Course Descriptions

The courses offered by the College are grouped by general subject areas and the number of credit hours appears after the course title. A credit hour means one recitation (or lecture) hour per week. Three laboratory hours are equivalent to one lecture hour.

The semester(s) after each course indicates when it is normally offered. The College reserves the right to alter the scheduled offering of a course when its enrollment is too small or when there is no qualified faculty member available to teach it.

Courses listed in this catalog are subject to change through normal academic channels. New courses, course deletions and changes in courses are initiated by the relevant departments and the College faculty.

Course Numbering System

100-499: Undergraduate courses for which no graduate credit may be given.

500-599: Graduate courses designed expressly for areas of specialization in post-baccalaureate programs. Qualified undergraduate students may enroll by permission of the instructor.

600-699: Graduate courses designed expressly for advanced levels of specialization. Undergraduate students with a cumulative grade point average of 3.000 or better may enroll in these courses with an approved petition.

700-999: Advanced graduate-level courses for which no under-graduate students may register. Shared resources courses, designated as 400/500 or 400/600, are designed when the topic coverage of both courses is the same. Separate course syllabuses are developed expressly differentiating the requirements and evaluative criteria between the undergraduate course and the graduate course. No type of cross listing may be offered unless approved by the ESF faculty.

ESF Subject Areas

APM	Applied Mathematics
BPE	Bioprocess Engineering
BTC	Biotechnology
CMN	Communications (Environmental Studies)
EFB	Environmental and Forest Biology
ENS	Environmental Science (Graduate)
ERE	Environmental and Resource Engineering
ESC	Environmental Science
ESF	Collegewide
EST	Environmental Studies
EWP	Environmental Writing Program
FCH	Chemistry
FEG	Forest Engineering
FOR	Forestry (Resources Management)
FTC	Forest Technology
LSA	Landscape Architecture
PSE	Paper Science and Engineering
WPE	Wood Products Engineering

Syracuse University Subject Areas

These courses are taught at Syracuse University's College of Arts and Sciences. Descriptions will be found at http://coursecatalog.syr.edu/.

AAS	African American Studies
ANT	Anthropology
APH	Art Photography
CHE	Chemistry
CIE	Civil Engineering
ELE	Electrical Engineering

ETS	English and Textual Studies
GEO	Geography
HST	History
LIN	Linguistics
LIT	Literature in Translation
MAT	Mathematics
MAX	Maxwell School
PAF	Public Affairs
PHI	Philosophy
PHY	Physics
PSC	Political Science
REL	Religion
SOC	Sociology

APM - Applied Mathematics

APM 101 Fundamentals of College Algebra (3)
Three hours of lecture/discussion per week. Algebraic operations on polynomials and rational functions as expressions, in equations, or inequalities. Graphing of linear and polynomial equations. An emphasis is placed on algebraic operations of expressions with rational exponents. Fall.

APM 103 Applied College Algebra and Trigonometry (3)
Three hours of lecture per week. This course is designed to enable non-science students to solve practical problems in their specific areas of study. Topics include algebraic, exponential, logarithmic, and trigonometric functions used in measurement and modeling. Applications include percents, scaling, slopes, and contour mapping. Spring, Fall.
Prerequisite(s): Math Placement or Consent of Instructor.

APM 104 College Algebra and Precalculus (3)
Three hours of lecture/discussion per week. Course meets the SUNY general education requirement for mathematics. Elements of analytic geometry. Emphasis on the concepts of polynomial and rational functions, exponential and logarithmic functions, trigonometry and trigonometric functions and their application to design and life and management sciences. Fall and Spring.
Prerequisite: Three years of high school mathematics.

APM 105 Survey of Calculus and Its Applications I (4)
Four hours of lecture per week. Introduction to calculus for students in the life and management sciences. Elements of analytic geometry, functions and their graphs, with an emphasis on the concepts of limits, and differentiation techniques for algebraic, exponential and logarithmic functions and their application to economics, and the life and management sciences. Some multivariable calculus including constrained optimization. Fall and Spring.
Prerequisite: Precalculus or 3 1/2 years of high school mathematics. Note: Credit will not be granted for APM 105 after successful completion of MAT 284, MAT 285, or MAT 295 at SU.

APM 106 Survey of Calculus and Its Applications II (4)
Four hours of lecture per week. A continuation of calculus for students in the life and management sciences. Elements of analytic geometry. An introduction to integration and applications of the definite integral. Differentiation and integration of trigonometric functions. Applications of first order differential equations and partial derivatives. Spring.
Prerequisite: APM 105 or permission of the instructor. Note: Credit will not be granted for APM 106 after successful completion of MAT 286 or MAT 296 at SU.

APM 205 Calculus I for Science and Engineering (4)
Four hours of lecture/discussion per week. Analytic geometry, limits, derivatives of functions and equations, optimization, rates, graphs, differentials, mean-value theorem, and applications of the derivative. Fall.
Prerequisite: APM 104 or permission of instructor.

APM 206 Calculus for Science and Engineering II (4)
Four hours of lecture/discussion per week. This course is a one semester continuation of differential calculus. Integral calculus is used to describe growth and size. Topics include: techniques of integration and their application, convergence of sequences and series, separable and first-order differential equations, and polar coordinates. Spring.
Prerequisite(s): Successful completion of a differential calculus course such as APM205 or MAT295.

APM 255 Computing Applications (3)
Three hours of lecture per week. Introduction to computing resources: timeshared and personal computers. Introduction to basic computing concepts. Introduction to computing and computer networks. Introduction to applications computing: word processing, spreadsheets and communications (electronic mail and other Internet services). Spring.

APM 360 Introduction to Computer Programming (3)
Three hours of lecture per week. The basic course in computer programming offered by the college, giving the student the skill and

understanding to write computer programs to solve problems. The course will cover instruction in a commonly used programming language such as Pascal or FORTRAN; will cover basic hardware and software concepts; will make use of electronic mail and computer networks; will introduce applications software, such as spreadsheets, statistical software or other appropriate types. No prior experience with computers or programming is required. Fall.

APM 391 Introduction to Probability and Statistics (3)
Three hours of lecture per week. Introduction to concepts and methods of statistics as applied to problems in environmental science and forestry. Topics include inference (confidence intervals and hypothesis testing), sampling distributions, descriptive statistics, exploratory data analysis, comparison of population means and proportions, categorical data analysis, regression and correlation, and nonparametric methods. Fall or Spring.

APM 395 Probability and Statistics for Engineers (3)
Three hours of lecture per week. This course provides a rigorous introduction to calculus-based probability and statistical theory, with applications primarily drawn from engineering and the environmental sciences. Topics include: descriptive statistics and data presentation, probability, the theory and use of discrete and continuous probability distributions, confidence intervals, classical and distributional hypothesis testing, and regression analyses. Spring.
Prerequisite(s): One year of Calculus. Note: Credit will not be granted for both APM 395 and APM 595.

APM 485 Differential Equations for Engineers and Scientists (3)
Three hours of lecture per week. First and second order ordinary differential equations, matrix algebra, eigen values and eigen vectors, linear systems of ordinary differential equations, numerical solution techniques and an introduction to partial differential equations. Spring.
Prerequisite: MAT 295, MAT 296, MAT 397.

APM 500 Introduction to Computer Programming for Graduate Students (3)
Three hours of lecture per week. A basic course in computer usage. Provides the skill needed to utilize digital computer languages for problem solving. Includes a study of FORTRAN with a discussion of APL and Assembly Language. Other topics include representation of information, management of files, error control, operational systems and job control. Fall.

APM 510 Statistical Analysis (3)
Three hours of lecture per week. Applications of descriptive and inferential statistics to natural resource problems. Basic concepts and techniques of estimation, confidence intervals, and hypothesis testing applied to one- and two-sample settings, paired designs, simple linear regression and correlation, contingency tables, and goodness of fit tests. Statistical software used to enhance data analysis skills. Fall.
Prerequisite(s): Graduate standing.

APM 595 Probability and Statistics for Engineers (3)
Three hours of lecture per week. This course provides a rigorous introduction to calculus-based probability and statistical theory, with applications primarily drawn from engineering and the environmental sciences. Topics include: descriptive statistics and data presentation, probability, the theory and use of discrete and continuous probability distributions, confidence intervals, classical and distributional hypothesis testing, and regression analyses. Spring.
Prerequisite(s): One year of Calculus. Note: Credit will not be granted for both APM 395 and APM 595.

APM 620 Experimental Design and ANOVA (3)
Three hours of lecture per week. Designing and analyzing experiments and observational studies; completely randomized, split plot, randomized complete block, and nested experiment designs; single-factor, factorial, and repeated measures treatment designs; expected mean squares and variance components; fixed, random, and mixed effects models; multiple comparison and contrast analyses; analysis of covariance; statistical computing. Spring.
Prerequisites: Graduate status and an introductory course in statistics covering material through the one-way analysis of variance.

APM 625 Sampling Methods (3)
Three hours of lecture per week. Application of probability sampling methods to environmental science and forestry. Simple random, stratified, cluster, systematic, two-phase, line-intercept, point, variable radius plot, adaptive cluster, and other variable probability sampling designs; model-assisted ratio and regression estimators; inclusion probabilities; properties of estimators for design-based inference; Horvitz-Thompson estimation as a unifying theory. Fall.

APM 630 Regression Analysis (3)
Three hours of lecture per week. Review of basic statistical concepts and matrix algebra. Classical simple and multiple linear models, indicator or dummy variables, residual analysis, transformation and weighted least squares, influence diagnostics, multicollinearity, nonlinear models and linear mixed models. Statistical computing using SAS and applications in forestry, biology, engineering, and social sciences. Spring.
Prerequisite: APM 391 or equivalent.

APM 635 Multivariate Statistical Methods (3)
Three hours of lecture per week. Review of basic statistical concepts and matrix algebra. Multivariate normal distribution, Hotelling's T2, multivariate analysis of variances, principal component analysis, factor analysis, discrimination and classification, cluster analysis, and canonical correlation analysis. Statistical computing using SAS and applications in forestry, biology, engineering, and social sciences. Fall.
Prerequisites: APM 391 or equivalent.

APM 645 Nonparametric Statistics and Categorical Data Analysis (3)
Three hours of lecture per week. Topics include: review of basic statistics, sign and ranked sign tests, median and Wilcoxon tests, c2 binomial tests, -test and contingency tables (with correspondence analysis), goodness-of-fit, nonparametric correlation and association analysis, logistic and Poisson regression, nonparametric regression techniques such as LOESS, GAM, and robust regression, bootstrapping and jackknifing. Fall (even years).
Prerequisite: APM 391 or equivalent.

APM 650 Operations Research (3)
Three hours of lecture per week. A survey of optimization techniques to support decision making in the management of natural resources. Techniques examined include linear programming, integer programming, network analysis, nonlinear programming, dynamic programming, and Markov chains. Fall (odd years).
Pre- or co-requisite(s): Calculus and Probability and Statistics.

APM 653 Simulation Design and Analysis (3)
Three hours of lecture per week. Statistical aspects of computer simulation. Topics examined include: identification and parameterization of probability distributions, evaluation of random number generators, random variate generation, and statistical analysis of simulation output. Fall (even years).
Prerequisite: Probability and Statistics.

