic conflict, human rights, status of women, population growth, food security, and environmental degradation.

PS 241 Introduction to Comparative Politics. *3(3-0) . F.* Introductory comparative analysis of a selected variety of political systems always including some developed democracies, some communist states and some developing countries. A minimum familiarity with the American political system is assumed.

PS 298 Special Topics in Political Science. *1-6.* Experimental course at the freshman and sophomore levels.

PS 301 The Presidency and Congress. *3(3-0) . S. Preq: PS 201.* Historical development, selection, and internal organization of the Presidency and Congress. Discussion of the relations between the branches and the influence of public opinion, interest groups and parties on the federal government. Analysis of the legislative process.

PS 302 Campaigns and Elections in the US Political System. *3(3-0) . F. Preq: PS 201.* Campaigns and elections in the United States with emphasis on presidential and congressional primary and general elections. Development of theoretical propositions concerning how and why people vote, how and why candidates campaign, and behavioral reasons underlying candidates' successes and failures. Special emphasis on the role of the mass media in the electoral process.

PS 303 Race in U.S. Politics. *3(3-0) . S. Alt. yr(even). Preq: Sophomore standing* Race in American politics with emphasis on the African-American political experience: civil rights legislation, voting rights, political representation, campaigns and party politics, survey attitudes, and public policies including affirmative action.

PS 305 The Justice System in the American Political Process. *3(3-0) F,S.Sum.* Criminal justice process and civil justice system in the American judiciary, including court organization and legal professionals such as police, attorneys and judges; formulation and implementation of policies by law enforcement and the courts; impact of political system upon police, attorneys and judges; interaction between public and legal professionals in judicial decision making.

PS 306 Law and Courts in the American Political System. *3(3 0) . F,S.* State and federal courts in the U.S. political system, including court organizations and legal personnel, the nature, law and its role in society, functions performed by courts in the political system, from dispute settlement to the initiation of social change, and the impact of judicial politics upon case adjudication.

PS 307 Introduction to Criminal Law in the United States. *3(3-0) . F,S.* Principles underlying the criminal law in the United States and classification of crimes, criminal act, factors affecting criminal responsibility and various types of offenses. Observation of state and federal court sessions.

PS 308 Supreme Court and Public Policy. *3(3-0) . S.* The role of the Supreme Court in American politics, with emphasis on the use of litigation as a form of political activity. Readings include relevant court cases as well as descriptions of the Supreme Court in action.

PS 309 Equality and Justice in United States Law. *3(3-0) . S, Alt. yr(odd).* Equality and justice in American law; federal and state court interpretation of constitutional and statutory law. Topics include racial justice; prisoners' rights and just punishments; nontraditional families and reproductive technologies; gay rights; immigration law; criminal justice practices.

PS 310 Public Policy. *3(3-0) .* Introduction to public policy formulation and analysis, including agenda-setting strategies, problems of legitimation, the appropriations process, implementation, evaluation, resolution, and termination.

PS 311 Criminal Justice Policy Process. *3(3-0) . F,S.* Formulation and implementation of policies in various criminal justice institutions. Police agencies, solicitors' offices, courts, prisons and probation and parole departments as public bureaucracies, and interactions of key officials.

PS 312 Introduction to Public Administration. *3(3-0) . F,S.* Administration in city, state and national governments: effectiveness and responsiveness, involvement in policy areas, and issues of ethics and responsibilities.

PS 314 Science, Technology and Public Policy. *3(3-0) . S.* Societal impacts of science and technology. Structures and processes for formulation, implementation, evaluation of United States science and technology policy. Political implications of selected issues in science and technology policy studies.

PS 320 U.S. Environmental Law and Politics. *3(3-0) . F,S.* Emergence of the environment as an issue in United States politics. Law and policy pertaining to air and water pollution, land-use, water, energy, toxic substances, and wilderness. Roles of national and state governments, scientists, corporations, and citizens groups in addressing environmental problems

PS 331 U.S. Foreign Policy. *3(3-0) . F,S.* The content, formulation, and execution of U.S. foreign policy during the postwar period, with concentration on major issues and trends, the instruments for implementing foreign policy, and analysis of the policy-making process.

PS 335 International Law. *3(3-0) . S.* Purpose and effectiveness of international law, including the rights and duties of sovereign states, peaceful settlement of disputes, laws of war, humanitarian law and role of non-state actors. Emphasis on formal legal reasoning and political analysis.

PS 336 Global Environmental Politics. *3(3-0) . F,S.* International politics, laws, and policies pertaining to global environmental problems in the realms of population, pollution, climate change, biological diversity, forests oceans, fisheries, Antarctica, and outer space.

PS 339 Politics of the World Economy. *3(3-0) . S* Politics of international trade and payments, including barriers to trade, dispute settlement, multinational corporations, financial crises, international economic institutions and the problems of economics underdevelopment.

PS 341 European Politics. *3(3-0) . F.* Comparative analysis of the interests, institutions and processes that determine political stability and economic security in Europe, including the political and economic development of Europe, the role of parties and party politics, the institutions and politics of the European Union.

PS 342 Politics of China and Japan. *3(3-0) . F,S.* Politics, public policy, and foreign affairs of China and Japan.

PS 345 Governments and Politics in the Middle East. *3(3-0) .* Historical, geographic, religious, and political-economic factors of the Middle East. Particular attention is given to the internal politics of selected countries, as well as issues of international concern.

PS 361 Introduction to Political Theory. *3(3-0) . F,S,Sum.* Nature and purpose of politics, as treated by such writers as Plato, Aristotle, St. Augustine, Machiavelli, Locke, Rousseau, Mill, Marx, and Nietzsche.

PS 362 American Political Thought. *3(3-0) . S.* American ideas and institutions as viewed from the perspective of great American political thinkers, such as Frederick Douglass, Thomas Jefferson, James Madison, Alexander Hamilton, Henry David Thoreau, Abraham Lincoln, Franklin Roosevelt, FrederickDouglass, and Malcolm X.

PS 371 Research Methodology of Political Science. *3(3-0) . F,S,Sum. Preq: ST 311 or (ST 301 and ST 302); (PS 101,PS 102, and PS 103) or equivalent.* Research methods in Social Science and quantitative analysis in political science and public policy including research design, data collection, statistical analysis and computer applications.

PS 391 Internship in Political Science. *1-6 F,S,Sum. Preq: Consent of instructor* Internship in a governmental agency, interest group, or like organization involves seminar or formal report.

PS 401 American Parties and Interest Groups. *3(3 0) . S.* American parties and interest groups as instruments for mobilizing electorates, shifting public opinion and setting political priorities. The role of parties and interest groups in operating and financing elections. Strategies, tactics and problems of parties and interest groups influencing elected officials, bureaucrats and the policy process.

PS 406 American State Politics. *3(3-0) .* Comparative study of the politics and policies of the fifty American states. Socioeconomic and political variations and state response to intergovernmental domestic programs. Analysis of state policy in economic development, environment, health, housing, education, transportation, criminal justice and regulation.

PS 408 Urban Politics. *3(3-0) .* Examination of politics in small towns, cities, counties, and urban regions including political development of cities, groups in urban politics, governmental institutions, local government officials, citizen participation, suburban development, metropolitan reform, and intergovernmental relations.

PS 411 Public Opinion and the Media in American Politics. *3(3-0) . Preq: PS 201.* Nature, content, origins, and effects of public opinion in the American political system; role of the mass media in articulating and shaping public opinion; issues concerning measurement of public opinion.

PS (SOC) 413 Criminal Justice Field Work. *4(2-8) . F,S. Preq: Acceptance in criminal justice option; senior standing; SOC 306 and PS 311.* Supervised observation and experience in a criminal justice agency. Study of relationships between ongoing programs and relevant political and sociological theory and research. Weekly seminars, small groups, and individual conferences. Presentation of an integrative report.

PS 415 Administration of Justice. *3(3-0) . F. Preq: PS 311 and junior standing. Credit will not be given for both PS 415 and PA 515.* Politics and administration in the American system of justice.

PS (WGS) 418 Gender Law and Policies. *3(3 0) . F. Preq: Nine hours of Political Science or Permission of Instructor.* Law and policy pertaining to contemporary gender issues. Examination of agenda setting, policy formation, implementation, judicial interpretation and evaluation of selected issues, such as reproductive policies, equal employment and sexual abuse.

PS 431 The United Nations and Global Order. *3(3-0) . F. Preq: PS 231 or PS 236 or PS 335.* United Nations in contemporary world politics. Functions and operation of central organs, commissions, and specialized agencies. Role in addressing global issues including peacekeeping, arms control, human rights, economic and social development, and environment.

PS 433 Global Problems and Policies. *3(3-0) . F. Preq: PS 231 or PS 236 or PS 241.* Critical analysis of issues and events in world politics, including terrorism, drug trafficking and money laundering, transmission of infectious diseases, democratization, globalization and economic development.

PS 437 U.S. National Security Policy. *3(3 0) . Preq: PS 331.* Formulation and implementation of United States national security policy, including its military, political and economic dimensions. Historical evolution of US policy primarily from the end of World War II through the end of the Cold War and to its contemporary context

PS 443 Seminar in Latin American & Caribbean Politics. *3(3-0) . S. Preq: Six hours of political science including PS 231. Credit cannot be given for both PS 443 and PS 543.* Comparative political development in Latin America and the Caribbean. Emphasis on democratization and implications for US foreign policy.

PS 445 Comparative Systems of Law and Justice. *3(3-0) . Preq: PS 311 and junior standing. Credit will not be given for both PS 445 and PS 545.* Legal culture and administration of justice in various countries and in the U.S. Emphasis on the impact of legal ideology on crime, political justice, police administration, corrections and judicial process.

PS 462 Seminar in Political Theory. *3(3-0) . S. Preq: PS 361 or consent of instructor.* A special area in political theory through selected texts, independent research, and seminar reports. Topics vary from year to year, such as ancient and modern political thought, democratic theory, and political theory in literature.

PS 471 Public Opinion Research Methodology. *3(3-0) F,S.* Survey research methodology in public opinion polling, campaign management, media and market research, needs assessment and program evaluation. Topics include questionnaire design, survey sampling, computer applications, and data analysis.

PS 490 Readings and Research in Political Science. *1-6. F.S. Preq: Consent of department.* Extensive readings or research in political science under direct faculty supervision.

PS 492 Honors Readings and Thesis in Political Science. *3-6. F,S,Sum. Preq: Admission to Honors Program and Consent of Instructor.* Independent reading and preparation of an honors thesis in political science.

PS 498 Special Topics in Political Science. *3 6. F,S. Preq: Six hours PS* Detailed investigation of a topic. Topic and mode of study determined by the student and a faculty member.

PS 500 Contemporary Political Science. *3(3-0) F.* Overview of history and contemporary state of discipline, its subfields, methodological emphases, controversies and orientations.

PS 502 The Legislative Process. *3(3 0) . S. Preq: Advanced undergrad. standing including 12 hrs. of PS, grad. standing or PBS status.* The formulation of public policy from institutional and behavioral viewpoints. Important current legislative problems at congressional and state legislative levels selected and serve as basis for analyzing legislative process.

PS 506 United States Constitutional Law. *3(3 0) . F. Preq: 12 hrs. of PS or grad. standing or PBS status.* Basic constitutional doctrines, including fundamental law, judicial review, individual rights and political privileges and national and state power. Special attention given to application of these doctrines to regulation of business, agriculture and labor and to rights safeguarded by First, Fifth and Fourteenth Amendments to the Constitution.

PS 507 Civil Liberties in the United States. *3(3-0) . F,S. Preq: 12 hrs of PS or grad. standing or PBS status.* Leading constitutional cases in civil liberties and individual rights along with writings of leading commentators.

PS 530 Seminar in International Relations. *3(3-0) . F, S, Sum. Preq: Six hrs. of 500-level course work.* May be taken for up to six hours credit. In-depth examination of a topic within larger field of international politics to be selected by instructor for each semester from subjects pertaining to interstate relations, international law and organization, regional politics, foreign and security policy or global issues. Students undertake substantial independent research project.

PS 531 International Law. *3(3-0) F,S. Preq: Grad. or advanced undergrad. standing.* Sources and subjects of international law, domestic and international jurisdictions, judicial settlement, legal and illegal uses of force and substance of law in selected policy areas.

PS 533 Global Problems and Policy. *3(3-0) F Preq: Advanced undergrad. standing including 12 hrs. of PS, grad. standing or PBS status.* International policy processes and policy responses to problems of global scope including role of international law. Consideration given to economic development, human rights and other policy problems selected for specific semesters. Independent research on a global policy problem of student's choice.

PS 536 Global Environmental Law and Policy. *3(3-0) S. Preq: Grad standing of PBS status.* International organizations, laws and policies addressing global environmental problems including: population growth, atmospheric pollution, climate change, use of oceans, forests and biodiversity. Relationship between environment and Third World economic development.

PS 539 International Political Economy. *3(3 0) . F. Alt. yrs. Preq: Advanced undergraduate, graduate or PBS* Politics of international trade and payments, with special emphasis on international and domestic determinants of protectionism, international and national political institutions, multinational corporations, debt crises, and dilemmas of economic underdevelopment.

PS 540 Seminar in Comparative Politics. *3(3 0) . F, S. Preq: One course in comparative politics and one course in PS methodology or Consent of Instructor* This seminar opens with a survey of the problems and methods of comparative political analysis, after which students assigned a specific, limited subject to be examined within framework of a systematic, analytical scheme appropriate to topic. Specific topics drawn from subjects of political ideologies, political groups, political elites and decision-making institutions and processes.

PS 542 Western European Politics. *3(3-0) . S. Preq: Nine hrs. of PS, grad. standing or PBS status.* Analysis of political institutions and processes in selected Western European states and the European community and of major social, economic and political issues confronting European societies.

PS 543 Latin American and Caribbean Politics. *3(3-0) . Preq: Advanced undergrad. standing including 12 hrs. of Political Science or PBS status.* Comparative political development in Latin America and the Caribbean. Emphasis on democratization and implications for US foreign policy.

PS 545 Comparative Systems of Law and Justice. *3(3-0) F.S. Preq: Grad. standing. Credit for both PS 445 and PS 545 is not allowed.* Legal culture and administration of justice in various countries and in the U.S. Emphasis on impact of legal ideology on nature of crime, political justice, police administration, corrections and judicial processes.

PS 571 Research Methods and Analysis. *3(3 0) . S. Preq. Advanced undergrad standing including 12 hrs of PS, grad standing or PBS status.* A survey of methods used in behavioral research as applied to field of political science: elements of empirical theory, research design, measurement of variables, sampling procedures, data courses, techniques of data collection, statistical analysis, qualitative methodologies and presentation of research findings.

PS 590 Special Topics. *F,S,Sum*

PS 602 Seminar in International Relations. *3(3-0) . F, S, Sum. Preq: Six hrs. of 500-level course work.* May be taken for up to six hours credit. In-depth examination of a topic within larger field of international politics to be selected by instructor for each semester from subjects pertaining to interstate relations, international law and organization, regional politics, foreign and security policy or global issues. Students undertake substantial independent research project.

PS 603 Seminar in Politics. *2-4. F, S. Preq: Advanced grad. standing.* Independent advanced research course in selected problems of government and politics. Problems chosen in accordance with needs and desires of students registered for course.

PS 610 Special Topics. *1-6. F, S. Preq: Six hrs. of PS.* Detailed investigation of a topic. Topic and mode of study determined by student and a faculty member.

PS 636 Readings and Research. *1-3. F, S. Sum. Preq: Grad. standing or PBS status.* Graduate students pursue a subject of particular interest to them by doing extensive readings or research in that subject under direct, individual faculty supervision.

PS 651 Internship in Political Science. *1 6. F, S Sum. Preq: Grad standing* Exposure to environmental and value systems of public organizations through a supervised work experience

PS 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

PS 690 Master's Examination. *1-6. F, S, Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

PS 693 Master's Supervised Research. *1-9. F, S, Sum. Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

PS 695 Master's Thesis Research. *1 9. F, S, Sum. Preq: Master's Student.* Thesis Research

PS 699 Master's Thesis Preparation. *1-3. F,S Preq: Master's Student. Credits Arranged* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

PSYCHOLOGY

PSY 200 Introduction to Psychology. *3(3-0) . F,S,Sum.* Survey of basic principles for the understanding of behavior and experience including development, learning, cognition, biological foundations, perception, motivation, personality, behavior abnormalities, measurement of individual differences, and social processes. The value of scientific observation and experimentation to the development of psychological understanding is emphasized.

PSY 220 Orientation to Psychology. *1(1-0) . F.* Orientation for new or potential Psychology majors. Analysis of expectations and demands of the psychology degree programs. Exploration of the challenges and opportunities presented by various post-baccalaureate educational and career options.

PSY (ST) 240 Introduction to Behavioral Research I. *3(3-0) . F,S. Preq: PSY 200. Coreq: PSY (ST) 241. For PSY and HRD majors only.* Introduction to quantitative methods in psychology, including measurement, experimental control, validity, and fundamentals of research design. Discussion of distributions and statistical inference.

PSY (ST) 241 Introduction to Behavioral Research I Lab. *1(0-2) . F,S. Preq: PSY 200. Coreq: PSY (ST) 240. For PSY and HRD majors only.* Students design, analyze and report a variety of simple experiments.

PSY (ST) 242 Introduction to Behavioral Research II. *3(3-0) . F,S. Preq: PSY (ST) 240. Coreq: PSY (ST) 243. For PSY and HRD majors only.* Continuation of PSY (ST) 240. Ethics of Research in Psychology. Techniques for the development of research proposals. Statistical techniques for data analysis including non-parametrics, one-way and two-way ANOVA and introduction to correlation and regression.

PSY (ST) 243 Introduction to Behavioral Research II Lab. *2(0-4) . F,S. Preq: PSY (ST) 240. Coreq: PSY (ST) 242. For PSY and HRD majors only.* Design and analysis of a major research project.

PSY 304 Educational Psychology. *3(3-0) . F,S,Sum.* Psychological principles applied to education, including cognitive and personality development, individual differences, learning and behavior theory, cognitive strategies for learning and remembering, critical thinking and problem-solving strategies, student motivation, classroom management techniques, components of teacher effectiveness, measurement and student evaluation procedures, characteristics of exceptional children, mainstreaming the classroom, and multicultural education.

PSY 307 Industrial and Organizational Psychology. *3(3-0) . F, S, Sum. Preq: PSY 200. Juniors and seniors* Surveys the application of psychological theories and methods to problems involving people in working settings. Topics include: organizational and management theory; work motivation and job satisfaction; job and organizational analysis; performance evaluation; personnel recruitment, selection, and placement; and personnel training and development.

PSY 311 Social Psychology. *3(3-0) . F,S,Sum. Preq: PSY 200.* Theory and research on how individuals respond and are responded to in social situations. Topics include attitude formation and change, affiliation, attraction, self and interpersonal perception, interpersonal relationships, aggression, helping behavior, intergroup behavior, and group dynamics.

PSY 312 Applied Psychology. *3(3-0) . F,S. Preq: PSY 200.* Covers diverse areas of psychological practice, related methods and ethical issues. Includes illustrative cases of psychological practice in health, education, work settings, law, sports, consumer markets, and cross-cultural settings. Explores professional roles and contributions in the contexts of social, organizational and technological change.

PSY 340 Ergonomics. *3(3-0) . F. Preq: PSY 200.* Concepts from ergonomics, environmental psychology, and cognitive psychology related through design examples to problems of everyday living. Criteria of efficiency, comfort and safety evaluated relative to the design of activity, products, and the environment. Topics include: visual and auditory perception, information processing, physical activity, noise and lighting, work space design, workload, and product design.

PSY 350 Human Resource Development Skills. *3(3-0) . F. Preq: Junior standing. Coreq: PSY 495, COM 112. For HRD majors only.* Theoretical, conceptual and intervention principles of human resource development practice in public and private settings; ethics and values; individual, group and organizational behavior; assessment methods; intervention methods. Emphasis on applying principles to internship settings.

PSY 370 Personality. *3(3-0) . F. Preq: PSY 200.* Major personality theories. Definition of personality associated with each theory as well as the assumptions and principles used in accounting for human behavior. Theories evaluated considering recent research.

PSY 376 Developmental Psychology. *3(3-0) . F, S, Sum. Preq: PSY 200 or 304.* Behavioral development during the life span, including study of current theories and project work with persons at various stages of the life cycle.

PSY 400 Perception. *3(3-0) . F,S,Sum. Preq: PSY 200. Junior standing.* Anatomy and physiology of the major sensory systems, their relationship to central structures of the brain, important and/or common pathological conditions. Basic issues and techniques of psychophysics. Perceptual phenomena and theory, with an emphasis on topics in two- and three- dimensional spatial perception, including the perceptions of size, depth and motion. Consideration of perceptual phenomena in practical settings

PSY (WGS) 406 Psychology of Gender. *3(3-0) . F, S Preq: PSY 200 or HSS 200 Credit cannot be given for both PSY 406 and PSY 506* Current theory and research on perceived and actual biological, social, cognitive, personality, and emotional similarities and differences of men and women throughout the lifespan. The construction and consequences of gender in our society and others.

PSY 410 Learning and Motivation. *3(3-0) . F. Preq: PSY 200; Junior standing.* Introduction to the primary laboratory research areas in learning and motivation: classical conditioning, operant conditioning, verbal learning, drive theory, and the role of motives. Emphasis upon research on conditioning and its motivational processes as the foundations for techniques in behavior modification. Examination of both the uses and limitations of current information on learning and motivation.

PSY 420 Cognitive Processes. *3(3-0) . F,S,Sum. Preq: PSY 200; Junior standing.* Introduction to research and theory in cognition, including such topics as memory, acquisition and use of language, reading, problem-solving, reasoning, and concepts.

PSY (PHI) 425 Introduction to Cognitive Science. *3(3-0) F. Preq: One upper-level course in either PHI, PSY, CSC or Linguistics, or permission of instructor.* Philosophical foundations and empirical fundamentals of cognitive science, an interdisciplinary approach to human cognition. Topics include: the computational model of mind, mental representation, cognitive architecture, the acquisition and use of language.

PSY 430 Biological Psychology. *3(3-0) . F,S. Preq: PSY 200 and either BIO 125 or 105; Junior standing.* Biological mechanisms of behavior, including elementary neuroanatomy and neurophysiology, sensory and motor processes, and their application to motivation, learning, and psychological processes.

PSY 436 Introduction to Psychological Measurement. *3(3-0) . S, Alt. yrs. Preq: PSY 240-241 or equivalent.* The basic principles of psychological measurement, including elementary statistical concepts, reliability, and validity. Emphasizes measurement in the science of psychology. Application of measurement principles to a wide variety of measurement problems.

PSY 470 Abnormal Psychology. *3(3-0) . S,Sum. Preq: PSY 200 or 304.* Common psychological disorders of children and adults. Historical and theoretical perspectives on abnormal behavior; issues of assessment and classification, etiology, symptoms, and treatment of disorders.

PSY 475 Child Psychology. *3(3-0) . F,S. Preq: PSY 200 or 304; PSY 376.* Theories, methods, and phenomena of child psychology and application of this information to the enhancement of child development. Multiple aspects of development, including physical, cognitive/intellectual, and social/emotional development, from conception to adolescence. Emphasis on recent research findings in developmental psychology.

PSY 476 Psychology of Adolescent Development. *3(3-0) . F,S,Sum. Preq: PSY 200 or PSY 304.* Theories, principles, and issues of human psychological development emphasizing adolescence. Cognitive, social, and physical changes; their interaction. Implications for teaching and parenting adolescents.

PSY 491 Special Topics in Psychology. *3(3-0) . F,S. Preq: PSY 200.* Exploration in depth of advanced areas and topics of current interest in psychology.

PSY 495 Human Resource Development Practicum. *3-8. F,S. Preq: Jr. standing. For HRD majors only.* Supervised practicum in a human resource development organization during two consecutive semesters. Application of human resource development knowledge and skills.

PSY 498 Psychology Honors Seminar. *3(1-4) . As needed. Preq: Permission of department; HRD and PSY honors students. Must take two semesters.* Seminar and independent study under faculty direction. Provides the undergraduate psychology honors students with an opportunity to practice skills in designing, conducting, and evaluating research. The student, working closely with a faculty advisor, designs a research approach to a particular body of literature. accumulates appropriate data, and analyzes and evaluates the data

PSY 499 Individual Study in Psychology. *1-6. F,S. Preq: Permission of the Department. Coreq: PSY 495 for HRD majors during their work semester.* Individual research project (literature review, experiment, survey, field study) open to any undergraduate, under the direction of a Psychology Department faculty member.

PSY 500 Visual Perception. *3(2-2) . F. Preq: Grad. standing or Consent of Instructor.* Detailed consideration of anatomy and physiology of visual system (both peripheral and central components). Modern quantitative approaches to psychophysical problems of detection, discrimination, scaling. Examination of chief determinants of visual perception, including both stimulus variables and such organismic variables as learning, motivation and attention. Discussion of perceptual theory and processes emphasizes several topics in two- and three-dimensional spatial perception.

PSY 502 Physiological Psychology. *3(3-0) . F. Preq: Twelve hrs. of PSY including PSY 200, 400,410.* Physiological foundations of behavior, basic vertebrate neuroanatomy and neurophysiology.

PSY (WGS) 506 Psychology of Gender. *3(3-0) . F,S, Alt. Yrs.(even). Preq: Permission of Instructor. Credit for both PSY 406 and PSY 506 is not allowed.* Current theory and research on perceived and actual biological, social, cognitive, personality, and emotional similarities and differences of men and women throughout lifespan. Construction and consequences of gender in our society and others.

PSY 508 Cognitive Processes. *3(3-0) . F. Preq: Grad. standing or PBS status.* Emphasis upon the results from research on a number of complex processes (e.g., remembering, concept learning, problem solving, acquisition and use of language) and the theories that have been proposed to explain these results.

PSY 510 Advanced Problems in Psychology. *F, S. Preq: Grad. standing.* Offers opportunities to explore various areas of psychology. Sections: Section D, developmental psychology; Section X, experimental psychology; Section I, industrial-organizational and vocational psychology; Section S, social psychology.

PSY 511 Advanced Social Psychology. *3(3-0) . F. Preq: Grad. standing or PBS status.* A survey of theory and research in social psychology through reading and discussion of primary source materials. In addition, the course deals with issues of methodology, ethical questions in social psychological research and application of research findings to the world at large.

PSY 513 Psychology and Law. *3(3-0) . S. Alt. yrs. Preq: Grad. standing.* Interaction between psychology and law, including pretrial surveys, jury selection, eyewitness identification, jury decision making, competence to stand trial, insanity, expert testimony, sexual assault and the death penalty.

PSY (PHI) 525 Introduction to Cognitive Science. *3(3-0) F. Preq· Grad. standing or Consent of Instructor. Credit for both PHI(PSY) 425 and PHI(PSY) 525 is not allowed.* Philosophical foundations and empirical fundamentals of cognitive science, an interdisciplinary approach to human cognition. The computational model of mind, mental representation, cognitive architecture, the acquisition and use of language.

PSY 535 Tests and Measurements. *3(3-0) . F,S. Preq: Six hrs. of PSY.* A study of the principles of psychological testing including norms and units of measurement, elementary statistical concepts, reliability and validity. In addition, some attention devoted to the major types of available tests such as general intellectual development, tests of separate abilities, achievement tests, measures of personality and interest inventories.

PSY 553 Principles and Practice of Ecological/Community Psychology. *3(3-0) . S Alt Yrs. Preq: Six hrs. PSY.* Introduction to community psychology and its attempt to redefine social problems according to an ecological frame-of-reference with emphasis on humanitarian values, cultural diversity, the promotion of a psychological sense of community among individuals and groups, and the need for psychologists to engage in systematic community research and action.

PSY 558 Psychology and the African Experience. *3(3-0) . S. Alt. yrs. Preq: Six hrs. PSY.* An ethnographic approach to the psychology of peoples of African descent through examination of the influence of historical and cultural phenomena. Specific attention to understanding the Africentric world view and issues of mental health, personality and identity development, racism, oppression and empowerment.

PSY 582 Adolescent Development. *3(3-0) . S, Alt. Yrs, Sum. Preq: 6 hours in PSY or Consent of Instructor.* Current theories and research on development during adolescence. Topics include: physical growth, cognitive changes, relationships with peers, parents and teachers, quest for identity and independence, morality and sexuality.

PSY 584 Advanced Developmental Psychology. *3(3-0) . F. Preq: Nine hrs. of PSY, including PSY 376, PSY 475 or PSY 476.* A survey of the role of growth and development in human behavior, particularly during the child and adolescent periods. This course pays particular attention to basic principles and theories in the area of developmental psychology.

PSY 591 History and Systems of Psychology. *3(3-0) . S. Preq: PSY 200,400,410,420; Consent of Instructor or Grad. status.* Aim of this course is to acquaint students with the history of psychology and psychological systems and to give students some practice in taking different approaches to a particular problem area.

PSY 596 Advanced Educational Psychology. *3(3-0) . F. Preq: Six hrs. of PSY.* A critical appraisal of current psychological findings relevant to educational practice and theory.

PSY 620 Special Problems in Psychology. *1-3 F, S. Preq. 6 hrs. of PSY Coreq. 3 hrs. of ST.* Course provides opportunity for exploration in depth of advanced areas and topics of current interest.

PSY 641 Psychological Clinic Practicum. *1 12. F S. Preq· Twelve hrs. in grad PSY, which must include clinical skill courses PSY "22 and PSY 723 and/or Consent of Instructor..* Clinical participation in interviewing, counseling, psycho-therapy and administration of psychological tests. Practicum to be concerned with adults and children.

PSY 651 Internship in Psychology. *1-12. F, S Preq. Approval of advisory committee.* Supervised work experience in an appropriate setting with professional supervision in the field from a doctoral level psychologist with credentials and/or experience in the appropriate specialty in psychology. Experience consists of full time for one semester or half time for an academic year or equivalent time.

PSY 680 Directed Study Psychology. *F, S. Preq: Consent of Instructor. Credits Arranged.* Research project for graduate students supervised by members of the graduate faculty. Research to be elected on basis of interest of student and not to be part of thesis or dissertation research.

PSY 685 Master's Supervised Teaching. *1 3. F S. Sum Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

PSY 693 Master's Supervised Research. *1-9 F, S. Sum Preq· Master's Student* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

PSY 695 Master's Thesis Research. *1-9. F, S. Sum Preq: Master's Student.* Thesis Research

PSY 699 Master's Thesis Preparation. *1 3. F, S, Sum. Preq· Master's Student. Credits arranged.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

PSY 700 Audition and Other Non-Visual Senses. *3(3 0) . S. Alt yrs. Preq: PSY 500.* Basics of physical and physiological acoustics, auditory anatomy and physiology, psychophysics, hearing loss and hearing conservation, frequency coding, loudness and pitch, binaural phenomena, complex pattern perception, auditory scene analysis, localization and speech perception. Coverage of at least one other topic relevant to non-visual senses (eg, the vestibular system, kinesthesis, pain, smell, taste, temperature, touch, perception of time).

PSY 703 Biological Factors in Abnormal Behavior. *3(3-0) . Sum, Alt. Yrs. Preq: Six hrs. of PSY and six hrs. of biology.* Biological influences and predispositions in abnormal human behavior, including brain damage and disconnection syndromes, psychosomatic illnesses, anxiety and neurosis, manic-depressive disorder, schizophrenia and disorders of memory, eating, movement, sexual behavior and others. Assumes only a moderate biology background.

PSY 704 Learning and Motivation. *3(3-0) . S. Preq: Grad. standing or PBS status.* A systematic analysis of some of the major classes of variables determining behavioral change. Learning variables analyzed within their primary experimental setting, and emphasis upon the diversity of the functions governing behavior change rather than upon the development of some comprehensive theory. Examination of both learning and motivational variables as they contribute to changes in performance within the experimental setting.