APM 671 Map Accuracy Assessment (1)
One hour of lecture per week.Statistical concepts and methods for quantifying the accuracy of maps. Sampling design and analysis for assessing accuracy of categorical attributes (e.g. land cover) is emphasized, with some discussion of continuous variables. Spring, even numbered years.

APM 696 Special Topics in Quantitative Methods (1 - 3)
Experimental and developmental courses in areas of quantitative methods not covered in regularly scheduled courses. A course syllabus will be available to students and faculty advisors prior to registration. Fall or Spring.

BPE - Bioprocess Engineering

BPE 132 Orientation Seminar: Bioprocess Engineering (1)
One hour lecture per week or three-hour lab/field trip per week. Introduction to campus resources available to ensure academic success. Introduction to bioprocess engineering as a field of inquiry and career path. Fall.
Note: Credit will not be granted for both BPE 132 and PSE 132.

BPE 230 China Experience (3)
Forty five hours (equivalent) of lecture and field studies. General survey of the history of China from ancient societies through the current time, with attention to cultural, ecological and natural resource issues focused on selected localities of China. The locality and/or hot spots will be selected from: the invention of paper; printing technology; renewable energy; anaerobic digesion of manual / plant biomass; wastewater treatment; Great Walls; Forbidden City; Three Gorges area; Canals; Chinese gardens; Sichuan; Dujianyang Irrigation Dam/Channels; Panda preservation; Hakka culture; Tibetan culture; plants and vegetation, etc. Analysis of the evolution of the Chinese culture. Historical and contemporary influences of China. Spring, Fall or Summer.

BPE 296 Special Topics in Engineering (1 - 3)
Provides experimental, interdisciplinary, or special coursework at the freshman and sophomore levels within the field of environmental resources engineering. Subject matter and course format vary from semester to semester and section to section. Fall and Spring.

BPE 300 Introduction to Industrial Bioprocessing (3)
Three hours of lecture and discussions per week. Industrial examples of biotechnology and bioprocessing will be reviewed. Topics include applications of biotechnology and bioprocessing to the food, water and wastewater treatment, industrial biotechnology, biopharmaceutical and biofuel industries. Through case studies of process flow sheets for different products students will develop an understanding of unit operations typically utilized in bioprocessing manufacturing operations. Fall.
Prerequisite(s): Cell biology and organic chemistry.

BPE 304 Summer Internship in Bioprocess Engineering (2)
Twelve weeks full time bioprocessing employment approved by the Department between the junior and senior years. The student must submit a comprehensive report and give a presentation to fulfill this requirement. Summer.
Prerequisite: PSE 370 or equivalent.

BPE 305 Co-op Experience in Bioprocess Engineering (2)
One semester full-time bioprocessing experience as an engineering intern on company-assigned projects. Typically, the student works for a semester and adjacent summer also taking BPE 304. The student must submit a comprehensive report and give a presentation to fulfill this requirement. Fall and Spring.
Prerequisite: PSE 370 or equivalent.

BPE 310 Colloid and Interface Science (3)
Three hours of lecture per week. This course will cover the basic principles of colloidal and interfacial science as applied to bioprocesses. It will provide a foundation and theoretical understanding that will be applied in bioseparations, transport phenomena, biochemical/bioprocess engineering and other advanced courses in the bioprocess engineering curriculum. Fall.
Prerequisites: PSE 370, PSE 361, FCH 150, FCH 152. Note: Credit will not be granted for both BPE 310 and PSE 467.

BPE 335 Transport Phenomena (3)
Three hours of lecture per week. Principles of heat and mass transfer as applied to the bioprocess industries. Topics include conduction, convective heat and mass transfer, diffusion of both steady-state and transient situations, analogies for heat and mass transfer, boundary layers, porous media transport, heat and mass transfer analyses. Discussion of specific bioprocess examples. Spring.
Prerequisites: PSE 370, PSE 371. Note: Credit will not be granted for both BPE 335 and ERE 534.

BPE 336 Transport Phenomena Laboratory (1)
Three hours of laboratory per week. Introduction to report writing and laboratory safety. Experiments on fluid mechanics, heat transfer, diffusion, and convective mass transfer as applied to the bioprocess industries. Data analysis and data presentation in oral and written form are required. Spring.
Prerequisites: PSE 370 and PSE 371 or equivalents. Co-requisite: BPE 335 (or prerequisite).

BPE 420 Bioseparations (3)
Three hours of lecture per week. Major unit operations used for the separation, purification and recovery of products from complex mixtures. Separation processes including sedimentation, filtration, centrifugation, membrane ultra-filtration, nanofiltration, ion exchange processes, chromatographic separations. Fall.
Prerequisite: BPE 310. Note: Credit will not be granted for both BPE 420 and BPE 620.

BPE 421 Bioprocess Kinetics and Systems Engineering (3)
Three hours of lecture per week. Topics in biochemical kinetics and reaction engineering are discussed including their application to

microbiological systems used for bioprocessing. Batch and continuous biochemical reactor designs. The role of agitation in gas and solids delivery and heat removal for inclusion in design decisions. Impact of engineering parameters and design decisions on operability and economics. Fall.
Prerequisite: BPE 335. Co-requisite: BPE 420. Note: Credit will not be granted for both BPE 421 and BPE 621.

BPE 435 Unit Process Operations (3)
Two hours of lecture and three hours of laboratory and/or recitation, discussions per week. Topics include packed towers, tray columns, fluidized bed, fluid mechanic limitations, pressure drop, mass transfer coefficient, mass transfer limits, thermodynamic limits, equilibrium stage calculations, packed tower and tray column design and performance analysis. Fall.
Prerequisite(s): BPE 335/336.

BPE 438 Introduction to Biorefinery Processes (3)
Three hours of lecture and discussions per week. Topics covered include chemical and physical properties of biomass feedstocks; sustainable biomass production/utilization, chemical and biological processes of converting plant biomass to chemicals, liquid fuels, and materials. Focus on green chemistry and/or environmentally benign processes, with some discussions on political and social aspects of sustainability and renewability. Fall.
Prerequisite(s): Cell biology and BPE 335 Transport Phenomena. Note: Credit will not be granted for both BPE 438 and BPE 638.

BPE 440 Bioprocess and Systems Laboratory (3)
One hour of lecture and six hours of laboratory per week. Measurement and analysis of bioprocess systems, including steady-state and dynamic modeling of systems. Investigation of various bioprocesses including fermentation, enzymatic reactions, and reactive processes involving lignocellulosic materials. Spring.
Prerequisite: BPE 420 and BPE 421.

BPE 441 Biomass Energy (3)
Three hours of lecture per week. Historical, current and future uses of biomass as a source of renewable energy for the production of bioenergy, biofuels and bioproducts. Characteristics of biomass, their conversion to different forms of energy and end products, and an assessment of their sustainability. Spring.
Prerequisite: ESC 325, ESC 335 or permission of instructor; one semester of freshman chemistry or permission of instructor. Note: Credit will not be granted for both BPE 441 and BPE 641.

BPE 480 Introduction to Biorefinery Processes (3)
Forty five hours of lecture and discussions. Topics covered in this course include chemical and physical properties of biomass feedstocks; chemical processes and biological processes associated with converting plant biomass and agricultural residues to chemicals, liquid fuels, and materials. Discussions will be more geared towards green chemistry and/or environmentally benign processes. While discussions will lead to political and policy trends on sustainability and renewability, more engineering and engineering science aspects will be covered. Fall.
Prerequisite(s): BPE 421 Co-requisite(s): BPE 421

BPE 481 Bioprocess Engineering Design (3)
Three hours of lecture per week. Methods for estimating capital investment, operating costs and return on investment for bioprocesses. Bioprocess flow sheet synthesis, operability, process simulation, optimization techniques, and preparation for a bioprocess design project. Spring.
Prerequisite: PSE 480.

BPE 496 Special Topics (1 - 3)
Lectures, readings, problems and discussions. Topics in environmental or resource engineering as announced. Fall and/or Spring.

BPE 498 Research Problem in Bioprocess Engineering (1 - 4)
Independent study. The student is assigned a research problem in bioprocess engineering. The student must make a systematic survey of available literature on the assigned problem. Emphasis is on application of correct research techniques rather than on discovery of results of commercial importance. The information obtained in the literature survey, along with the data developed as a result of the investigation, is to be presented as a technical report. Fall, Spring, and Summer.

BPE 501 Bioprocess Microbiology (3)
Two hours of lecture and three hours of laboratory/discussion per week. Topics include general microbiology, enzymology, enzyme kinetics, biochemistry, metabolic regulation, microbial growth and product formation (with general stoichiometry), media formulation and bioprocess design including batch, fed-batch, and continuous modes, techniques for product recovery and purification, and mammalian cell lines/culture. Microbiological growth media, batching, and the operation of bench-top bioreactors and various analytical instrumentation. Fall.
Prerequisites: Permission of instructor; basic understanding of chemistry and biology; appropriate quantitative skills.

BPE 535 Transport Phenomena (3)
Three hours of lecture per week. Principles of heat and mass transfer as applied to the bioprocess industries. Topics include conduction, convective heat and mass transfer, diffusion of both steady-state and transient situations, analogies for heat and mass transfer, boundary layers, porous media transport, heat and mass transfer analysis. Discussion of specific bioprocess examples. Spring.
Note: Credit will not be granted for both BPE 335 and BPE 535.

BPE 596 Special Topics (1 - 3)
Lectures, conferences, discussions and laboratory. Topics in environmental and resource engineering not covered in established courses. Designed for the beginning graduate student or selected upper-division undergraduate. Fall and/or Spring.

BPE 620 Bioseparations (3)
Three hours of lecture per week. Cell disruption, solid liquid separations, centrifugation, chromatographic techniques (gel filtration, affinity, ion exchange), and membrane processes. Extraction. Crystallization and drying. Aseptic filtration. Fall.
Prerequisite: BPE 501. Note: Credit will not be granted for both BPE 620 and BPE 420.

BPE 621 Bioreaction Engineering (3)
Three hours of lecture/discussion per week. Bioprocess kinetics, reaction engineering, mass and energy balances, stoichiometry, enzyme kinetics, growth and product synthesis kinetics, mass transfer effects, bioreactor analysis and design, instrumentation and control, batch

processing, bioreactor scale-up, agitation, oxygen delivery, heat removal and kinetics of sterilization (clean and sterilization in place (CIP and SIP). Spring.
Prerequisites: Mass and Heat Transfer, or Transport Phenomena. Note: Credit will not be granted for both BPE 621 and PBE 421.

BPE 635 Unit Process Operations (3)
Two hours of lecture and three hours of laboratory and/or recitation, discussions. Topics include packed towers, tray columns, fluidized bed, fluid mechanic limitations, pressure drop, mass transfer coefficient, mass transfer limits, thermodynamic limits, equilibrium stage calculations, packed tower and tray column design and performance analysis. Fall.

BPE 638 Introduction to Biorefinery Processes (3)
Three hours of lecture and discussions per week. Topics covered include chemical and physical properties of biomass feedstocks; sustainable biomass production/utilization, chemical and biological processes of converting plant biomass to chemicals, liquid fuels, and materials. Focus on green chemistry and/or environmentally benign processes, with some discussions on political and social aspects of sustainability and renewability. Fall.
Note: Credit will not be granted for both BPE 438 and BPE 638.

BPE 641 Biomass Energy (3)
Three hours of lecture per week. Historical, current and future uses of biomass as a source of renewable energy for the production of bioenergy, biofuels and bioproducts. Characteristics of biomass, their conversion to different forms of energy and end products and an assessment of their sustainability. Spring.
Prerequisite: ESC 525, ESC 535 or permission of instructor; one semester of freshman chemistry or permission of instructor.

BPE 681 Bioprocess Plant Design (3)
Three hours of lecture per week. Topics covered include integration of process and support systems and equipment; concepts of facility design integrating Good Manufacturing Practice (GMP), equipment and systems cleanability, people flow, product protection, capital investment, and operating costs. This course will focus towards facility design in the biopharmaceutical industry. Spring.
Prerequisites: BPE 620, BPE 621 or equivalents.

BPE 796 Advanced Topics (1 - 3)
Lectures, conferences, discussions and laboratory. Advanced topics in forest engineering, paper science and engineering, and wood products engineering. Fall and/or Spring.
Prerequisite: Permission of instructor.

BPE 797 Seminar (1 - 3)
Discussion of assigned topics in the fields related to Bioprocess Engineering. Spring and Fall.

BPE 798 Research in Bioprocess Engineering (1 - 12)
Independent research topics in Bioprocess Engineering. Fall, Spring or Summer.
Credit hours to be arranged.

BPE 898 Professional Experience/Synthesis (1 - 6)
A supervised, documented professional work experience in the Master of Professional Studies degree program. Fall, Spring, or Summer.
Pre- or co-requisite(s): Approval of proposed study plan by advisor, Faculty, and any sponsoring organization.

BPE 899 Master's Thesis Research (1 - 12)
Research and independent study for the master's thesis. Fall, Spring or Summer.
Credit hours to be arranged.

BPE 999 Doctoral Thesis Research (1 - 12)
Research and independent study for the doctoral dissertation. Fall, Spring or Summer.
Credit hours to be arranged.

BTC - Biotechnology

BTC 132 Orientation Seminar (1)
One hour of lecture or discussion per week. Occasional tour of laboratories or field trips. Introduction to campus facilities, personnel, lower-division curriculum, and upper-division study options to facilitate transition of students into the program and assist them in making informed decisions on course selection and future career directions. Fall.

BTC 401 Molecular Biology Techniques (4)
Two hours lecture and six hours laboratory per week. Theories behind techniques in molecular biology are introduced in lecture. Laboratory includes the extraction and quantification of genomic and plasmid DNA, agarose gel electrophoresis, restriction digestion, ligation, bacterial transformation, DNA sequencing and PCR. Additional topics in molecular biology are presented by the students. Fall.
Prerequisite(s): EFB 307, 308, 325, or equivalents. Note: Credit will not be granted for both BTC 401 and EFB 601.

BTC 420 Internship in Biotechnology (3 - 5)
Full- or part-time employment or volunteer work with an agency, institution, clinic, professional group, business, or individual involved in activities consistent with the student's educational and professional goals. The extent of the internship activities shall be commensurate with the credits undertaken. A resident faculty member must serve as the student's academic sponsor. A study plan outlining the internship's educational goals must be completed prior to its commencement. Grading will be based on a written report from the student and submitted to the sponsoring faculty member and on an evaluation of the student's performance written by the site supervisor to the sponsoring faculty member. Fall, Spring, Summer.
Prerequisite: Consent of a faculty sponsor.

BTC 425 Plant Biotechnology (3)
Two hours of lecture and three hours of laboratory per week. The use of transgenic plants to improve the human condition and remediate environmental problems is a rapidly growing field of study. Students are taught the principles of gene structure and regulation, gene cloning, transformation of plant species, and current applications. Format includes lectures, discussions, student presentations, and a laboratory

project. Spring.
Note: Credit will not be granted for both BTC 425 and EFB 625.

BTC 426 Plant Tissue Culture Methods (3)
Two hours of lecture and discussion and three hours of laboratory per week. Introduction to plant tissue culture for biotechnology research and as a propagation method. Emphasis will be on learning laboratory instrumentation and techniques for establishing cell cultures, producing transgenic cell lines, and regenerating whole plants. Fall.
Prerequisites: One course in botany, microbiology, or genetics; or permission of instructor. Note: Credit will not be granted for BTC 426 and FOR 626/EFB 626.

BTC 496 Topics in Biotechnology (1 - 3)
Experimental, interdisciplinary, or special topic coursework in biotechnology for undergraduate students. Subject matter and method of presentation varies from semester to semester. May be repeated for additional credit if topic changes. Fall or Spring.

BTC 497 Research Design and Professional Development (1)
One hour of discussion or seminar each week covering the scientific method, professional ethics and responsibilities of the practicing scientist. Employment opportunities, future career choices, safety considerations, and use of the scientific literature are covered. Students will select a research topic and prepare a proposal, which may be applied to BTC 498 or BTC 420. Spring.
Pre- or co-requisite: Biotechnology major or permission of instructor.

BTC 498 Research Problems in Biotechnology (1 - 9)
Laboratory research experience with research time agreed upon by student and instructor. Independent research experience covering biotechnological topics. Specific topics determined through consultation between student and appropriate faculty member. Tutorial conferences, discussions, and critiques scheduled as necessary. Grading determined by the instructor and could include, but not required, evaluation of skills learned, data obtained, and laboratory notebook record keeping. A final written report is required. Fall or Spring.
Prerequisite: Permission of instructor.

BTC 499 Senior Project Synthesis (1)
One hour of discussion or seminar each week. Students will learn to synthesize results gained from their own independent research and present those data in a scientific poster at a research symposium. Topics of professional preparation will also be discussed. Spring.

CME - Construction Management and Engineering

CME 132 Orientation Seminar: Sustainable Construction Management and Engineering (1)
One hour of lecture and discussion per week. Introduction to campus resources available to ensure academic success in the area of Sustainable Construction Management and Engineering. Fall.

CME 202 Introduction to Professional Communications (3)
Three hours of lecture per week. Introduction to intermediate-level use and understanding of Microsoft Office Word, Excel, PowerPoint, and Access applications for data analysis, presentations, and report preparation. Focused on developing the ability to prepare reports and presentations including preparation of documents, data analysis, and verbal, written and digital presentations. Fall.

CME 215 Sustainable Construction (3)
Three hours of lecture/discussion per week. Overview of sustainable design and construction concepts and practices. The emergence of green building, issues, and rating systems. Sources of chemicals in buildings, indoor air quality, and human comfort. Basic energy principles and energy-efficient technologies. Selection of materials. Role of the contractor in the management and construction of green projects. Spring.

CME 226 Statics and Mechanics of Materials (4)
Four hours of lecture/discussion per week. Equilibrium systems of forces in two and three dimensions. Analysis of structural components for stresses and deformations. Stability and design of beams and columns made of common engineering materials. Design methods and safety considerations. Spring and Fall.
Prerequisite: Calculus I, Physics I.

CME 255 Plan Interpretation and Quantity Takeoff (3)
Three hours of lecture/discussion per week. Introductory course in construction plan interpretation and quantity takeoff. Will address how to read and interpret construction plans and introduce basic quantity takeoff skills. Fall.

CME 303 Sustainable Construction Management and Engineering Internship (1 - 3)
Full or part-time employment with an organization that involves the student in an educational experience in a professional establishment. A resident faculty member must serve as the student's academic sponsor. A study plan that describes the internship's educational goals must be submitted prior to its commencement. Fall and Spring.
Prerequisite: Upper-division status.

CME 304 Environmental Performance Measures for Buildings (3)
An overview of how building rating systems for green construction have developed, their present application, and future directions for growth. The course will explore the process for development of individual standards, the different building certification systems that have been developed using these standards, and long-term development and code adoption of such certification systems.

CME 305 Sustainable Energy Systems for Buildings (3)
Three hours of lecture/discussion per week. Exploration of construction management-related issues in creating a more sustainable energy use in our building stock. Integrating sustainable energy sources in construction as well as issues related to using energy more efficiently. Fall.

CME 306 Engineering Materials for Sustainable Construction (3)
Two hours of lecture/discussion per week and one lab per week. Introduction to the principal structural materials used for building construction and their engineering properties and environmental impacts. The production and performance of these materials will be explored through class discussion and laboratory experiments. The application of each of the materials during sustainable construction processes will be emphasized. Spring.

CME 315 Production and Operation Management (3)
Three hours of lecture per week. Basic productivity issues and simulation modeling. Students will learn basic productivity theories, construction productivity tools, and discrete-event simulation modeling. In addition to basic lectures, students are asked to select construction activities and develop computer simulation models to optimize construction operations by optimizing resource allocation. Spring.
Prerequisite: Junior or senior status. Note: Credit will not be granted for both CME 515 and CME 315.

CME 322 Mechanical Processing (3)
Two hours of lecture and three hours of laboratory per week. Primary log reduction methods and industry practices. Lumber grading. Wood cutting principles. Machining practice in secondary wood-using industries. Experience in the operation of certain primary and secondary machining equipment. Fall.

CME 326 Fluid Treatment of Wood (3)
Two hours of lecture, three hours of laboratory per week. Basic wood-moisture relationships, wood shrinkage and swelling, permeability, thermal conductivity, wood drying and preservation treatments, and fire retardancy. Flow of fluids, heat and water vapor are treated as analogous phenomena related to the cellular structure of wood. Laboratory studies in relative humidity measurement, wood-moisture relations, relationships between wood permeability and drying and treatability, industrial wood drying, dry kiln operation and preservation treatments, and fire retardancy. Spring.
Prerequisite: CME 387 or permission of instructor. Note: Credit will not be granted for both CME 326 and CME 682.

CME 330 Building Code of New York State (3)
Three hours of lecture/discussion per week. Introduction to the Building Code that legally governs the design and construction of all building types within New York State. The course includes a basic understanding of the Code including history and origin, legal enforcement, basic definitions, and terminologies. Fall.

CME 331 Construction Safety (3)
Occupational Safety and Health Practices in the construction industry with coverage of the U. S. Department of Labor, Occupational Safety and Health Regulations (CFR 1910 and 1926 Standards). Detailed study of Construction Safety and Hazardous Communications programs, personal protective equipment, tools, electrical power, ladders, and scaffolding, floor and wall openings, cranes and power equipment. Special problems related to concrete work, erection and demolition. OSHA 30 Hr. card earned. Fall.
Note: Credit will not be granted for both CME 331 and CME 531.

CME 332 Mechanical and Electrical Equipment (3)
Three hours of lecture per week. The course introduces the basic concepts of mechanical systems design and construction for residential and commercial buildings. Simplified design and construction estimates are performed for heating, cooling, plumbing, sanitation, electrical, and lighting systems. Relevant code requirements are stressed. Fall.