PSY 710 Special Topics in Psychology. *1-3. F, S. Preq: Grad. standing, Consent of Instructor.* Course provides opportunity for exploration in depth of advanced topical areas which, because of their degree of specialization, are not generally involved in other courses; for example, multivariate methodology in psychology, computer simulation, mathematical model building. Some new 700-level courses will first be offered under this title during developmental phase and as such may involve lectures and/or laboratories.

PSY 712 Attitudes. *3(3-0) . S. Preq: Six hrs. grad. PSY or Consent of Instructor.* Theory and research in attitude formation and change; analysis of various persuasion paradigms employed in mass communication and group influence processes; study of individual attitudinal structures, resistance to persuasion, behavior as a precursor to attitude change; attitude behavior discrepancy, attitude measurement techniques and methodological considerations.

PSY 713 Attribution. *3(3-0) . S, Alt. Yrs. Preq: PSY 511.* The determinants and consequences of assigning causes for the behavior of others and ourselves. Topics include attributional models, emotional states, success and failure, responsibility assignments, self-handicapping, self-fulfilling prophecy, motivational biases and applications to therapy.

PSY 714 Social Psychology: Small Groups Research. *3(3-0) . S. Preq: PSY 511.* Surveys the literature and research pertaining to social psychological processes in and between groups. Course content includes basic principles of group formation, role differentiation, communication, influence, norms, social exchange, equity, cooperation/conflict, decision making and pro-social behavior. Environmental factors affecting group behavior also considered. In conjunction with each substantive topic, suitable methodologies for research considered.

PSY 720 Psychological Survey Operations. *3(3-0) . S. Preq: ST 507 or equivalent. Coreq: ST 508 or equivalent.* Emphasis on application of survey operational methods to problems of interest to psychologists in governmental, institutional and industrial settings. Course designed to provide competency in questionnaire construction, data collection, design and analysis procedures and report writing. The class will design, conduct and analyze a survey on topic of their own selection in the area of psychology.

PSY 721 Area Seminar in School Psychology. *1-6. F, Alt. Yrs. Preq: Grad. standing or PBS status.* The following topics dealt with: (1) the development of school psychology as a professional area, (2) methods of inquiry, (3) scientific and theoretical bases, (4) contemporary issues, (5) ethical questions, (6) relationship to other areas within psychology.

PSY 722 Individual Intelligence Measurement. *4(4-3) . F, Alt. Yrs. Preq: PSY 535 and consent of school psychology coordinator.* Theoretical approaches to and individual assessment of intellectual functioning, child development, adaptive behavior, and visual motor functioning. Administration, scoring, and interpretation of current standardized instruments and nonstandardized assessment. Written communication of findings.

PSY 723 Personality Measurement. *3(2-3) . S, Alt. Yrs. Preq: PSY 722.* Theory and practicum in individual personality testing of children and adults with emphasis on projective techniques, other personality measures, report writing and case studies.

PSY 724 Psychological Intervention I. *3(2-2) . F, Alt. Yrs. Preq: PSY 723 and Consent of Instructor.* Designed to examine theories, research, techniques, ethics and professional responsibilities related to approaches to psychological intervention. Types of psychological intervention include behavior modification, milieu approaches, crisis intervention techniques and group process methods, in addition to more intensive relationship approaches. A close integration of experiences, content and supervision emphasized in a variety of professional settings with a wide range of personal problems and age groups.

PSY 725 Psychological Intervention II. *3(2-2) . S, Alt. Yrs. Preq: PSY 724.* The primary purpose of this course is to provide students opportunities to acquire information, conceptual frameworks, interpersonal skills and a sense of ethical responsibility, all basic to their further development as practicing psychologists. A major effort in the course made to help the student increase his/her interpersonal skills as a means of promoting the psychological growth and effective-ness of others.

PSY 727 Psychological Consultation. *3(2-2) . S. Preq: Nine hrs. grad. PSY or ED.* Introduction to psychological consultation with emphasis on school setting. Presentation of various consultation models and theoretical bases. Development of skills in practice of consultation.

PSY 732 Theories of Intelligence. *3(3 0) . S, Alt. Yrs. Preq: Grad. standing.* Critical analysis of the psychological construct of intelligence. Traditional theories, as well as cognitive developmental, information-processing, comparative psychology, artificial intelligence, cross-cultural and epistemological approaches to intelligence explored.

PSY (IE) 740 Human Factors in Systems Design. *3(3-0) . F. Preq: IE 452 or PSY 340. Coreq: ST 507 or 511.* Introduction to problems of the systems development cycle, including human-machine function allocation, military specifications, display control compatibility, the personnel sub-system concept and maintainability design. Detailed treatment given to people as information processing mechanisms.

PSY (IE) 743 Ergonomic Performance Assessment. *3(3-0) . F, Alt. Yrs. Preq: PSY 200, ST 507 and 508 or equivalent.* Fundamentals of ergonomic performance measurement used to assess the effects of environment and system design on human performance. Treatment of topics such as workload measurement, measurement of complex performance, simulator studies, measurement of change, task taxonomies, criterion task sets and statistical methods of task analysis. Problems of laboratory and field research, measurement of change and generalizability of findings.

PSY (IE) 744 Human Information Processing. *3(3-0) . S, Alt. Yrs. Preq: PSY 200, ST 507 and 508 or equivalent.* Fundamentals of human information processing basic to skilled operator performance and the design of displays, controls and complex systems. Treatment of topics such as channel capacity, working memory, long-term memory, decision making, attention and process monitoring. Problems of display and control design and evaluation, evaluation of textual material, and human-computer interaction.

PSY (IE) 745 Human Performance. *3(3-0) . S, Alt. Yrs. Preq: Grad. standing; ST 507 or equivalent.* Fundamentals of human perceptual and motor abilities basic to skilled operator performance. Theoretical models of man as an operator. The human as an information processing mechanism. Motor skills learning, performance decrement and information feedback. Channel capacity, stress, fatigue, arousal theory. Attention, time-sharing and workload. Sustained performance, vigilance, monitoring, search, inspection and tracking. Circadian rhythms; sleep loss; shift work.

PSY 750 Area Seminar in Human Resources Development. *1-6. F,S. Preq: Consent of Instructor.* The following topics dealt with: (1) human resources development as an area of inquiry, (2) methods of inquiry, (3) contemporary issues, (4) ethical questions, (5) relationship to other areas within psychology.

PSY 751 Human Resource Planning. *3(3-0) . F, Alt. Yrs. Preq: Grad. standing or PBS status. Coreq: ST 507 or equivalent.* Review of the literature, methods and research issues in the field of human resource planning and evaluation. Goal-setting, needs assessment, information systems, subjective probability, human resource accounting, decision processes, incentive programs, human productivity and related subjects. Focus on planning and evaluation methods for communities and organizations.

PSY 752 Action Research in Psychology. *3(3-0) . S. Preq: ST 511 or equivalent Coreq: ST 508 or equivalent.* Action research models in psychology and their relationships to research methods. Research in field settings and implications for ethics and social responsibility, internal and external validity, experimenter and volunteer effects and problems of measurement.

PSY 755 Cross-Cultural Research and Development. *3(3 0) S, Alt. Yrs. Preq: ST 507 or equivalent, grad. standing. Coreq: ST 508 or Consent of Instructor* Review of the literature, methods and issues in cross cultural research and development. Cross-cultural programs evaluation and policy studies in health, education, technology transfer, international cooperation and communications. For graduate students in science and technology with plans to work in international settings.

PSY 756 Consumer Research. *3(3 0) . S, Alt Yrs Preq ST 507 or equivalent, grad standing or PBS status. Coreq: ST 508.* Review of the literature, methods and research issues pertaining to consumer behavior. Consumer demographics, psychographics, attitudes, persuasion, intentions, decision processes, consumption, saving, innovation and related topics. Research methods including experiments, surveys, focus groups and case studies.

PSY 757 Innovation and Technology. *3(3-0) . F. Preq. 3 hrs. grad. ST or research methods.* Social science theory and research on innovation process and consequences of deploying and implementing technologies. Interactions between social and technical systems: R&D management; social/administrative technology; adoption and dissemination; public policy; computer-mediated communications; implementation; and intended and unintended outcomes for individuals, organizations and society.

PSY 761 Psychological Measurement. *3(3-0) . F. Preq: ST 507 or 511 or equivalent, 12 hrs. of PSY.* Theory of psychological measurement. Statistical problems and techniques in test construction.

PSY 762 Quasi-Experimental Evaluation Design. *3(3-0) . S. Preq: ST 507 or equivalent.* An introduction to quasi-experimental design as applied to HRD program evaluation: (1) Methods of assessing informational needs, (2) recognition of internal and external validity threats, (3) design of quasi-experiments to minimize threats and (4) use of results by program decision makers.

PSY 763 Systems Theory and Applications in Human Resource Development. *3(3-0) . F. Preq: PSY 750 or equivalent.* An introduction to the systems approach and general systems theory. (1) Concepts and terminology of general systems theory, (2) techniques currently used to access system requirements and (3) methods of analyzing system performance. Emphasis on application of systems techniques to the design and implementation of human resource development programs.

PSY 764 Survey of Industrial/Organizational Psychology. *3(3-0) . S. Preq: PSY 535.* Issues surrounding the person, organization and job. Employee motivation and work attitudes, work analysis and design, recruitment, selection, training, and performance appraisal of employees, and organizational leadership and group/team processes. Emphasis on scientist-practitioner model throughout the course.

PSY 765 Vocational Psychology. *3(3-0) . F, Alt Yrs. Preq: ST 507, PSY 761 or equivalent.* The study of the individual's vocational behavior and development through the years of choice and adjustment. An up-to-date review and synthesis of research and theory in the field of vocational psychology. Empirical studies and theoretical statements in the field appraised and evaluated to determine what behavioral laws apply to vocational phenomena.

PSY 766 Personnel Selection Research. *3(3-0) . F, Alt. Yrs. Preq: Six hrs. of grad. ST, PSY 535.* A survey of theoretical, methodological and research literature on personnel selection. Topics include organization, task and person analyses, validation strategies, utility and equal opportunity issues and selection strategies. Emphasis on research.

PSY 767 Training Research. *3(3-0) . F, Alt Yrs. Preq: Six hrs. of grad. PSY and six hrs. of grad. ST.* A survey of conceptual and research literature on training. Topics include needs assessments, learning, transfer, maintenance, criterial and evaluation issues, as well as a review of research on specific training techniques. Emphasis on research methods and findings, not skill development in specific training techniques.

PSY 768 Organizational Psychology. *3(3-0) . F. Preq: Nine hrs. of PSY.* A study of the application of behavioral science, particularly psychology and social psychology, to organizational and management problems.

PSY 769 Work Motivation. *3(3 0) . S, Alt. Yrs. Preq: PSY 768.* Theory and research in work motivation. An in-depth examination of motivation theory as it pertains to the study of individual behavior in work settings.

PSY 770 Organization Development and Change. *3(3 0) . S. Alt. Yrs. Preq: PSY 768.* A survey of theory and research in organization development. Attention directed to: (1) methods of diagnosing need for organizational change, (2) techniques currently used to implement and evaluate organizational change, (3) professional ethics and other issues dealing with client-consultant relationship. Emphasis on developmental approaches originating from psychology and allied fields.

PSY 785 Methodological Issues in Developmental Psychology. *3(3-0) . S, Alt. Yrs. Preq: PSY 584 and 3 hrs. of grad. statistics.* Methodological issues, research designs and statistical techniques in developmental psychology. Role and meaning of age as a research variable. Interpretation of research reports. Ethical issues.

PSY 786 Cognitive Development. *3(3 0) . S, Alt .Yrs. Preq: PSY 584.* Examination of research and theory in cognitive development. Primary focus on childhood, but implications for the entire life span addressed. Application of cognitive developmental principles in creating interventions and educational programs also discussed.

PSY 787 Social Development. *3(3-0) . S, Alt .Yrs. Preq: PSY 584.* Survey of current theory and research on the development of social behavior systems, including attachment, aggression, gender-role behavior, prosocial behavior. Attention to the role of social class, race and culture, and to contemporary phenomena such as day care, single-parent and dual-career families, child abuse.

PSY 788 Adulthood and Aging: Cognitive and Intellectual Change. *3(3-0) . F, Alt. Yrs. Preq: PSY 584 or equivalent.* Critical examination of theory and research associated with the study of cognitive and intellectual change in adulthood and aging. Memory and learning, information processing, language, intelligence, social cognition and expertise.

PSY 789 Socio-Emotional Processes in Adulthood and Aging. *3(3-0) . F, Alt. Yrs. (Odd). Preq: PSY 584.* Current theory and research on social, emotional and personality development during adulthood and aging. Generally including self-concept and identity, interpersonal relations (friendship, marriage, parenting, work), control, coping and life satisfaction. Attention to gender, culture and contemporary issues in adult development and aging.

PSY 792 Psychology of Families and Parenting. *3(3-0) . F, Alt. Yrs. Preq: Nine hrs. grad. PSY or ED.* Special topics in the area, including family influences on cognitive development, effects of parental divorce on children, single-parenting, step-families, child abuse and ethnic/cultural differences in family functioning. A critical examination of traditional and contemporary parenting approaches and an introduction to family therapy.

PSY 795 Stress and Coping. *3(3-0) . F, Alt. Yrs. Preq: Two grad. PSY courses.* Discussion of current research findings and theories in area of psycho-social stress. Topics include: biology of the stress response, methodology, physical, behavioral and psychological reactions to stress, and relationships between personality and social support to the development of stress-related disorders.

PSY 800 Introduction to Graduate Study in Psychology. *1(1-0) . F. Preq: Grad. standing in PSY.* Orientation to graduate study in psychology. Library and computer systems. Faculty research and teaching interests. Special research facilities and populations. Standards for research with human and infra-human subjects. Ethical principles of American Psychological Association. Generic and specialty guidelines for providers of psychological services. North Carolina Licensing Law and supporting rules. Psychology as science, discipline and profession.

PSY 802 Area Seminar in Ergonomics. *1(1-0) . F. Preq: Grad. standing or PBS status.* Introduction to ergonomics as an area of study; historical aspects; contemporary issues; ethical questions; overview of campus research, facilities and courses in the area; consideration of information sources, financial support for research proposals and employment opportunities.

PSY 807 Advanced Seminar in Research Design. *3(3-0) . F. Preq: Nine hrs. of statistical methods and research or Consent of Instructor, Advanced grad. status.* A seminar-type course with topics selected each semester in accordance with the interests and needs of the students. Attention given to the research strategies that underlie educational and psychological research, to the development of theoretical constructs, to a critical review of research related to problems in which the students interested, and to a systematic analysis and critique of research problems in which the students engaged.

PSY 809 Psychology Colloquium. *1(1-0) .*

PSY 820 Special Topics in Psychology. *1-3. F, S. Preq: 6 hrs. of PSY. Coreq: 3 hrs. of ST.* Course provides opportunity for exploration in depth of advanced areas and topics of current interest.

PSY 825 Advanced Problems In Perception. *3(3 0) . S, Alt Yrs. Preq: PSY 700.* An exploration of advanced topics in the field of perception. Specific coverage varies from year to year but may include examination of attentional and organizational factors in perception, information processing approaches to perception, theories of perception and/or perceptual/motor skills.

PSY 826 Advanced Problems in Cognition. *3(3-0) . S. Preq: PSY 508 or Consent of Instructor.* This seminar provides the opportunity for exploring in depth problems and issues in memory, concept learning, problem solving, psycholinguistics and other areas in cognition.

PSY 841 School Psychology Practicum. *1-12. F, S. Preq: Twelve hrs. in grad. PSY, which must include clinical skill courses PSY 722 and PSY 723 and/or Consent of Instructor.* Clinical participation in interviewing, counseling, psycho-therapy and administration of psychological tests. Practicum to be concerned with adults and children.

PSY 846 Practicum in Industrial/Organizational Psychology. *3(3-0) . F,S Alt. Yrs.(odd). Preq: PSY 764.* Procedures and techniques used by Industrial and Organizational Psychologists in the field. Students write work proposals, conduct interventions in field, and codument results. Review one or more I/O procedure step-by-step.

PSY 851 Internship in Psychology. *1-12. F, S. Preq: Master's degree in PSY and approval of advisory committee.* Supervised work experience in an appropriate setting with professional supervision in the field from a doctoral level psychologist with credentials and/or experience in the appropriate specialty in psychology. Experience consists of full time for one semester or half time for an academic year or equivalent time.

PSY 880 Directed Study in Psychology. *F, S. Preq: Consent of Instructor. Credits Arranged.* Research project for graduate students supervised by members of the graduate faculty. Research to be elected on basis of interest of student and not to be part of thesis or dissertation research.

PSY 885 Doctoral Supervised Teaching. *1-3. F, S, Sum. Preq: Doctoral Student.* Teaching experience under the mentorship of faculty who assist the student in planing for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

PSY 890 Doctoral Preliminary Exam. *1-9. F, S, Sum. Preq: Doctoral Student.* For students who are preparing for and taking written and/or oral preliminary exams.

PSY 893 Doctoral Supervised Research. *1-9. F, S, Sum. Preq: Doctoral Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

PSY 895 Doctoral Dissertation Research. *1-9. F, S, Sum Preq: Doctoral Student.* Dissertation Research

PSY 899 Doctoral Dissertation Preparation. *1-3. F, S, Sum. Preq: Doctoral Student.* For students who have completed all credit hour requirements, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

PHYSICS

PY 101 Perspectives on Physics. *1(1-0) . F. Preq: Course available for Physics majors only.* Orientation to the current practice of physics, including discussion of historical background, scientific viewpoint, current topics, and careers in physics. Visits to departmental research laboratories.

PY 123 Stellar and Galactic Astronomy. *3(3-0) . F,S.* Introductory, descriptive survey of stars, galaxies and cosmology, designed primarily for non-science majors. Exotic recent discoveries such as quasars, pulsars, and black holes will be included. Complements PY 124, Solar System Astronomy. Companion laboratory course PY 125.

PY 124 Solar System Astronomy. *3(3-0) . F,S.* Introductory, descriptive survey of the solar system designed primarily for non-science majors, including current results from space probes, history of astronomy, and the motions of the moon, stars, and planets in the night sky. Complementary course covering stars, galaxies and cosmology (PY 123). Companion laboratory course (PY 125).

PY 125 Astronomy Laboratory. *1(0-2) . F,S. Coreq: PY 123 or 124.* Introduction to astronomical observing. Twelve exercises include astronomical instruments; the nature of light; Kepler's and Newton's laws of motion; the constellations, planets, binary stars, stellar clusters, and galaxies. Use of small telescopes to observe celestial objects.

PY 126 Computer-based Astronomy Laboratory. *1(0-2) . F,S. Coreq: PY 123 or PY 124.* Ten computer-based laboratory exercises in astronomy. Celestial coordinates, motions of celestial objects, and bright stars and constellations. Simulated observing of planets, stars, and galaxies, with data reduction and analysis. Co-requisite: PY 123 or PY 124.

PY 131 Conceptual Physics. *4(3-2) . F,S,Sum. For humanities and social science students only.* Fundamentals of physics from a conceptual rather than a mathematical viewpoint. Applications of physics to everyday phenomena and experiences. Numerous demonstrations and discovery-based laboratory. Mechanics, properties of matter, heat, sound, electricity and magnetism, light and relativity.

PY 133 Conceptual Physics: Optics. *4(3-2) . F,S.* Fundamentals of optics from a conceptual rather than a mathematical viewpoint. Applications of optics ranging from everyday phenomena to modern optical devices; from rainbows to lasers. Numerous demonstrations and discovery-based laboratory. Properties of light, color, optical devices, light in the atmosphere, vision in animals and man, light in modern physics, light in the cosmos.

PY 201 General Physics I. *4(3-3) . F. Coreq: MA 141.* First course of three semester sequence for students majoring in physical and mathematical sciences. Calculus used throughout. Principles of classical Newtonian mechanics covered in detail.

PY 202 General Physics II. *4(3-3) . S. Preq: PY 201, MA 141. Coreq: MA 241.* Second course of three semester sequence designed primarily for students majoring in physical and mathematical sciences. Calculus used throughout. Principles of electricity and magnetism covered in detail.

PY 203 General Physics III. *4(3-3) . F. Preq: PY 202, MA 241. Coreq: MA 242.* Third course of three semester sequence designed primarily for students majoring in physical and mathematical sciences. Calculus is used throughout. Principles of wave optics and modern physics are covered in detail.

PY 204 General Physics. *3(3-0) . Preq: MA 141. Credit cannot be earned for both PY 204 and PY 205.* Introduction to physics, including the study of mechanics, sound, heat, and thermodynamics. The analytical approach is employed with emphasis on problem solving. Identical to PY 205, except that there is no laboratory. Offered only through Independent Study by Extension.

PY 205 Physics for Engineers and Scientists I. *4(3-3) . F,S,Sum. Preq: MA 141 with a grade of C or better.* First semester of a two-semester sequence in introductory physics, with laboratory. A calculus-based study of mechanics, sound and heat.

PY 206 General Physics Laboratory. *1(0-2) . F,S,Sum. Preq: PY 204. Enrollment subject to approval of Physics Department, and limited to students who have passed PY 204. Not open to students having credit for PY 205.* Approximately ten experiments taken from the fields of mechanics, sound, heat and thermodynamics.

PY 208 Physics for Engineers and Scientists II. *4(3-3) . F,S,Sum. Preq: PY 205 and MA 241 with grade of C or better.* Second semester of a two-semester sequence in introductory physics, with laboratory. A calculus-based study of electricity, magnetism, optics and modern physics.

PY 211 College Physics I. *4(3-2) . F,S,Sum. Preq: MA 107 or MA 111. Credit not allowed for both PY 211 and either PY 201 or PY 205.* First semester of a two-semester introductory sequence in non-calculus physics, with laboratory. Mechanics, heat, wave motion and sound.

PY 212 College Physics II. *4(3-2) . F,S,Sum. Preq: PY 211. Credit not allowed for both PY 212 and either PY 202 or PY 208.* Second semester of a two-semester introductory sequence in non-calculus physics, with laboratory. Electricity, and magnetism, light, modern physics.

PY 299 Special Problems in Physics. *1-3. F,S,Sum. Preq: Consent of department.* Study in experimental or analytical topics in classical and modern physics.

PY 328 Stellar and Galactic Astrophysics. *3(3-0) . S. Preq: PY 202 or PY 208.* Introduction to the study of stars, galaxies and the universe. Stars and stellar evolution; interstellar medium; galaxies and galaxy clusters; cosmology. Recent developments in the understanding of neutron stars, black holes, active galaxies, quasars and inflationary cosmologies.

PY 341 Space Time Physics. *3(3-0) . S. Preq: PY 203 or 407.* Introduction to space time physics in accordance with Einstein's special theory of relativity; time dilation, twin paradox, Doppler effect, relativistic space travel, four-vectors, relativistic momentum and energy conservation laws in high energy physics. Consequences of Einstein's gravitational theory in cosmology; models of the expanding universe, neutron stars, black holes and the "big bang" hypothesis. .

PY 401 Quantum Physics I. *3(3-0) . F,S. Preq: PY 411.* An introduction to the basic principles of quantum physics with an emphasis on selected applications to atoms, molecules, solids, nuclei and elementary particles.

PY 402 Quantum Physics II. *3(3 0) . F,S. Preq: PY 411.* An introduction to the basic principles of quantum physics with an emphasis on selected applications to atoms, molecules, solids, nuclei and elementary particles.

PY 407 Introduction to Modern Physics. *3(3-0) . F,S, Sum. Preq: MA 242, PY 208. Credit not allowed for both PY 203 and PY 407.* Major developments in modern physics: special relativity, origin of the quantum theory, atomic and molecular structure, radioactivity, properties of nuclei.

PY 411 Mechanics I. *3(3-0) . F. Preq: PY 203 or 208, MA 341.* First semester of a two-semester sequence in particle and continuum mechanics at the intermediate level. Focuses on single-particle dynamics: Elementary Newtonian mechanics, harmonic oscillator, central force motion, conservation laws, motion in non-inertial frames, Coriolis and centrifugal forces, Lagrangian dynamics, Hamilton's equations.

PY 412 Mechanics II. *3(3-0) . S. Preq: PY 411.* Second semester of a two-semester sequence in particle and continuum mechanics at the intermediate level. Focuses on dynamics of systems of particles and continua: Center of mass, collisions, rigid bodies, inertia tensor, principal axes, stress and strain tensors, mechanical properties of fluids and solids; Waves in discrete and continuum systems, coupled oscillators, normal modes, elements of special relativity.

PY 413 Thermal Physics. *3(3-0) . S. Preq: PY 203 or 407, MA 341.* An introduction to statistical mechanics and thermodynamics. The statistical study of physical systems emphasizing the connection between the statistical description of macroscopic systems and classical thermodynamics. Concepts of heat, internal energy, temperature and entropy. Classical and quantum statistical distributions.

PY (NE) 414 Electromagnetism I. *3(3-0) . F. Preq: PY 203 or 208, MA 341.* First semester of a two-semester sequence. An intermediate course in electromagnetic theory using the methods of vector calculus. Electrostatic field and potential, dielectrics, solution to Laplace's and Poisson's equations, magnetic fields of steady currents.

PY (NE) 415 Electromagnetism II. *3(3-0) . S. Preq: PY 414.* A continuation of PY 414. Electromagnetic induction, magnetic fields in matter, Maxwell's equations, wave guides, radiation.

PY 452 Advanced Physics Laboratory. *3(1-4) . F,S. Preq: Senior standing. Senior Physics students only.* Introduction to laboratory electronics and instrumentation. Experiments in mechanics; electromagnetism; electronics; optics; and atomic, nuclear, plasma and solid state physics.

PY (MEA) 463 Fluid Physics. *3(3-1) . F. Preq: MA 341 and PY 208.* A derivation of the basic equations governing fluid motion in a rotating coordinate system. Equations include conservation of mass or the continuity equation, momentum equations, thermodynamic energy equation and the vorticity equation. Application of equations to simplified oceanic flows which include surface gravity waves, inertial motion, geostrophic motion, Ekman dynamics and vorticity dynamics.

PY 499 Independent Research in Physics. *1-6 F,S,Sum. Preq: Consent of department.* Study and research in physics. Topics for experimental or theoretical investigation.

PY 501 Quantum Physics I. *3(3-0) . F. Preq: PY 411. Credit for both PY 401 and PY 501 is not allowed.* Basic principles of quantum physics with emphasis on selected applications to atoms, molecules, solids, nuclei and elementary particles. PY 501 - first semester in two-semester sequence in quantum mechanics; PY 501 - second semester of sequence.

PY 502 Quantum Physics II. *3(3-0) . S. Preq: PY 401 Credit for both PY 402 and PY 502 is not allowed.* Basic principles of quantum physics with emphasis on selected applications to atoms, molecules, solids, nuclei and elementary particles. PY 502 - second semester in two-semester sequence in quantum mechanics; PY 501, first semester of sequence.

PY 506 Nuclear and Subatomic Physics. *3(3 0) . F. Preq: PY 203 or 407, PY 412.* Introduction to nuclear and subatomic phenomena: properties of nuclear radiations and detectors, accelerators, nuclear forces and nuclear structure, elementary particles, fundamental symmetries and conservation laws.

PY 507 Elementary Particle Physics. *3(3-0) . S. Preq: PY 401 and PY 506.* Introduction to fundamental symmetries and dynamics of quarks and leptons. The Standard Model, Dirac equation, Feynman rules in QED and QCD, the Higgs mechanism and electroweak unification.

PY 508 Ion and Electron Physics. *3(3-0) F. Preq: PY 414* Topics: charged particle dynamics, introduction to plasma physics, processes in ionized gases, electron emission and the physics of electron beams.

PY 509 Plasma Physics. *3(3-0) . F. Preq: PY 414.* Individual and collective motion of charged particles in electric and magnetic fields and through ionized gases.

PY 511 Mechanics I. *3(3-0) . F. Preq: PY 203 or 208, MA 341. Credit for both PY 411 and PY 511 is not allowed.* First semester of two-semester sequence in particle and continuum mechanics at intermediate level. Single-particle dynamics: Elementary Newtonian mechanics, harmonic oscillator, central force motion, conservation laws, motion in non-inertial frames, Coriolis and centrifugal forces, Lagrangian dynamics, Hamilton's equations.

PY 512 Mechanics II. *3(3-0) . S. Preq: PY 511. Credit for both PY 412 and PY 512 is not allowed.* Second semester of two-semester sequence in particle and continuum mechanics at intermediate level. Dynamics of systems of particles and continua: Center of mass, collisions, rigid bodies, inertia tensor, principla axes, stress and strain tensors, mechanical properties of fluids and solids; waves in discrete and continuum systems, coupled oscillators, normal modes, elements of special relativity.

PY 514 Electromagnetism I. *3(3-0) . F. Preq: PY 203 or PY 208, MA 341. Credit for both PY 414 and PY 514 is not allowed.* First semester of two-semester sequence. An intermediate course in electromagnetic theory using the methods of vector calculus. Electrostatis field and potential, dielectrics, solution to Laplace's and Poisson's equations, magnetic fields of steady currents.

PY 515 Electromagnetism II. *3(3-0) . S. Preq: PY 514. Credit for both PY 415 and PY 515 is not allowed.* Continuation of PY 514. Electromagnetic induction, magnetic fields in matter, Maxwell's equations, wave guides, radiation.

PY 516 Physical Optics. *3(3-0) . F. Preq: PY 415.* Physical optics with major emphasis on wave properties of light. Boundary conditions, interference and diffraction, optics of thin films, fiber optics and applications to absorption, scattering and laser operation. A background in Maxwell's equations and vector analysis required.

PY 517 Atomic and Molecular Physics. *3(3-0) . S. Preq: PY 401, 412.* The quantum mechanical treatment of structure and spectra for atoms and molecules. The hydrogen atom, helium atom, multielectron atoms, selection rules, diatomic and simple polyatomic molecules and nuclear magnetic resonance spectroscopy.

PY 525 Computational Physics. *3(3-0) . F. Preq: MA 341, PY 411, PY 414.* Computational approach to physics problem solving using standard software relevant for physicists. Electrostatic potentials, data analysis, Monte Carlo simulations, Fourier optics, particle orbits, Schrodinger's equation. Examples and assignments for each topic chosen to complement other physics courses.

PY (NE) 528 Introduction to Plasma Physics and Fusion Energy. *3(3-0) . F Preq. MA 401 and PY 208 or equivalent.* Concepts in plasma physics, basics of thermonuclear reactions; charged particle collisions, single particle motions and drifts. radiation from plasmas and plasma waves. fluid theory of plasmas. formation and heating of plasmas, plasma confinement, fusion devices and other plasma applications.

PY 543 Astrophysics. *3(3-0) . S. Preq: PY 203 or 407; PY 411.* Basic physics necessary to investigate, from observational data, internal conditions and evolution of stars. The formation and structure of spectral lines, methods of energy generation and transport, stellar structure, degeneracy, white dwarfs and neutron stars.

PY (ECE) 552 Introduction to the Structure of Solids. *3(3-0) . S. Preq: PY 401.* Basic considerations of crystalline solids, metals, conductors and semiconductors.

PY 561 Electronics For Physicists. *3(1-4) . S. Preq: Grad. standing.* Analog and digital electronics laboratory course serving as introduction to use of modern instrumentation required for experimental research in physics. Bipolar and field effect transistors, operational amplifiers, oscillators, power supplies, analog-digital and digital-analog conversion and digital logic circuits.

PY (MA) 575 Mathematical Introduction to Celestial Mechanics. *3(3-0) . F. Preq: MA 301.* Central orbits, N-body problem, 3-body problem, Hamilton-Jacobi theory, perturbation theory, applications to motion of celestial bodies.

PY (MA) 576 Orbital Mechanics. *3(3-0) . S. Preq: MA 341, 405, knowledge of elementary mechanics and computer programming.* Keplerian motion, iterative solutions, numerical integration, differential corrections and space navigation, elements of probability, least squares, sequential estimation, Kalman filter.

PY 601 Seminar. *1(1-0) . F, S.* Reports on topics of current interest in physics. Several sections offered so that students with common research interests may be grouped together.