CME 335 Cost Engineering (3)
Three hours of lecture/discussion per week. Statistics, cost of money, rates of return, cash flow, budget development, cost tracking, productivity and progress, constructability and value engineering, change control and risk analysis. Fall.
Prerequisite: Upper division standing or permission of instructor. Note: Credit will not be granted for both CME 335 and CME 535.

CME 342 Light Construction (3)
Three hours of lecture per week. An introduction to the construction process with an emphasis on the unique aspects of light construction. Introduces construction management principles related to material properties, building science, structural design, estimating, and scheduling. Fall.

CME 343 Construction Estimating (3)
Three hours of lecture/discussion per week. Basic estimating/bidding theory and process. The processes for reviewing and interpreting contracts, specifications and blueprints and their role in the estimating/bidding process. How to perform a quantity takeoff, be able to create a final estimate/bid including the appropriate General Conditions and Markups. Several projects based upon the concepts are assigned on the material listed above as well as utilizing either a spreadsheet or Timberline Precision Computer Estimating. Spring.
Prerequisite(s): CME 255 Plan Interpretation and QTO or permission of instructor. Note: Credit will not be granted for both CME 343 and CME 543.

CME 350 Construction Methods and Equipment (3)
Three hours of lecture/discussion per week. The study of production, methods of operation and costs of heavy construction equipment. Analysis of heavy construction operations. Economics of equipment use. The fundamentals of decision making involved in the selection of methods and equipment that will result in the most effective and efficient performance on a project. Spring.
Note: Credit will not be granted for both CME 350 and CME 525.

CME 376 Decay of Wood Products (3)
Three hours of lecture/laboratory/demonstration per week. Degradation of wood by fungi and other biological agents. Emphasis on the effects of decay on wood properties, methods of decay detection in wood products and decay prevention. Spring.
Prerequisite(s): CME 386 or CME 387.

CME 386 Structure and Properties of Wood (3)
Two hours of lecture per week. Structure of wood in relation to defects, properties and uses. The variability of wood. Spring.

CME 387 Sustainable Structural Materials for Construction (3)
Three hours of discussion, lecture and demonstration per week. Properties and uses of major structural construction materials. Identification and knowledge of the major wood species and their applications in construction. Fall.

CME 388 Wood and Fiber Identification Laboratory (2)
Six hours of laboratory per week. Wood and papermaking fiber identification using both gross and microscopic features. Fall.
Prerequisite: CME 387 to be taken concurrently or previously.

CME 389 Wood Identification Laboratory (1)
Three hours of laboratory per week. Identification of principal commercial timbers of United States on gross characteristics. Spring.
Prerequisite: CME 387.

CME 390 Fiber Identification Laboratory (1)
Three hours of laboratory per week. Identification of woody and nonwoody papermaking fibers. Spring.
Prerequisite: CME 387.

CME 400 Introduction to Forest Products (3)
Three hours of lecture per week. Characteristics of the products of the forest tree and manufacture of wood products. Spring.

CME 404 Applied Structures (3)
Three hours of lecture/discussion/demonstration per week. Applications of statics/mechanics to common engineering structures. Analysis and design of wood, concrete and steel systems considering sustainability and life-cycle analysis. Spring.
Prerequisite(s): CME 226, Statics and Mechanics of Materials.

CME 405 Building Information Modeling for Construction Management (3)
Three hours of lecture per week. An introduction to the basic concepts of building information modeling as a construction approach, and an exploration of its application to construction management. Emphasis on the use of building information modeling for estimation, scheduling, clash detection, and project communication. Spring.
Prerequisite(s): CME 255 Plan Interpretation and Quantity Takeoff. Co-requisite: CME 343 Construction Estimating.

CME 410 Computer-Aided Design and Drafting (3)
One-half hour lecture, two-and-one-half hours lab, and a minimum of six hours additional lab is required. This course introduces the student to the fundamentals of computer-aided design and drafting. It covers the commands needed to create a two-dimensional drawing, with particular emphasis on techniques used in the design profession applications. The requirements for the course include completing self-tutorials, creating drawings, and the completion of two major projects. Spring.
Note: Credit will not be granted for both CME 410 and CME 610.

CME 413 Computer-Aided Senior Project (3)
Three hours of lecture per week. Open-ended real-life design projects with microcomputer aids. Systems approach is emphasized. Project requirements, system selection, approximate design, value engineering and final design are among design aspects considered. Analytical and model analysis. Spring.

CME 414 Computer Applications in Engineering (3)
Three hours of lecture per week. Microcomputer applications in a broad spectrum of selected topics in engineering sciences and practice. Hands-on experience is emphasized. Coursework is directed toward solving real-life engineering problems. Software is provided and used. No computer programming or skills are required. Spring.

CME 415 Lean Project Management (3)
Three hours of lecture per week. Overview of Lean production theory and the Lean project management system and their relations to the AEC (Architect, Engineering, and Construction) industries. Topics include the Toyota production system, lean principles, the Last Planner System, and supply chain management. Fall.
Prerequisite: Junior or senior status. Note: Credit will not be granted for both CME 615 and CME 415.

CME 422 Composite Materials for Sustainable Construction (3)
Two hours of lecture, three hours of laboratory per week. Properties, manufacture and design of multiphase materials. Applications and testing for service in sustainable construction systems and life-cycle analysis. Fall.
Prerequisite(s): CME 226, Statics and Mechanics of Materials and CME 387, Renewable Materials for Sustainable Construction.

CME 430 Computer Applications in Construction Management (1 - 3)
Guided individual study. Projects are estimated, scheduled and/or managed exclusively by industry standard construction-related software, including Timberline Precision Estimating, Quest Earthworks, Quest for Contractors, Primavera Project Planner, SureTrak Project Manager by Primavera and Expedition by Primavera. Final report covers entire project. Fall and Spring.
Prerequisite: Senior standing or permission of instructor. Note: Credit will not be granted for both CME 430 and CME 630.

CME 444 Materials Marketing (3)
Three hours of lecture and discussion per week. Fundamentals of marketing forest products, building and construction industry materials, including products, markets, distribution, segmentation, pricing, promotion and sales. Specific focus is on the unique nature and issues of forest products and building materials; vertical and horizontal integration, distribution channels, market segmentation and product positioning strategies. Fall.
Prerequisite: FOR 207 Introduction to Economics or equivalent.

CME 453 Construction Planning and Scheduling (3)
Three hours of lecture per week. The use of common types of schedules: Gantt, Activity on Node, Precedence Diagram, PERT and Linear. Identification of activities and performance duration analyses of these activities. Updating of schedules, resource planning and assignment, cost planning and scheduling are all covered. Schedule development is performed both manually and with industry-accepted software. Fall.
Prerequisite(s): CME 343 or permission of instructor. Note: Credit will not be granted for both CME 453 and CME 653.

CME 454 Construction Project Management (3)
Three hours of lecture/discussion and three hours of laboratory per week. How to define and properly identify company organizational structures and project delivery systems. Integration of estimating, bidding, scheduling and cost control into the management process. Safety, quality control, value engineering, procurement, labor relations and insurance and bonding requirements as integral parts of a construction project. Projects based upon Expedition project management software. Spring.
Prerequisites:CME 343, CME 453, senior standing or permission of instructor. Note: Credit will not be granted for both CME 454 and CME 654.

CME 455 Construction Contracts and Specifications (3)
Three hours of lecture/discussion per week. The types of contracts used in the construction industry. Analysis of the contractor, designer and owner duties and obligations as determined by the construction contract documents. Study of concepts, language, formats and procedures for project manual organization practice and the general conditions of the contract for construction. Spring.
Prerequisite(s): Upper division standing or permission of instructor. Note: Credit will not be granted for both CME 455 and CME 658.

CME 480 Fundamentals of Microscopy (3)
Three hours of lecture/demonstration per week. Introduction to light microscopy, electron microscopy, atomic force, confocal, Raman, Near Field Optical, Correlative and other microscopic methods and their newest applications. Light microscopic techniques include brightfield, phase contrast, polarized light, Nomarski, Kohler illumination. Imaging and recording methods. Fall.
Note: Credit will not be granted for both CME 480 and CME 680.

CME 487 Wood Chemistry and Physics (3)
Two hours of lecture and three hours of laboratory per week. Wood chemistry and physical properties described in relation to the practical function of wood products. The methodologies used to explore these relationships; including microscopy, mechanical testing, and chemical analysis and their interpretation. Fall.
Prerequisite: CME 387.

CME 488 Professional Construction Project Management Presentation Seminar (2)
Two hours of lecture/seminar/preparation per week. A preparatory course for participation in a professional construction management proposal process including proposal development and professional presentation of the proposal. The course culminates in participation at a regional construction management competition sponsored by the Associated Schools of Construction Region 1. Fall.
Prerequisites: Junior or Senior standing and permission of the instructor.

CME 497 Senior Seminar (3)
Three hours of lecture/discussion per week. Student papers/presentations are directed toward professional issues in career preparation, ethics and presentation skills. Fall.
Prerequisite(s): Senior status in SCME.

CME 498 Research or Design Problem (1 - 3)
Conferences, library, laboratory and/or field research on a specific problem in wood products engineering. Written report required. Fall, Spring and Summer.
Prerequisite: Permission of instructor and advisor.

CME 515 Production and Operation Management (3)
Three hours of lecture/discussion per week. Basic productivity issues and simulation modeling. Topics include basic productivity theories, construction productivity tools, and the discrete-event simulation model. Through independent research students select construction activities and develop a computer simulation model to optimize construction operations by identifying and correcting inefficient operation. Spring.
Prerequisite: Three credits of any physical or analytical engineering, or permission of instructor. Note: Credit will not be granted for both CME 515 and CME 315.

CME 525 Construction Methods and Equipment (3)
Three hours of lecture/discussion per week. Analysis of heavy construction operations and related environmental concerns. Production calculations, means and methods selection and operating costs of heavy construction equipment are addressed. The economics of equipment use are analyzed. The use of a digitizer in earthwork quantity takeoff is explored. The outcome of the course is to select the most cost efficient and performance efficient method and equipment. A term paper is required. Spring.
Note: Credit will not be granted for both CME 525 and CME 350.

CME 531 Construction Safety (3)
Three hours of lecture per week. Occupational Safety and Health practices in the construction industry. An overview of the US Department of Labor, Occupational Safety and Health Regulations, 29 CFR 1910 and 29 CFR 1926. Comprehensive review of: general safety and health requirements, hazard communication, confined space entry, lockout/tagout programs, workplace violence, personal protective equipment, fire protection, signs and barricades, rigging, small tools – hand and power, welding and cutting, electrical, fall protection, scaffolding, cranes, mobile equipment, excavation and trenching, steel erection, stairways and ladders and permissible exposure limits. A term paper is required. Fall.
Note: Credit will not be granted for both CME 531 and CME 331.

CME 532 Mechanical and Electrical Equipment (3)
Three hours of lecture per week. The course introduces the basic concepts of mechanical systems design and construction for residential and commercial buildings. Simplified design and construction estimates are performed for heating, cooling, plumbing, sanitation, electrical, and lighting systems. Relevant code requirements are stressed. An experiment-based project is required. Fall.
Note: Credit will not be given for both CME 332 and CME 532.