PY 610 Special Topics. *F, S. Preq: Consent of department. Credits Arranged.* Investigations in physics under staff guidance. May consist of literature reviews, experimental or theoretical projects or special topics lectures.

PY 615 Advanced Special Topics in Physics. *1-3. F, S. Preq: Consent of Instructor.* Advanced study in astrophysics, atomic and molecular physics, condensed matter physics, nuclear physics or plasma physics. Emphasis on new and rapidly developing research areas.

PY 660 Advanced Placement Physics for Secondary School Teachers. *6(6-0) . Sum. Preq: Teaching certificate.* A preparation for teaching advanced placement physics to high school students. Review of the physics content on the AP curriculum and discussion of teaching techniques, demonstrations and laboratories for use in such a program.

PY 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment and evaluate the student upon completion of the assignment.

PY 693 Master's Supervised Research. *1-9. F, S, Sum. Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

PY 695 Master's Thesis Research. *1-9. F, S, Sum. Preq: Master's Student.* Thesis Research

PY 699 Master's Thesis Preparation. *1-3. F, S, Sum. Preq: Master's Student. Credits Arranged.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

PY 711 Advanced Quantum Mechanics I. *3(3-0) . F. Preq: MA 512, PY 782.* Introduction to relativistic quantum theory of Dirac particles and the positron. Other topics including second quantization technique and its application to many-body problems, radiation theory and quantization of the electromagnetic field.

PY 712 Advanced Quantum Mechanics II. *3(3-0) . S. Preq: PY 601, 711.* A general propagator treatment of Dirac particles, photons and scalar and vector mesons. Applications of Feynman graphs and rules illustrating basic techniques employed in treatment of electromagnetic, weak and strong interactions. Renormalization theory, the effects of radiative corrections and aspects of the general Lorentz covariant theory of quantized fields.

PY 721 Statistical Physics I. *3(3-0) . S. Preq: PY 401, PY 413.* Basic elements of kinetic theory and equilibrium statistical mechanics, both classical and quantum; applications of the techniques developed to various ideal models of noninteracting particles.

PY 722 Statistical Physics II. *3(3-0) . F. Preq: PY 721.* A continuation of PY 721, with emphasis on the static and dynamic properties of real (interacting) systems. Topics including equilibrium theory of fluids and linear response theory of time-dependent phenomena.

PY (ECE) 727 Semiconductor Thin Films Technology. *3(3-0) . S. Alt. Yrs.. Preq: ECE 730.* Techniques and processes encountered in growth and characterization of epitaxial semiconductor films. Examples of growth techniques: solution growth, chemical vapor deposition, molecular beam epitaxy and sputtering. Film characterization includes electrical characterization using Hall techniques, optical characterization using x-ray and electron microscopy techniques, surface and thin film analysis such as auger and secondary ion mass-spectrometer.

PY 730 Nuclear Structure Physics I. *3(3-0) . S. Preq: PY 782; PY 506.* Advanced description of nuclear models and nuclear reactions. Topics including internucleon forces, compound-nucleus processes, shell model, optical model, R-matrix theory, direct reactions, collective model, electromagnetic transitions, isobaric analog states.

PY 753 Introduction to the Structure of Solids II. *3(3-0) . F. Preq: PY 552 or equivalent.* The properties of semiconductors, superconductors, magnets, ferroelectrics and crystalline defects and dislocations.

PY 754 Properties of Surfaces and Interfaces. *3(3-0) . Preq: PY(ECE) 552.* Properties of surfaces and interfaces of materials. Relation between electronic properties and atomic structure. (A) Surfaces: thermodynamics, experimental techniques, structure and reconstruction.

PY 781 Quantum Mechanics I. *3(3-0) . F, S. Preq. MA 512; PY 411 or 414 grad. standing or permission of the Director of Grad. Programs.* Fundamental concepts and formulations, including interpretation and techniques, and the application of theory to simple physical systems, such as the free particle, the harmonic oscillator, the particle in a potential well and central force problems. Other topics including approximation methods, identical particles and spin, transformation theory, symmetries and invariance, and an introduction to quantum theory of scattering and angular momentum.

PY 782 Quantum Mechanics II. *3(3-0) . F, S. Preq: MA 512; PY 411 or 414; grad standing or permission of the Director of Grad. Programs.* Fundamental concepts and formulations, including interpretation and techniques, and the application of theory to simple physical systems, such as the free particle, the harmonic oscillator, the particle in a potential well and central force problems. Other topics including approximation methods, identical particles and spin, transformation theory, symmetries and invariance, and an introduction to quantum theory of scattering and angular momentum.

PY 783 Advanced Classical Mechanics I. *3(3-0) . F. Preq: MA 512, PY 412. PY 414; grad. standing or permission of the Director of Grad. Programs.* Introduction to theoretical physics in preparation for advanced study. Emphasis on classical mechanics, special relativity and the motion of charged particles. Topics including variational principles, Hamiltonian dynamics and canonical transformation theory, structure of the Lorentz group and elementary dynamics of unquantized fields.

PY 785 Advanced Electricity and Magnetism I. *3(3-0) . F, S. Preq: PY 415; grad. standing or permission of the Director of Grad. Programs.* Topics including techniques for solution of potential problems, development of Maxwell's equations; wave equations, energy, force and momentum relations of an electromagnetic field; covariant formulation of electrodynamics; radiation from accelerated charges.

PY 786 Advanced Electricity and Magnetism II. *3(3-0) F, S. Preq: PY 415, grad. standing or permission of the Director of Grad. Programs.* Topics including techniques for solution of potential problems, development of Maxwell's equations; wave equations, energy, force and momentum relations of an electromagnetic field; covariant formulation of electrodynamics; radiation from accelerated charges.

PY 801 Seminar. *1(1-0) . F, S, Sum.* Reports on topics of current interest in physics. Several sections offered so that students with common research interests may be grouped together.

PY 810 Special Topics in Physics. *F, S. Preq: Consent of department. Credits Arranged.* Investigations in physics under staff guidance. May consist of literature reviews, experimental or theoretical projects or special topics lectures.

PY 815 Advanced Special Topics in Physics. *1-3. F, S. Preq: Consent of Instructor.* Advanced study in astrophysics, atomic and molecular physics, condensed matter physics, nuclear physics or plasma physics. Emphasis on new and rapidly developing research areas.

PY 860 Advanced Placement Physics for Secondary School Teachers. *6(6-0) . Sum. Preq: Teaching certificate.* A preparation for teaching advanced placement physics to high school students. Review of the physics content on the AP curriculum and discussion of teaching techniques, demonstrations and laboratories for use in such a program.

PY 885 Doctoral Supervised Teaching. *1-3. F, S, Sum. Preq: Doctoral Student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment and evaluate the student upon completion of the assignment.

PY 890 Doctoral Preliminary Examination. *1 9. F, S, Sum. Preq: Doctoral Student.* For students who are preparing for and taking written and/or oral preliminary exams.

PY 893 Doctoral Supervised Research. *1-9. F, S, Sum. Preq: Doctoral Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

PY 895 Doctoral Dissertation Research. *1-9. F, S, Sum. Preq: Doctoral Student.* Dissertation Research

PY 899 Doctoral Dissertation Preparation. *1-3. F, S, Sum. Preq. Doctoral Student* For students who have completed all credit hour requirements, full-time enrollment, preliminary examination and residency requirements for the doctoral degree and are writing and defending their dissertations.

RELIGION

REL (FLH) 101 Elementary Biblical Hebrew I. *3(3-0) . F,S.* The elements of grammar and syntax essential for a reading knowledge of Biblical Hebrew. Reading is drawn primarily from the Book of Genesis and some attention given to exegetical method.

REL (FLH) 102 Elementary Biblical Hebrew II. *3(3-0) . F,S. Preq: REL (FLH) 101.* A continuation of REL (FLH) 101 with increased emphasis upon reading selected prose passages.

REL (FLH) 201 Intermediate Biblical Hebrew I. *3(3-0) . F,S. Preq: REL (FLH) 102.* Continuing development of vocabulary and understanding of grammar and syntax through reading of selected prose and poetic passages in the Hebrew Bible. Exegetical matters are considered.

REL (FLH) 202 Intermediate Biblical Hebrew II. *3(3-0) . F,S. Preq: REL (FLH) 201.* Exclusive attention devoted to reading and interpreting selected prose and poetic passages in the Hebrew Bible.

REL 298 Special Topics in Religion. *3(3-0) .* Selected studies in religion that do not appear regularly in the curriculum. Topics will be announced for each semester in which the course is offered.

REL 300 Religious Traditions of the World. *3(3-0) . F,S,Sum.* Major Eastern and Western religious traditions with attention to their basic teachings and practices as well as to the historical, geographical, social, and political settings in which they have arisen and developed.

REL (SOC) 309 Religion and Society. *3(3-0) . Preq: 3 cr. in SOC, 200 level.* Religious beliefs, practices, and organizations addressed as social phenomena. Structural functionalism, conflict and subjectivism as theoretical orientations for understanding influences between religion and society. Relationship of religions to family, government and economy, and to social divisions, conflict, and change.

REL 311 Introduction to the Old Testament. *3(3-0) .* Study of Old Testament books, examining their content, background and development. Comparisons of the biblical material with other Ancient Near Eastern literature. Assessment of contributions from archeology and literary studies to clarifying the text.

REL 312 Introduction to the New Testament. *3(3-0) .* Literary and historical study of the New Testament in its Jewish and Greco-Roman contexts. Special attention to distinctive characteristics of the Gospels and their relationships, early controversies with Judaism and the emergence of church structure and teaching.

REL 314 Introduction to Intertestamental Literature. *3(3-0) . S.* Intertestamental literature in the context of Jewish history, institutions and beliefs of the Intertestamental Period (ca. 300 B.C.-ca. 100 A.D.)

REL 317 Christianity. *3(3-0) . S.* Development of Christianity from its origins to the present; events, persons, ideas, beliefs, and practices which were most significant in this development.

REL (HI) 320 Religion in American History. *3(3-0) . F. Preq: 3 hours of History or Sophomore standing.* Representative people, movements and thought in the major religions within the context of American society and culture.

REL 323 Religious Cults, Sects and Minority Faiths in America. *3(3-0) . F.* Religious cults, sects and minority faiths in America, including Mormonism, Christian Science and Jehovah's Witnesses. Also covers such alternate groups as the holiness-charismatic movement and the Unification Church. Origins, development and teachings of these groups within the context of American culture and religion.

REL 326 The Catholic Traditions. *3(3-0) . S.* The history, basic teaching, and cultural influences of Roman Catholicism and Eastern Orthodoxy.

REL 327 Issues in Contemporary Religion. *3(3-0) .* Responses of contemporary Western religious thinkers to critics of religion and to challenges posed by the 20th century including the Nazi Holocaust, social injustice (liberation theologies - black, feminist, Third World), ecological crisis, threat of nuclear warfare and conflicts between religions.

REL 331 The Hindu Tradition. *3(3-0) .* Basic religio-philosophical concepts, social institutions, and individual practices of Hindu civilization from earliest Vedic times to the present. Focus on major traditions: Action (karma), Knowledge (jnana) and Devotion (bhakti), with emphasis on disciplines (yoga), myth, symbol, art.

REL 332 The Buddhist Traditions. *3(3-0) .* History and structure of the Buddhist tradition analyzed through the "three jewels": the Buddha, the Monastic Community (sangha), and the Teachings (dharma). Emphasis on fundamental religio-philosophical concepts, social history and ritual practices of Southern Buddhism, early Mahayana development, and Tantric ideals. Growth of the traditions in China and Japan.

REL 333 Chinese Religions. *3(3-0) . S. Alt. yrs(odd).* Survey of Chinese religions from prehistoric times to present. Confucianism, Daoism, primary Buddhist schools in China, spirit possession, divination and popular religious worship.

REL 334 Japanese Religions. *3(3-0) . F. Alt. Yr(even).* Survey of various strands of Japanese religious life from prehistoric times until present. Kami worship; primary Buddhist schools in Japan; Japanese Christianity; Confucianism and New Religions.

REL (HI) 402 Early Christianity to the Time of Eusebius. *3(3-0) . S. Alt Yrs.(odd). Preq: One of: REL 312, REL 317, or HI 207.* Growth and diffusion of early Christianity from the end of the first century up to the time of Eusebius and the conversion of Constantine (early fourth century); Christianity in its Greco-Roman environment; Roman policy towards Christianity; heterodox Christian movements; anti-heretical writings; orthodox institutions of authority.

REL (HI) 407 Islamic History to 1798. *3(3-0) . Preq: 3 hours of history. Credit will not be given for both HI 407 and HI 507.* The history of the Islamic Near East to 1798. Topics include the East Mediterranean before Islam, Muhammad and the development of Islam, sources of Muslim civilization, Islamic law, science, philosophy, art and architecture, Islam in Spain, India, Asia and Africa, the Crusades, the Ottomans, Islam and Europe.

REL (HI) 408 Islam in the Modern World. *3(3-0) . Preq: 3 hours of history or religious studies.* Evolution of modern Islam from 17th century to the present. Primary emphasis on North Africa, the Middle East and South Asia. Pre-modern Islamicate empires, reform and revival. Historical origins of current issues in the Islamic world.

REL (HI) 460 American Religion After Darwin. *3(3-0) . F,S. Preq: 3 credit hours in REL or HI.* Major religious issues in America from the Civil War to the mid-1920s, including science and religion, the impact of Darwin's evolutionary theory, biblical criticism, liberalism versus fundamentalism, the churches in an industrial society.

REL 481 Myth, Metaphor, and Religious Imagination. *3(3-0) . Preq: 300-level course in REL, HI, or ENG.* Mythology from world religions; history of the academic study of mythology in 19th-20th centuries; disciplined techniques for interpretation of myth, including historical criticism, ritual study, structuralism, hermeneutics, psychoanalytic theories, Marxist and feminist criticism, and post-structural approaches; nature and role of metaphor in mythic language and religious imagination

REL 484 Myth and History in Religious Biography. *3(3-0) . Preq: 300-level course in REL, HI, or ENG.* Cross-cultural typology of religious biography, including sacred biography, hagiography, confessional biography, autobiography and myth; structure and function of myth in creating the biographical image of religious subjects; hermeneutic theory and methodological strategies for reading and interpreting individual life histories; multiple case-studies including Buddha, Moses, Jesus, Muhammad, Luther and Krishna-Caitanya.

REL 491 Advanced Readings in Theological and Religious Literature. *3(3 0) . Preq: 300-level course in Religion and consent of instructor. Course may be used for individualized study programs by arrangement with the instructor.* Critical analysis of advanced theological works; close reading of primary texts; methods of interpretation (hermeneutics).

REL 496 Seminar in Religious Studies. *3(3-0) . Preq: 300-level course in Religion and consent of instructor. Open primarily to Religious Studies majors and minors.* Advanced research and writing in selected topics; application of contemporary and historical methods for the study of religion; hermeneutic theory.

REL 498 Special Topics in Religion. *Preq: 6 hours REL.* Detailed investigation of selected topics in religion. Topics determined by faculty members in consultation with head of the department. Course may be used for individualized study programs.

SOCIOLOGY

SOC 202 Principles of Sociology. *3(3-0) . F,S,Sum.* Introduction to sociology. Analyses of key processes and institutions including interaction, inequality, organization, socialization, and social change. Includes core sociological concepts, methods, theories.

SOC 203 Current Social Problems. *3(3-0) . F,S,Sum.* Examination of social problems linked to structures of economic, political, gender and racial inequality; including poverty, disease, racism, sexism, unemployment, psychological distress, educational failure, environmental destruction and violence. Possible solutions viewed from a variety of perspectives. Includes core sociological concepts, methods and theories.

SOC (WGS) 204 Sociology of Family. *3(3-0) . F,S,Sum.* Contemporary American family structures and processes and their development. Focus on socialization, mate selection, marital adjustment and dissolution. Includes core sociological concepts, methods, theories.

SOC 205 Jobs and Work. *3(3-0) . F,S,Sum.* Work experience in terms of intrinsic and extrinsic rewards for worker. Work experience as intersection of occupation, industry, organization, region, and time period Research skills for comparing job options to individual goals. Includes core sociological theories, concepts, and methods.

SOC 206 Social Deviance. *3(3-0) . F,S,Sum.* Social processes in the creation and maintenance of deviant populations: classification, objectification of social meanings, functions of subcultures and social outcomes of the deviance-ascription process. Includes core sociological concepts, methods, theories.

SOC (GEO) 220 Cultural Geography. *3(3-0) . F,S.* Investigates the world's past and present cultural diversity by studying spatial patterns of population, language, religion, material and non-material culture, technology and livelihoods, communities and settlements and political organization and interaction.

SOC 241 Sociology of Agriculture and Rural Society. *3(3-0) . F,S.* Application of sociological concepts, methods, theories and styles of reasoning to major social problems facing rural America. Changing structure of agriculture; social impact of agricultural technology; rural community growth and decline; rural industrialization, rural poverty, natural resources and environmental issues in rural America. Includes core sociological concepts, methods, theories.

SOC (ANT) 261 Technology in Society and Culture. *3(3-0) . F,S.* Processes of social and cultural change with a focus on role of technological innovation. Cross-cultural emphasis. Workplace changes and societal risks associated with technological innovations. Special attention to the role of scientists and engineers in socio-cultural change. Topical case studies apply course concepts and principles. Core sociological and anthropological concepts, methods, theories.

SOC 300 Social Research Methods. *4(3-2) F,S,Sum. Preq: 3 cr in SOC 200 level. Coreq: ST 311.* Basic methods of social research, research design, sampling, data collection, measurement, and analysis: the relationship between theory and research. Laboratory exercises on computer applications.

SOC 301 Human Behavior. *3(3-0) . F,S,Sum. Preq: 3 cr in SOC, 200 level.* The development of personality as a consequence of social interactions and behavior of individuals in social contexts. Processes of learning, socialization, social perception, organization, stability and change of attitudes, norms, norm-formation and conformity, social roles and role strain, interpersonal attraction, and intergroup and intragroup relations.

SOC (WGS) 304 Women and Men in Society. *3(3-0) . F,S. Preq: 3 cr. in SOC, 200 level.* A sociological analysis of women and men in contemporary American society. Perpetuation of and change in gender stratification using sociological concepts, theories and research. How gender expectations developed and transmitted. Historical data and research on diversity in American society used for analysis of causes and consequences of gender inequality.

SOC 305 Racial and Ethnic Relations. *3(3-0) F,S,Sum. Preq: 3 cr in SOC, 200 level.* Study of the nature of the relationships among racial and ethnic groups in societies around the world but with emphasis on the United States. Explores topics such as inequalities of wealth, power and status, racism, conflict and social boundaries among groups. Current trends in intergroup relations are discussed.

SOC 306 Criminology. *3(3-0) . F,S,Sum. Preq: 3 cr. in SOC, 200 level.* Study of processes whereby behavior is defined as crime and persons are identified as criminals. Includes a sociological investigation of agencies of law enforcement, adjudication, corrections and prevention; patterns of criminal behavior; explanations of variations in criminality with emphasis on sociocultural and sociopsychological theories.

SOC (REL) 309 Religion and Society. *3(3-0) . F,S. Preq: 3 cr. in SOC, 200 level.* Religious beliefs, practices and organizations addressed as social phenomena. Structural functionalism, conflict and subjectivism as theoretical orientations for understanding influences between religion and society. Relationship of religions to family, government, and economy and to social divisions, conflict and change.

SOC 310 Managers, Work, and Organizations. *3(3-0) . F,S,Sum. Preq: Any 200-level SOC, SOC 205 recommended.* Sociological analysis of managers, who they are, and what they do. How recent changes in the U.S. economy have altered managers' work. How managers influence and adapt to the organizational environment. Relationship of management and labor in the production process.

SOC 311 Community Relationships. *3(3-0) . F,S,Sum. Preq: 3 cr. in SOC, 200 level.* Institutions, organizations and agencies found in modern communities; social problems and conditions with which they deal; their interrelationships and trends toward comprehensive planning.

SOC 342 International Development. *3(3-0) . F. Preq: 3 cr. in SOC, 200 level.* Sociological explanations of the causes of development and underdevelopment and origins of the present world system with emphasis on lesser developed countries. Recent global changes in the world situation including the increasing internationalization and interdependence of all countries.

SOC 351 Population and Planning. *3(3-0) . F. Preq: 3 credits in SOC at the 200 level.* Effects of births, deaths and migration on population size, composition and distribution. Socioeconomic and political implications of demographic change. Impact of alternative policies on demographic processes.

SOC 381 Sociology of Medicine. *3(3-0) . F,S. Preq: 200 level Sociology.* Use of theory and empirical studies to understand the social etiology of disease health practices, practitioners and institutions and the special area of mental health. Historical as well as contemporary examples of social influences on and effects of health throughout the world, but especially in the United States. Core sociological concepts, methods, theories.

SOC 400 Theories of Social Structure. *3(3-0) . F,S,Sum. Preq: 3 cr. in SOC, 200 level.* Contributions of Durkheim, Marx, Weber and others to contemporary macro-level sociological theories. Origins and development of functionalist and conflict approaches. Theories of social solidarity, class structure, the state, bureaucratization, ideology. Uses of original works.

SOC 401 Theories of Social Interaction. *3(3-0) . F,S,Sum. Preq: 3 cr. in SOC, 200 level.* Contributions of Weber, Simmel, Mead, Homans, Goffman and others to contemporary micro-level sociological theories. Origins and development of symbolic interaction, ethnomethodology, exchange theory and dramaturgy. Theories of the self, social construction of reality, emotions, interpersonal relationships. Interrelationship of theory and research; use of original works.

SOC 402 Urban Sociology. *3(3-0) . Preq: SOC 300 or equivalent research methods course.* Urban social structures emphasizing determinants and consequences of changes in urban places and life styles. Current urban problems and various approaches to urban social planning.

SOC 404 Families and Work. *3(3-0) . S. Preq: SOC 200 level, SOC 300 or equivalent research methods course.* Sociological analysis of the interplay between economy and family. How men and women make decisions regarding work and family. Theory and research techniques appropriate to the student of work/family conflicts.

SOC (WGS) 407 Sociology of Sexualities. *3(3-0) . S. Preq: 3 hours SOC 200 level, 300 level, or equivalent research methods course.* Exploration of sexuality in a social context. Relationship between sexuality, gender, and power in the U.S. Historical trends in behaviors and identities: social movements and sexual issues; current behavioral trends. Some issues covered; identity, social construction, sexual meanings.

SOC 410 Sociology of Organizations. *3(3-0) . Preq: 3 cr. in SOC, 200 level, SOC 300 or equivalent research methods course.* Application of sociological theories to study of organizational structures and processes. Special attention to control and coordination, relations with other organizations and decision making.

SOC (PS) 413 Criminal Justice Field Work. *4(2-8) . F,S. Preq: SOC 306 and PS 311, senior standing in Criminal Justice option.* Supervised observation and experience in a criminal justice agency. Study of relationships between ongoing programs and relevant political and sociological theory and research. Weekly seminars, small groups and individual conferences. Presentation of an integrative report.

SOC 414 Social Class. *3(3-0) . Preq: SOC 300.* The universality of social inequality, its bases and consequences. Relationship of social inequality to social class, life chances, life styles and social mobility. Theories and research methods pertinent to the study of social class.

SOC 418 Sociology of Education. *3(3-0) . F, Alt. yrs. Preq: SOC 300 or equivalent research methods course.* Application of sociological theories to education, relating processes of stratification, socialization and organization. Sociological analysis of classrooms and learning. Connections of schooling with family, community and work. Cross-cultural and U.S. research.

SOC 425 Juvenile Delinquency. *3(3-0) . F,S,Sum. Preq: 3 cr. in SOC, 200 level; SOC 300 or equivalent research methods course.* Nature and extent of juvenile delinquency; measurement problems; and biogenic, psychogenic and sociogenic theories of delinquency causation. Policy implications of delinquency theories for treatment and prevention. Evaluation of treatment and prevention programs.

SOC 427 Sociology of Law. *3(3-0) . F. Preq: 3 cr. in SOC, 200 level; SOC 300 or equivalent research methods course.* Sociological concepts, theories, and research of law as social control. Social forces behind the creation, maintenance, and application of law in American Society.

SOC 428 Formal Institutions of Social Control. *3(3-0) . S. Preq: 3 hours SOC 200 level; SOC 300 or equivalent research methods course.* Development, structure, and behavior of formal institutions of social control in the United States (police, courts, corrections); divergent philosophies of punishment that guide the juvenile and adult criminal justice system, dimensions of inequality that influence processing decisions, and effectiveness of formal institutions in controlling violations of legal norms.

SOC 429 Data Analysis in Criminology. *3(3-0) . S. Preq: SOC 300, SOC 306, ST311 or equivalent research methods course.* Analysis of quantitative data in criminology. Relationship between theory and research, operationalization and measurement. Computer coding of social covariaties. Descriptive and inferential analysis. Writing research reports.

SOC 430 Community and Crime. *3(3-0) . S. Preq: 3 credits in SOC 200 level, SOC 300 or equivalent research methods course.* Neighborhood development, structure, and processes as related to delinquency, crime, and criminality. Divergent theories of the effect of neighborhood context on crime, and crime on neighborhood processes. The interaction of person and neighborhood context. Implications of community processes for social control.

SOC 440 Social Change. *3(3-0) . S. Preq: 3 cr in SOC, 200 level; SOC 300 or equivalent research methods course.* Sources, processes, and consequences of social change on macro and micro levels. Applications of classical and contemporary theories to historical and modern examples of social change in international, national, regional, community, and institutional settings. Examples of empirical studies and appropriate methodologies for each level of analysis.

SOC 450 Environmental Sociology. *3(3-0) . F, Alt. Yr(odd). Preq: 3 hours SOC 200 level, SOC 300, or equivalent research methods class.* Systematic relations between natural environment and human societies. Dependency on the natural world. Population technology, cultural and economic influences on ecosystems. Development of environmentalism and alternative models for understanding threats and potentials. current environmental issues and considerations of their global contexts.

SOC 492 External Learning Experience. *1-6. F,S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

SOC 493 Special Problems in Sociology. *1-6. F,S. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes campus facilities and resources. Arrangements must be initiated by student and approved by a faculty advisor and departmental teaching coordinator.

SOC 495 Special Topics in Sociology. *1-3.* Offered as needed to present materials not normally available in regular course offerings or for new courses on a trial basis.

SOC 498 Independent Study in Sociology. *1-6. Preq: Six hours SOC above the 200 level.* A detailed investigation of a topic in sociology. Topic and mode of study determined by the faculty member(s) in consultation with the department head.

SOC 505 Medical Sociology. *3(3-0) . Preq: Six credits in SOC or grad. standing or PBS status.* Advanced sociological analysis of health care organizations and their systemic linkage to other community institutions. Measurement of health and illness and their social significance. Applications of sociological and social-psychological theories to practitioner-client relationships and interaction. Implications of alternative models of health care provision.

SOC 508 Social Organization. *3(3-0) . Preq: SOC 400 or SOC 701.* Introduction to study of social structure. Focus on inequality, work, organizations, the economy, the state. Classic writings and their impacts.

SOC 509 Population Problems. *3(3-0) . Preq: SOC 202 or equivalent.* Examination of population growth, rates of change and distribution. Emphasis on functional roles of population, i.e., age, sex, race, residence, occupation, marital status and education. Stress on population dynamics fertility, mortality and migration. Analysis on population policy in relation to national and international goals stressing a world view.

SOC 513 Community Organization and Development. *3(3-0) . Preq: SOC 202 or equivalent.* Community organization viewed as a process of bringing about desirable changes in community life. Study of community needs and resources. Stress on democratic processes in community action and principles of organization, along with techniques and procedures. Analysis of roles of lay and professional workers.

SOC 514 Developing Societies. *3(3-0) . Preq: Six hrs. SOC or ANT or grad. standing or PBS status.* Definition of major problems posed for development sociology and exploration of social barriers and theoretical solutions for development set forth with regard to newly developing countries. Review of significant past strategies and presentation of main themes in current development schemes. Proposal and discussion of untested strategies for the future. Examination of these problems in their national and international contexts.

SOC 520 Sociology of Religion. *3(3-0) . Preq: SOC 202 or equivalent or grad. standing or PBS status.* Presentation of alternative theoretical analyses for religious beliefs, practices and organizations and the relationships between these and other social phenomena. Assessment of the utility and deficiencies of each conceptual framework through general applications and case studies. Review of major research findings in this classical field of sociology. Address of contemporary trends and issues concerning religion in society.

SOC 533 The Community. *3(3-0) . Preq: Six hrs. SOC.* The community viewed in sociological perspective as a functioning entity. Presentation and application of a method of analysis to eight "dimensions," with emphasis on the unique types of understanding to be derived from measuring each dimension. Finally, analysis of effect of change on community integration and development.

SOC 591 Special Topics in Sociology. *1-6. F,S,Sum. Preq: Consent of Instructor.* An examination of current problems organized on a lecture-discussion basis. Course content varies as changing conditions require new approaches to emerging problems.

SOC 601 Seminar. *Credits Arranged.* Appraisal of current literature; presentation of research papers by students; progress reports on departmental research; review of developing research methods and plans; reports from scientific meetings and conferences; other professional matters.

SOC 610 Special Topics in Sociology. *1-6. F,S. Preq. Consent of Instructor.* An examination of current problems organized on a lecture-discussion basis. Course content varies as changing conditions require new approaches to emerging problems.

SOC 642 Practicum in Sociology. *3-6. F,S. Preq: Grad. standing in the Master of Sociology program and nine hrs. of SOC at the 500-600 level.* Opportunity for student under supervision of graduate advisory committee chair and organization/agency supervisor to develop and demonstrate competency in the area of graduate specialization through application of sociological knowledge to practical problems facing the organization/agency.

SOC 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

SOC 690 Master's Examination. *1-3. F, S, Sum. Preq: Master's student. Credits Arranged.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

SOC 693 Master's Supervised Research. *1-9. F, S, Sum. Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

SOC 695 Master's Thesis Research. *1-9. F, S, Sum. Preq: Master's Student.* Thesis Research

SOC 699 Master's Thesis Preparation. *1-3. F, S, Sum. Preq: Master's Student. Credits arranged.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

SOC 701 Classical Sociological Theory. *3(3-0) . Preq: Six hrs. SOC and grad. standing or PBS status.* The interdependence of theory and research in sociology; major theoretical classics in the discipline and how they provide foundations for subsequent developments and for analysis in substantive areas.

SOC 702 Contemporary Sociological Theory. *3(3-0) . Preq: SOC 701 or equivalent.* Works by major figures representing leading schools of sociological theory in the post-World War II period studied as primary sources. Underlying assumptions made explicit, the structure of the theory, including propositions, examined critically, and discussion of relationships with other theoretical perspectives.

SOC 703 Theory Construction. *3(3-0) . Preq: SOC 701 or equivalent.* Providing students with a capability to develop theoretical frames of reference within which to devise and implement research activities. Acquainting students with philosophical and disciplinary bases of theory, establishing relationship between theory and research and enabling objective evaluation of theoretical positions encountered in the literature.

SOC 707 Quantitative Sociological Analysis. *3(3-0) Preq: ST 501* Introduction to application of common quantitative methodologies in sociology including multiple regression and path analysis. Emphasis on selecting appropriate analytical techniques, model estimation and sociological interpretation of findings.

SOC 708 Advanced Sociological Analysis. *3(3-0) . Preq: SOC 311 ST 501 or ST 711.* Examination of advanced analysis techniques adaptable to needs of sociological research. Special attention given to causal analysis, analysis of change, and aggregate versus individual level data analyses. Consideration of sociological examples. Attention to emerging issues and techniques.

SOC 711 Research Methods in Sociology I. *3(3-0) . Preq: SOC 300. ST 311 or equivalent.* Issues in philosophy of science, causation, relationship of theory and research. Qualitative, experimental and survey design methodologies.