CME 535 Cost Engineering (3)
Three hours of lecture/discussion per week. Statistics, cost of money, rates of return, cash flow, budget development, cost tracking, productivity and progress, constructability and value engineering, change control and risk analysis.
Prerequisite: Upper division standing or permission of instructor. Note: Credit will not be granted for both CME 535 and CME 335.

CME 543 Construction Estimating (3)
Three hours of lecture/discussion per week. Definition and explanation of estimating/bidding theory and process. The processes for reviewing and interpreting contracts, specifications and blueprints as well as their role in the estimating/bidding process. Perform a quantity takeoff. Create a final estimate/bid, including the appropriate General Conditions and Markups. Several projects based on the concepts listed above as well as utilizing either a spreadsheet or Timberline Precision Estimating. A term paper describing how the relevant topics of the course fit a specific industry application, and production of an additional project based on Timberline Precision estimating software or equivalent are required. Spring.
Prerequisites: CME 255 Plan Interpretation and QTO or basic estimating experience and permission of the instructor. Note: Credit will not be granted for both CME 543 and CME 343.

CME 565 Sustainable Innovations in Residential Construction (3)
Three hours of lecture per week. Principles of sustainable residential construction; the adaptation of biological, ecological, and cultural elements into building performance standards, practical building specifications, standards and systems. Spring.

CME 580 Microtechnique of Wood (3)
Three hours of laboratory per week. Instruction on the use of the sliding microtome to slice thin sections of wood for light microscopy and for

sample surface preparation of wood for scanning electron microscopy. Care of the microtome blade, staining of wood sections and preparation of microscope slides. Fall or Spring.
Pre- or co-requisite: permission of instructor.

CME 585 Light Microscopy for Research Applications (3)
Two hours of lecture/three hours of laboratory per week. Principles of light microscopy and photomicrographic digital imagery using Spot camera and Image Pro 7.0 software. Extensive laboratory component. Spring.
Prerequisite: Permission of instructor.

CME 610 Computer-Aided Design and Drafting (3)
One-half hour lecture, two-and-one-half hours lab, and a minimum of six hours additional lab is required. This course introduces the student to the fundamentals of computer-aided design and drafting. It covers the commands needed to create a two-dimensional drawing, with particular emphasis on techniques used in the design profession applications. The requirements for the course include completing self-tutorials, creating drawings, and the completion of two major projects at an advanced level. Spring.
Note: Credit will not be granted for both CME 410 and CME 610.

CME 615 Lean Project Management (3)
Three hours of lecture/discussion per week. Lean production theory and the Lean project management system and their relations to the architecture, engineering, and construction industries. Topics include the Toyota production system, lean principles, the Last Planner System, and supply chain management. Through independent research students learn how to identify and improve the value stream of the construction process. Fall.
Prerequisite: Three credits of management or permission of instructor. Note: Credit will not be granted for both CME 615 and CME 415.

CME 630 Computer Applications in Construction Management (1 - 3)
Guided individual study. Projects that will be estimated, scheduled or managed exclusively by industry-standard, construction-related software, including Timberline Precision Estimating, Quest Earthworks, Quest for Contractors, Primavera Project Planner, SureTrak Project Manager by Primavera and Expedition by Primavera. A final report with annotated bibliography is required. Spring.
Prerequisite: Permission of instructor. Note: Credit will not be granted for both CME 630 and CME 430.

CME 643 Estimating for Construction in a Green Global Economy (3)
Three hours of lecture per week. Building upon the estimating skills developed through undergraduate coursework and professional experience this course will look at how to address global estimating concerns such as monetary value between various currencies, how the purchase of commodities futures effects material pricing, the linkages between financial, real estate development and policies and their effects on the construction markets. How to price multi-year projects addressing the previous issues and how to construct an estimate that will convey the information relative to green construction costs to the client in a proper manner will also be addressed. Fall or Spring.
Prerequisites: CME 543 or equivalent or 3 to 5 years of professional estimating experience and permission of instructor.

CME 653 Construction Planning and Scheduling (3)
Three hours of lecture/discussion per week. The use of Gantt, Activity on Node, Precedence Diagram, PERT and Linear schedules. Identification of activities and duration analyses of these activities. Update schedules, plan and assign resources, plan cost and schedule. Schedule development is performed both manually and with industry accepted software. A term paper describing how the relevant topics of the course fit a specific industry application and an additional project utilizing the software are required. Fall.
Prerequisites: Estimating experience and/or equivalent scheduling experience. Note: Credit will not be granted for both CME 653 and CME 453.

CME 654 Construction Project Management (3)
Three hours of lecture/discussion per week. How to define and properly identify company organizational structures. Project delivery systems, integration of estimating, bidding, scheduling and cost control into the management process. How safety, quality control, value engineering, procurement, labor relations and insurance and bonding requirements are integral parts of a construction project. A term paper describing how the relevant topics of the course fit a specific industry application is required. Spring.
Prerequisite(s):CME 543, CME 653, or equivalent experience and permission of the instructor. Note: Credit will not be granted for both CME 654 and CME 454.

CME 658 Construction Contracts and Specifications (3)
Three hours of lecture/discussion per week. The types of construction contracts used in the construction industry from the Owner, Contractor, Subcontractor and Supplier viewpoints. Types of required insurance and the remedies available to contractors are presented. The process of bidding and negotiating from the legal perspective is covered along with contract administration. Specifications are introduced by type and the requirements of each type are discussed, based on current industry-accepted standards. A term paper describing how the relevant topics of the course fit a specific industry application is required. Spring.
Prerequisite: Upper division standing or permission of instructor. Note: Credit will not be granted for both CME 658 and CME 455.

CME 663 Managing a Construction Project through Construction Planning and Scheduling (3)
Three hours of lecture per week. Building upon planning and scheduling skills developed through undergraduate coursework and professional experience this course will examine the use of project schedules as the means to manage construction projects. The relationships between project progress, labor, materials, equipment and the project timeline will be explored. The use of the project schedule as a revenue projection, revenue measuring device will be discussed. How the schedule is used to deal with major project changes such as scope reductions, natural disaster impacts and major site accidents will also be covered. Earned value will be discussed and how the schedule can assist in its determination. Fall or Spring.
Prerequisites: CME 653 or equivalent or 3 to 5 years of professional estimating experience and permission of instructor.

CME 664 Urban Project Management (3)
Three hours of lecture per week. Building upon project management skills developed through undergraduate coursework and professional experience this course will look at the unique challenges of construction projects in urban settings. Topics to be addressed include but are not limited to: site logistics and their importance to a successful project, the influence of permits and codes on the project, the growing use of technology to solve urban project problems, the issues related to labor, subcontractors and suppliers in this high intensity setting. The importance of communication and project documentation will be addressed as well. Fall or Spring.
Prerequisities: CME 654 or equivalent professional experience and permission of instructor.

CME 680 Fundamentals of Microscopy (3)
Three hours of lecture/demonstration per week. Introduction to light microscopy, electron microscopy, atomic force, confocal, Raman, Near Field Optical, Correlative and other microscopic methods and their newest applications. Light microscopic techniques include brightfield, phase contrast, polarized light, Nomarski, Kohler illumination. Imaging and recording methods. Fall.
Note: Credit will not be granted for both CME 480 and CME 680.

CME 682 Transport Processes (3)
Two hours of lecture and three hours of laboratory per week. The relationship between wood structure and wood permeability, moisture movement, and heat transfer. Fire retardant and wood-preservation treatments. Wood drying. Unsteady-state transport processes. An advanced laboratory problem with report in wood-moisture relationships, wood drying, the relationship between wood permeability and treatability, or wood preservative treatments. Spring.
Prerequisite: CME 387 or permission of instructor. Note: Credit will not be granted for both CME 682 and CME 326.

CME 685 Transmission Electron Microscopy (2 - 5)
Two hours of lecture/two hours of laboratory/demonstration/minimum of four to ten hours of individual laboratory per week. The theory and operation of the transmission electron microscope including specimen preparation, photographic technique and interpretation of micrographs. 2 credit course Spring or Fall. Five-credit course offered in spring semester only.
Prerequisite: Permission of instructor.

CME 686 Wood-Water Relationships (3)
Two hours of lecture and three hours of laboratory per week. Relationship between wood moisture content and the environment, electrical and thermal properties, theories of moisture sorption, hygroscopic swelling and shrinking, thermodynamics of moisture sorption, mechanism of moisture movement as it relates to activation theory. Laboratory exercises will complement the theoretical topics discussed in the lecture. Fall.
Prerequisite: Permission of instructor.

CME 770 Biodegradation of Wood (3)
Two hours of lecture and 1 hour of laboratory/demonstration/discussion per week. Biology of lignicolous fungi and other microorganisms concerning their effects on wood properties. Anatomical, biological and chemical aspects of the major types of wood decay. Spring.
Prerequisite: Introductory biology and permission of instructor.

CME 785 Scanning Electron Microscopy (5)
Two hours of lecture/demonstration/laboratory per week. Ten hours of independent laboratory experience per week. Theory and operation of the scanning electron microscope, including specimen preparation, digital imaging, and interpretation of micrographs. Fall.
Prerequisite: Permission of instructor.

CME 797 Seminar (1 - 3)
Discussion of assigned topics in the fields related to Sustainable Construction Management and Wood Science. Spring and Fall.

CME 798 RESEARCH IN RESEARCH IN SUSTAINABLE CONSTRUCTION MANAGEMENT AND WOOD SCIENCE (1 - 12)
Independent research topics in Sustainable Construction Management and Wood Science. Fall, Spring or Summer.
Credit hours to be arranged.

CME 898 Professional Experience/Synthesis (1 - 6)
A supervised, documented professional work experience in the Master of Professional Studies degree program. Fall, Spring, or Summer.
Pre- or co-requisite(s): Approval of proposed study plan by advisor, Faculty, and any sponsoring organization.

CME 899 Master's Thesis Research (1 - 12)
Research and independent study for the master's thesis. Fall, Spring or Summer.
Credit hours to be arranged.

CME 999 Doctoral Thesis Research (1 - 12)
Research and independent study for the doctoral dissertation. Fall, Spring or Summer.
Credit hours to be arranged.

CMN - Communications

CMN 220 Public Presentation Skills (3)
Three hours of lecture per week. Development of skills and fluency needed by environmental professionals in preparing, delivering and evaluating effectiveness of expository and persuasive oral presentations. Communication theory, rhetorical analysis, and visualizations of complex and technical data, self and peer evaluation, listening skills. Fall and Spring.

CMN 420 Advanced Public Presentation Skills (3)
Three hours of lecture/discussion/student presentations per week. Emphasizes both theory and practice in effectively delivering, interpreting, and responding to public presentations. Social, cultural, and political dimensions of public addresses are examined. Issues of diversity and power are discussed. Small group communication is viewed as a site for creative problem solving. Audience analysis, adaptation, strategic arrangement, and concept development are explored. Fall and Spring.
Prerequisite: Junior or senior status, or permission of instructor.