SOC 712 Advanced Survey Research Methods. *3(3-0) . S, Alt yrs(odd). Preq: SOC 711 and SOC 707 (or consent of instructor).* Advanced survey methodology including research design, sampling, questionnaire development, and surveys using the World Wide Web. Designing and executing substantive and methodological studies using surveys to peretionalize behavioral and social constructs and to test hypotheses.

SOC 713 Applied Research. *3(3-0) . Preq: SOC 202 or equivalent.* Studies research process with emphasis upon its application to action problems. Stress upon development of research design to meet action research needs.

SOC 721 Deviant Behavior. *3(3-0) . Preq: Six hrs. SOC or ANT or grad. standing or PBS status.* Topics include: the inevitability of deviance and its social utility; cross-cultural variations in appearance and behavioral cues for labeling the deviant; descriptive and explanatory approaches to kinds and amounts of deviance in contemporary American society; social change, anomie and social disorganization theories; the process of stigmatization; formal and informal societal responses to deviance and the deviant; social action implications.

SOC 722 Social Control. *3(3-0) . Preq: Six hrs. SOC above 200 level or grad. standing or PBS status.* Examination of need, functions, utilization and effects of both informal and formal social control mechanisms. Emphasis and critical evaluation of theoretical perspectives on social control and the empirical support for these positions.

SOC 723 Research on Crime and Deviance. *3(3-0) . Preq: SOC 721 or equivalent.* Major topics including an examination of conceptual problems and research issues and methods in study of crime and deviance; an assessment of current research on crime causation and deviance processes; an examination of research on social control processes and agencies; and an assessment of social action and evaluative research. A variety of substantive topics dealt with in the context of above topical areas including: delinquency, drug usage, mental illness, obesity, stuttering, suicide, prostitution, homicide and rape.

SOC 724 Crime and Collective Action. *3(3-0) . Preq: SOC 721 or equivalent.* Examination of organized and spontaneous community responses to criminality, other normative violations and unpopular governments. Comparison and critique of alternative theoretical explanations for emergence of legal and extra-legal punishment. Application of sociological interpretations to contemporary community and societal policy including economic, political and social consequences of crime.

SOC 727 Comparative Societies. *3(3-0) . Preq: Six hrs. SOC.* Sociological analysis of societies around the world with particular reference to North and South America. Special emphasis given to cultural and physical setting, population composition, levels of living, relationship of the people to the land, structure and function of major institutions and forces making for change.

SOC 728 Social Systems and Planned Change. *3(3-0) . Preq: Three hrs. SOC.* An examination of social systems within framework of both functional theory and conflict theory, with particular emphasis upon system change and the planning of social change.

SOC 731 Survey of Family Sociology. *3(3-0) . Preq: SOC 202.* Examination of structural and demographic continuities and changes for American families in general and within major subgroups (e.g., race, ethnicity, social class). Consideration of historical and cross-cultural comparisons. Assessment of the impact of families upon their members and the dynamics of marital and family relationships.

SOC 732 Contemporary Family Theory and Research. *3(3-0) . Preq: SOC 731 or Consent of Instructor.* Emphasis on contemporary research, theory and methodological techniques used by sociologists studying families. Critical examination of where field is now and where it appears to be heading. Primarily for graduate students designing or doing research about families.

SOC 736 Social Stratification. *3(3-0) . Preq: Six hrs. SOC.* The theoretical background, methodological approaches and analysis of the consequences of systems of stratification. Emphasis on static and dynamic qualities of stratification systems on relations within and between societies. Attention to the integrative and divisive quality of stratification as expressed in life styles, world views, etc.

SOC (WGS) 737 Sociology of Gender. *3(3-0) . F, Alt yrs(even). Preq: SOC 736 or 731 or consent of instructor. Graduate Student Status.* Theories about the development and maintenance of gender. Historical development of gender stratification. How individuals "do gender" in their daily lives. Contemporary research and substantive readings about gender in public and intimate relationships.

SOC 738 Race and Ethnic Inequality. *3(3-0) . S, Alt. Yrs.(odd). Preq: Six hours of Sociology.* Theoretical and methodological approaches and critical debates on race. Impact of racial discrimination on inequality. Effects of inequality on community institutions. Formation of attitudes and identities.

SOC (WGS) 739 Social Psychology of Inequality. *3(3-0) . Preq: SOC 746 or 508 or equivalent.* The effects of race, class and gender inequality on the formation of group consciousness, self-evaluations, emotions, values, attitudes and beliefs. Attention to interpersonal processes through to reproduction of inequality in everyday life.

SOC 742 Social-Psychological Processes in Health and Illness. *3(3-0) . Preq: SOC 505* Contemporary issues in the sociology of health and illness from a social psychological perspective. The social meaning of illness, social group differences in health, social causes of distress, morbidity and mortality, and measurement of health and illness.

SOC 743 Psychiatric Sociology and Mental Health. *3(3 0) . F, Alt. Yr. (odd) Preq: SOC 505 or permission of instructor.* Major issues in mental health. Epidemiology, causes, course, consequences, correlates, treatment, institutions, and services for mental illness.

SOC 744 Health Behavior and Interventions. *3(3-0) . S. Preq: SOC 381, SOC 505 or consent of instructor.* Health of the US population and rates of illness, accidents, and causes of death for high risk groups. Theories and models for changing behavior. Designing health interventions. Results of selected major health interventions.

SOC 746 Sociological Social Psychology. *3(3-0) . Preq: SOC 401 or equivalent.* Central issues in sociological social psychology, including formation of the self, effects of social structure on individual development, emergence of ritualized interaction and tension between individual agency and societal constraint. Emphasis on symbolic interactionist and dramaturgical perspectives.

SOC 747 Social Psychology. *3(3-0) . Preq: Six hrs. SOC.* The presentation of the major ideas of social psychology in context of the theoretical orientations from which they have emerged. Examination of nature and role of theory in social psychology. The social psychologies of various theorists then examined in terms of their particular approaches including the Gestalt, Field, Role, Psychoanalytic and Reinforcement orientations and combinations of these.

SOC 752 Work and Industry. *3(3-0) . Preq: SOC 400 or SOC 508 or SOC 701.* Control of economy and workplace. Special attention to economic restructuring, the labor process and recent workplace innovations. Theories include managerialism, bank hegemony and deskilling. Historical studies complement analyses of contemporary settings and issues.

SOC 753 Formal Organizations. *3(3-0) . Preq: SOC 701 or equivalent or another course on organizations or Consent of Instructor.* Sociological study of bureaucracies and other formal organizations, including theoretical roots, current theory and research, especially on organization-environment relations. Sociological assessment of psychological, economic and managerial theories of organizations.

SOC 756 Sociological Analysis of Agricultural Development. *3(3-0) . Preq: Six hrs. SOC or grad. standing.* Systematic sociological analysis of agricultural development and change, emphasizing less-developed countries. Review of classical and contemporary theoretical perspectives. Specific topics: land tenure and agricultural development; peasants and peasant societies; peasant revolt and revolution; women and development.

SOC 757 Sociology of U.S. Agriculture. *3(3-0) . Preq: Six hrs. of SOC or grad. standing.* Analysis of structural transformation of U. S. agriculture in 19th and 20th centuries, particularly in terms of the role of the state in agricultural development. Review of theoretical perspectives and research in rural sociology and the sociology of agriculture.

SOC 758 Rural Sociology. *3(3-0) . S, Alt. Yrs.(odd). Preq: Six hours of Sociology.* Rural conditions and trends including environmental resources; human and social resources; institutions and change; theory, research, and rural development policy.

SOC 762 Urban Ecology. *3(3-0) . Preq: SOC 509 or equivalent.* An historical approach to development of the field as well as an analysis of present state of the field. Because of the range of subject matter subsumed under the topic of ecology, linkages between sociology and other disciplines concerning themselves with the subject delineated and examined.

SOC 791 Special Topics in Sociology. *1-6. F,S,Sum. Preq: Consent of Instructor.* An examination of current problems organized on a lecture-discussion basis. Course content varies as changing conditions require new approaches to emerging problems.

SOC 800 Practicum in Sociology. *3-6. Preq: Grad standing in the Master of Sociology program and nine hrs. of SOC at the 500-600 level.* Opportunity for student under supervision of graduate advisory committee chair and organization/agency supervisor to develop and demonstrate competency in the area of graduate specialization through application of sociological knowledge to practical problems facing the organization/agency.

SOC 801 Seminar. *F. S. Sum. Credits Arranged.* Appraisal of current literature; presentation of research papers by students; progress reports on departmental research; review of developing research methods and plans; reports from scientific meetings and conferences; other professional matters.

SOC 810 Special Topics in Sociology. *1-6. F, S, Sum. Preq: Consent of Instructor.* An examination of current problems organized on a lecture-discussion basis. Course content varies as changing conditions require new approaches to emerging problems.

SOC 885 Doctoral Supervised Teaching. *1-3. F, S, Sum. Preq: Doctoral Student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

SOC 890 Doctoral Preliminary Exam. *1-9. F, S, Sum. Preq: Doctoral Student.* For students who are preparing for and taking written and/or oral preliminary exams.

SOC 893 Doctoral Supervised Research. *1-9. F, S, Sum. Preq: Doctoral Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

SOC 895 Doctoral Dissertation Research. *1-9. F, S, Sum Preq Doctoral Student* Dissertation Research

SOC 899 Doctoral Dissertation Preparation. *1-3. F, S, Sum. Preq: Doctoral Student.* For students who have completed all credit hour requirements, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

SOIL SCIENCE

SSC 185 Land and Life. *3(3-0) .* Land quality and the social, economic, and political practices of societies utilizing different land resources. The underlying physical reasons for land quality differences and land management options for technological, primitive, and developing societies. Stresses macro and micro scale societal responses to land quality.

SSC 200 Soil Science. *4(3-3) . Preq: One semester of college chemistry.* Fundamentals of soils including origin, composition and classification; their physical, chemical, and biological properties; significance of these properties to soil-plant relationships and soil management.

SSC (BAE) 323 Water Management. *3(2-0) . Preq: Junior standing.* Water management principles applied to agriculture; hydrologic cycle, runoff, surface and sub-surface drainage, soil conservation measures to reduce erosion and sedimentation, irrigation, pond construction, open channel flow, water rights and environmental laws pertaining to water management. Emphasis on problem solving

SSC (BAE) 324 Elementary Surveying. *1(0-3) . Preq: Junior standing.* Theory and practice of plane surveying to include measuring distances as well as record keeping differential leveling, profile leveling, topographic mapping, stadia surveying, and the use of these tools in agricultural applications.

SSC 341 Soil Fertility and Fertilizers. *3(3-0) . Preq: SSC 200, BIO 125.* Principles of managing plant nutrition for crop production, fertilizer materials, crop fertilization, soil fertility maintenance, and management practices for optimizing fertilizer use; soil and plant tissue testing as diagnostic tools in nutrient management.

SSC 342 Soil Fertility Laboratory. *1(0-3) . Coreq: SSC 341.* Soil sampling and analyses for acidity and nutrient content. Calculating lime and fertilizer recommendations and calibrating fertilizer spreaders. Discussion of fertilizer materials and calculation of least cost blends. Computer programs to confirm recommendations and least cost blends. Field trip to a fertilizer distributer and to a fertilizer user.

SSC 361 Role of Soils in Environmental Management. *3(2-3) . Preq: SSC 200.* Importance of soils in land application of municipal, industrial, and agricultural wastes; onsite disposal of domestic wastewater; bioremediation of contaminated sites; erosion and sedimentation control; farm nutrient management; and nonpoint sourcewater pollution.

SSC 452 Soil Classification. *4(3-4) . Preq: SSC 200.* Genesis, morphology, and classification of soils; characterization of soils according to their diagnostic properties; interpreting soil use potential; emphasis on North Carolina soils and their taxonomy; field exercise in soil mapping and site evaluation; several field trips, one overnight.

SSC 461 Soil Physical Properties and Plant Growth. *3(3-0) . Preq: SSC 200.* Soil physical properties and their influence on plant growth and environmentally sound land use; soil solid-porosity-density relationships, soil water, heat and air relations and transport. Principles and applications of these topics using current literature in agronomy, turf, horticulture, water quality, waste management, and urban land use.

SSC (CS) 462 Soil-Crop Management Systems. *3(2-3) . S. Preq: CS 213, CS 414, SSC 342, SSC 452; senior standing.* Unites principles of soil science and crop science with those of allied areas into realistic agronomic applications; practical studies in planning and evaluation of soil and crop management systems.

SSC 470 Wetland Soils. *3(3-0) . F. Preq: SSC 200, SSC 452 recommended. Credit will not be given for both SSC 470 and SSC 570.* Wetland definitions, concepts, functions, and regulations; chemical, physical, and morphological characteristics of wetland soils. Wetland soil identification using field indicators and monitoring equipment; principles of wetland creation, restoration, and mitigation. Special project required for SSC 570. Two mandatory field trips.

SSC 472 Forest Soils. *3(2-3) . Preq: SSC 341, or FOR 304.* Soil as a medium for tree growth; relation of soil physical, chemical, and biological factors to the practice of silviculture; extensive soil management in the forest and intensive soil management in forest nurseries and in seed orchards; relation of soil and site to forest genetics, ecology, pathology, and entomology.

SSC (CS) 490 Senior Seminar in Crop Science and Soil Science. *1(1-0) . Preq: Senior standing.* Review and discussion of current topics in crop science, soil science, agronomy and natural resource management. Preparation and presentation of scientific information in written and oral format.

SSC 492 External Learning Experience. *1-6. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with the prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator and the academic dean prior to the experience.

SSC 493 Special Problems in Soil Science. *1-6. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes campus facilities and resources. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, the departmental teaching coordinator prior to the experience.

SSC 495 Special Topics in Soil Science. *1-6. Preq: SSC 200.* Offered as needed to present materials not normally available in regular course offerings or for offering of new courses on a trial basis.

SSC 511 Soil Physics. *4(3-3) . Preq: SSC 200, PY 212.* Soil physical properties and theory of selected instrumentation to measure them. Topics including soil solids, soil water, air and heat. Emphasis on transport processes and the energy concept of soil and water.

SSC 521 Soil Chemistry. *3(3-0) . S. Preq: SSC 200, one yr. of general inorganic chemistry.* A consideration of the chemical and colloidal properties of clay and soil systems, including ion exchange and retention, soil solution reactions, solvation of clays and electrokinetic properties of clay-water systems.

SSC (MB) 532 Soil Microbiology. *4(3-3) . Preq: MB 351; CH 220 or Consent of Instructor.* Soil as a medium for microbial growth, the relation of microbes to important mineral transformations in soil, the importance of biological equilibrium and significance of soil microbes to environmental quality.

SSC 541 Soil Fertility. *3(3-0) . Preq: SSC 341.* Soil conditions affecting plant growth and the chemistry of soil and fertilizer interrelationships. Factors affecting the availability of nutrients. Methods of measuring nutrient availability.

SSC 551 Soil Morphology, Genesis and Classification. *3(3-0) . Preq: MEA 120, SSC 200, SSC 341.* Morphology: Chemical, physical and mineralogical parameters useful in characterizing soil. Genesis: soil-forming factors and processes. Classification: historical development and present concepts of soil taxonomy with particular reference to worldwide distribution of great soil groups as well as discussions of logical bases of soil classification.

SSC 562 Environmental Applications of Soil Science. *3(2-3) . Preq: SSC 200 or equivalent.* Identification and evaluation of basic factors influencing movement of potential pollutants through soil and their underlying strata. Development of understanding of processes of soil and site evaluation for waste disposal and transport of pollutants through soils.

SSC 570 Wetland Soils. *3(3-0) . F. Preq: SSC 200, SSC 452 recommended. Credit will not be given for both SSC 470 and SSC 570.* Wetland definitions, concepts, functions, and regulations; chemical, physical, and morphological characteristics of wetland soils. Wetland soil identification using field indicators and monitoring equipment; principles of wetland creation, restoration, and mitigation. Special project required for SSC 570. Two mandatory field trips.

SSC (BAE) 573 Hydrologic and Water Quality Modeling. *3(2-2) . S, Alt. yrs.. Preq: BAE 471, SSC 200 or Consent of Instructor.* Concepts in basic hydrologic, erosion and chemical transport used in modeling. Evaluation of typical hydrologic/water quality models on watershed systems. Usage of state-of-the-art models in project examples.

SSC (CS, FOR) 577 Conservation and Sustainable Development I: Concepts and Method. *3(3-0) . Preq: Consent of Instructor.* Agronomic, ecological and economic concepts of sustainability, with emphasis on application in developing countries; forest, soil and wildlife resources; models in conservation biology; historical, cultural and sociological perspectives; policy analysis. Offered as part of the program of the Center for World Environment and Sustainable Development.

SSC (FOR) 578 Conservation and Sustainable Development II: Integrated Problem Solving. *3(3-0) . Preq. FOR (SSC) 577.* Approaches to reconciling conservation and development with emphasis on developing countries. Case studies; project formulation, implementation and evaluation; institutional policy formation; conflict resolution. Offered as part of the program of the Center for World Environment and Sustainable Development.

SSC (FOR) 581 Agroforestry. *3(3 0) . Preq: Consent of Instructor.* Global agroforestry systems across diverse agroecological zones and under an array of socioeconomic conditions. Methods for selecting sustainable forest, agricultural and silvipastoral crops drawing upon production agriculture and forestry, community and ecosystem ecology, sociology and economics. Extension of research results to the rural poor in developing countries.

SSC 590 Special Problems. *F,S,Sum. Preq: SSC 200. Credits Arranged.* Special problems in various phases of soils. Emphasis placed on review of recent and current research.

SSC 601 Seminar. *1(1-0) . F, S. Preq: Grad. standing in SSC.* A maximum of two semester hours allowed toward the master's degree, but any number toward the doctorate. Scientific articles, progress reports in research and special problems of interest to soil scientists reviewed and discussed.

SSC 609 Colloquium In Soil Science. *F, S. Preq: Grad. standing in SSC. Credits Arranged.* Seminar-type discussions and lectures on specialized and advanced topics in soil science.

SSC 620 Special Problems. *F, S. Preq: SSC 200. Credits Arranged.* Special problems in various phases of soils. Emphasis placed on review of recent and current research.

SSC 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's Student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

SSC 690 Master's Exam. *1-3. F, S, Sum. Preq: Master's student. Credits Arranged.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

SSC 693 Master's Supervised Research. *1-9. F, S, Sum. Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

SSC 695 Master's Thesis Research. *1-9. F, S, Sum. Preq: Master's Student.* Thesis Research

SSC 699 Master's Thesis Preparation. *1-3. F, S, Sum. Preq: Master's Student. Credits arranged.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

SSC 701 Tropical Soils: Characteristics and Management. *3(3-0) . S Alt Yrs. Coreq: Six credits in SSC.* Characteristics of the tropical environment. Distribution and classification of tropical soils. Soil-plant relationships in the tropics. Soil management systems with emphasis on shifting cultivation, flooded rice production, subsistence farming and tropical pasture management.

SSC 720 Soil and Plant Analysis. *3(2-3) . S, Alt Yrs. Preq: PY 212; CH 315; at least three soils courses including SSC 341 or Consent of Instructor.* Theory and advanced principles of utilization of chemical instruments to aid research on the heterogeneous systems of soils and plants.

SSC 722 Advanced Soil Chemistry. *3(0-0) . F, Alt Yrs. Preq: SSC 521, CH 730 or equivalent.* Critical review of application of chemical thermodynamics and kinetics to under standing soil systems, solution equilibria, precipitation and dissolution, complexation, reduction-oxidation, surface-solute interactions and chemical transport. Application of chemical speciation models.

SSC (CS, HS, TOX) 725 Herbicide Chemistry. *1(1-0) . S. Preq: CH 201 and 221.* Chemical properties of pesticides including hydration and solvation, ionization, volatilization, lipophilicity, molecular structure and size, and reactivity and classification according to chemical description, mode of action or ionizability. Taught during the first 5 weeks of semester. Drop date is last day of 3rd week of the minicourse.

SSC (CS, HS, TOX) 727 Herbicide Behavior in Soil and Water. *2(2-0) . S. Preq: CS(HS,SSC,TOX) 725, SSC 200.* Sorption/desorption, soil reactivity, movement, volatilization, bioavailability, degradation and stability of pesticides in the environment. Taught during the last 10 weeks of semester. Drop date is last day of 3rd week of the minicourse.

SSC 753 Soil Mineralogy. *3(2-3) . F, Alt. Yrs. Preq: SSC 200, SSC 341, MEA 330.* Composition, structure, classification, identification, origin, occurrence and significance of soil minerals with emphasis on primary weatherable silicates, layer silicate clays and sesquioxides.

SSC 760 Advanced Soil Management. *3(3-0) . Sum, Alt. Yrs. Preq: SSC 200, 341.* Studies of soil characteristics in the coastal plain, piedmont and mountain areas of North Carolina. Discussion of management practices that should be associated with various soils for different types of enterprises. Two overnight field trips required.

SSC (BAE) 771 Theory of Drainage--Saturated Flow. *3(3-0) . F, Alt. Yrs.* Discussion of physical concepts and properties of fluids and porous media in relation to soil-water movement. Derivation and discussion of the fundamental laws and equations governing saturated flow in porous media. Analysis of mathematical solutions of steady-state and transient flow equations to determine their applicability to drainage problems. Consideration of analogs and models of particular drainage problems.

SSC 772 Soil Properties and Plant Development. *3(3-0) . S Alt Yrs. Preq: SSC 521 or equivalent.* An examination of the interrelationships of soil properties and plant characteristics which regulate inorganic ion accumulation and dry matter production in higher plants.

SSC (FOR) 773 Forest Productivity: Edaphic Relationships. *3(3-0) . F, Alt. Yrs.* Advanced ecophysiological consideration of forest stand productivity and how influenced by resource availability, genetics and their interactions. This knowledge used as a foundation to discuss the influence of natural stresses, silvicultural treatments and other anthropogenic disturbances on forest productivity.

SSC (BAE) 774 Theory Of Drainage--Unsaturated Flow. *3(3-0) . S,Alt. Yrs. Preq: BAE 771 or equivalent.* Involvement of forces and utilization of theories in unsaturated flow of porous media in relation to soil-water movement. Development and solution of steady-state and transient unsaturated flow equations for horizontal and vertical moisture movement. Application of solutions to present day laboratory and field technology. Consideration of molecular diffusion and hydrodynamic dispersion considered in light of current tracing techniques.

SSC (BAE) 780 Transport and Fate of Chemicals in Soils and Natural Waters. *3(3-0) . F. Preq: SSC 511, SSC 521 or equivalent.* Ecological and environmental significance of movement of chemicals from agricultural and forested land to water and/or the atmosphere. Movement, depostition and chemical and biological transformations of chemicals. Emphasis on saprolite and the vadose zone. Transport to ground water and/or laterally toward surface water. Design of course for advanced graduate students.

SSC (FOR) 782 Silviculture and Management of Forest Plantations in the Tropics. *3(3-0) . S. Preq: Grad. standing or Consent of Instructor.* Establishment and management of forest tree plantations in the tropics and subtropics. Genetic adaptability of trees used as exotics, establishment and management of tree improvement programs, tree harvesting, wood manufacturing, gene conservation and maintaining site productivity.

SSC 790 Special Topics. *F,S,Sum.*

SSC 801 Seminar. *1(1-0) . F, S, Sum.*

SSC 809 Colloquium in Soil Science. *F, S, Sum. Preq: Grad. standing in SSC. Credits Arranged.* Seminar-type discussions and lectures on specialized and advanced topics in soil science.

SSC 820 Special Problems. *F, S. Preq: SSC 200. Credits Arranged.* Special problems in various phases of soils. Emphasis placed on review of recent and current research.

SSC 885 Doctoral Supervised Teaching. *1-3. F, S, Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

SSC 890 Doctoral Preliminary Examination. *1-9. F, S, Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

SSC 893 Doctoral Supervised Research. *1-9. F, S, Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graudate Faculty.

SSC 895 Doctoral Dissertation Research. *1-9. F, S, Sum. Preq: Doctoral student.* Dissertation research.

SSC 899 Doctoral Dissertation Preparation. *1-3. F, S, Sum. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination and residency requirements for the doctoral degree and are writing and defending their dissertations.

STATISTICS

ST 101 Statistics by Example. *3(3-0) Credit not allowed if student has prior credit for another ST course.* Sampling, experimental design, tables and graphs, relationships among variables, probability, estimation, hypothesis testing. Real life examples from the social, physical, and life sciences, the humanities and sports.

ST (PSY) 240 Introduction to Behavioral Research I. *3(3-0) F,S Preq: PSY 200. Coreq: PSY (ST) 241. For PSY and HRD majors only.* Evolution of modern Islam from 17th century to the present. Primary emphasis on North Africa, the Middle East and South Asia. Pre-modern Islamicate empires, reform and revival. Historical origins of current issues in the Islamic world.

ST (PSY) 241 Introduction to Behavioral Research I Lab. *1(0-2) . F.S. Preq PSY 200. Coreq: PSY (ST) 240. For PSY and HRD majors only.* Students design, analyze and report a variety of simple experiments.

ST (PSY) 242 Introduction to Behavioral Research II. *3(3-0) . F,S. Preq: PSY (ST) 240. Coreq: PSY (ST) 243. For PSY and HRD majors only.* Continuation of PSY (ST) 240. Ethics of Research in Psychology. Techniques for the development of research proposals. Statistical techniques for data analysis including non-parametrics, one-way and two-way ANOVA and introduction to correlation and regression.

ST (PSY) 243 Introduction to Behavioral Research II Lab. *2(0-4) . F.S. Preq: PSY (ST) 240. Coreq: PSY (ST) 242. For PSY and HRD majors only.* Design and analysis of a major research project.

ST 301 Statistical Methods I. *3(3-0) . Preq: MA 141, CSC 112.* Contemporary description and analysis of single samples of data. Graphical data presentation methods for determination of patterns and relationships among variables. Classical and robust alternative methods for single sample data summary procedures. Probability concepts, sampling, and expectations. Confidence interval and hypothesis testing for sample mean and proportion. Computer use emphasized.

ST 302 Statistical Methods II. *3(3-1) . Preq: ST 301.* Confidence intervals and hypothesis testing with graphics in multiple samples and/or variables cases: tests for means/proportions of two independent groups, analysis of variance for completely randomized design, contingency table analysis, correlation, single and multiple linear regression; design of experiments with randomized blocks, factorial design and analysis of covariance. Computer use emphasized.

ST 311 Introduction to Statistics. *3(3-0) . Credit not allowed if student has prior credit for another ST course or BUS 350.* Examining relationships between two variables using graphical techniques, simple linear regression and correlation methods. Producing data using experiment design and sampling. Elementary probability and the basic notions of statistical inference including confidence interval estimation and tests of hypothesis. One and two sample t-tests, one-way analysis of variance, inference for count data and regression.

ST (BUS) 350 Economics and Business Statistics. *3(3-0) . Preq: MA 114; EC 201 or ARE 201.* Introduction to statistics applied to management, accounting, and economic problems. Emphasis on statistical estimation, inference, simple and multiple regression, and analysis of variance. Use of computers to apply statistical methods to problems encountered in management and economics.

ST 361 Introduction to Statistics for Engineers. *3(3-0) . F,S,Sum. Preq: College algebra. Credit not allowed for both ST 361 and ST 370 or ST 380.* Statistical techniques useful to engineers and physical scientists. Includes elementary probability, frequency distributions, sampling variation, estimation of means and standard deviations, basic design of experiments, confidence intervals, significance tests, elementary least squares curve fitting.

ST 370 Probability and Statistics for Engineers. *3(3-0) . Preq: MA 241. Credit not allowed for both ST 370 and ST 361 or ST 380.* Calculus-based introduction to probability and statistics with emphasis on Monte Carlo simulation and graphical display of data on computer workstations. Statistical methods include point and interval estimation of population parameters and curve and surface fitting (regression analysis). The principles of experimental design and statistical process control introduced.

ST 371 Introduction to Probability and Distribution Theory. *3(3-0) . F,S,Sum. Preq: MA 241. Coreq: MA 242.* Basic concepts of probability and distribution theory for students in the physical sciences, computer science and engineering. Provides the background necessary to begin study of statistical estimation, inference, regression analysis, and analysis of variance.

ST 372 Introduction to Statistical Inference and Regression. *3(3-0) . F,S,Sum. Preq: ST 371.* Statistical inference and regression analysis including theory and applications. Point and interval estimation of population parameters. Hypothesis testing including use of t, chi-square and F. Simple linear regression and correlation. Introduction to multiple regression and one-way analysis of variance.

ST 380 Probability and Statistics for the Physical Sciences. *3(3-0) . Preq: MA 241. Credit not allowed for both ST 380 and ST 361 or ST 370.* Introduction to probability models and statistics with emphasis on Monte Carlo simulation and graphical display of data on computer laboratory workstations. Statistical methods include point and interval estimation of population parameters and curve and surface filling (regression analysis).

ST 421 Introduction to Mathematical Statistics I. *3(3-0) . Preq: MA 242.* First of a two-semester sequence of mathematical statistics, primarily for undergraduate majors and graduate minors in Statistics. Introduction to probability, univariate and multivariate probability distributions and their properties, distributions of functions of random variables, random samples and sampling distributions.

ST 422 Introduction to Mathematical Statistics II. *3(3-0) . Preq: ST 421.* Second of a two-semester sequence of mathematical statistics, primarily for undergraduate majors and graduate minors in Statistics. Random samples, point and interval estimators and their properties, methods of moments, maximum likelihood, tests of hypotheses, elements of nonparametric statistics and elements of general linear model theory.

ST 430 Introduction to Regression Analysis. *3(3-0) . Preq: ST 302, MA 305 or MA 405.* Regression analysis as a flexible statistical problem solving methodology. Matrix review; variable selection; prediction; multicolinearity; model diagnostics; dummy variables; logistic and non-linear regression. Emphasizes use of computer.

ST 431 Introduction to Experimental Design. *3(3-0) . S. Preq: ST 302.* Experimental design as a method for organizing analysis procedures. Completely randomized, randomized block, factorial, nested, latin squares, split-plot and incomplete block designs. Response surface and covariance adjustment procedures. Stresses use of computer.

ST 432 Introduction to Survey Sampling. *3(3-0) . S. Preq: ST 302.* Design principles pertaining to planning and execution of a sample survey. Simple random, stratified random, systematic and one- and two-stage cluster sampling designs. Emphasis on statistical considerations in analysis of sample survey data. Class project on design and execution of an actual sample survey.

ST 435 Statistical Methods for Quality and Productivity Improvement. *3(3-0) . Preq: ST 302.* Use of statistics for quality control and productivity improvement. Control chart calculations and graphing, process control and specification; sampling plans; and reliability. Computer use will be stressed for performing calculations and graphing.

ST 445 Introduction to Statistical Computing and Data Management. *3(3-0) . Preq: ST 302.* Use of computers to manage, process and analyze data. Concepts of research; data management; JCL and utility programs; use of statistical program package for data analyses and graph production; and writing statistical programs to perform simulation experiments. Major paper required.

ST 495 Special Topics in Statistics. *1-6. F,S,Sum. Preq: Consent of Instructor.* Offered as needed to present material not normally available in regular departmental course offerings, or for offering new courses on a trial basis.

ST 498 Independent Study in Statistics. *1-6. F,S,Sum. Preq: Six hours of ST and Consent of Department.* Detailed investigation of topics of particular interest to advanced undergraduates under faculty direction.

ST 505 Applied Nonparametric Statistics. *3(3-0) . S Preq: ST 3"2 or ST 511.* Statistical methods requiring relatively mild assumptions about the form of the population distribution. Hypothesis testing, point and interval estimation and multiple comparison procedures for a variety of statistical problems.

ST 506 Sampling Animal Populations. *3(3-0) . F, Alt. yrs. Preq: ST 512.* Statistical methods applicable to sampling of wildlife populations, including capture-recapture, removal, change in ratio, quadrant and line transect sampling. Emphasis on model assumptions and study design.

ST 507 Statistics for the Behavioral Sciences I. *3(3-0) . F,S.* A general introduction to the use of descriptive and inferential statistics in behavioral science research. Methods for describing and summarizing data presented, followed by procedures for estimating population parameters and testing hypotheses concerning summarized data.

ST 508 Statistics for the Behavioral Sciences II. *3(3-0) . F,S. Preq: ST 507 or Consent of Instructor.* Introduction to use of statistical design principles in behavioral science research. Presentation of use of a statistical model to represent structure of data collected from a designed experiment or survey study. Opportunities provided for use of a computer to perform analyses of data, to evaluate proposed statistical model and to assist in post-hoc analysis procedures. Least squares principles used to integrate topics of multiple linear regression analysis, the analysis of variance and analysis of covariance.

ST 511 Experimental Statistics for Biological Sciences I. *3(3-0) . F,S,Sum. Preq: ST 311 or grad. standing.* Basic concepts of statistical models and use of samples; variation, statistical measures, distributions, tests of significance, analysis of variance and elementary experimental design, regression and correlation, chi-square.

ST 512 Experimental Statistics for Biological Sciences II. *3(3-1) . F,S,Sum. Preq: ST 511.* Covariance, multiple regression, curvilinear regression, concepts of experimental design, factorial experiments, confounded factorials, individual degrees of freedom and split-plot experiments. Computing laboratory addressing computational issues and use of statistical software.

ST 513 Statistics for Management I. *3(3-0) . F. Preq: Grad. standing.* Analysis of data to represent facts, guide decisions and test opinions in managing systems and processes. Graphical and numerical data analysis for descriptive and predictive decisions. Scatter plot smoothing and regression analysis. Basic statistical inference. Integrated use of computer.

ST 514 Statistics for Management and Social Sciences II. *3(3-0) . F. Preq. ST 507.* Linear regression, multiple regression and concepts of designed experiments in an integrated approach, principles of the design and analysis of sample surveys, use of computer for analysis of data.

ST 515 Experimental Statistics for Engineers I. *3(3-0) . F. Preq: ST 361 or Graduate Standing.* General statistical concepts and techniques useful to research workers in engineering, textiles, wood technology, etc. Probability distributions, measurement of precision, simple and multiple regression, tests of significance, analysis of variance, enumeration data and experimental design.

ST 516 Experimental Statistics for Engineers II. *3(3-0) . S. Preq: ST 515.* General statistical concepts and techniques useful to research workers in engineering, textiles, wood technology, etc. Probability distributions, measurement of precision, simple and multiple regression, tests of significance, analysis of variance, enumeration data and experimental designs.

ST 520 Statistical Principles of Clinical Trials and Epidemiology. *3(3-0) . F. Preq: ST 511. Coreq: ST 512.* Statistical methods for design and analysis of clinical trials and epidemiological studies. Phase I, II, and III clinical trials. Principle of Intention-to Treat, effects of non-compliance, drop-outs. Interim monitoring of clinical trials and data safety monitoring boards. Introduction to meta-analysis. Epidemiological design and methods.

ST 521 Statistical Theory I. *3(2 2) . F. Coreq: MA 425 or MA 511 and MA 405.* Probability tools for statistics: description of discrete and absolutely continuous distributions, expected values, moments, moment generating functions, transformation of random variables, marginal and conditional distributions, independence, orderstatistics, multivariate distributions, concept of random sample, derivation of many sampling distributions.

ST 522 Statistical Theory II. *3(2-2) . S. Preq: MA 511 or MA 425 and ST 521/ST 521.* General framework for statistical inference. Point estimators: biased and unbiased, minimum variance unbiased, least mean square error, maximum likelihood and least squares, asymptotic properties. Interval estimators and tests of hypotheses: confidence intervals, power functions, Neyman-Pearson lemma, likelihood ratio tests, unbiasedness, efficiency and sufficiency.

ST 524 Statistics in Plant Science. *3(3-1) . F. Preq: ST 512.* Principles and techniques of planning, establishing and executing field and greenhouse experiments. Size, shape and orientation of plots; border effects; estimation of size of experiments for specified accuracy; subsampling plots and yields for laboratory analysis; combining data from a series of years and/or locations; rotation experiments; repeated measures data; multiple comparisons in variety trial results; selection of predictors in multiple regression; introduction to interspecies and intraspecies plant competition experiments and models.

ST 535 Statistical Process Control. *3(3-1) . F. Preq: ST 515; students must have access to an MS-DOS PC.* Modern methods of statistical process control for graduate students with calculus-level course in engineering statistics. Classical and modern methods of SPC in framework of the Deming quality management philosophy emphasizing continuous process improvement. Orientation toward use of PC-class computers for computations.

ST 536 Off-Line Quality Control. *3(3-0) . S. Preq: ST 421 or ST 515.* Off-line quality control methods for graduate students with a calculus-level first course in engineering statistics. About one third of lectures presentation of material from area of sampling inspection with emphasis upon using PCs for computations. Remainder of course presentation of material from design of experiments especially important in industrial applications: factorial experiments, orthogonal arrays, Plackett-Burman plans, Box-Behnken designs, response surfaces, design optimality, variability analysis.

ST (MA) 546 Theory of Probability I. *3(3-0) . F.* Axioms, combinatorial analysis, conditional probability, independence, random variables, expectation, special discrete and continuous distributions, probability and moment generating functions, central limit theorem, laws of large numbers, branching processes, recurrent events, random walk.

ST 552 Linear Models and Variance Components. *3(2-2) . S. Preq: MA 405, ST 521. Coreq: ST 522.* Theory of estimation and testing in full and non-full rank linear models. Normal theory distributional properties. Least squares principle and the Gauss-Markoff theorem. Estimability and properties of best linear unbiased estimators. General linear hypothesis. Application of dummy variable methods to elementary classification models for balanced and unbalanced data. Analysis of covariance. Variance components estimation for balanced data.

ST (ECG) 561 Intermediate Econometrics. *3(3-0) . S. Preq: ECG 700 and ST 514.* Formalization of economic hypotheses into testable relationships and application of appropriate statistical techniques. Major attention to procedures applicable for single equation stochastic models expressing microeconomic and macroeconomic relationships. Statistical considerations relevant in working with time series and cross sectional data in economic investigations. Survey of simultaneous equation models and the available estimation techniques.

ST 590 Special Topics. *F, S, Sum.*

ST 601 Seminar. *1(1-0) . F, S, Sum.*

ST 620 Special Problems. *1-3. F, S, Sum. Preq: Consent of Instructor.* Development of techniques for specialized cases, particularly in connection with thesis and practical consulting problems.

ST 625 Advanced Special Problems. *1-3. F, S, Sum. Preq: ST 512, ST 552.* Any new advance in the field of statistics which can be presented in lecture series as unique opportunities arise.

ST 630 Independent Study.

ST 635 Readings.

ST 641 Statistical Consulting. *1(1-0) . F, S, Sum. Preq: ST 512 and ST 522.* Participation in regularly scheduled supervised statistical consulting sessions with faculty member and client. Consultant's report written for each session. Regularly scheduled meetings with course instructor and other student consultants to present and discuss consulting experiences.

ST 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ST 690 Master's Examination. *1-6. F, S, Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

ST 693 Master's Supervised Research. *1-9. F, S, Sum. Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ST 695 Master's Thesis Research. *1 9. F, S, Sum. Preq: Master's Student.* Thesis Research

ST 699 Master's Thesis Preparation. *1-3. F, S, Sum. Preq: Master's Student. Credits Arranged.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

ST (MA, OR) 706 Nonlinear Programming. *3(3-0) . F. Preq: OR(IE,MA) 505 and MA 425 or equivalent.* An advanced mathematical treatment of analytical and algorithmic aspects of finite dimensional nonlinear programming. Including an examination of structure and effectiveness of computational methods for unconstrained and constrained minimization. Special attention directed toward current research and recent developments in the field.

ST 708 Applied Least Squares. *3(3-0) . F. Preq: ST 512.* Least squares estimation and hypothesis testing procedures for linear models. Consideration of regression, analysis of variance and covariance in a unified manner. Emphasis on use of the computer to apply these techniques to experimental (including unequal cell sizes) and survey situations.

ST 711 Design of Experiments. *3(3 0) . F. Preq: ST 512.* Review of completely randomized, randomized complete block and Latin square designs and basic concepts in the techniques of experimental design. Designs and analysis methods in factorial experiments, confounded factorials, response surface methodology, change-over design, split-plot experiments and incomplete block designs. Examples used to illustrate application and analysis of these designs.

ST 714 Life-Testing and Reliability. *3(3-0). F. Preq: ST 422 or ST 516.* Statistical methods for analyzing life-testing data and accessing system reliability. Grouped and time-censored data, order statistics. Classical and Bayesian inference for univariate and multivariate exponential, Weibull, lognormal and gamma distributions. Experimental designs and sampling plans for accelerated testing and burn-in procedures. Taguchi's reliability improvement philosophy. Field performance and software reliability analysis.

ST 715 Theory of Sampling Applied to Survey Design. *3(3-0). F. Preq: ST 422, ST 512.* Principles for interpretation and design of sample surveys. Estimator biases, variances and comparative costs. Simple random sample, cluster sample, ratio estimation, stratification, varying probabilities of selection. Multi-stage, systematic and double sampling. Response errors.

ST (GN) 721 Genetic Data Analysis. *3(3-0) . S, Alt Yrs. Preq: ST 430 and GN 411.* Analysis of discrete data, illustrated with genetic data on morphological characters allozymes, restriction fragment length polymorphisms and DNA sequences. Maximum likelihood estimation, including iterative procedures. Numerical resampling. Development of statistical techniques for characterizing genetic disequilibrium and diversity. Measures of population structure and genetic distance. Construction of phylogenetic trees. Finding alignments and similarities between DNA sequences. Locating genes with markers.

ST (BMA, OR) 722 Decision Analytic Modeling. *4(3-2) . F, Alt Yrs. Preq: MA 421 or ST 421 plus ST 511 or ST 516.* Analysis of decision problems involving risk and uncertainty. Modeling decision process; Bayesian probability analysis, use of information, and subjective probability; utility theory and multiattribute utility assessment; dynamics of interacting with decision makers and subject matter specialists; decision trees, influence diagrams and other tools to assist in modeling decision problems. Laboratory develops skill in implementing methodology.

ST 730 Applied Time Series Analysis. *3(3-0) . F. Preq: ST 512.* An introduction to use of statistical methods for analyzing and forecasting data observed over time. Trigonometric regression. periodogram/spectral analysis. Smoothing. Autoregressive moving average models. Regression with autocorrelated errors. Linear filters and bivariate spectral analysis. Stress on methods and applications; software implementations described and used in assignments.

ST 731 Applied Multivariate Statistical Analysis. *3(3-0) . S Preq: ST 512.* An introduction to use of multivariate statistical methods in analysis of data collected in experiments and surveys. Topics covered including multivariate analysis of variance, discriminant analysis, canonical correlation analysis and principal components analysis. Emphasis upon use of a computer to perform multivariate statistical analysis calculations.

ST 732 Applied Longitudianal Data Analysis. *3(3-0) . S. Preq: ST 512.* Statistics methods for analysis of multivariate data, focusing on data collected in form of repeated measurements. Multivariate normal distribution, Hotelling's T2. multivariate analysis of variance, repeated measures analysis of variance, growth curve models, mixed effects models. Methods for analyzing multivariate data in form of counts, categorical data and binary data, emphasizing recent approaches in statistical literature.

ST 733 Applied Spatial Statistics. *3(3-1) . S. Preq: ST 512.* Graphical and quantitative description of spatial data. Kriging, block kriging and cokriging. Common variogram models. Analysis of mean-nonstationary data by median polish and universal kriging. Spatial autoregressive models. estimation and testing. Spatial sampling procedures. Use of existing software with emphasis on analysis of real data from the environmental, geological and agricultural sciences.

ST 744 Categorical and Censored Data Analysis. *3(3-0) . S. Preq: ST 512 and ST 522.* Statistical models and methods for categorical responses including logistic regression and generalized linear models, probit analysis and log-linear models. Censored data methods include Kaplan-Meier estimation, accelerated life regression and proportional hazards regression. Discussion of software implementation of methods and usage in assignments.

ST 745 Analysis of Survival Data. *3(3-0) . S. Preq: ST 522.* Statistical methods for analysis of time-to-event data, with application to situations with data subject to right-censoring and staggered entry, including clinical trials. Survival distribution and hazard rate; Kaplan-Meier estimator for survival distribution and Greenwood's formula; log-rank and weighted long-rank tests; design issues in clinical trials. Regression models, including accelerated failure time and proportional hazards; partial likelihood; diagnostics.

ST (MA) 746 Introduction to Stochastic Processes. *3(3-0) . S. Preq: MA 405 and MA(ST) 546 or ST 521.* Markov chains and Markov processes, Poisson process, birth and death processes, queuing theory, renewal theory, stationary processes, Brownian motion.

ST 750 Statistical Computing. *3(3-0) . F, Alt Yrs. Preq: ST 552.* The intent of the course is to provide the statistician with the computational tools for statistical research and applications using digital computing machinery. Topics including random number generation and Monte Carlo methods, regression computations and application to statistical methods of optimization, sorting and Fast Fourier transform.

ST (ECG) 751 Econometrics. *3(3-0) . F. Preq: ECG 701, ST 421, ST 422.* Role and uses of statistical inference in economic research; problem of spanning gap from an economic model to its statistical counterpart; measurement problems and their solutions arising from statistical model and nature of the data; limitations and interpretation of results of economic measurement from statistical techniques.

ST (ECG) 752 Topics in Econometrics. *3(3-0) . S. Preq: ECG(ST) 751.* Survey of current literature on estimation and inference in simultaneous stochastic equations systems. Techniques for combining cross section and time series data including covariance, error correlated and error component models. Lag models and inference in dynamic systems. Production functions, productivity measurement and hypotheses about economic growth. Complete and incomplete prior information in regression analysis. Nonlinear estimation in economic models.

ST 755 Advanced Analysis of Variance and Variance Components. *3(3-0) . S, Alt Yrs. Preq: ST 512, ST 552.* Expected mean squares, exact and approximate tests of hypotheses for balanced and unbalanced data sets. Fixed, mixed and random models. Randomization theory. Estimation of variance components using regression, MINQUE and general quadratic unbiased estimation theory.

ST (GN) 756 Computational Molecular Evolution. *3(3-0) . F,Alt. yrs. Preq: GN 411 and ST 511 or Consent of Instructor.* Phylogenetic analyses of nucleotide and protein sequence data. Sequence alignment, phylogeny reconstruction and relevant computer software. Prediction of protein secondary structure, database searching, bioinformatics and related topics. Project required.

ST (GN) 757 Statistics for Molecular Quantitative Genetics. *3(3-0) . F, Alt Yr.(even). Preq: ST 512 and GN 703 or ST 721.* Genetic mapping data. Linkage map reconstruction, quantitative genetical models. Statistical methods and computer programs for mapping quantitative trait loci and estimating genetic architecture of quantitative traits.

ST 760 Advanced Topics in Construction and Analysis of Experimental Designs. *3(3-0) . S, Alt Yrs. Preq: ST 512, ST 552.* Construction and analysis of multifactor designs, factorials, fractional factorials, balanced incomplete block designs, Latin squares, orthogonal arrays of strength d and response surface designs. Fractionating mixed level factorials, confounding and blocking techniques, study of robustness of designs to loss of design point.

ST 762 Nonlinear Statistical Models for Univariate and Multivariate Response. *3(3-0) . F. Preq: ST 512, ST 552.* Inference for general nonlinear parametric statistical models for univariate and multivariate continuous and discrete response, including generalized linear models, nonlinear models with nonconstant variance, and generalized estimating equation procedures for multivariate response, including repeated measurement data. Linear and quadratic estimating equations, models for covariance structure, effects of model misspecification and robustness. Survey of major theoretical results and implementation using standard statistical software.

ST (GN) 770 Statistical Concepts in Genetics. *3(3-0) . S, Alt Yrs. Preq: GN 703. Coreq. ST 512.* Migration, mutation, selection, drift, linkage, mating system and other processes bearing on rates of change in population frequencies, means and variances; magnitude and nature of genotypic and nongenotypic variability and their role in alternative procedures of plant and animal breeding; experimental and statistical approaches to the analysis of quantitative inheritance.

ST (BMA, MA) 771 Biomathematics I. *3(3-0) . F. Preq: Advanced calculus, reasonable background in biology or consent of instructor.* Role of theory construction and model building in development of experimental science. Historical development of mathematical theories and models for growth of one-species populations (logistic and off-shoots), including considerations of age distributions (matrix models, Leslie and Lopez; continuous theory, renewal equation). Some of the more elementary theories on the growth of organisms (von Bertalanffy and others; allometric theories; cultures grown in a chemostat). Mathematical theories of two and more species systems (predator-prey, competition, symbosis; leading up to present-day research) and discussion of some similar models for chemical kinetics. Much emphasis on scrutiny of biological concepts as well as of mathematical structure of models in order to uncover both weak and strong

points of models discussed. Mathematical treatment of differential equations in models stressing qualitative and graphical aspects, as well as certain aspects of discretization. Difference equation models.

ST (BMA, MA) 772 Biomathematics II. *3(3-0) . S. Preq: BMA 771, elementary probability theory.* Continuation of topics of BMA 771. Some more advanced mathematical techniques concerning nonlinear differential equations of types encountered in BMA 771: several concepts of stability, asymptotic directions, Liapunov functions; different time-scales. Comparison of deterministic and stochastic models for several biological problems including birth and death processes. Discussion of various other applications of mathematics to biology, some recent research.

ST (BMA, MA, OR) 773 Stochastic Modeling. *3(3 0) . S,Alt. Yrs. Preq: BMA 772 or ST (MA) 746.* Survey of modeling approaches and analysis methods for data from continuous state random processes. Emphasis on differential and difference equations with noisy input. Doob-Meyer decomposition of process into its signal and noise components. Examples from biological and physical sciences, and engineering. Student project.

ST (MA) 778 Measure Theory and Advanced Probability. *3(3 0) . F, S. Preq: MA 426; ST 521 or MA(ST) 546 or equivalent* Modern measure and integration theory in abstract spaces. Probability measures, random variables, expectations. Distributions and characteristic functions. Modes of convergence. Independence, zero-one laws, laws of large numbers, three-series theorem. Central limit problem. Conditional expectations, martingales and martingale convergence theorems.

ST (MA) 779 Measure Theory and Advanced Probability II. *3(3-0) . F, S. Preq: ST 778.* Modern measure and integration theory in abstract spaces. Probability measures, random variables, expectations. Distributions and characteristic functions. Modes of convergence. Independence, zero-one laws, laws of large numbers, three-series theorem. Central limit problem. Conditional expectations, martingales and martingale convergence theorems.

ST 782 Time Series Analysis: Time Domain. *3(3-0) . S, Alt Yrs. Preq: ST 512 and ST 522.* Estimation inference for coefficients in autoregressive, moving average and mixed models and large sample. Distribution theory for autocovariances and their use in identification of time series models. Stationarity and seasonality. Extensions of theory and methods to multiple series including vector autoregressions, transfer function models, regression with time series errors, state space modeling.

ST 783 Time Series Analysis: Frequency Domain. *3(3-0) . S, Alt Yrs. Preq: ST 512 and ST 522.* Theory and methods of time series analysis from frequency point of view. Harmonic analysis, complex demodulation and spectrum estimation. Frequency domain structure of stationary time series and space-time processes. Sampling distributions of commonly used statistics.

ST 784 Multivariate Analysis. *3(3-0) . S, Alt. Yrs. Preq: ST 522.* Survey of multivariate statistical theory. Multivariate distributions including the multinormal, Wishart, Hotelling's T, Fisher-Roy-Hsu, Wilks' and multivariate Beta distributions. Applications of maximum likelihood estimation, likelihood ratio testing and the union-intersection principle. Development of the theory of Hotelling's T tests and confidence sets, discriminant analysis, canonical correlation, multivariate analysis of variance and principal components.

ST 785 Introduction to Statistical Decision Theory. *3(3-0) . F, Alt. Yrs. Preq: ST 522.* Zero sum two-person games and statistical inference. Bayesian methods and orthodox statistical estimation and testing; minimax decision rules; empirical Bayes procedures; Bayes sequential decision procedures.

ST 790 Advanced Special Topics. *F, S, Sum.*

ST 793 Advanced Statistical Inference I. *3(3-0) . F. Preq: ST 522.* Inference with emphasis on definition of statistical models, construction and use of likelihoods, and general estimating equations. Comparison of inference methods based on jackknife, bootstrap, and normal approximations. Rank and permutation tests and concepts from robust inference.

ST 794 Advanced Statistical Inference II. *3(3 0) . S Preq: ST ~~8 and ~93.* Principles of inference including introduction to Bayesian inference. Optimality results for regular estimation and hypothesis testing situations. Asymptotic results for estimators and tests based on likelihoods, general estimating equations and resampling plans.

ST 801 Seminar. *1(1-0) F, S, Sum*

ST 810 Advanced Topics in Statistics. *F,S.*

ST 820 Special Problems. *1-3. F, S, Sum. Preq. Consent of Instructor.* Development of techniques for specialized cases, particularly in connection with thesis and practical consulting problems.

ST 825 Advanced Special Problems. *1-3. F, S, Sum. Preq: ST 512, ST 552.* Any new advance in the field of statistics which can be presented in lecture series as unique opportunities arise.

ST 830 Independent Study. *F,S.*

ST 835 Readings.

ST 841 Statistical Consulting. *1(1-0) . F, S, Sum. Preq: ST 512 and ST 522.* Participation in regularly scheduled supervised statistical consulting sessions with faculty member and client. Consultant's report written for each session. Regularly scheduled meetings with course instructor and other student consultants to present and discuss consulting experiences.

ST 885 Doctoral Supervised Teaching. *1-3. F, S, Sum. Preq: Doctoral Student.* Teaching experience under the mentorship of faculty who assist the student in planing for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ST 890 Doctoral Preliminary Examination. *1-9. F, S, Sum. Preq· Doctoral Student.* For students who are preparing for and taking written and/or oral preliminary exams.

ST 893 Doctoral Supervised Research. *1-9. F, S, Sum. Preq: Doctoral Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ST 895 Doctoral Dissertation Research. *1-9. F, S, Sum. Preq: Doctoral Student.* Dissertation Research

ST 899 Doctoral Dissertation Preparation. *1-3. F, S, Sum. Preq: Doctoral Student.* For students who have completed all credit hour requirements, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

SOCIAL WORK

SW 201 Community Social Services. *3(3-0) .* Study of social services typical of American communities including services to children, families and older persons: and services in mental health, criminal and juvenile justice, and industry. Pre-professional work experience included..

SW 290 The Development of Social Welfare and Social Work in the U.S. *3(3-0) . Preq: SW 201.* Major programs and policy developments in U.S. social welfare from colonial period through the early 1900s including institutionalization, charity organization, New Deal, the war on poverty, and reform efforts in the 1950s. Emphasis on the development of the social work profession in the 20th century.

SW 300 Social Work Research Methods. *3(3-0) . F, S. Preq: SW 201. Coreq: ST 311. Social Work Majors.* Principles and methods of basic social work research. Substantive research knowledge and research methodology. Research ethics within the context of social work purposes and values. Formulation of problems for study that address the social needs of diverse groups.

SW 307 Social Welfare Programs and Policy. *3(3-0) . Preq: SW 290.* Major social welfare programs and policy issues, including public assistance and anti-poverty programs, healthcare, aging, employment, housing and social service organizations.

SW 310 Human Behavior Theory for Social Work Practice. *3(3-0) .* Theory regarding human social functioning for students intending to practice social work. Emphasis on social, biological, psychological and cultural factors in human life.

SW 320 Social Work Practice I. *3(3-0) . Preq: SW 310.* Elements of the general method of social work practice: professional values, client-worker relationships and professional roles. Interviewing skills and problem analysis.

SW 405 Social Work Practice II. *3(3-0) . Preq: SW 320.* Second of two-course sequence on social work practice. Focus on employing general method of social work practice, working with individuals, families, groups and communities. Social work theory, problem solving methods, practice techniques emphasized. Volunteer work in social service required.

SW 410 Multi-Cultural Social Work. *3(3-0) . Preq: SW 310.* Study of social service provision to diverse populations with particular emphasis on implications for social work practice. Population groups will include African Americans, Asian Americans, Caucasians, Gays and Lesbians, Hispanic Americans, Native Americans and selected religious groups.

SW 412 Social Work in Schools. *3(3-0) . Preq: Social work students.* Models and roles relevant to school social work practice. Cooperative work with school personnel in the identification, prevention and treatment of social, emotional and behavioral problems of children and interventive techniques with parents and community groups. For individuals preparing for social work practice in the public schools and for school social workers seeking recertification.

SW 413 Black Families in the Social Environment. *3(3-0) . S. Preq: Sophomore standing.* Alternative conceptual models of Black family life and their relationships to other social institutions and to social policy development. Policy implications of Black family demographic characteristics, socialization patterns, gender roles, and kinship patterns.

SW 414 Social Work Practice in Health Care. *3(3-0) . Practice* skills and knowledge required of social workers in health care systems. Multi-disciplinary team work in health care. Social components of major illnesses and disabilities, including prevention and rehabilitation. Emotional, cultural, economic and social factors in health and illness. Health needs of specific population groups.

SW 415 Child Welfare. *3(3-0) . S, Alt. Yrs.(even).* Social work practice with children and families. Emphasis on child welfare programs and the development of assessment and case planning skills. Methods of protective services, adoption, and foster care are studied.

SW 420 The Legal Aspects of Social Work. *3(3-0) . Preq: SW 307; Social Work students.* Legal environment of the social work profession. Relationships among legal processes, the delivery of social work services, and client problems.

SW 480 Preparation for Field Work. *1(1-0) . F,S. Preq: SW 320. Coreq. SW 405. Social Work majors.* Introduction to aspects of field placement process and necessary skills for a successful internship. Application, interview, ethical practice, documentation, supervision and learning contract.

SW 490 Field Work in Social Services. *12(3 32) . Preq: SW 405.* Supervised placement in a social service organization; application of social work knowledge and skill. Weekly integrative seminar.

SW 495 Special Topics in Social Work. *3(3-0) . F,S,Sum.* Detailed investigation of a topic in social work. Topic and mode of study determined by faculty member.

SW 498 Independent Studies in Social Work. *1-6. F,S,Sum. Preq: Nine credits in social work courses. Must be Junior or Senior with a major or minor in Social Work.* Independent or small group study of a social work practice or social welfare area.

TEXTILES

T 110 Textiles Scholars Forum. *0(2-0) . Preq: Enrollment limited to participants in the Textiles Scholars Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

T 200 Introduction to Textiles. *3(3-0) . Not open to students required to take TT 105; open to transfer students.* Survey of textiles including technical and economic history of the industry; physical and chemical processes involved in producing textile products from raw materials; unique aesthetic, physical and chemical properties of textiles and how these properties are determined by raw materials and production processes; and influence of properties of textile materials on their utilization and performance.

T 210 Textiles Scholars Forum. *0(2 0) . Preq. Enrollment limited to participants in the Textiles Scholars Program.* Interdisciplinary seminar series with presentations by distinguished faculty members and experts drawn from technical, academic, business and government communities. Discussions of major public issues and topics of contemporary concern.

T 491 Honors Seminar in Textiles. *1(0 0) . Preq: By invitation into Honors Program in Textiles.* A seminar on current university and industrial research in the field of textiles.

T 493 Industrial Internship in Textiles. *3(3 0) . Preq: Textile core courses. Limited to three hours per student.* Paid professional-level work experience in textiles, relating academic training in science and technology to industrial practice under professional guidance. Written and final oral presentation used for grading..

T 497 Independent Research in Textile Engineering, Chemistry and Materials Science I. *3(0-9) . Preq: Junior standing in TECS; 2.8 GPA; course coordinator's approval.* Independent research in Textile Engineering, Chemistry and Materials Science topics through experimental, theoretical and literature studies. Written and oral reports required.

T 498 Independent Research in Textile Engineering, Chemistry and Materials Science II. *1-3. Preq: T 497; course coordinator's approval.* Independent research in Textile Engineering, Chemistry and Materials Science topics through experimental, theoretical and literature studies. Written and oral reports required.

TEXTILE AND APPAREL MANAGEMENT

TAM 170 Textile Design Orientation. *1(0-2) .* Orientation course designed to present the breadth and scope of the Textile Design profession together with future opportunities in this field.

TAM 218 Introduction to Apparel Technology Management. *3(3-0) . Preq: TT 105.* Structure and organization of the apparel industry and its strategic function in the soft goods pipeline with an analysis of the critical stages involved in the manufacture of apparel and other sewn products.

TAM 271 Computer-Aided Textile Design. *3(1-4) . Sum. Preq: TT 105 or ADN 101 or 111. Credit not allowed for students enrolled in TT curriculum with the exception of the dual degree in the Bachelor of Art and Design and BS in Textile Technology.* Instruction in several software programs for the design of woven textiles. CAD experimentation and design of various woven structures. Development of a range of colorways for designs. Interfacing of computer with loom to weave samples of electronically designed fabrics. Storyboard preparation, presentation and critique will also be included.

TAM 315 Apparel Production I. *3(2-2) . Preq: TAM 218.* Concepts and practices for the production of basic apparel items, beginning with selection of fabric and other raw material garment components and extending through computerized pattern development, pattern grading, and pattern engineering. Techniques for development of styled patterns and for solution of problems of fit.

TAM 316 Apparel Production II. *3(2-2) . Preq: TAM 315.* Principles of apparel manufacturing including computerization of the design, marker making and production areas; spreading and cutting technology; apparel assembly systems; production systems evaluations; fusing and pressing.

TAM 371 Woven Textile Design. *3(1-4) . Preq: TT 105 and a grade of C- or better in ADN 111. For students admitted to Design Minor only.* Design and production of woven fabrics. Exploration of various basic structures, color and textural effects. Development of design abilities through hand-production methods, including an introduction to Computer-integrated Design systems and an awareness of industrial processes.

TAM 372 Knitted Textile Design. *3(1-4) . Preq: Grade of C- or better in ADN 111 or DF 101. For students admitted to Design Minor only.* Design and production of hand- and machine-knitted fabrics. Exploration of basic structures, color and textural effects. Development of design abilities through hand- and machine-production methods, including an introduction to Computer-integrated Design systems and an awareness of industrial processes.

TAM 380 Management and Control of Textile and Apparel Systems. *3(3-0) Preq: TT 221, 241 and 251 or TE 301* Management approaches, practices and basic economic considerations in the development, production and distribution of industrial and consumer textile and apparel products.

TAM 381 Supervision in the Textile and Apparel Industries. *3(3 0) . Preq. TAM 380.* Supervision applied to the specific problems confronting the textile and apparel industries. Role of supervisors in maintaining productivity in an atmosphere wherein continuing and critical problems prevail. Emphasis on supervisor's competencies needed to effectively discharge their responsibilities.

TAM 382 Principles of Soft Goods Marketing. *3(3-0) . Preq: EC 201. Credit not allowed for both TAM 382 and BUS 360.* Principles of marketing textiles in the consumer goods sector. Emphasis on market segmentation, product strategy, pricing decisions, promotion and channels of distribution. Interface between textile manufacturers and those producing apparel and upholstered furniture. Marketing channel for apparel to the retailer.

TAM 383 Management of New Product Development. *3(3-0) . Preq: TMS 211, TT 241, TT 251 and TAM 382.* Examination of the strategic and tactical issues implicit in a new product development program. Qualitative and quantitative determination of consumer perceptions and preferences. Addresses issues associated with management decisions concerning product features and design, marketing mix, testing, and introduction of new products. Emphasis is on textile and apparel products using other markets as models.

TAM (TC) 401 Environmental Aspects of the Textile Industry. *3(3-0) . Preq: Junior standing.* Environmental pollution sources and effects, occupational safety and health, and typical problems specific to the textile industry. Survey of natural and synthetic fiber pollution problems with case histories. Techniques for pollution control by source reduction and treatment. Safety and health management for hazards in the industry.