CMN 440 Environmental Visualization (3)
Three hours of lecture and discussion per week. The course includes an overview of graphic perception and cognition, a theoretical framework for classifying graphics, and introductions to the use and misuse of visualizations in the effective communication of environmental processes and project proposals to multiple publics. Students will compile a critical workbook of examples and develop a series of preliminary visualizations. Fall.
Prerequisite: Senior status in environmental studies communication and information option or permission of instructor.

CMN 493 Environmental Communication Workshop (3)
Three hours of cooperative learning activities, lecture and discussion per week. A workshop format on a specified environmental program or issue introduces the theories and skills of alternative dispute resolution approaches, public participation structures and dynamics, public policy

decision making and implementation, risk communication, leadership styles, and small group dynamics. Spring.
Prerequisite: Senior status or permission of instructor.

EFB-Environmental and Forest Biology

The Department of Environmental and Forest Biology offers a diverse array of courses at both undergraduate and graduate levels. Based on student interest, curricula can be designed to accommodate a degree of specialization in one or more subdisciplines of biology. **NOTE**: All EFB courses of 300 level and above require a minimum prerequisite of one year of general biology or equivalent. A course at an appropriate level may be taken with permission of instructor.

EFB 101 General Biology I: Organismal Biology and Ecology (3)
Three hours of lecture per week. Introductory exploration of biological principles at ecosystem, population, and organismal levels. Emphasis on form, function, diversity, ecology and evolution of living organisms. Fall.
Co-requisite: EFB 102.

EFB 102 General Biology I Laboratory (1)
Three hours of laboratory per week. Major concepts of organismal biology and ecology will be reinforced with hands-on laboratory exercises and required field trips exploring the form, function, diversity, ecology, and evolution of living organisms. Fall.
Co-requisite: EFB 101.

EFB 103 General Biology II: Cell Biology and Genetics (3)
Three hours of lecture per week. Organization and function of living cells. Key topics include biological molecules, organelle structure and function, gene expression, cell division, metabolism, photosynthesis, cell signaling, genomics, and population genetics. Spring.
Co-requisite: EFB 104.

EFB 104 General Biology II Laboratory (1)
Three hours of laboratory per week. Major concepts of cell biology and genetics will be reinforced with hands-on laboratory exercises using analytical and experimental techniques such as light microscopy, chromatography, electrophoresis, enzyme assays, aseptic culture techniques, and transformation of bacterial cells. Spring.
Co-requisite: EFB 103.

EFB 120 The Global Environment and the Evolution of Human Society (3)
Three hours of lecture per week. An integrated overview of large-scale environmental issues and their relation to the development of human societies and resource-use strategies over time. Focus is on population growth and societal pressures on physical and biotic resources. Topics include energy-use issues, causes and socio-economic implications of climate change, pollution, and loss of biodiversity. Fall and Spring.

EFB 132 Orientation Seminar: Environmental and Forest Biology (1)
One hour of lecture, discussion and/or exercises per week. Introduction to campus resources available to ensure academic success. Introduction to EFB as a field of inquiry. Fall.

EFB 200 Physics of Life (3)
Three hours of lecture and discussion per week. Introduction to basic principles of physics from a perspective of biological function, structure and adaptation. Fall.

EFB 202 Ecological Monitoring and Biodiversity Assessment (3)
Forty-five hours of lecture, laboratory and field instruction per week for three weeks. An introduction to the biodiversity of northeastern North American terrestrial, wetland, and aquatic communities with a focus on vascular plants and invertebrate and vertebrate animals. Incorporates practical field exercises designed to acquaint the student with problem solving. Summer, Cranberry Lake Biological Station.

EFB 210 Diversity of Life I (3)
Two hours of lecture and 3 hours of laboratory instruction per week. Introductory exploration of the diversity of life at local, regional and global scales. Hands-on laboratory exercises explore the form, function, diversity, ecology, and evolution of living organisms, focusing on viruses, fungi and plants. Fall.
Prerequisite(s): One year of introductory biology.

EFB 211 Diversity of Life II (3)
Two hours of lecture and 3 hours of laboratory instruction per week. Introductory exploration of the diversity of life at local, regional and global scales. Hands-on laboratory exercises explore the form, function, diversity, ecology, and evolution of living organisms, focusing on microbes, protistans and animals. Spring.
Prerequisite(s): EFB 101 and 102 or equivalent year of introductory Biology. Note: Credits will not be granted for both undergraduate and graduate versions of the same course.

EFB 215 Interpreting Science Through Art (3)
Three hours of lecture per week. This course examines the intersections of art and science. Major reciprocal influences in both a historical and contemporary format are treated. Fundamental methods and skills of some artistic processes, e.g., nature illustration and photography, are introduced in a context of practical applications interpreting science. Fall.
Prerequisite: General biology.

EFB 217 Peoples, Plagues, and Pests (3)
Three hours of lecture/discussion per week. Impacts of selected diseases and pests on the development and course of human civilizations. Emphasis is on the impacts of plagues and pests on non-western civilizations. Spring.

EFB 220 Urban Ecology (3)
Two hours lecture/discussion, three hours of outdoor laboratory per week. Explores the city from an ecosystems perspective. Addresses the role and importance of science, engineering, the design professions, and community participation in creating livable communities. Environmental equity and justice are addressed. Fall.

EFB 296 Special Topics in Environmental and Forest Biology (1 - 3)
Experimental, interdisciplinary or special coursework at the freshman or sophomore levels. Subject matter and course format vary from semester to semester or offering on the basis of needs and objectives of the course. Fall or Spring.

EFB 301 Latin for Scientists (1)
One hour of lecture per week. Students are taught the basic principles of Latin noun declension and verb conjugation, as well as the general principles of Latin grammar. Students are required to develop a project identifying and deriving uses of Latin in their chosen field of science, usually biology. Fall.

EFB 303 Introductory Environmental Microbiology (4)
Three hours of lecture and three hours of laboratory per week. An introduction to the biology of microorganisms and viruses and a study of their interactions with other microbes and macroorganisms. Fall.

EFB 305 Indigenous Issues and the Environment (3)
Three hours of lecture and discussion per week. Introduction to perspectives of indigenous people on environmental and natural resources management issues, including tribal forestry, fisheries, biocultural restoration, conservation strategies, climate change and treaty rights. Integrates scientific and indigenous worldviews and knowledge systems. Spring.
Note: Credit will not be granted for both EFB 305 and EFB 605.

EFB 307 Principles of Genetics (3)
Three hours of lecture and discussion per week. A general course covering concepts of genetics and evolution basic to upper-division biology and biochemistry courses. Includes the inheritance and analysis of Mendelian and quantitative traits, the chemical nature of the gene and its action, genetic engineering, the genetic structure of populations and their evolution. Numerical methods for characterizing and analyzing genetic data are introduced. Fall.

EFB 308 Principles of Genetics Laboratory (1)
Three hours of auto-tutorial laboratory per week. Experiments with plants and animals and computer simulation exercises demonstrate the basic principles of inheritance of Mendelian traits and changes in populations caused by major forces in evolution or by breeding procedures. Numerical methods for characterizing quantitative traits and for testing hypotheses are introduced. Fall.
Co-requisite: EFB 307.

EFB 311 Principles of Evolution (3)
Three hours of lecture or discussion per week. An introduction to the fundamental processes driving evolution (genetic drift, gene flow, mutation, sexual selection, and natural selection), the evolution of life-histories, trade-offs, and phenotypic plasticity. Macroevolutionary concepts covered include speciation, extinction, co-evolution, and the reconstruction of phylogenies. Spring.
Prerequisites: EFB 307 and EFB 320, or equivalents.

EFB 320 General Ecology (4)
Three hours of lecture and one three-hour field trip/laboratory per week. An introduction to plant and animal ecology, including concepts and techniques in population ecology, community dynamics, physiological and behavioral ecology, biogeography, ecosystem ecology, nutrient cycling and energy flow. Ecological management applications, human ecological impacts and problems are considered. Fall.

EFB 325 Cell Biology (3)
Three hours of lecture per week. Morphology and physiology of cells. Emphasis on macromolecule structure and function, cell division, gene expression, cell signaling, biochemical pathways, transport, metabolism, and motility. Spring.
Prerequisite: One year of introductory biology, one semester of organic chemistry, Genetics.

EFB 326 Diversity of Plants (3)
Two hours of lecture and one three-hour laboratory per week. An evolutionary survey of plants from unicellular prokaryotes to multicellular eukaryotes. Coverage includes the algae, fungi, bryophytes, lower vascular plants, ferns, gymnosperms and angiosperms. Spring.

EFB 327 Adirondack Flora (3)
Two hours of lecture, and eight hours of field work and discussion each day for two weeks. An integrated field and laboratory course in the identification of vascular plants and recognition of ecological characteristics of major plant species and communities of the Adirondack Mountain region. Satisfies elective field study requirement in Environmental and Forest Biology. Appropriate for upper and lower division undergraduate students seeking instruction in plant identification and ecology. Summer, Cranberry Lake Biological Station.
Prerequisite: General botany or general biology.

EFB 334 Woody Plants in the Natural and Built Landscape (2)
One hour of lecture, followed by three hours of field or indoor laboratory each week. Required by, and restricted to, undergraduates in the Landscape Architecture program. An introduction to the identification, site requirements, natural history, community ecology, and landscape value of native and exotic trees and shrubs for landscape planting and restoration purposes. Fall.
Prerequisite: Undergraduate standing in the Landscape Architecture program.

EFB 335 Dendrology (2)
One hour of lecture per week and one three-hour laboratory/field trip. Field study, identification and major characteristics of important forest trees of North America. Fall.
Prerequisite: Open only to students in the forest engineering curriculum.

EFB 336 Dendrology (3)
Two hours of lecture per week and one three-hour laboratory/field trip. Field study, identification, natural history and elementary silvics of important forest trees of North America. Fall.

EFB 337 Field Ethnobotany (3)
Two hours of lecture per week and six to eight hours of field work and discussion each day for two weeks. A field-based introduction to the identification and traditional cultural uses of plants in the Adirondack region for food, medicine and fiber. Topics include plant identification, traditional ecological knowledge and use of ecological and ethnobotanical methods. Satisfies elective field course requirement in programs offered by Department of Environmental and Forest Biology. Cranberry Lake Biological Station. Summer.
Prerequisite: EFB 226 or equivalent.

EFB 340 Forest and Shade Tree Pathology (3)
Two hours of lecture per week and three hours of auto-tutorial laboratory. Major diseases of forest, shade and ornamental trees; and deterioration of forest products, with emphasis on disease identification, principles of disease development, effects of disease on the host, and practical control measures. Spring.

EFB 342 Fungal Diversity and Ecology (3)
Two hours of lecture, and eight hours of fieldwork and discussion each day for two weeks. An integrated field and laboratory course designed to provide an introduction to the collection, identification and ecology of fungi and fungal-like organisms. Included in the course are Oomycetes (Kingdom Straminipila) and Myxomycetes (Kingdom Protista), as well as the more familiar groups of Kingdom Fungi. Satisfies field study elective requirement in Environmental and Forest Biology. Summer, Cranberry Lake Biological Station.
Prerequisite: General biology or general botany.

EFB 345 Forest Health (3)
Seven and one-half hours of lecture and 45 hours of field exercises per week for two weeks. Required in the Forest Health major, but open to others. Examines the varied ecological roles and impacts of pests and pathogens in managed and unmanaged northern forests. Students learn to collect, identify, and study forest insects and pathogens using inventory, survey, analytic methods, and independent research. Summer, Cranberry Lake Biological Station.
Prerequisites: One year of general biology, and EFB 202 or equivalents.

EFB 351 Forest Entomology (3)
Two hours of lecture and three hours of laboratory per week. Basic insect diversity, ecology and pest management with an emphasis on insect pests of forested ecosystems. Designed for students in Environmental Biology, Forest Health and Forest Resources Management. Fall, even years.
Note: Credit will not be granted for both EFB 351 and EFB 551.

EFB 352 Entomology (3)
Two hours of lecture and three hours of laboratory per week. Basic insect diversity, ecology and pest management with an emphasis on common insect pests of the northeastern U.S. Designed for students in Environmental Biology and Forest Health. Fall, odd years.
Note: Credit will not be granted for both EFB 352 and EFB 552.

EFB 355 Invertebrate Zoology (4)
Three hours of lecture and three hours of laboratory per week. Structure, function, classification and evolution of invertebrates. Emphasis on functional biology and ecological interactions. Spring.

EFB 360 Epidemiology (3)
Three hours of lecture/discussion per week. Introduction to the study of disease in populations and factors influencing disease occurrence. Case studies explore population measures of disease, clinical measures and causation. Emphasizes quantitative approaches, study design, ethics, intervention and implementation. Spring.
Prerequisite(s): One year of Introductory Biology, one Statistics course or equivalent by permission.

EFB 381 Vertebrate Museum Techniques (2)
One hour of lecture and three hours of laboratory per week. Theory and practice of vertebrate museum methods, with emphasis on the preparation and curation of vertebrate specimens. Spring.
Prerequisites: At least junior status and permission of instructor. Limited to 10 students.

EFB 384 Field Herpetology (3)
Two hours of lecture, and eight hours of field work and discussion each day for two weeks. An integrated field and laboratory course in the identification, natural history, ecology, and conservation of amphibians and reptiles of the Adirondack region. Satisfies field study elective requirement in Environmental and Forest Biology. Summer, Cranberry Lake Biological Station.
Prerequisite: General biology or general zoology.

EFB 385 Comparative Vertebrate Anatomy (4)
Three hours of lecture and three hours of laboratory per week. Analysis of vertebrate structure, with emphasis on comparative study of organ systems. Includes evolution of form and function, major adaptive patterns and phylogenetic relationships in vertebrates. Spring.

EFB 388 Ecology of Adirondack Fishes (3)
Two hours of lecture, and eight hours of fieldwork and discussion each day for two weeks. An integrated field and laboratory course in the identification of fish and recognition of ecological characteristics of major fish species and communities of Adirondack waters. Satisfies a component of the field study elective requirement in Environmental and Forest Biology. Summer, Cranberry Lake Biological Station.
Prerequisite: General zoology or general biology.

EFB 390 Wildlife Ecology and Management (4)
Three hours of lecture and one hour of recitation per week. A study of the ecological principles governing wild animal populations and their habitats, and the relationship of these principles to management programs and decisions. Directed primarily toward students majoring in wildlife science, conservation biology, and forest resources management. Fall.
Prerequisite or co-requisite: General ecology.

EFB 400 Toxic Health Hazards (3)
Three hours of lecture per week. Introduction to contemporary concepts of toxicology and to scientific basis for regulations and personal decisions about toxic health hazards. For students in natural or social sciences of environmental relevance. Topics include xenobiotic load, co-evolution of plant/animal defenses, chemical interactions, animal tests and risk assessment. Fall.
Prerequisites: General biology and general chemistry. Note: Credit will not be granted for both EFB 400 and EFB 600.

EFB 403 Microbiological Diseases of Fish and Wildlife (1)
One hour lecture/discussion per week. Surveys microbial diseases with pervasive effects on fish or wildlife populations and those with potential or actual impact on human populations. An individual disease will be examined in detail each week. Spring.
Prerequisites: EFB 303 or equivalent microbiology course is highly recommended.

EFB 404 Natural History Museums and Modern Science (3)
Two hour lecture per week and a one-week spring break field trip. This course examines the major roles of contemporary natural history museums as places of research and public education. The contributions of these institutions to science and science education through research, exhibits, collections and programs are emphasized. Participation in an organized instructional visit to natural history museums during the Spring break is required. Travel expenses to be anticipated. Spring.
Prerequisites: General biology and ecology.

EFB 405 Literature of Natural History (2)
One hour lecture and one hour discussion/seminar per week. This course examines key examples of the literature of natural history from the late 18th century to present. Major influences, perspectives and contexts associated with each selection are treated. Spring.
Prerequisites: General biology and ecology.

EFB 406 Great Naturalist Seminar (1)
One hour of seminar per week. This course examines the lives and contributions of selected, significant naturalists from the late 18th century to present. Perspectives, contexts and contemporaries of the naturalists are treated in seminar format. Basic and enriched presentation skills are practiced to encourage personal understanding and enhance professionalism. Fall.
Prerequisites: General biology and ecology.

EFB 409 Molecular Basis of Evolution (3)
Two hours of lecture and one hour of discussion per week. The major processes of organic evolution (e.g., mutation, natural selection, speciation and extinction) are discussed in a molecular-level context. Coverage ranges from changes to genic and nongenic regions of the genome to the evolution of entire genomes. Methods used to study molecular evolution and to reconstruct phylogenies are described and demonstrated.
Prerequisites: EFB 307, EFB 308, EFB 325. Note: Credit will not be granted for both EFB 409 and EFB 609.

EFB 412 Introduction to Chemical Ecology (3)
Three hours of lecture with discussion per week. Centers on chemical signals among organisms from microbes to man as they affect ecology, physiology and behavior; and as they can be utilized for agriculture, pest management and animal husbandry. Spring.
Prerequisite: Organic chemistry (one year). Note: Credit will not be granted for both EFB 412 and FCH 440.

EFB 413 Introduction to Conservation Biology (3)
Two hours of lecture and one hour of discussion/recitation per week. As an introduction to the discipline of conservation biology, the course seeks to demonstrate how basic biological science can be integrated with social, economic and political perspectives to achieve the goals of biological conservation. Lectures will provide students with an understanding of processes that generate and erode biological diversity. Discussion/recitation exercises will provide students with hands-on experience and skill development in solving the sorts of complex problems typically encountered by conservation biologists. Spring.
Pre- or co-requisite(s): EFB 307, EFB 320.

EFB 414 Senior Synthesis in Conservation Biology (3)
Three hours of discussion/seminar per week. Students research a topic in conservation biology, then practice critical thinking and discourse by presenting seminars and participating in discussions. The focus is on integrating knowledge from previous coursework in biology, management and policy for the wise use and conservation of biological diversity. Spring.
Pre- or co-requisite: EFB 413.

EFB 415 Ecological Biogeochemistry (3)
Three hours of lecture and discussion per week. Investigation of the principles of biogeochemistry in ecosystems. The transformations and fluxes of elements in terrestrial and aquatic ecosystems including global cycles are emphasized. Fall.
Prerequisites: Courses in general ecology and introductory chemistry.

EFB 416 Introduction to Environmental Interpretation (3)
Three hours of lecture and three hours of laboratory per week. Introductions to popular activities and products of nature interpretation such as nature trails and traditional nature walks to explore and illustrate the philosophy, principles and concepts of environmental interpretation. Fall.
Prerequisite: EFB 320. Note: Credit will not be granted for both EFB 416 and EFB 616.

EFB 417 Perspectives of Interpretive Design (3)
Three hours of lecture and three hours of laboratory per week. Applications of environmental interpretation theory and methods to nature center programming, science education, and various fields of resource management emphasizing procedures for creating and implementing products such as slide presentations, publications, exhibits, and nature walks. Spring.
Prerequisite: EFB 320. Note: Credit will not be granted for both EFB 417 and EFB 617.

EFB 418 Interpretation of Field Biology (5)
This five-week residential course offers introductions to Adirondack flora and fauna in a regional context as subjects for various interpretive programs and products such as nature walks and trailside presentations, and slide presentations. The application of professional interpretive techniques and the inclusion of natural history in science education are highlights. Summer.
Prerequisite: EFB 320 or permission of instructor. Note: Credit will not be granted for both EFB 418 and EFB 618.

EFB 419 Problem-solving in Conservation Biology (3)
Two hours of lecture/recitation and three hours of laboratory per week. "Hands-on" experience in problem-solving, using methods and concepts related to a wide range of biodiversity conservation issues. Includes management of genetic diversity, analysis and modeling of populations, ecosystem management, and the public policy process, and of methods of information management, analysis and communication used by conservation professionals. Spring.
Prerequisite: EFB 413 or equivalent; major in Conservation Biology or permission of instructor.

EFB 420 Internship in Environmental and Forest Biology (3 - 5)
Full- or part-time employment or volunteer work with an agency, institution, professional group or individual involved in activities consistent with the student's educational and professional goals. The extent of internship activities shall be commensurate with the credits undertaken. A resident faculty member must serve as the student's academic sponsor. A study plan outlining the internship's educational goals must be

completed prior to its commencement. Fall and Spring.
Prerequisite: Permission of an academic sponsor from the environmental and forest biology department.

EFB 423 Marine Ecology (4)
Three hours of lecture per week, two hours of laboratory per week and one weekend field trip. Introduction to marine organisms and systems using the principles of population, community and ecosystem ecology. Hands-on demonstrations, discussions, presentations, lectures, and field trip allow study of major marine habitats (e.g., intertidal, pelagic, coral reefs, deep sea), and the increasing human impact on marine environments. Small fee charged for mandatory weekend field trip. Spring, even years.
Prerequisites: One year general biology and general ecology or equivalents. Note: Credit will not be granted for both EFB 423 and EFB 623.

EFB 424 Limnology: Study of Inland Waters (3)
Three hours of lecture per week, with some additional hands-on activities during the semester. An introduction to the geology, physics, chemistry and biology of inland waters (lotic and lentic). The course focuses on inland waters as integrated ecosystems and explores the effects of natural and anthropogenic perturbations on these systems. Fall.
Prerequisites: Senior status, introductory courses in physics and chemistry, and EFB 320, or permission of instructor. Note: Credit will not be granted for both EFB 424 and EFB 624.

EFB 427 Plant Anatomy and Development (3)
Three hours of lecture and three hours of laboratory instruction per week. This course offers a dynamic approach to the study of plant anatomy by understanding how cells, tissues and organs are formed using concepts and tools from genetics and molecular biology. Laboratory involves hands-on activities using current techniques. Fall.
Prerequisite: one year introductory biology. Note: Credit will not be granted for both EFB 427 and EFB 627.