TAM (MDS) 414 Textiles and Society. *3(3-0) . Alt. yrs. Sophomore standing.* Historical and sociological study of the textile and apparel industries since the Middle Ages with emphasis on 1850-present. Changes in industry composition, corporate structure, production technology, work organization, and labor-management relations. Impact on communities, workers, and the environment. Long range trends and implications.

TAM 415 Apparel Product Development. *3(1-3) . Preq: TAM 316.* Introduction to various methods of generating patterns for mass-produced apparel with emphasis on "flat pattern" design techniques. Relationship of body configuration to pattern shape, specifications to garment size and fit, standards for judging fit, distinctions between ease and style fullness, and design analysis procedures are included.

TAM 416 Apparel Production III. *3(2-2) . Preq: St/BUS 350 or ST 361; TAM 316.* Traditional and non-traditional workplace designs for textile and apparel production. Applications of computerized predetermined time study, work measurement and line balancing techniques as production optimization tools in labor-intensive environments. Emphasis on computer applications for simulation and management of apparel production, product data management, payroll and incentive systems.

TAM (TT) 431 Quality Management and Control in Textile Manufacturing. *3(3-0) . F,S. Preq: TT 221, TT 241, TT 251, TT 331 and ST 361 or BUS 350.* Principles of quality and process management and control in textile/apparel manufacturing with emphases in quality management systems, quality costs, statistical control chart procedures, process capability, acceptance sampling and optimal process and product design and improvement methods.

TAM 471 Textile Design Projects I. *3(1-4) . F. Preq: Senior standing, ADN 272, TAM 371, TAM 372.* Introduction to textile design through applied technological, theoretical and marketing studies. Written and oral presentation of reports.

TAM 472 Textile Design Projects II. *3(1-4) . S. Preq: TAM 471.* Projects in design and development in various areas of textile design. Written and oral presentation of reports.

TAM 480 Production Management Decisions for Textile Operations. *3(2-2) . Preq. TAM 380, ACC 280 or 210 BUS/ST 350 or ST 361, MA 132 or equivalent, senior standing.* Quantitative techniques for decision making and management in a textile/apparel environment.

TAM 481 Product Costing in the Textile and Apparel Industry. *3(2-2) . Preq: TT 221, TT 241, TT 251 and TAM 218.* Capstone course covering cost issues in yarn manufacturing, fabric formation, finishing, apparel production and retail operations. Traditional and activity-based costing systems will be addressed. Relevance of costing to managerial decisions as well as cost reduction strategies will be emphasized.

TAM (BUS) 482 Textile Marketing Management. *3(2-2) . F,S. Preq: TAM 380 and TAM 382.* The development and state of the art of current textile marketing management theory and practice are covered in classroom sessions. Management lab sessions include experiential, marketing games and role-playing exercises. Current industry practice and government relations are stressed.

TAM 483 Textile and Apparel in International Trade. *3(3-0) . F. Preq: EC 201.* Course presents the textile and apparel industries in the global setting of trade and markets.

TAM 484 Management Decision Making for the Textile Firm. *3(3-0) . Preq: TAM 380 and Sr. standing.* Economic, institutional and environmental settings within which management decisions are made, including in-depth analyses of specific issues and problem areas affecting the textile industry. Special emphasis on strategic management and topics of current interest and significance.

TAM 485 Textile Computer Integrated Manufacturing. *3(3-0) . F. Preq: TAM 380.* Survey of computer integrated manufacturing (CIM) systems in the textiles and apparel industries. Topic discussed include: computer aided design (CAD); computer aided manufacturing (CAM); computer aided engineering (CAE); material handling systems; automation and robotics; information systems; and Internet resources.

TAM 486 Total Quick Response in the Textile Industry. *3(3-0) S. Preq: TAM 380* Survey of planning and control strategies in the Integrated Textile Complex for creating a Total Quick Response environment. Case studies of textile operations with field trips to textile manufacturing companies.

TAM 487 Textile and Apparel Labor Management. *3(3-0) Preq: Sr. standing.* Labor management problems. Emphasis directed toward role of production supervision in textile and apparel plants. Study of NLRB decisions and court opinions involving textile and apparel corporations.

TAM 490 Development Projects in Textile and Apparel Management. *1-3. Preq. Junior standing and 2.75 GPA. Courses may be taken twice provided projects are different subject matter..* Directed research in Textile and Apparel Management through experimental, theoretical and literature studies in textile and apparel-related problems.

TAM 491 Special Topics in Textile and Apparel Management. *1-3. Preq: Sr. standing.* Special topics related to textile and apparel management.

TAM 494 International Industrial Internship in Textile Management. *3(3-0) . F,S,Sum. Preq: At least FL 202 or equivalent for internships in non-English speaking countries. Minimum GPA 2.5, Junior Standing.* Professional level work experience in textile management abroad, relating academic training, international textile management and technology to industrial practice under professional guidance. Grading based on written report and oral presentation.

TAM 497 Textile Management Senior Project. *4(1-2) . F,S. Preq: Senior standing. Restricted to students in TATM Department.* A project-based course. Individual work in small teams to solve assigned problems through desk and field research. Team presentation of findings and analysis in a written report with a formal presentation to class. Assessment on both team and individual performance. Workshop sessions with specific business skills.

TAM 589 Special Studies in Textile Management and Technology. *1-4. F, S. Preq: Sr. or grad. standing.* New or special course on developments in textile management and technology. Specific topics and prerequisites vary.

TEXTILE CHEMISTRY

TC 105 Introduction to Textiles and Computers. *3(2-2) .* Introduction to College of Textiles programs and facilities, including library and information resources. An overview of the properties and uses of polymers, fibers, yarns, fabrics, dyestuffs and textile finishes. Emphasis on computer applications in practicum.

TC 203 Introduction to Polymer Chemistry. *3(3-0) . Preq: TC 105 or TT 105.* Organic reaction principles necessary to understand the preparation, properties and chemistry of polymers. Synthesis, applications and behavior of common classes of polymers with emphasis on those materials used in the textile industry. The chemistry and structure of natural and man-made fibers.

TC 301 Technology of Dyeing and Finishing. *4(3-2) . Preq: TC 203.* Basic principles and procedures for the preparation, dyeing, printing, and finishing of natural and man-made fibers. The chemical nature of dyes and fastness properties, and the chemical nature of finishes used to impart specific end-use properties.

TC 302 Technology of Textile Wet Processing. *4(3-2) . F, S, Sum. Preq: TT 105 or TC 105, TMS 211, CH 101, PY 211 or PY 205.* Introduction to the science and technology used in textile wet processing. Topics include preparation, dyeing, printing, and finishing of textiles, basics of color generation and measurement. Emphasis mainly on cotton, wool, nylon and polyester. Laboratory includes experiments in wet processing and a project on statistical analysis of fabric defects.

TC 305 Introduction to Color Science and Its Applications. *3(2-2) . S. Preq: PY 212 or PY 208, and TC 301.* Basic principles and applications of color science. Physical, physiological and psychophysical aspects of color, color perception, color specification, color measurement and color control. Laboratory and computer color graphics exercises to aid understanding of color science.

TC 310 Textile Preparation and Finishing Chemistry. *3(3-0) . Preq: TC 301* Topics in textile wet processing. Chemical mechanisms and unit operations in fabric preparation and finishing.

TC 320 Textile Dyeing and Printing. *3(3-0) . Preq: TC 301. Coreq: CH 223.* Topics in coloration of textile fibers; chemical and physical mechanisms in textile dyeing and printing.

TC (TAM) 401 Environmental Aspects of the Textile Industry. *3(3-0) . Preq: Junior standing.* Environmental pollution sources and effects, occupational safety and health, and typical problems specific to the textile industry. Survey of natural and synthetic fiber pollution problems with case histories. Techniques for pollution control by source reduction and treatment. Safety and health management for hazards in the industry.

TC 402 Introduction to the Theory and Practice of Fiber Formation. *3(3-0) . Preq: Senior standing; TC 203, PY 208 or 212, MA 242, CH 201.* Flow behavior of polymeric materials as related to the formation of fibers by melt, dry and wet extrusion. Elementary theories of drawing and heat setting. Application of fiber-forming theories to synthetic and cellulosic fibers.

TC 403 Carpet Industry. *3(3-0) . F, Alt. yrs. Preq: TC 301 or 302; TT 221, 241 and 251 or TMS 210 or TE 301 and 302 and Sr. standing.* An overview of all aspects of carpet production and marketing including fiber properties and selection, yarn formation, carpet formation, dyeing and finishing, design, quality assurance and testing, marketing and environmental issues. Instruction provided by industry professionals. May include a field trip.

TC 407 Wet Processing Operations and Quality Control. *3(1-6) . Preq: TC 310, TC 320, TMS 210, and CH 431 or TC 441.* Pilot-scale batch and continuous wet processing. Selection and use of processes and quality control tests.

TC 412 Textile Chemical Analysis. *3(2-3) . Preq: TC 301; CH 431 or TC 441.* Application of certain techniques of analysis to fibers, textile chemicals and textile processes; ultraviolet, visible and infrared spectrophotometery; chromatography; viscometry; interfacial tension; calorimetric, gravimetric and mechanical thermalanalyses. Emphasis on solving problems of analysis involving such processes as sorption, solution, diffusion, crystallization, etc.

TC 441 Theory of Physico-Chemical Processes in Textiles I. *3(3-0) . Preq: C in MA 231 or 241 and C in PY 205 or 211. Coreq: PY 212.* First semester of a two-semester sequence. Systems and processes, thermodynamics. Applications to polymer and textile wet processing situations.

TC 442 Theory of Physico-Chemical Processes in Textiles II. *3(3-0) . Preq: TC 441.* Second semester of a two-semester sequence. Ideal and non-ideal solutions, colligative properties. Electro chemistry, dyeing isotherms, chemical kinetics, surface chemistry, theory of repellency and other special topics.

TC (CH) 461 Introduction to Fiber Forming Polymers. *4(3-3) . F. Preq: CH 223.* Formation and properties of fiber-forming polymers. Step-growth and chain-growth polymerization. Survey of formation techniques for man-made fibers. Relationships between chemical structure and physical properties of natural and man-made fibers.

TC 466 Polymer Chemistry Laboratory. *3(2-6) . Preq: TC 441 or CH 431; Senior standing.* Synthesis and characterization of polymers; thermodynamics of rubber elasticity and gelation; spectroscopic, thermal and scattering techniques for polymer analysis. The processing of polymers into fibers and films.

TC 490 Undergraduate Research in Textile Chemistry. *3(0-6) . Preq: TC 442 or CH 433, TC 301, CH/TC 461.* Faculty-supervised individual research for undergraduates in TC.

TC 491 Seminar in Textile Chemistry. *1(2-0) . Preq: TC 310, TC 320 and senior standing.* Familiarizes student with the principal sources of textile chemistry literature and emphasizes importance of keeping abreast of developments in the field. Emphasizes fundamentals of technical writing. Reports, lectures arranged.

TC 492 Special Topics in Textile Chemistry. *1-3. Preq: permission of instructor.* Presentation of material not normally available in regular course offerings or offering of new courses on a trial basis. Credits and content determined by faculty member in consultation with the Department Head.

TC 530 The Chemistry of Textile Auxiliaries. *3(3-0) . F. Preq: One yr. of organic chemistry.* Industrially important textile chemicals used for enhancing fiber and fabric properties such as durable press, water repellency, anti-soiling, flame retardancy, softness, stiffness, lubricity and other uses. Correlation of effect with structure, end-use influences, interaction with fabric and fibers, sources and synthetic routes, economic and environmental considerations.

TC (MAT) 561 Organic Chemistry of Polymers. *3(3-0) . S. Preq: TC 461 and CH 231 or CH 431.* Principles of step reaction and addition polymerizations; copolymerization; emulsion polymerization; ionic polymerization; characterization of polymers; molecular structure and properties.

TC 565 Polymer Applications and Technology. *3(3-0) S. Preq: One yr. of organic chemistry; TC 461* Poly(olefins), poly(vinyl chloride), poly(vinyl acetate), poly(urethanes), epoxies, silicones, styrene copolymers used as textile finishes, nonwoven binders, fabric coatings, composites, adhesives, foams, carpet backing adhesives. Emphasis upon synthesis, industrial processes, properties and products.

TC (TE, TMS) 589 Special Studies Textile Engineering and Science. *1 4. F, S, Sum. Preq: Senior or graduate standing.* New or special course on developments in textile engineering and science. Specific topics and prerequisites identified vary. Generally used for first offering of a new course.

TC 601 Seminar. *1(1 0) . F, S, Sum.* Discussion of scientific articles and presentations; review and discussion of student papers and research problems.

TC 630 Independent Study. *3(3-0) . F, S, Sum.*

TC 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

TC 690 Master's Examination. *1-6. F, S, Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

TC 693 Master's Supervised Research. *1-9. F, S, Sum. Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

TC 695 Master's Thesis Research. *1-9. F, S, Sum. Preq: Master's Student.* Thesis Research

TC 699 Master's Thesis Preparation. *1-3. F, S, Sum. Preq: Master's Student. Credits arranged.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

TC (FPS) 704 Fiber Formation--Theory and Practice. *3(3-0) F. Preq: MA 301. PY 208 or Consent of Instructor* Practical and theoretical analysis of the chemical and physical principles underlying conventional methods of converting bulk polymer to fiber; rheology; melt, dry and wet polymer extrusion; fiber drawing; heat setting; general theory applied to unit processes.

TC 705 Theory of Dyeing. *3(3-0) S. Preq. CH 433 or Consent of Instructor* Mechanisms of dyeing. Application of thermodynamics to dyeing systems. Kinetics of diffusion in dyeing processes.

TC 706 Color Science. *3(3 0) . F. Preq: Sr. or grad. standing in TC. Coreq: TC 707.* Basis of modern techniques for color specification, measurement, control and communication. Applications of color science to textiles, plastics, color reproduction, computer-based imaging and display systems. Basic concepts taught by computer color graphics.

TC 707 Color Laboratory. *1(0-2) . F. Preq: Sr or grad. student in textile chemistry. Coreq: TC 706.* Exercises with modern methods and equipment to aid in understanding color perception, color science and color measurement. Computer color graphics exercises for comprehension of basic concepts. Independent projects in color science. Limited enrollment.

TC 720 Chemistry of Dyes and Color. *3(3-0) . S. Preq. CH 221 and CH 223.* Correlation of color and chemical constitution, synthetic routes for popular dyes of all important types; electronic mechanisms for reactive dyes; chemistry of dye interactions with light, washing and other in-use influences; economic and environmental considerations.

TC 721 Dye Synthesis Laboratory. *3(0-9) . F. Preq: TC 720.* Laboratory work in preparation and analysis of synthetic dyes of a large number of types. Personal instruction in techniques and processes for preparation and purification of intermediates and dyes.

TC 725 Dyeing Cellulose. *3(3-0) . F. Preq: TC 305, TC 320, TC 442.* Organic and physiocochemical principles in the application of dyes to cellulose. Stress on practical aspects of applications. Types and sources of cellulose. Quality control practices and issues in raw materials and dyeing. Specific application information for each dye class.

TC (CH, MAT) 762 Physical Chemistry of High Polymers-Bulk Properties. *3(3-0) F, Alt. Yrs. Preq: CH 220 or TC 203. CH 431.* Molecular weight description; states of aggregation and their interconversion; rubbery, glassy and crystalline states; rubber elasticity; diffusion properties.

TC (CHE) 769 Polymers, Surfactants and Collodial Materials. *3(3-0) . F. Preq: CHE 316, CH 223.* Relationships between molecular structure and bulk properties of nonmetallic materials applied to commercial products and chemical engineering processes. Applications of surface and colloid chemistry and polymer science to product development and process improvement.

TC 771 Polymer Microstructures, Conformations and Properties. *3(3 0) . F.Alt Yrs (Even). Preq: CH 220 or equivalent or Consent of Instructor.* Exploration of connections between microstructures and properties of polymers afforded by analysis of their conformational characteristics. Analysis of NMR spectroscopy and conformational energy estimates to establish polymer microstructures and resultant sizes and shapes of polymer chains, which then related to their unique and rich variety of physical properties.

TC (CH, MAT) 772 Physical Chemistry of High Polymers--Solution Properties. *3(3-0) . S, Alt Yrs. Preq: CH 433, TC (CH, MAT) 762.* Thermodynamics of polymer solutions; phase equilibria; determination of molecular weight.

TC (CHE) 779 Diffusion in Polymers. *2(2-0) . S Preq. CHE 769 or Consent of Instructor.* Theory of small molecule transport in polymers; applications of membrane transport processes in chemical, polymer, textile, coatings and natural fiber industries.

TC 791 Special Topics in Textile Science. *1-4 F, S. Preq: Sr. or grad. standing and consent of instructor.* Intensive treatments of selected topics in textile, polymer and fiber science.

TC (TES) 792 Special Topics in Fiber Science. *1-3. F.S. Preq: Consent of instructor.* Study of selected topics of particular interest in various advanced phases of fiber science.

TEXTILE ENGINEERING

TE 105 Introduction to Textile Engineering Practice. *2(2-0) . F. Coreq: E 115.* Emphasis on engineering design approaches, team-based design, total quality and real-world constraints. Development of leadership and teamwork skills and oral and written communication skills. Emphasis on preparation for academic success.

TE 201 Textile Engineering Science. *4(3-2) . S. Preq: MA 241, TC 203, PY 205.* Structure, physical and mechanical properties of fibers; structure of assemblies. Structure/property relations. Laboratory exercises in characterization of fiber properties.

TE 205 Textile Engineering Systems. *4(3-2) . S. Preq: PY 208; C- or better in CSC 114. Coreq: MA 341.* An holistic systems engineering approach to modeling electrical and mechanical systems. Basic circuit principles, the analysis of simple filters, examples of DC motors and rotating machinery. Laplace Transforms, block diagrams, and matrix algebra.

TE 301 Textile Manufacturing Processes and Systems I. *4(3-2) . Preq: MAE 206, MA 242.* Engineering analysis of textile structures, especially yarns. Unit processes of production, handling and packaging. Production sequences, intermachine effects, machine design and their consequences on the textile product.

TE 302 Textile Manufacturing Processes and Systems II. *4(3-2) . Preq: TE 301, CSC 114.* Mechanisms used in the production of woven, knitted and nonwoven fabrics. Design and operation of these mechanisms and their impact on the fabric. System dynamics of the different fabric forming processes.

TE 303 Thermal Processes in Textile Engineering. *3(3-0) . F. Preq: MA 242, PY 208.* Introduction to the concept of energy and the laws governing the transfer and transformation of energy. Emphasis on thermodynamic properties and the First and Second Law analysis of systems and control volumes. Emphasis on textile processes. Analysis of basic power cycles.

TE 305 Textile Instrumentation and Control. *3(3-0) . Preq: MA 341, TE 205.* Linear feedback control systems using transfer functions. Transient and steady-state responses using root-locus, Bode plots and Nyquist diagrams. Classical control theory techniques to determine and modify the dynamic response of a system. Emphasis on textile applications and processes.

TE 401 Textile Engineering Design I. *4(3-3) . Preq: TE 302.* The design process including initial specification, design constraints, sources of information and design strategy. Development of fact-finding ability in areas unfamiliar to the student. Analysis of existing designs and the development of improved or new designs.

TE 402 Textile Engineering Design II. *4(3-4) . Preq: TE 401.* Application of textile engineering principles using team approach to design, construct and analyze novel engineering solutions to textile industry problems. Evaluation of design to assess the impact on worker, industry and society.

TE 403 Mechanics of Fibrous Structures. *3(3-0) . Preq: TE 201, TE 302, MA 341, MAE 314.* Mechanics of fibrous structures including fibers, yarns and fabrics. Transverse isotropy of fibers; tensile, bending, and shear behavior of fabrics.

TE 404 Textile Engineering Quality Improvement. *4(3-2) . Preq: ST 370, TE 302.* Defining and quantifying quality of textile products; quality improvement using statistical process control (SPC) and design of experiment (DOE) techniques.

TE 440 Textile Information Systems Design. *4(3-3) . F. Preq: CSC 340, TE 305.* Textile information system design, real-world constraints. Principles of hardware, software, security and ethics issues. Emphasis on solving a real world problem.

TE 463 Polymer Engineering. *3(3-0) . F. Preq: TE 201. Coreq: TE 303.* Chemical and physical properties of polymers and fibers; thermodynamics of crystallization, time dependent phenomena, fracture mechanics and rheology. Advanced topics in extrusion.

TE 466 Polymeric Biomaterials Engineering. *3(3-0) . F. Preq: PY 208; TC 203 or CH 220 or 221; MAE 206.* In-depth study of the engineering design of biomedical polymers and implants. Polymeric biomaterials, including polymer synthesis and structure, polymer properties as related to designing orthopedic and vascular grafts. Designing textile products as biomaterials including surface modification and characterization techniques. Bioresorbable polymers.

TE 492 Special Topics in Textile Engineering. *1-3. Preq: Permission of instructor.* Presentation of material not normally available in regular course offerings or offering of new courses on a trial basis. Credits and content determined by faculty member in consultation with the Department Head.

TE 501 Analysis and Design of Yarn Production Systems. *3(3-0) . S. Preq: TE 301 or Equivalent.* Analysis of fiber preparation and yarn forming processes and machinery. Analysis of traditional methods and state-of-art technology with respect to critical functions and opportunities for improvement in safety, quality, production rates, new products and markets, and profitability. Use of engineering design theory and system modeling guide a team-based design project addressing a specific design project addressing a machine design problem identified by class.

TE 502 Dynamics of Fabric Production Systems. *3(3-0) . F. Preq: TE 302 or Equivalent.* Analysis of fabric forming processes and machinery for production of specialty fabrics.. Dynamics of mechanisms and their influence on quality of fabrics and their properties.

TE 505 Textile Systems and Control. *3(3-0) . S. Preq: TE 305 or Equivalent, CSC 114 or Equivalent.* Theory and application of instruments and control systems used in modern textile plants. Description of basic instruments and computer systems along with their use in process control, production control, research and development.

TE (TMS) 565 Textile Composites. *3(3-0) S. Preq: MA 341, MAE 206.* Fiber architecture of textiles used for composites. Manufacturing processes and geometric quantification. Basic analysis for predicting elastic properties. Interrelationship of elastic properties and geometric quantities. Failure criteria for these materials.

TE 566 Polymeric Biomaterials Engineering. *3(3-0) . F. Preq: PY 208; TC 203 or CH 220 or 221; MAE 206. Credit for TE 466 and TE 566 is not allowed..* In-depth study of the engineering design of biomedical polymers and implants. Polymeric biomaterials, including polymer synthesis and structure, polymer properties as related to designing orthopedic and vascular grafts. Designing textile products as biomaterials including surface modification and characterization techniques. Bioresorbable polymers.

TE (TC, TMS) 589 Special Studies In Textile Engineering and Science. *1-4. F,S. Preq: Sr. or grad. standing.* New or special course on developments in textile engineering and science. Specific topics and prerequisites identified vary. Generally used for first offering of a new course.

TE 601 Seminar. *1(1-0) .*

TE 630 Independent Study. *3(3-0) .*

TE 676 Special Projects. *F, S, Sum*

TE 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

TE 690 Master's Examination. *1-3. F, S, Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

TE 693 Master's Supervised Research. *1-9. F, S, Sum. Preq: Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

TE 695 Master's Thesis Research. *1-9. F, S, Sum. Preq: Master's Student.* Thesis Research

TE 699 Master's Thesis Preparation. *1-3. F, S, Sum. Preq: Master's Student. Credits arranged.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

TE (ECE, MAE) 717 Multivariable Linear Systems Theory. *3(3 0) . S, Alt. yrs.(even). Preq: ECE 716.* Advanced theory of control to linear systems with application to textile processing systems. Transfer matrices, controllability/observability, LQR. Algebraic treatment of feedback systems, coprime factorization. Analytic and harmonic functions, Hdesign.

TE (FPS, TT) 781 Mechanics of Twisted Structures. *3(3-0) . S,Alt yrs. (even). Preq. TES 561 or equivalent* Structure and mechanics of twisted linear textiles (yarns, cords, ropes) with particular emphasis on translating fiber load deformation behavior into load deformation behavior of product, using micromechanics approach.

TE (FPS, TT) 782 Mechanics of Fabric Structures. *3(3-0) S. Alt .yrs (odd) Preq: TES 561 or equivalent* Structure and mechanics of woven, knit and nonwoven fabrics. Particular emphasis on translating fiber/yarn load deformation into in plane and out-of-plane load deformation of fabrics through structure using micro-mechanics approach.

TECHNOLOGY EDUCATION

TED 115 Wood Processing. *4(2 4) .* Basic knowledge and skills needed to design and construct functional wood products. Includes a study of tools, materials and processes used to machine, form, assemble and finish wood products. Laboratory activities in the design and construction ofwood products. Teaching techniques are discussed.

TED 122 Metals Technology. *4(2 4) .* Introduction to metal layout, cutting, machining, forming, fabricating, finishing processes, and current technologies including composite materials. Experience in oxyacetylene and arc welding, sheet metals, bench metals, heat-treatment, and foundry work.

TED 221 Construction Technology. *3(1 4) .* Overview of structures and their construction. Drawings and models completed in a laboratory environment to simulate construction methods.

TED 246 Graphic Arts Technology. *4(2-4)* Basic principles associated with using electronic publishing, offset lithography, screen printing, and photography for visual communication. Basic understanding of how visual art and technology principles are combined to communicate effectively using photographic and print media.

TED 351 The Art and Craft of Clay. *3(2-2) .* Contemporary and historical examples of the art and craft of ceramics will be studied. Experiences in designing ceramic forms and expressing individual ideas through the medium of clay.

TED 359 Electronics Technology. *3(2-2) . Preq: Junior standing.* Direct current, alternating current, and semiconductors. Measurement and circuit behavior. Experimentation with application circuits.

TED 384 Computer Applications in Industry. *3(1-4) .* Computerized control systems used in industry including computers and controllers, automated machines, and robots. Students design and operate automated systems.

TED 430 Manufacturing Technology. *3(1-4) . Preq: GC 120, TED 115 or TED 122* Manufacturing organization, product design, and production system design. Students design, operate and evaluate a small-scale manufacturing system.

TED 461 Communication Technology. *3(2-2) Preq: GC 200, TED 246 and 359.* Technological means of communication and their present and potential historical impacts on society, culture, economy, politics, ethics and the environment. Lab experiments, radio and television production, and development of learning activities for middle school and secondary school students.

TED 476 Transportation Technology: Energy and Power. *3(1-4) . Preq: MA 111, PY 231* Theoretical and practical aspects of transportation. Topics include energy, energy conversion, transmission, and control; transportation systems and industries; and conservation of energy. Emphasis on laboratory testing, experimenting, developing; and on the use of equipment.

TED 490 Special Problems in Technology Education. *Preq: Junior level standing and permission of Instructor.* Supervised, independent investigation in a defined area of interest in Technology Education.

TED 709 Seminar in Occupational Education. *3(3 0) . F,S. Preq: EOE 701.* A seminar-type course with topics selected each semester. Attention given to the broad concepts of occupational education as manifested in the Vocational Education Act of 1963 and its amendments. Problems and issues underlying the development and implementation of programs of occupational education at elementary, junior high, senior high and postsecondary levels.

TED 797 Special Topics in Occupational Education. *3(3-0) .*

TEXTILE MATERIALS SCIENCE

TMS 210 Yarn and Fabric Formation and Properties. *4(3-2) . Preq: TT 105, TMS 211. Coreq: PY 205, or 211.* The basic concepts of yarn formation, weaving, knitting, and nonwoven fabric formation. Emphasis on structure property relationship. Impact on product performance.

TMS 211 Introduction to Fiber Science. *3(2-2) . Preq: TT 105. Coreq: MA 131 or 141.* Properties of fibers related to type and chemical structure. Fiber classification and identification. Reaction to moisture, stress-strain properties and methods of measuring physical properties. Relationship between polymer structure, fiber properties, and utilization.

TMS 460 Physical & Mechanical Properties of Textile Materials. *3(3 0) Preq. MA 231 or MA 241, PY 211, TMS 211.* Structural and physical properties of fibers, yarns and fabrics, including mechanical, thermal, optical, frictional, electrical and moisture properties. Relationships between structure, properties and performance.

TMS 500 Fiber and Polymer Microscopy. *3(3-0) . F. Preq: PY 208, MA 242, TC 203.* Art and science of light and electron microscopy; theoretical and practical aspects of visibility, resolution and contrast. Laboratory practice in assembling, testing and using various microscopes and accessories in analyzing, describing and identifying unoriented and oriented crystalline or amorphous materials. Laboratory emphasis on study of fibers and polymers through transmission microscopy with polarized light.

TMS (TT) 521 Filament Yarn Production Processing and Properties. *3(2-2) . F. Graduate Standing or PBS status; credit not allowed for both TT 521 and TT 425.* Structure, properties and processes for manufacturing and treating continuous filament yarns. Response of fibers to elevated temperatures, twist, false twist and various bulking processes. Yarn structures and properties required for stretch and molded fabrics. Independent laboratory and critical literature review in general area of filament yarn processing, properties and test methods.

TMS (TE) 565 Textile Composites. *3(3-0) . S. Preq: MA 341, MAE 206.* Fiber architecture of textiles used for composites. Manufacturing processes and geometric quantification. Basic analysis for predicting elastic properties. Interrelationship of elastic properties and geometric quantities. Failure criteria for these materials.

TMS (TC, TE) 589 Special Studies in Textile Engineering and Science. *1-4. F,S. Preq: Sr. or grad. standing.* New or special course on developments in textile engineering and science. Specific topics and prerequisites identified vary. Generally used for first offering of a new course.

TMS 601 Seminar. *1(1-0) . F,S.* Discussion of scientific articles of interest to the textile industry; review and discussion of student papers and research problems.

TMS 602 Textiles Technology Seminar. *2(2-0) .*

TMS 630 Independent Study. *3(3-0) .*

TMS 676 Special Projects.

TMS 685 Master's Supervised Teaching. *1-3. F,S. Preq. Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

TMS 690 Master's Exam. *1-6. F,S. Preq: Master's student* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

TMS 693 Master's Supervised Research. *1-9. F,S. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

TMS 695 Master's Thesis Research. *1-9. F,S. Preq. Master's student* Thesis research

TMS 699 Master's Thesis Preparation. *1-3. F,S. Preq: Master's student* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

TMS (FPS) 761 Mechanical and Rheological Properties of Fibrous Material. *3(3-0) S. Preq: MA 301* In-depth study of the stress-strain, bending, torsional, dynamic and rheological behavior of natural and man-made fibers. Presentation and discussion of theoretical relations and advanced techniques.

TMS 762 Physical Properties of Fiber Forming Polymers, Fibers and Fibrous Structures. *3(3-0) . F, Alt.yrs. Preq: MA 301, PY 208.* Experimental results and theoretical considerations of physical properties of fibers and fiber-forming polymers. Electrical, thermal, optical, frictional and moisture properties of these materials. Influence of chemical and molecular fine structure on these properties.

TMS (MAT) 763 Characterization of Structure of Fiber Forming Polymers. *3(3-0) F. Preq: MA 301, PY 208.* Theories, experimental evidence and characterization methods of the molecular fine structure of fiber forming polymers in the solid state. Characterization methods include X-ray diffraction, microscopy, infrared, thermal and magnetic resonance. An introduction to nucleation theory of polymer systems.

TOXICOLOGY

TOX 620 Special Problems. *1-3. F, S, Sum. Preq: Grad. standing.* Topics include responsibility in science, environmental fate of chemicals, developmental toxicology, lab rotations, journal club and wildlife toxicology.

TOX 660 Free Radicals in Toxicology. *1(1-0) . F, Alt Yrs. Preq: BCH 451 and TOX 710.* Introduction to the field of free radicals and their role in toxicology and health; chemical and physical properties of partially reduced oxygen intermediates and the natural biological defense mechanisms.

TOX 690 Master's Exam. *1-6. F, S, Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

TOX 693 Master's Supervised Research. *1-9. F, S, Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

TOX 695 Master's Thesis Research. *1-9. F, S, Sum. Preq: Master's student.* Thesis research.

TOX 699 Master's Thesis Preparation. *1-3. F, S, Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

TOX 701 General Toxicology. *3(3-0) . F. Preq: BCH 451, senior or graduate standing..* The basis of toxic action at cellular and molecular levels covering the absorption, distribution, elimination and metabolism of toxicants; toxic action (acute toxicity, carcinogenesis, mutagenesis, organ toxicity, etc.); chemical classes of toxicants; and toxicity testing.

TOX 704 Chemical Risk Assessment. *1(1-0) . S. Preq: TOX 701, a ST course.* Concepts and vocabulary of risk assessment. Risk assessment models and techniques used in cancer and non-cancer risk assessment and strategies for successful risk communications. Case studies of risk assessment and issues of current interest. Utilization of background in toxicology and statistics to examine a critical end-point in toxicological science, the quantitative risk assessment.

TOX (IMM) 705 Immunotoxicology. *2(2-0) F, Alt. Yrs. Preq: TOX 701.* Concepts in the study of adverse effects of chemicals on the immune system, including allergic responses, autoimmunity and immunosuppression. Significance of immunotoxic effects resulting from environmental or workplace exposure. Role of immunotoxicity in risk assessment.

TOX 710 Biochemical Toxicology. *3(3-0) . S. Preq: BCH 451; TOX 701.* Fundamental understanding of biochemical, molecular and cellular mechanisms through which xenobiotics alter cellular homeostasis, produce toxicity and alter organ function. Current biochemical, molecular and cellular experimental approaches for study of biochemical mechanisms of toxicity.

TOX 715 Environmental Toxicology. *3(3-0) . F. Preq: Two years of biology.* Evaluation of fundamental processes relating fate and effects of chemicals in the environment. Emphasis on effects of pollutants on non-human species, environmental risk assessment and historically relevant incidents of environmental contaminants.

TOX 721 Chemical Carciogenesis. *1(1-0) . F, Alt Yrs. Preq: BCH 553, TOX 701, TOX 710.* Emphasis on mechanisms including somatic mutation hypothesis, pathology of neoplasia, multistage carcinogenesis, tumor promotion, oncogenes, tumor suppressor genes and rodent bioassays. Fundamentals of cancer biology and their relationships to chemical-induced carcinogenesis.

TOX (ENT) 722 Insecticide Toxicology. *3(3-0) . Even Alt. Yrs. Preq: BCH 451, CH 223.* Chemistry, biochemistry and toxicology of major classes of insecticide chemicals including relationships between chemical structure and toxicity; mode of action of insecticides; metabolism of insecticides in insects, mammals and environment; insecticide selectivity and resistance mechanisms; nontarget and environmental effects from insecticide use; registration and regulation of insecticides; and risk assessment associated with insecticide use.

TOX (CS, HS, SSC) 725 Pesticide Chemistry. *1(1-0) . S. Preq: CH 201 and 221.* Chemical properties of pesticides including hydration and solvation, ionization, volatilization, lipophilicity, molecular structure and size, and reactivity and classification according to chemical description, mode of action or ionizability. Taught during the first 5 weeks of semester. Drop date is last day of 3rd week of the minicourse.

TOX (CS, HS, SSC) 727 Pesticide Behavior and Fate in the Environment. *2(2-0) S. Preq: CS(HS,SSC,TOX) 725, SSC 200.* Sorption/desorption, soil reactivity, movement, volatilization, bioavailability, degradation and stability of pesticides in the environment. Taught during the last 10 weeks of semester. Drop date is last day of 3rd week of the minicourse.

TOX 795 Special Topics in Toxicology. *F,S.*

TOX 801 Toxicology Seminar. *1(1-0) . F, S. Preq: Grad. standing.*

TOX 820 Special Problems in Toxicology. *1-3. F, S. Preq: Grad. standing.* Topics include responsibility in science, environmental fate of chemicals, developmental toxicology, lab rotations, Journal Club, and wildlife toxicology.

TOX 860 Free Radicals in Toxicology. *1(1-0) . F, Alt Yrs. Preq: BCH 451 and TOX 710.* Introduction to the field of free radicals and their role in toxicology and health; chemical and physical properties of partially reduced oxygen intermediates and the natural biological defense mechanisms.

TOX 890 Doctoral Preliminary Examination. *1-9. F, S, Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

TOX 893 Doctoral Supervised Research. *1-9 F, S, Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

TOX 895 Doctoral Dissertation Research. *1-9 F, S, Sum. Preq: Doctoral student* Dissertation research.

TOX 899 Doctoral Dissertation Preparation. *1-3 F, S, Sum. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

TEXTILE TECHNOLOGY

TT 105 Introduction to Textile Technology. *4(3 2) . F, S.* Introduction to the University, College of Textiles, and Textile and Apparel Technology and Management. Structures and production methods for fabrics, yarns and fibers. Introduction to the nature of polymers and the characteristics of polymers which makes them useful for producing fibers which are practically and aesthetically desirable.

TT 221 Yarn Production and Properties I. *3(2-2) . F, S, Sum. Coreq: MA 131, PY 211 or PY 205, TT 105.* The techniques available for manufacturing yarns from staple fibers. A review of yarn numbering and fiber properties. The principles involved in opening, cleaning, blending, drafting, twisting and winding. Short and long staple spinning systems including a review of opening and cleaning lines, carding, draw frames, roving frames and different spinning machines. Filament yarn processing.

TT 241 Knitted Fabric Technology I. *3(2-2) . F, S,. Preq: TT 221.* Introduction to the science and technology of weft and warp knitting. Definition, notational systems, fabric properties and comparisons, knitting cycles, patterning and engineering considerations, fabric analysis. Quality overview, causes, solution and prevention of typical yarn and knitting problems. Practicum will include operation of knitting machinery, fabric analysis and problem solving situations.

TT 251 Woven Fabric Technology I. *3(2-2) . F, S Preq: TT 221.* Fundamentals of the conversion of yarns into woven fabrics and weaving systems. Relationships of woven fabric design, construction and raw material with properties and performance of end product.

TT 305 Fiberweb and Nonwoven Production. *3(2 2) . Preq. MA 231 or 241, PY 211 or 205. Coreq· ST 361 PY 212 or 208* Fiberweb/nonwoven fabrics produced directly from fibers or their precursors. Physical and chemical nature of local bonding and fiber entanglement. Viable processes for producing these fabrics. Economic justification for process and production. Plantvisits whenever possible.

TT 321 Yarn Production and Properties II. *3(2-2) . F, S. Preq: TT 331.* Fiber and machine interactions in blending, carding, drawing and spinning. Drafting theories and the influence of fiber and machine variables on irregularity. The role of twist on yarn structure, properties and productivity. Developments and limitations in processing technology.

TT 331 Performance Evaluation of Textile Materials. *4(3-2) F, S. Preq. TMS 211, TT 221, TT 251, ST 361 or BUS 350* Standards, principles and effects of test conditions in measuring basic physical and mechanical properties of textile materials. Design of test and interpretation of test results in relation to end-use performance, product development, process control, research and development and other requirements.

TT 341 Knitted Fabric Technology II. *3(2-2) S Preq: TT 241.* Review of knitted fabric production techniques. Technology of more advanced weft and warp knitting. Jersey and rib fabric modification techniques, yarn knitability and productivity, yarns, creels, patterning and machinery developments, manufacture and properties of warp knit fabrics such as mesh, laid-in, weft insertion and plush. Quality measures, measurement and standards, defects and problem solving. Management of knitting operations.

TT 351 Woven Fabric Technology. *3(2-2) . F, S. Preq: TT 251.* Technology of producing woven fabrics including yarn preparation for weaving. Process control and automation in weaving. Fabric development, design, and management of weaving operations.

TT 370 Technical Fabric Design. *4(3-2) . Preq: Two courses out of TT 341, 351 and 305.* Properties of woven, knitted and nonwoven fabrics. Computer techniques and other methods of reproducing structural designs and means of designing fabrics to specifications. Laboratory consists of projects involving design analysis and testing.

TT 425 Textured Yarn Production and Properties. *3(2-2) . Preq: MA 231 or 241, PY 211 or 205, TT 221, TT 331.* Structure and properties of continuous filament yarns. Examine response to elevated temperature and variables for texturing methods of producing bulked, textured and torqued yarns. Testing of yarn behaviors and discussion of problems encountered during processing.

TT (TAM) 431 Quality Management and Control in Textile Manufacturing. *3(3-0) . F,S. Preq: TT 221, TT 251, TT 331 and ST 361 or BUS 350.* Principles of quality and process management and control in textile/apparel manufacturing with emphases in quality management systems, quality costs, statistical control chart procedures, process capability, acceptance sampling, and optimal process and product design and improvement methods.

TT 441 Advanced Knitting Systems and Fabrics. *3(2-2) . F. Preq: TT 341.* Loop forming concepts and mechanisms of complex warp and weft-knitted fabrics. Structural design and limitations, potential applications and knitability. Analysis of mechanical systems and tensioning forces on fabric formation. The effect on dimensional and mechanical properties.

TT 451 Advanced Woven Fabric Design. *3(2-2) . S. Preq: TT 370.* Design and production requirements for highly specialized woven fabric structures. The laboratory activities will include a project on design from concept to final production and finishing.

TT 497 Technology of Product/Process Development in Textiles I. *3(1-4) . F. Preq: Senior standing, TT 331, Textile Technology Core Electives.* Introduction to textile technology research through experimental, theoretical and literature studies on product and process development. Written and oral presentation of reports.

TT 498 Technology of Product/Process Development in Textiles II. *3(1-4) . S. Preq: TT 497.* Projects in research, design or development in various areas of textile technology. Written and oral presentation of reports.

TT 520 Yarn Processing Dynamics. *3(2-2) . F. Graduate Standing or PBS Status.* Principles and practice involved in modern yarn and manufacture; including machine-fiber interactions occurring during different processing stages. Not normally for credit for undergraduate textile majors.

TT (TMS) 521 Filament Yarn Production Processing and Properties. *3(2-2) . F. Graduate Standing or PBS status; credit not allowed for both TT 521 and TT 425.* Structure, properties and processes for manufacturing and treating continuous filament yarns. Response of fibers to elevated temperatures, twist, false twist and various bulking processes. Yarn structures and properties required for stretch and molded fabrics. Independent laboratory and critical literature review in general area of filament yarn processing, properties and test methods.

TT (TTM) 530 Textile Quality and Process Control. *3(3-0) . S. Preq: TT 331 or equivalent. Coreq: ST 311 or ST 515 or equivalent.* Quality control and improvement methods for textile processes and products including quality systems, statistical control chart procedures, process capabilities, acceptance sampling plans, textiles process and product designs, on-line and off-line control systems and specific quality factors governing textile products and processes and their variabilities.

TT 541 Theory and Practice of Knitted Fabric Production and Control. *3(3-0) . F. Preq: TT 370 and Consent of Instructor.* The technology and control systems for manufacturing simple and complex knitted fabrics; control and monitoring of yarn feeding systems; influence of yarn, machine, finishing and fabric structure on the fabric aesthetics, physical and mechanical properties; optimization of fabric properties and machine productivity, including costing; problems of jacquard fabric processing and control.

TT 549 Warp Knit Engineering and Structural Design. *3(3-0) . S. Preq: TT 443.* Engineering analysis of tricot and raschel machinery. Design of yarn let-off and fabric take-up mechanisms. Studies of fabric production techniques and quality control systems. Theory of production optimization and the properties of fabrics. Complexgeometrical loop models and their application.

TT 550 Production Mechanics and Properties of Woven Fabrics. *3(2-2) . S. Graduate Standing or PBS.* Interrelation between mechanics of production and mechanical properties of woven fabric; unit operations required to prepare yarns for weaving and the mechanism employed in weaving; fabric structure, geometry and mechanical properties; designing for specific fabrics properties. Not normally for credit for undergraduate textiles majors.

TT 551 Advanced Woven Fabric Design & Structures. *3(2-2) . F. Preq: TT 550. Graduate Standing or PBS Status; Credit not allowed for TT 451 and TT 551.* Theory and practice of structural design and technology requirements for highly specialized woven fabrics. Emphasis upon resultant physical behavior of different fabrics and their components.

TT 591 Special Studies in Textile Technology. *1-4. F,S,Sum. Graduate Standing or PBS Status.* Special Studies in Textile Technology to fulfill needs not covered by current offering. Student and faculty required to submit topics to be covered to director of graduate programs within first week of semester.

TT 601 Seminar. *1(1-0) . F, S, Sum.* Discussion of scientific articles of interest to the textile industry; review and discussion of student papers and research problems.

TT 630 Independent Study in Textile Technology. *3(3-0) . F,S,Sum.. A maximum of 3 credit hours will be allowed towards Master of Textiles Degree. No credit is allowed towards MS (Textiles).* Problems of specific interest in textile technology. Preparation of report, in format suitable for publication required. One-page outline signed by advisor must be submitted to director of graduate programs within first week of semester.

TT 676 Special Projects Textile Technology. *F,S.*

TT 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's Student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

TT 690 Master's Examination. *1-3. F, S, Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

TT 693 Master's Supervised Research. *1-9. F,S,Sum. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

TT 695 Master's Thesis Research. *1 9. F, S, Sum. Preq: Master's Student.* Thesis Research

TT 699 Master's Thesis Preparation. *1-3. F, S, Sum. Preq: Master's Student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

TT (FPS) 720 Yarn Production/Properties: Advanced Topics. *3(2-2) . S, Alt. yrs.(Even). Preq: TT 520 or TE 501.* Lectures and seminar discussion of recent development in yarn manufacturing. Group research into topical areas of yarn production and properties.

TT (FPS) 721 Advanced Textile Testing. *3(2-2) . Preq: TT 530 or TAM 380 or TE 404 or equivalent.* Management and quality engineering concepts, strategies, practices and operating tools required to initiate and sustain a Total Quality Management program which can succeed in modern textile environments.

TT (FPS) 750 Advances in Woven Fabric Formation and Structure. *3(2-2) . S. Preq: TT 551 or equivalent. Graduate Standing.* Advances in formation mechanics and structure of woven fabrics covered through lectures, seminars and independent studies. Advances in yarn preparation processes, essential weaving motions, auxiliary motions, automation, and their impact on weaving room management. Recent research in formation of advanced complex woven structures.

TT (FPS, TE) 781 Mechanics of Twisted Structures. *3(3-0) . S,Alt yrs. (even). Preq: TES 561 or equivalent.* Structure and mechanics of twisted linear textiles (yarns, cords, ropes) with particular emphasis on translating fiber load deformation behavior into load deformation behavior of product, using micromechanics approach.

TT (FPS, TE) 782 Mechanics of Fabric Structures. *3(3-0) . S, Alt. yrs.(odd). Preq: TES 561 or equivalent.* Structure and mechanics of woven, knit and nonwoven fabrics. Particular emphasis on translating fiber/yarn load deformation into in-plane and out-of-plane load deformation of fabrics through structure using micro-mechanics approach.

TEXTILE TECHNOLOGY MANAGEMENT

TTM 501 Textile Enterprise Integration. *3(3-0) F Graduate Standing· Background in textile manufacturing required..* Discussion of philosophy, strategy and technology of enterprise integration for textile manufacturing. Survey of enabling technologies such as computer-aided design; computer-aided manufacturing; material handling systems; information systems for control, supervision and planning; and internet resources.

TTM 502 Supervisory Control and Data Acquisition Systems for Textile Manufacturing. *3(1-6) . S (Alt, yrs.) odd. Graduate standing, background in textile manufacturing needed.* Design and development of supervisor control and data acquisition systems (SCADA) for textile manufacturing. Projects to develop demonstration and actual systems. Automation of a work cell for textile equipment to development of plant supervisory systems. Latest high-level application development environments.

TTM (TT) 530 Textile Quality and Process Control. *3(3-0) . S. Preq: TT 331 or equivalent. Coreq: ST 511 or ST 515 or equivalent.* Quality control and improvement methods for textile processes and products including quality systems, statistical control chart procedures, process capabilities, acceptance sampling plans, textiles process and product designs, on-line and off-line control systems and specific quality factors governing textile products and processes and their variabilities.

TTM 531 Total Quality Management in Textiles. *3(3-0) . F. Preq: TT 331 or TAM 380 or TE 404 or equivalent.* Management and quality engineering concepts, strategies, practices and operating tools required to initiate and sustain a Total Quality Management program which can succeed in modern textile environments.

TTM 561 Strategic Technology Management in the Textile Complex. *3(3-0) S. Graduate Standing or PBS Status.* Management approaches and strategies for forecasting, planning, creating, and implementing technology changes in textile industry complex undergoing rapid market place and global competitive changes.

TTM (BUS) 585 Market Research in Textiles. *3(3-0) . S. Preq: TAM (EC) 482.* A study and analysis of quantitative methods employed in market research in the textile industry. Function of market research and its proper orientation to management and decision making.

TTM 591 Special Studies in Textile Technology Management. *F,S,Sum. Graduate Standing or PBS Status.* Special Studies in Textile and Apparel, Technology and Management to fulfill needs not covered by current offerings. Student and faculty required to submit topics to be covered to director of graduate programs within first week of semester.

TTM 601 Seminar. *1(1-0) . F, S, Sum.* Discussion of scientific articles of interest to the textile industry; review and discussion of student papers and research problems.

TTM 630 Independent Study in Textile Technology Management. *3(3-0) . F,S,Sum.* Problems of specific interest in textile and apparel technology. Preparation of report, in a format suitable for publication required. One-page outline signed by advisor must be submitted within first week of semester.

TTM 676 Special Projects in Textile and Apparel Management. *F,S,Sum. Graduate Standing or PBS Status.* Advanced studies on current problems of the industry. independent investigations, seminars, and technical presentations, both oral and written.

TTM 685 Master's Supervised Teaching. *1-3. F,S,Sum. Preq: Master's Student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

TTM 690 Master's Examination. *1-5. F, S, Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

TTM 693 Master's Supervised Research. *1-9 F, S, Sum. Preq. Master's Student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

TTM 695 Master's Thesis Research. *1 9 F S,Sum Preq: Master's student* Thesis research.

TTM 699 Master's Thesis Preparation. *1 3. F S, Sum Preq: Master's Student* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis

TTM 761 Supply Chain Management and Information Technology. *3(3-0) S Preq: BUS 5?3 or equivalent.* Working knowledge of management concepts and information technologies to design and manage supply chain operations in textile complex. Deals with markets and operations distributed geographically and institutionally.

TTM 786 Advanced Textile Labor Management Seminar. *3(3-0) . F, S, Preq: TAM 487 or Consent of Instructor.* Advanced labor management problems in the textile industry, with particular emphasis directed toward application of the Occupational Safety and Health Act.

TTM 801 Seminar. *1(1-0) . F, S, Sum.*

TTM 830 Independent Study. *3(3-0) . F, S, Sum.*

TTM 876 Special Project TTM. *F, S, Sum.*

TTM 885 Doctoral Supervised Teaching. *1-3. F, S, Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

TTM 890 Doctoral Preliminary Examination. *1-9. F, S, Sum. Preq: Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

TTM 893 Doctoral Supervised Research. *1-9. F, S, Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

TTM 895 Doctoral Dissertation Research. *1-9. F, S, Sum. Preq: Doctoral student.* Dissertation research.

TTM 899 Doctoral Dissertation Preparation. *1-3. F, S, Sum. Preq: Doctoral student* For students who have completed all credit hour. full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

VETERINARY SCIENCE

VMS 490 Special Topics in Veterinary Medicine. *1-6. Preq: Approval of department. Undergraduate students only.* Offered as needed to cover new or special subject matter within the scope of veterinary medicine at the undergraduate level.

WOMEN'S AND GENDER STUDIES

WGS (MDS) 200 Introduction to Women's and Gender Studies. *3(3-0) . F* Introduction to women's and gender studies as an interdisciplinary field spanning the humanities, social sciences, and natural sciences. Study of historical perspectives and contemporary understanding of women and gender. Theory, systematic analysis, and experimental accounts used to explore complexities of gender, and other identity determinants, mechanisms of power and privilege, and avenues for social change.

WGS (SOC) 204 Sociology of Family. *3(3 0) . F,S,Sum.* Contemporary American family structures and processes and their development. Focus on socialization, mate selection, marital adjustment and dissolution. Includes core sociological concepts, methods, theories.

WGS 210 Women and Gender in Science and Technology. *3(3-0) . F.* Interdisciplinary introduction to the reciprocal relationships between scientific/technological research and contemporary understanding of gender. Special emphasis on social factors influencing scientists and engineers in their professions.

WGS (SOC) 304 Women and Men in Society. *3(3-0) . F,S. Preq: 3 cr. in SOC, 200 level.* A sociological analysis of women and men in contemporary American society. Perpetuation of and change in gender stratification using sociological concepts. theories and research. How gender expectations developed and transmitted. Historical data and research on diversity in American society used for analysis of causes and consequences of gender inequality.

WGS (ENG) 305 Women and Literature. *3(3 0) . S.* Nineteenth- and twentieth-century womens' literature, as shaped by the intersecting and competing claims of gender, race, sexuality, and culture. Focus on fiction, accompanied by critical readings from American studies, feminist literary criticism, and postmodern theory.

WGS (MDS) 310 Women's and Gender Studies Internship. *3(3-0) . F, S.* Internship program. Introduction to careers that deal specifically with women's issues. Ten-hours-per-week work at a nonprofit or governmental organization. Contextualization of that experience through additional academic requirements.

WGS (MUS) 360 Women in Music. *3(3-0) . S.* The role of women in music as patrons, teachers, composers, and performers, placing them within the social, economic, and political framework to which they belong. Emphasis on Western Art Music and the role of women in popular music. No previous formal training in music is required.

WGS (COM) 362 Male/Female Communication. *3(3-0) . F,S. Preq: Junior Standing; COM 112.* Effects of gender on the interpersonal communication process. Explanations of gender differences, communication about women and men via language and via media, and interpersonal communication

WGS (PSY) 406 Psychology of Gender. *3(3-0) . F, S. Preq: PSY 200 or HSS 200. Credit cannot be given for both PSY 406 and PSY 506.* Current theory and research on perceived and actual biological, social, cognitive, personality, and emotional similarities and differences of men and women throughout the lifespan The construction and consequences of gender in our society and others.

WGS (SOC) 407 Sociology of Sexualities. *3(3 0) . S Preq: 3 hours SOC 200 level. 300 level, or equivalent research methods course.* Exploration of sexuality in a social context. Relationship between sexuality, gender, and power in the U.S. Historcial trends in behaviors and identities: social movements and sexual issues; current behavioral trends. Some issues covered; identity, social construction, sexual meanings.

WGS (PS) 418 Gender Law and Policies. *3(3 0) . F. Preq. Nine hours of Political Science or Permission of Instructor.* Law and policy pertaining to contemporary gender issues. Examination of agenda setting, policy formation, implementation, judicial interpretation and evaluation of selected issues, such as reproductive policies, equal employment and sexual abuse.

WGS (ANT) 444 Cross-Cultural Perspectives on Women. *3(3-0) . S. Alt. Yrs. Preq. 3 hours cultural anthropology.* Comparison of women in a variety of societies: western and non-western; hunting and gathering to industrialized. Cross-cultural perspective on the similarity and diversity of women's statuses and roles. Effect of gender on social position

WGS (HI) 447 History of American Women to 1900. *3(3-0) .* The historical experience of women in America from the colonial period to 1890. Women's work, education, legal and political status, religious experience, and sex roles: age, class, race, sexual preference, and region as significant variables in women's experience.

WGS (HI) 448 American Women in the Twentieth Century. *3(3 0) . Credit will not be given for both HI 448 and HI 548.* Women's historical experience in America, 1890-1990. Changes in women's work, education, legal and political status, and sex roles, age, class, race, sexual preference, and region as significant variables in women's experience.

WGS (MDS) 492 Theoretical Issues in Women's and Gender Studies. *3(3-0) S. Preq: MDS 200.* Examination of feminist theory. Study of formative texts in modern feminism, drawn from various disciplines within the humanities, social sciences, and natural sciences. In-depth exploration of feminist perspectives on issues of race, class, gender, sexuality, work and mothering, among others. Analysis of local and global cultural practices using feminist theoretical frameworks.

WGS (MDS) 493 Special Topics in Women's and Gender Studies. *3(3-0) . F.* Examination of varying topics on women and/or gender from a multidisciplinary perspective.

WGS (PSY) 506 Psychology of Gender. *3(3-0) . F,S, Alt. Yrs.(even). Preq: Permission of Instructor. Credit for both PSY 406 and PSY 506 is not allowed.* Current theory and research on perceived and actual biological, social, cognitive, personality, and emotional similarities and differences of men and women throughout lifespan. Construction and consequences of gender in our society and others.

WGS (ECD) 540 Gender Issues in Counseling. *3(3-0) . S .Preq: Grad. standing or 6 hrs. of ED or PSY.* Exploration of gender as primary identity and social construct. Emphasis on gender dynamics in counseling, client empowerment and preventive approaches.

WGS (HI) 547 History of American Women To 1900. *3(3 0) . Preq: 6 hrs. of advanced history. Credit for both HI 447 and HI 547 is not allowed.* Historical experience of women in America from colonial period to 1900. Women's work, education, legal and political status, religious experience and sex roles: age, class, race, sexual preference and region as significant variables in women's experience.

WGS (HI) 548 American Women in the Twentieth Century. *3(3-0) . Credit for both HI 448 and 548 is not allowed.* Women's historical experience in America, 1890-1990. Changes in women's work, education, legal and political status, and sex roles; age, class, race, sexual preference and region as significant variables in women's experience.

WGS (SOC) 737 Sociology of Gender. *3(3-0) . F, Alt. yrs(even). Preq: SOC 736 or 731 or consent of instructor. Graduate Student Status.* Theories about the development and maintenance of gender. Historical development of gender stratification. How individuals "do gender" in their daily lives. Contemporary research and substantive readings about gender in public and intimate relationships.

WGS (SOC) 739 Social Psychology of Inequality. *3(3-0) . Preq: SOC 746 or 508 or equivalent.* The effects of race, class and gender inequality on the formation of group consciousness, self-evaluations, emotions, values, attitudes and beliefs. Attention to interpersonal processes through to reproduction of inequality in everyday life.

WOOD AND PAPER SCIENCE

WPS 101 Introduction to Pulp & Paper Technology. *1(1-0) .* Overview of pulping and papermaking industry and processes: status of the industry in the United States and the world, wood and fiber characteristics, pulping, bleaching, papermaking, paper product testing, recycling, and environmental issues. Orientation to Pulp and Paper Curriculum.

WPS 102 Introduction to Pulp & Paper Science & Technology. *1(1-0) .* Introduction to terminology and technology specific to the pulp and paper industry.

WPS (FOR) 202 Wood Anatomy and Properties. *3(2-3) . Preq: None.* Formation, anatomy, and properties of wood. Structural features of softwoods and hardwoods and the relationships among anatomy, physiology, physical and mechanical properties. Variability, naturally occurring defects, and wood deterioration are discussed and related to wood utilization. Techniques on hand lens and microscopic identification of wood.

WPS 203 Wood Physical Properties. *4(3-2) .* Physical properties of wood, including specific gravity, dimensional behavior, stress and set, psychrometry, thermal, electrical and moisture relations.

WPS 205 Wood Products Practicum. *5(3-0) . Preq: WPS 202 or 203.* Preparation of drawings and bill of materials for a furniture item. Parts are machined, assembled, and finished. Lumber grading, drying, and gluing principles. Four to five days are spent visiting industries to provide an appreciation for products and processes. The student is responsible for room and board; transportation is provided.

WPS 210 Wood Products Internship. *1(1-0) . Preq: Completion of summer practicum.* Experience in the forest products or related industries with a departmentally selected employer.

WPS 211 Pulp and Paper Internship. *1(1-0) . Preq: Completion of soph. year.* Experience in the pulp and paper industry. Problem solving in an industrial setting to gain insight of pulp and paper technology. Written report required.

WPS 215 Pulping Technology. *3(3-0) . Preq: CH 201.* Physical and chemical characteristics of wood and cellulose. Chemistry and technology of major mechanical, chemical and semichemical processes employed in the manufacture of pulp and paper.

WPS 216 Papermaking Technology. *3(3-0) . Preq: WPS 215.* Processing of fibers into paper via the many commercial systems used in the paper industry.

WPS 240 Wood Products. *3(3-0) .* Introduction to forest products industries, including the economic importance, current manufacturing technology, raw material requirements and the future of the industries.

WPS 242 Wood Fiber Analysis. *2(2-0) . F,S.* The macro and micro structure of wood and the relationships of anatomical structures to the physical properties of wood and paper.

WPS 301 Wood Processing I. *4(3-2) . Preq: WPS 202 or WPS 203; WPS 205.* The processes of drying, gluing, and finishing wood. Insect, fungal, and thermal degradation of wood. Drying procedures, glued wood products, furniture and panel finishing, and treatments to prevent biological and thermal degradation. Current industrial equipment and processes.

WPS 302 Wood Processing II. *4(3-2) . Preq: WPS 202 or WPS 203; WPS 205.* Theories and techniques of processing raw wood into useable products. Principles of operation of current industrial wood milling equipment including primary and secondary processing. Machining of reconstituted wood products.

WPS 310 Paper Properties and Additives. *3(2-3) . Preq: Jr. standing in PPT.* Standard testing methods for paper and paperboard: measurement and characterization of the structural, mechanical, and optical properties of paper. Effect of additives on paper properties. Relationship between paper properties and end use requirements.

WPS 319 Principles of Wood Science. *3(3 0) . Preq: MA 131, PY 211.* Basic principles of solid mechanics. Mechanisms of wood deterioration. Chemical bonding in wood. Polymer concepts, adhesion.

WPS 332 Wood and Pulping Chemistry. *3(3-0) . Preq: CH 221, 223; PY 205 PY 208; CH 331 or CH 431 or CHE 315.* Introduction to carbohydrate chemistry focusing on the structure and reactivity of wood polysaccharides, hemicelluloses and cellulose and on the chemical structure of lignins and wood extractives. Special emphasis on the chemical reaction of wood components occurring in pulping and bleaching processes.

WPS 344 Introduction to Quality Control in Wood Products. *3(3-0) . Preq. ST 361* Statistical quality control techniques applicable to the manufacture of wood products. Control chart techniques for monitoring defects, defectives and measurements. Acceptance sampling procedures. Examples from the wood products industries will be used.

WPS 350 Wood Products Literature. *2(2-0) . Preq: Completion of WPS 205.* Exploration of the wood products literature; use of library services, oral and written reports, with emphasis on independent study.

WPS 355 Pulp and Paper Unit Processes I. *3(3-0) . Preq: CHE 205 with a C or better. Not open to PPT-Chemical Engineering Concentration students.* Selected topics in chemical engineering as applied in the pulp and paper industry. Emphasis on computational practice.

WPS 360 Pulp and Paper Unit Processes II. *3(3-0) . Preq: WPS 355 or CHE 311, WPS 215.* Application of chemical engineering principles to the analysis of pulp and paper unit processes. Emphasis on practical problems in fluid dynamics, heat transfer, mass transfer, and thermodynamics.

WPS 371 Pulping Process Analysis. *2(1-3) . Preq: WPS 215. Coreq: WPS 332, WPS 381.* Preparation and evaluation of different types of wood pulp. A new wood raw material selected each year with the purpose of studying and critically evaluating the principal pulping and bleaching variables.

WPS 381 Pulping and Bleaching Chemistry Lab. *1(0-4) . Preq: WPS 215. Coreq: WPS 332, WPS 371.* Laboratory studies on chemistry of pulping and bleaching, including quantitative analysis of pulping and bleaching chemicals, composition and chemical properties of wood and pulp by various analytical chemical techniques.

WPS 410 Modeling and Simulation of Pulp and Paper Processes. *3(2-2) . Preq: WPS 215, 216, 360.* Application of modeling and simulation techniques for the analysis of pulp and paper processes. Model development and computer simulations using existing models are required to study process variable interactions and process modifications.

WPS 416 Project Management and Analysis. *3(2-3) Preq: WPS 410.* Design, management, and analysis of technical projects. Emphasis on concepts and techniques used in economic analysis of projects. Teams work on projects involving the design and economic analysis of projects that can be implemented in a mill. A detailed final report and presentation of the project required.

WPS (FOR) 423 Forest Machinery and Systems. *3(2 3) . F. Preq. Junior standing in FOR. WP or BAE.* Applications of engineering principles to problems in forest operations: power sources; testing: rating and capabilities of forest machinery; power requirements and utilization efficiencies; effects of vehicle design parameters on stability, safety, and operation under load; traction devices and vehicle mechanics.

WPS 441 Wood Mechanics. *4(3 3) . Preq: MA 231, PY 212, WPS 319* Introduction to orthotropic elasticity. Shear effect on beam deflections. Wood- based composite beams. Shear and bending stress distribution in composite beams. Elastic stability. Influence of density, moisture content, load direction, temperature and load duration on mechanical properties of wood. Creep and mechanosorptive creep. Grading for structural applications. Allowable stresses . Structural fasteners.

WPS 444 Wood Composites. *3(3-0) . Preq: Senior standing in Wood Products.* Manufacture, properties, and processing of wood-based composites. Commodity products - plywood, particleboard, waferboard, and oriented strandboard - as well as specialty composite products.

WPS 450 Wood Industry Case Studies. *2(2-0) . Preq. Sr. standing in WP.* Presentation of relevant Wood industry problems involving material selection, processing and managerial techniques. Causes of in-use failures of wood products and means of prevention.

WPS 460 Environmental Issues in the Paper Industry. *1(1-0) . S. Preq: Senior standing in PPT.* Introduction of environmental issues and external pollutant control technologies. Process modifications to decrease environmental impact of pulp and paper mills. Concepts of integration of environmental controls with production process.

WPS 465 Paper Products Design. *2(2-0) . S. Preq: Senior Standing in PPT.* Uses and characteristics of pulp and paper products presented by market segment; special emphasis on material and processing concepts that affect product properties for converting and value-added end use requirements.

WPS 472 Paper Process Analysis. *3(1-6) . Preq: WPS 216, 310, 371.* Product analysis, materials selection, process planning, manufacture of various types of paper using pilot plant equipment, finished product testing and comparison with standard products. Machine unit operations, materials flow balances, energy balances performed on operations. Team assignments with written and oral presentation of results.

WPS 475 Process Control in Pulp and Paper. *3(2-3) . Preq: Sr. Standing in PPT. Coreq: WPS 410.* Overview of the various aspects of control including process modeling, design of control loops, and stability analysis in pulp and paper. Emphasis on distributed digital control (DDC), including hands-on programming and control loop development on a DDC computer.

WPS 482 Projects in Wood Products. *2(0-2) . Preq: Senior standing in WP.* Individual library or laboratory research projects selected and conducted with the approval and guidance of faculty.

WPS 491 Special Topics in Wood and Paper Science. *1-4.* Independent study of management or technology problems selected with faculty approval or the offering of experimental courses.

WPS (CE) 528 Structural Design in Wood. *3(3-0) . S. Preq: CE 325.* Behavior, strength and design of wood structural members subjected to moment, shear and axial forces. Design of connections and introduction to design of wood structural systems.

WPS (MAE) 534 Mechatronics Design. *3(2-2) . S. Preq. Structured Programming Experience. Senior/Graduate Standing in WPS/MAE or Permission of Instructor.* Principles of Mechatronics Design, review of logic gates, microprocessor architecture, sensors and actuators, A/D and D/A conversion techniques, real-time multi-tasking programming concepts, direct digital control implementation. "Hands-on" experience through several laboratory assignments and final team project.

WPS 591 Master's Seminar. *1(1-0) . Preq: Sr. or grad. standing.*

WPS 595 Special Topics Wood and Paper Science. *F,S.*

WPS 601 Seminar. *1(1-0) . F. S. Preq: Grad. standing.* Presentation and discussion of progress reports on research, special problems and outstanding publications.

WPS 620 Wood and Paper Science Problems. *F, S, Sum. Preq: Sr. or grad. standing. Credits Arranged.* Assigned or selected problems in the field of wood, paper and pulp science and technology.

WPS 625 Advanced Wood and Paper Science Problems. *F, S. Preq: Grad. standing. Credits Arranged.* Selected problems in the field of wood and paper science.

WPS 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

WPS 690 Master's Examination. *1-6. F, S, Sum. Preq: Master's student.* For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

WPS 691 Methods of Research in Wood and Paper Science. *Preq: Advanced undergrad. or grad. standing. Credits Arranged.* Research procedures, problem outlines, presentation of results; consideration of selected studies by forest research organizations; sample plot techniques.

WPS 693 Master's Supervised Research. *1 9. F,S,Sum Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

WPS 695 Master Thesis Research. *1-9. F,S,Sum. Preq: Master's student.* Thesis research.

WPS 699 Master's Thesis Preparation. *1-3. F,S,Sum. Preq: Master's student.* For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

WPS 704 Timber Physics. *3(3 0) . F, Alt. Yrs. Preq: WPS 202.* Density, specific gravity and moisture content variation affecting physical properties; physics of drying at high and low temperatures; thermal, sound, light and electrical properties of wood.

WPS 713 Tropical Woods. *2(1-3) . F, Alt. Yrs. Preq: WPS 202.* Structure, identification, properties, characteristics and use of tropical woods, especially those used in plywood and furniture.

WPS 715 Surface and Colloid Chemistry of Papermaking. *3(3-0) . S. Preq: CH 331 or CH 431.* The fundamental principles of surface and colloid chemistry important in paper making and their application to optimizing wet-end processes. Electrokinetic basis of flocculation, retention and other wet-end phenomena and the science of wet-end additives.

WPS 721 Chemistry of Wood Polysaccharides. *3(3-0) . F, Alt. Yrs. Preq: CH 223 and WPS 332 or BCH 451.* Fundamental chemistry and physical chemistry of monosaccharides and polysaccharides with emphasis on hemicellulose and cellulose. Topics including construction and configuration, stereochemistry, solution properties, molecular weight determination and reactivity.

WPS 722 Chemistry of Lignin and Extractives. *3(3-0) . S, Alt. Yrs.* The biosynthetic pathways, structure and reactivity of lignin and wood extractives with emphasis on topics important to pulping and conversion to useful by-products.

WPS 725 Pollution Abatement in Forest Products Industries. *3(3-0) . Preq: Grad. or advanced undergrad. standing in science or engineering curricula.* Pollution sources, in-plant control and treatment of water and air pollution in forest products with concentration on the pulp and paper industry.

WPS 733 Advanced Wood Anatomy. *3(1-6) . S, Alt. Yrs. Preq: WPS 202 or Consent of Instructor.* Fundamental wood anatomy and cell wall ultrastructure. Laboratory techniques for light and electron microscopic studies of wood.

WPS 740 Wood Composites. *3(3 0) . S, Alt. Yrs. Preq: WPS 441; grad. or advanced undergrad. standing.* Course designed to acquaint advanced undergraduate and graduate students with rapidly expanding field of wood composites. Presentation of production processes for particle board, plywood, hardboard, fiberboard, and other wood composites. Development of elastic theory for the stiffness, strength and buckling resistance of composites. Test procedures for determining mechanical properties and design procedures for glued laminated members, panel products, and built-up members, including I- and box-beams, stressed-skin panels and sandwich panels, outlined.

WPS 750 Wastewater Treatment in the Paper Industry. *3(1-6) . Preq: WPS 725 or Consent of Instructor.* Laboratory practice in pollutant characterization and wastewater treatment processes for the paper industry.

WPS 760 Advanced Pulp and Paper Process Analysis. *3(3-0) . S. Preq: WPS 215 and 216.* Design and analysis of pulp and paper mill processes; process control applications in pulping, chemical recovery, bleaching and papermaking; principles of pulp mill chemical and energy recovery; and new alkaline pulping recovery technology.

WPS 791 Doctoral Seminar. *1(1-0) .*

WPS 795 Advanced Special Topics.

WPS 801 Seminar. *1(1-0) . F, S, Sum.*

WPS 820 Special Problems. *F,S. Preq: Sr or grad. standing.* Assigned or selected problems in the field of wood, paper and pulp science and technology.

WPS 825 Advanced Wood and Paper Science Problems. *1 9. Preq. Grad. standing.* Selected problems in the field of wood and paper science.

WPS 885 Doctoral Supervised Teaching. *1 3. F,S.Sum. Preq: Doctoral student* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

WPS 890 Doctoral Preliminary Examination. *1-9. F.S.Sum. Preq. Doctoral student.* For students who are preparing for and taking written and/or oral preliminary exams.

WPS 891 Methods of Research in Wood and Paper Science. *Preq. Advanced undergrad or grad. standing. Credits Arranged* Research procedures, problem outlines, presentation of results; consideration of selected studies by forest research organizations; sample plot techniques.

WPS 893 Doctoral Supervised Research. *1 9. F.S.Sum. Preq: Doctoral student* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

WPS 895 Doctoral Dissertation Research. *1-9. F S.Sum. Preq: Doctoral student.* Dissertation research.

WPS 899 Doctoral Dissertation Preparation. *1-3 F.S.Sum Preq. Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

ZOOLOGY

ZO 150 Animal Diversity. *4(3-3) .* Classification of animals, macroevolution, systematics, and phylogeny, including relationship to other kingdoms. Patterns of diversifications in body design and relationship between body design and environment, with emphasis on invertebrate animals. Study selected animal assemblages.

ZO 160 Introduction to Cellular and Developmental Zoology. *4(3-3) .* Basic concepts and principles of cellular and developmental zoology with emphasis on the physical basis of life, the cell as the fundamental unit of life and the mechanisms involved in the development of multicellular animals.

ZO 212 Basic Human Anatomy and Physiology. *4(3-3) . Preq: BIO 125 or BIO 183 or ZO 150 or ZO 160.* Major emphasis on structure and function of the muscular, skeletal, circulatory and nervous systems of humans.

ZO (MEA) 220 Marine Biology. *3(3-0) . Preq: MEA 200 or BIO 125.* Introduction to marine plants and animals, their adaptations to life in the sea and ecological interactions in selected marine environments (e.g. coral reefs, deep sea, salt marshes). Interactions of man with the sea: food from the seas, biology of diving. Optional trip.

ZO (FOR, FW) 221 Conservation of Natural Resources. *3(3 0) .* Importance of natural resources and their role in human environment. Physical, biological and ecological principles underlying sustainability of natural resources with attention to consequences of human impacts while meeting society needs.

ZO 250 Animal Anatomy and Physiology. *4(3-3) . Preq: ZO 150 and (ZO 160 or BIO 125 or BIO 183).* Roles of physical laws, enviornmental challenges, and evolutionary history in shaping animal structure and function. Selected examples from invertebrates and vertebrates. Laboratory in anatomy and physiology, hypothesis generation and testing, anddata analysis and presentation.

ZO 260 Evolution, Behavior, and Ecology. *4(3-3) . Preq: ZO 150 for Zoology majors; BIO 125 or equivalent for non-majors.* Principles of evolution, animal behavior, and ecology. Mechanisms of microevolution and speciation, modes, and variation in animal behavior, and population, community, and ecosystem level processes. Methodology and logic of evolution, behavior, and ecology and applications to conservation and management issues.

ZO 295 Special Topics in Zoology. *Preq: BIO 125 or BIO 183 or ZO 150 or ZO 160.* Experimental offerings in Zoology.

ZO 315 General Parasitology. *3(2-3) . Preq: ZO 150 or ZO 160 or BIO 125 or BIO 183* General principles of parasitic symbiosis. Emphasis on life cycles, epidemiology, and pathology of major parasites of humans and domestic animals.

ZO (FW) 353 Wildlife Management. *3(3-0) Preq. ZO 150* Historical development of Wildlife Management from anecdotal, observational practices to modern, scientific approaches used around the world. Principles of population analysis, management, protection and conservation of animals, particularly those of conservation, aesthetic, sport or food values in urban rural and wilderness areas. Ethics of hunting and trapping. Contradictory objectives challenging modern wildlife managers.

ZO 361 Principles of Embryonic Development. *3(3-0) . Preq: ZO 150 or ZO 160 or BIO 125 or BIO 183* An integrated study of descriptive and experimental embryology. Development of both invertebrates and vertebrates at levels of organization from molecular to organismal

ZO 370 Developmental Anatomy and Histology of the Vertebrates I. *3(3-0) . Preq: ZO 150 or ZO 160 or BIO 125 or BIO 183. Coreq: ZO 375.* An integrated study on the embryonic development, gross anatomy, microanatomy, and phylogeny of vertebrate organ systems; surface and connective tissues, the skeleton, and the muscular system.

ZO 371 Developmental Anatomy and Histology of the Vertebrates II. *3(3-0) . Preq: ZO 370. Coreq: ZO 376.* An integrated study on the embryonic development, gross anatomy, microanatomy, and phylogeny of vertebrate organ systems; the circulatory, respiratory, digestive, urogenital, endocrine, and nervous systems.

ZO 375 Developmental Anatomy and Histology Laboratory I. *2(0-6) . Preq: ZO 150 or ZO 160 or BIO 125 or BIO 183. Coreq: ZO 370.* Vertebrate organ systems utilizing dissections of preserved specimens and microscopic examination of embryos and tissue preparations; early embryonic development, surface and connective tissues, the skeleton, and muscular system.

ZO 376 Developmental Anatomy and Histology Laboratory II. *2(0-6) . Preq: ZO 370 and ZO 375. Coreq: ZO 371.* Vertebrate organ systems utilizing dissections of preserved specimens and microscopic examination of embryos and tissue preparations; late embryonic development and the circulatory, respiratory, digestive, urogenital, endocrine, and nervous systems.

ZO 402 Invertebrate Zoology. *2(2-0) . Preq: ZO 150.* Even Yrs. Survey of invertebrate phyla, excluding the Protista, emphasizing their functional biology.

ZO 403 Invertebrate Zoology Laboratory. *2(0-6) . Preq: 150.* Even Yrs. Examination of living and preserved invertebrates to study their distinguishing characteristics and to observe anatomical modifications for function.

ZO 410 Introduction to Animal Behavior. *3(3-0) . Preq: ZO 250 or ZO 360 or Consent of Instructor.* Studies of animal behavior in vertebrates and invertebrates including physiological mechanisms and adaptive significance.

ZO (BO) 414 Cell Biology. *3(3-0) Preq: ZO 160 or ZO 250 or BIO 125 or BIO 183* The chemical and physical bases of cellular structure and function with emphasis on methods and interpretations.

ZO 419 Limnology. *4(3-3) . Preq: BO 360 or ZO 260. Credit in both ZO 419 and ZO 319 is not allowed.* Structure and function of lakes and ponds, including physical, chemical and biological controls of productivity and species composition of aquatic plants and animals, and effects of pollution on water quality. One local weekend field trip is required.

ZO (FW) 420 Introduction to Fisheries Science. *3(3-0) . F. Preq: ZO 150. Coreq: Zo 260 or BO 360.* Role of fish in aquatic ecosystems, fish biology, fish ecology, fisheries management and conservation. Emphasis on aquatic ecosystems and food webs, life history and ecology of important sport and commercial fishes, population and community dynamics, and theory and practice of fisheries management and conservation. Case studies from freshwater, esuarine and marine systems.

ZO 421 Principles of Physiology. *3(3-0) . Preq: CH 223 and ZO 250 or equivalent* A comprehensive survey of the processes involved in the function of specialized cells, tissues and organ systems. Emphasis on basic concepts with orientation toward mammalian and human systems

ZO 422 Biological Clocks. *3(3-0) . Preq: ZO 250 or equivalent or Consent of Instructor. Coreq: Credit in both ZO 422 and ZO 522 is not allowed.* The anatomy, physiology, and development of biological clocks in a variety of organisms, including humans.

ZO 423 Introduction to Fisheries Sciences Laboratory. *1(0-3) . F. Coreq: FW (ZO) 420.* General anatomy and identification of common freshwater, estuarine and marine fish. functional morphology, age and growth analyses, fish health and diets. Computer analyses of bioenergetic and population dynamics.

ZO (ENT) 425 General Entomology. *3(2-3) . Preq: ZO 150 or equivalent.* Explores the science of entomology by focusing on the basic principles of systematics, morphology, physiology, development, behavior, ecology, and control of insects. Field trips provide opportunities to collect insects and study their adaptations to a wide variety of natural environments.

ZO (FW) 430 Fisheries and Wildlife Administration. *3(3-0) . Preq: PS 201, PS 202; FW (ZO) 420, FW (ZO) 353.* Describes and compares the administrative structures and programs of federal and state fish and wildlife agencies and develops an understanding of the basis on which these agencies function. Evaluates the interrelationships that fisheries-wildlife professionals, special interest groups, public agencies and legislative bodies play in resource management programs.

ZO 441 Biology of Fishes. *3(3-0) . Preq: BO 360 or ZO 260.* Behavior, evolution, physiology and ecology of fishes, emphasizing their adaptations for life in streams, lakes, and oceans.

ZO 442 Biology of Fishes Laboratory. *1(0-3) . Preq: BO 360 or ZO 260. Coreq: ZO 441.* Field and laboratory exercises with the common fish species and communities of North Carolina. Field trips to local streams and lakes plus weekend trips to coastal, estuarine, and mountain habitats.

ZO 450 Evolutionary Biology. *3(3 0) Preq: ZO 202, ZO 208. GN 411 recommended.* Principles and patterns of organic evolution. Origin of life, patterns of genetic variability within populations; adaptations, natural selection, and the formation of species. The living world as an historical process governed by diverse principles of organization.

ZO 460 Aquatic Natural History Laboratory. *2(0-4) . Preq: BO 360 or ZO 260.* Field and laboratory study of taxonomy and environmental adaptations of freshwater protists, plants, and animals. Ecology of principle freshwater ecosystems, effects of pollution, and examples of conservation. Establishment of freshwater aquarium with local organisms. Weekend field trips required

ZO 480 Laboratory Techniques in Cellular Biology. *3(1 6) Preq: ZO 160 or BIO 125 or BIO 183 and CH 223.* Selected laboratory techniques in modern biological research including immunochemistry, animal cell culture, light microscopy, and detection and isolation of recombinant proteins.

ZO 492 External Learning Experience. *1-6 Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser. the prospective employer and the departmental teaching coordinator prior to the experience.

ZO 493 Special Problems/Research Exploration. *1 6. Preq: Sophomore standing.* A learning experience in agriculture and life sciences within an academic framework that utilizes campus facilities and resources. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser. the prospective employer, the departmental teaching coordinator prior to the experience.

ZO 495 Special Topics in Zoology. *1-3.* Offered as needed for development of new courses in various areas of zoology.

ZO 501 Ornithology. *3(2-3) . S. Preq: ZO 150 or ZO 250; BO 360 or ZO 260.* The biology of birds, including evolution, functional morphology, physiology, ecology and behavior. Field and museum laboratories emphasize particular aspects of morphology, ecology and behavior, as well as taxonomy and identification. One coastal weekend field trip required.

ZO (PHY) 503 General Physiology I. *3(3-0) . F. Preq: Sr. or grad. standing; the following courses are recommended: ZO 421 or equivalent, BCH 451 or equivalent, a yr. of physics.* Discussion of general principles of homeostasis, emphasizing importance of integrative action. Following systems studied: muscular, cardiovascular and nervous systems.

ZO (PHY) 504 General Physiology II. *3(3-0) . S. Preq: PHY (ZO) 503.* Discussion of general principles of homeostasis, emphasizing importance of integrative action. Following systems studied: alimentary, renal, respiratory and endocrine systems.

ZO (ENT) 509 Ecology of Stream Invertebrates. *4(2-6) . S Odd Yrs. Preq: ZO 150 or ZO 402, BO 360 or ZO 260.* Introduction to stream ecology and analysis of animal communities. Lectures cover community structure and function, life histories of dominant animals, sampling design and techniques and responses to pollution. Laboratory exercises include field collections, identification of animals and quantitative research techniques. A personal collection of animals and a weekend field trip to mountain streams required.

ZO 512 Animal Symbiosis. *3(3-0) . S Odd Yrs. Preq: 12 hrs. of biology and ZO.* Symbiotic associations of animals including mutualism, commensalism and parasitism. The morphological, physiological, behavioral and ecological adaptations of symbionts and the complex interactions between partner species.

ZO (PHY) 513 Comparative Physiology. *3(3-0) . F Odd Yrs. Preq: ZO 421 or Consent of Instructor.* Comparative study of the organ systems of vertebrates and physiological processes involved in maintaining homeostatic state. Various compensatory mechanisms employed during environmental stress included.

ZO (FW) 515 Fish Physiology. *3(2-3) . F Odd Yrs. Preq: GN 411, ZO 420, 421, 441.* The biology of fishes: physiology, anatomy, endocrinology, behavior and genetics. Designed especially for graduate students in fisheries. Several trips to research laboratories taken.

ZO 519 Limnology. *4(3-3) . F. Preq: Grad. standing and Consent of Instructor. Credit in both ZO 419 and ZO 519 is not allowed.* Structure and function of lakes and ponds, including physical, chemical and biological controls of productivity and species composition of aquatic plants and animals and effects of pollution on water quality. One local weekend field trip required.

ZO 522 Biological Clocks. *3(3-0) . S. Preq: Grad. standing or Consent of Instructor.* The anatomy, physiology and development of biological clocks in a variety of organisms, including humans. Required readings in primary literature.

ZO (PHY, PO) 524 Comparative Endocrinology. *4(3-3) . S. Preq: ZO 421 or equivalent.* Basic concepts of endocrinology, including functions of major endocrine glands involved in processes of growth, metabolism and reproduction.

ZO 542 Herpetology. *3(2-3) . S Even Yrs. Preq: ZO 250 and ZO 421.* The biology of the amphibians and reptiles: systematics, life history, anatomy, behavior, physiology and ecology.

ZO 544 Mammalogy. *4(3-3) . F. Preq: ZO 250.* The biology of mammals: evolution, functional morphology, reproduction, behavior, ecology, population biology, classification and identification. One weekend field trip planned.

ZO (MEA) 550 Principles of Biological Oceanography. *3(3-0) . S.* Biological productivity and trophic relationships in Plankton, Nekton and Benthos; community ecology of selected habitats (estuaries, intertidal zones, coral reefs, deep sea) and adaptation of organisms to marine environment.

ZO (FW) 553 Principles of Wildlife Science. *3(2-3) . F. Preq: BO 360 or ZO 260.* The principles of wildlife management and their application studied in the laboratory and in the field.

ZO (FW) 554 Wildlife Field Studies. *3(2-3) . S. Odd yrs.. Preq: ZO 553, ST 311; Consent of Instructor.* Field application of methods for studying vertebrate wildlife populations; sampling methods, data gathering, analysis and interpretation of results practiced. Participation in field laboratories and one or two weekend field trips required.

ZO (MB) 555 Protozoology. *4(2-6) . S Odd Yrs. Preq: Consent of Instructor.* The biology of the Protozoa: lectures including morphology, physiology, ecology, genetics, reproduction, evolution, systematics and life-cycles of both free-living and parasitic taxa; laboratory stressing recognition of selected forms and demonstrate techniques used to prepare specimens for microscopic examination.

ZO 581 Helminthology. *4(2-4) . F Odd Yrs. Preq: ZO 250, ZO 315 or equivalent.* The morphology, biology and control of parasitic helminths.

ZO (ENT) 582 Medical and Veterinary Entomology. *3(2-3) . S, Alt. Yrs. Preq: ENT 425 and ZO 315 or equivalent.* The morphology, taxonomy, biology and control of the arthropod parasites and disease vectors of man and animals. The ecology and behavior of vectors in relation to disease transmission and control.

ZO (FW) 586 Aquaculture I. *1(3-0) . F Even Yrs. Preq: BO 360 or ZO 260, sr. or grad. standing.* Biological and general principles of aquaculture. Emphasis on the present status of aquaculture, species involved, techniques employed, and problems encountered. Discussion of recent advances in research and development and identification of areas of future research and development.

ZO (FW) 587 Aquaculture I Laboratory. *1(0-3) . F, Even Yrs. Preq: BO 360 or ZO 260, sr. or grad. standing. Coreq: ZO 586.* Methods and techniques of cultivating aquatic organisms. Field trips and reports on local hatcheries and facilities required. (Three to four overnight field trips taken on week days to coastal areas, state hatcheries, and private hatcheries; students responsible for shared room costs and their meals. Four field trips also taken on laboratory day within driving range of Raleigh.)

ZO 601 Seminar. *1(1 0) . F, S, Sum.* The presentation and defense of original research and current literature.

ZO (ANS, CBS, PHY) 602 Seminar in Biology of Reproduction. *2(2-0) . S. Preq: ANS(PHY) 702 or Consent of Instructor.* Current topics in animal reproduction presented by reproductive physiologists from various Research Triangle institutions. Student presentations of research projects or library projects in area of animal reproduction.

ZO 603 Aquatic Ecology Seminar. *1 3. F, S. Preq: Grad . PBS or sr. standing; one course in aquatic, marine or fisheries areas.* Presentations and discussions of recent research and topical issues in aquatic and marine sciences. Each student enrolled for credit must make at least one presentation.

ZO (MEA) 624 Topical Problems. *1-3. F, S. Preq: Consent of Instructor.* Organized, formal lectures and discussion of a special topic.

ZO 631 Special Topics. *1-6. F, S. Sum. Preq: Twelve hours ZO. Consent of Instructor.* A directed individual investigation of a particular problem in zoology, accompanied by a review of the pertinent literature. A maximum of three hours allowed toward master's degree.

ZO 685 Master's Supervised Teaching. *1-3. F, S, Sum. Preq: Master's students.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ZO 690 Seminar. *F, S, Sum.* The presentation and defense of original research and current literature.

ZO 693 Master's Supervised Research. *1-9. F,S. Preq: Master's student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ZO 695 Master's Thesis Research. *1-9. F,S. Preq: Master's student.* Thesis research.

ZO 699 Research In Zoology. *F, S, Sum. Preq: Twelve semester credits in ZO and Consent of Instructor. Credits Arranged.*

ZO (ST) 710 Sampling Animal Populations. *3(3-0) . F, Alt. Yrs.. Preq: ST 512.* Statistical methods applicable to sampling of wildlife populations, including capture-recapture, removal, change in ratio, quadrant and line transect sampling. Emphasis on model assumptions and study design.

ZO 714 Advanced Cell Biology. *3(3-0) . S Even Yrs.. Preq: ZO (BO) 414 or equivalent.* The current problems of cell biology including the problems of molecular organization and functions of membrane systems, subcellular organelles and specialized cells.

ZO 718 Community Ecology. *3(3 0) S, Odd Yrs Preq. BO 360 or ZO 260 BO(ZO) 760 or equivalent; BO(ZO) 365 or equivalent* Animal community structure and function. Effects of competition, predation, coevolution and disturbance on community composition. Emphasis on ecological and evolutionary controversies from empirical and theoretical approaches.

ZO . 721 Fishery Science. *3(2-3) . F Even Yrs. Preq. ST 511 ZO 420. a course in calculus* An analysis of fishery research methods. Population enumeration and dynamics. The relationship between fluctuations in natural populations and environmental factors.

ZO 726 Quantitative Fisheries Management. *3(2-3) F, Even Yrs Preq. ST 501 and ZO 420 or equivalent* Current methods for assessment and management of exploited fish populations, including sampling methods, data analysis and modeling. A required research paper or project.

ZO (GN) 740 Evolutionary Genetics. *3(3 0) . F, Alt yr(even) Preq. GN 703 or Consent of Instructor.* Genetic basis of evolution. Molecular evolution, molecular population genetics, evolutionary genetics of quantitative characters and the genetics of speciation. Critical reading of original research publications and student seminars.

ZO (MEA) 750 Marine Benthic Ecology. *3(3-0) . S, Alt Yrs.* Marine benthic systems in deep sea and in shallow waters, focusing upon abiotic and biotic processes regulating density, diversity and taxonomic and functional composition. Discussions of benthic-pelagic coupling, predation, interspecific competition, biogeography, sampling problems, evolutionary trends, trophic structure and community organization.

ZO (MEA) 754 Advances in Marine Community Ecology. *3(3-0) . S Alt Yrs.* Current research and biological and physical processes structuring shallow and deep water benthic communities. Recent research on competition, predation, disturbance, succession, animal-sediment-flow interactions, life history tactics and experimental design in marine benthic biology. Student discussion of current issues and critique of recent papers.

ZO (MEA) 756 Ecology of Fishes. *3(3-0) . F, Odd Yrs..* Physiological ecology of fishes emphasizing energetics, production and adaptations to aquatic mediums. Ecological classification of fishes and theory of resource partitioning in freshwater, estuarine and marine realms.

ZO (BO) 760 Principles of Ecology. *4(3-3) . F. Preq: Three semesters of college-level biology courses.* A consideration of principles of ecology at graduate level. Each of the major subject areas of ecology developed in sufficient depth to provide a factual and philosophical framework for the understanding of ecology.

ZO (BO) 770 Advanced Topics in Ecology I. *3(3-0) . S.* Development of subject matter in major fields of ecology through seminars and lectures and principles illustrated by laboratory exercises and field trips. Microenvironment, population biology, community ecology, ecosystems and nutrient cycling.

ZO 784 Advanced Topics in the Study of Mammals. *3(2-3) . S, Even Yrs.. Preq: ZO 544.* Current topics in the study of mammals with concentration each year on a different topic, such as community ecology, population biology, evolution or functional morphology. Student research projects required.

ZO 789 Advanced Limnology. *3(3-0) . S Even Yrs. Preq: ZO 419.* Recent topics in limnological research. Lectures and discussion draw from journal articles on physical, chemical and biological aspects, including nutrient control of productivity, predator control of community structure and determinants of water quality. A research paper or project required.

ZO 790 Special Topics.

ZO 791 Topics in Animal Behavior. *3(3-0) . F, Even Yrs.. Preq: Grad. standing.* Intensive examination of selected aspects of animal behavior and their relationship to physiology, ecology and other biological fields. May be repeated for credit when topic changes.

ZO (ANS, CBS, PHY) 802 Seminar in Biology Of Reproduction. *2(2 0) . S Preq. ANS(PHY) "02 or Consent of Instructor.* Current topics in animal reproduction presented by reproductive physiologists from various Research Triangle institutions. Student presentations of research projects or library projects in area of animal reproduction.

ZO 804 Seminar in Evolutionary Biology. *F S Sum Credits Arranged.* Seminar exploring current concepts and issues in evolutionary aspects of animal behavior, ecology and population biology. Topic varies, may be repeated for credit when topic changes. Format may be reading and discussing important new books, current journal articles or classic papers. Intended primarily as forum for interaction of students in this area of zoology but open to others.

ZO 824 Topical Problems. *1 3 F, S Preq Consent of Instructor* Organized, formal lectures and discussion of a special topic.

ZO 829 Special Topics. *F,S. Preq: Twelve hours ZO, Consent of Instructor.* A directed individual investigation of a particular problem in zoology, accompanied by a review of the pertinent literature. A maximum of three hours allowed toward master's degree.

ZO 831 Special Topics. *1-6. F,S. Preq: Twelve hours ZO, Consent of Instructor.* A directed individual investigation of a particular problem in zoology, accompanied by a review of the pertinent literature. A maximum of three hours allowed toward master's degree.

ZO 885 Doctoral Supervised Teaching. *1-3. F, S, Sum. Preq: Doctoral student.* Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

ZO 890 Doctoral Preliminary Examination. *1-9. F, S, Sum. Preq: Doctoral student.* For student who are preparing for and taking written and/or oral preliminary exams.

ZO 893 Doctoral Supervised Research. *1-9. F, S, Sum. Preq: Doctoral student.* Instruction in research and research under the mentorship of a member of the Graduate Faculty.

ZO 895 Doctoral Dissertation Research. *1-9. F, S, Sum. Preq: Doctoral student.* Dissertation research

ZO 899 Doctoral Dissertation Preparation. *1 3. F, S, Sum. Preq: Doctoral student.* For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

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