EFB 428 Mycorrhizal Ecology (3)
Two hours of combined lecture/discussion and 3 hours of laboratory per week. Introduction to mycorrhizal symbioses, their role in plant nutrient uptake, and function in plant community dynamics. Emphasis is on important historical and current literature, and on learning methodological approaches used in mycorrhizal research. Fall, even years.
Prerequisites: General ecology or plant ecology, genetics. Note: Credit will not be granted for both EFB 428 and EFB 628.

EFB 439 Forest Health Monitoring (3)
Three hours of lecture/discussion per week on theoretical and applied aspects of forest health monitoring including concepts, data acquisition, analysis, quality assurance, interpretation and reporting. Spring.
Pre- or co-requisite(s): Courses in forest resources management, ecology, pathology and entomology.

EFB 440 Mycology (3)
Two hours of lecture and three hours of laboratory per week. Fundamentals of the morphology, taxonomy, life histories, ecology and symbiotic relationships of fungi. Fall.
Note: Credit will not be granted for both EFB 440 and EFB 640.

EFB 443 Plant Virology (3)
Two hours of lecture and three hours of laboratory per week. History of plant virology, identification and characterization of plant viruses, including transmission mechanisms, vector relationships, purification and serology. Laboratory will present techniques for the identification and characterization of plant viruses. Spring, even years.
Prerequisite: EFB 303 or permission of instructor. Note: Credit will not be granted for both EFB 443 and EFB 643.

EFB 444 Biodiversity and Geography of Nature (3)
Three hours of lecture per week. Earth history (plate tectonics, etc.), topography and geographic variation in environmental conditions influence species and communities. Major geographic patterns in biological diversity and strategies for conserving native species are presented. Fall, even years.
Prerequisite: EFB 320 or permission of instructor. Note: Credit will not be granted for both EFB 444 and EFB 644.

EFB 445 Plant Ecology and Global Change (3)
Three hours of lecture and discussion per week. Impacts of global changes in climate, biodiversity, land-use, and biogeochemical cycles on structure and function of terrestrial plant communities and ecosystems. Examined scales range from ecophysiological processes occurring in individual leaves to global patterns of primary productivity and biodiversity. Spring.
Prerequisite: EFB 320 General Ecology or equivalent. Note: Credit will not be granted for both EFB 445 and EFB 645.

EFB 446 Ecology of Mosses (3)
Two hours of lecture and one three-hour laboratory or field trip per week. A study of taxonomic diversity, ecological adaptations and the roles of bryophytes in ecosystems. Spring.
Note: Credit will not be granted for both EFB 446 and EFB 646.

EFB 453 Parasitology (3)
Two hours of lecture/discussion per week, three hours laboratory per week. Diversity, ecology, and impact of parasites of ecological, medical, and veterinary importance. Emphasis on identification, life history, control, host-parasite interactions and evolution, population patterns, and parasite communities. Spring, even years.
Prerequisite(s): One year of Introductory Biology, Ecology. Note: Credit will not be granted for both EFB 453 and EFB 653.

EFB 457 Fish and Wildlife Diseases (3)
Two hours of lecture/discussion per week, three hours laboratory per week. Impacts and diversity of disease causing agents in fish and wildlife. Causation, epidemiology, and patterns of disease. Host pathogen interactions, disease dynamics, control and management in wild species. Fall, even years.
Prerequisite(s): One year of Introductory Biology, Ecology. Note: Credit will not be granted for both EFB 457 and EFB 657.

EFB 462 Animal Physiology: Environmental and Ecological (3)
Three hours of lecture, discussion and/or exercises per week. An introduction to the physiology of adaptation to the physical and biotic environments, including animal energetics, biology of body size and physiological constraints on animal life history. Fall.
Note: Credit will not be granted for both EFB 462 and EFB 662.

EFB 480 Principles of Animal Behavior (4)
Three hours of lecture and one hour of recitation per week. Basic principles of animal behavior and the scientific process. Proximate and ultimate mechanisms controlling the behavior of animals including humans, with an emphasis on evolution. Spring.
Prerequisite(s): A full year of general biology.

EFB 482 Ornithology (4)
Three hours of lecture and discussion, three hours of laboratory/field trip per week and additional mandatory field trips. Students become familiar with all aspects of birds: taxonomy, structure, function, ecology, population dynamics, conservation and identification. Emphasizes identification of the birds of the eastern United States by sight, and the common species by sound. Exposure to birds worldwide. Fall.
Prerequisite: General biology and general ecology.

EFB 483 Mammal Diversity (4)
Three hours of classroom instruction and three hours of laboratory per week. Describes the evolutionary development, ecology and diversity of mammals world-wide and within New York State. Laboratory exercises and discussions complement lectures, providing hands-on experience in identification, adaptive morphology, and techniques in field mammalogy. Spring.
Prerequisites: Junior standing in EFB.

EFB 484 Mammalian Winter Ecology (3)
Ten-day field course conducted during one weekend in February and during March break in the Adirondack Mountains of New York. The course explores ecological adaptations of mammals for surviving the winter in northern latitudes. Students are in the field daily. There is a course fee. Spring.
Prerequisites: EFB 202, EFB 320.

EFB 485 Herpetology (3)
Two hours of lecture and three hours of laboratory per week. An introduction to the structure, function, ecology, behavior, development and distribution of amphibians and reptiles as they relate to the systematics of the various groups. Fall.

EFB 486 Ichthyology (3)
Two hours of lecture and three hours of laboratory per week. An introduction to the anatomy, physiology, ecology, behavior and taxonomy of fishes. Spring.

EFB 487 Fisheries Science and Management (3)
Three hours of lecture per week. Introduction to biology, ecology, quantitative assessments, conservation, and management of fish species targeted in fisheries. Includes models and empirical studies of population dynamics, life history theory, bioenergetics, population sampling, growth, mortality, production, exploitation, ecological effects, and approaches to fisheries management. A practicum (EFB 488) is optional. Fall.
Prerequisite: Calculus and either Limnology or Ichthyology or permission of instructor. Note: Credit will not be granted for both EFB 487 and EFB 687.

EFB 488 Fisheries Science Practicum (1)
Three hours of laboratory per week with 2 weekend field trips. Practical experience in fisheries science, including introduction to collecting techniques, data collection, analysis, and use of models. A nominal fee is charged to defray costs on weekend trips. Designed as a complement to EFB 487. Fall, even years.
Co-requisite: EFB 487 (may be taken in a previous year).

EFB 491 Applied Wildlife Science (3)
Two hours of discussion and three hours of laboratory per week, plus a field project and professional experience. Practical experience with tools used to monitor and manage wildlife populations. Designed for biology students wishing to pursue careers as wildlife biologists. Spring.
Prerequisite: EFB 390.

EFB 492 Senior Synthesis in Aquatic and Fisheries Science (1)
One hour of seminar per week. Students will develop a synthesis by defining a scientific hypothesis on an aquatic topic of interest, gathering/analyzing data from the literature or elsewhere, interpreting findings, and presenting their work both orally and in a written technical report. That synthesis will relate to prior coursework and current issues in aquatic sciences. Spring.
Prerequisite: Senior standing in the Aquatic and Fisheries Science major.

EFB 493 Wildlife Habitats and Populations (4)
Three hours of lecture/discussion and one three-hour laboratory per week; one Saturday field trip required. Application of ecological concepts, including succession and population biology to wildlife management planning and program assessment. Students are exposed to U.S. Fish and Wildlife Service habitat evaluation procedures and fundamentals of population modeling. Fall.
Prerequisites: EFB 491 or permission of instructor. Note: Credit will not be granted for both EFB 493 and EFB 693.

EFB 495 Undergraduate Experience in College Teaching (1 - 3)
An opportunity for qualified, senior undergraduate students to gain experience in fully supervised, college-level teaching of the type they can expect to perform in graduate school. Students assist the instructor in the preparation and presentation of laboratory or recitation material in an undergraduate course. A maximum of 6 credit hours of EFB 495, and 3 credit hours relating to any single assisted course, may apply toward graduation requirements. Fall and Spring.
Prerequisites: Previous completion of the course being assisted (with a grade of B or higher), a GPA at ESF of 3.0 or higher, and permission of instructor.

EFB 496 Topics in Environmental and Forest Biology (1 - 3)
Experimental, interdisciplinary or special coursework in biology for undergraduate students. Subject matter and method of presentation varies from semester to semester. May be repeated for additional credit. Fall or Spring.

EFB 497 Seminar (1)
One hour of presentations and discussion per week. A topic in environmental and forest biology will be emphasized and its importance to contemporary issues will be addressed. Fall or Spring.

EFB 498 Research Problems in Environmental and Forest Biology (1 - 3)
Independent research in topics in forest biology for the superior undergraduate student. Selection of subject area determined by the student in

conference with appropriate faculty member. Tutorial conferences, discussions and critiques scheduled as necessary. Final written report required for departmental record. Fall, Spring and/or Summer.

EFB 500 Forest Biology Field Trip (1 - 3)
A five- to 10-day trip to: 1) agencies engaged in biological research, management and administration; or 2) regions or areas of unusual biological interest. A final report is required. Additional fees required to cover cost of travel and lodging during field portion of course. Fall or Spring.

EFB 502 Ecology and Management of Invasive Species (3)
Three hours of discussion/lecture per week. Explores the growing problem of invasive species as a leading threat to global biodiversity. Topics include: invasion pathways and mechanisms, community resistance, biological control, effects on ecosystems, law and policy as management tools, prediction and risk assessment, and interactions with anthropogenic environmental change. Fall.

EFB 505 Microbial Ecology (2)
Two hours of lecture/discussion per week. An in-depth survey of contemporary topics in microbial ecology including carbon, nitrogen and sulfur cycling, microbial degradation of recalcitrant compounds, frost control, and utilization of wood-based feedstocks as carbon sources for bioconversion to bioenergy, biofuels, and biomaterials. Spring.
Prerequisite: EFB 303 or similar microbiology course is recommended.

EFB 513 Adirondack Forest Ecology and Management (2 - 3)
One-week, field-based examination of sustainable forest management in the Adirondacks, framed by concepts and issues associated with plant and wildlife ecology, silviculture, and forest management. Contemporary research on central Adirondack forests is featured based on work at the Huntington Wildlife Forest. Emphasis is on experiential learning via a series of trips to, and laboratories in, the forest. Fall (late summer).
Note: Credit will not be granted for both EFB 513 and FOR 513.

EFB 516 Ecosystems (3)
Three hours of lecture/discussion per week. Ecosystems emphasize the integration of biological, chemical and physical aspects of the environment applied in an integrative fashion to units of landscape and water. Major topics covered include a survey of ecosystem types, energy flow, nutrient cycles and the relation of ecosystem processes to plant and animal populations. Spring.
Prerequisite: EFB 320.

EFB 518 Systems Ecology (4)
Three hours of lecture and three hours of laboratory/field experience per week. Survey of history, literature and techniques of systems ecology, including, especially, the teaching of intellectual, basic mathematical and computer skills that allow the student to take an environmental problem of his or her choosing and simulate it on a computer. Fall.
Prerequisite: One course in ecology. It is also recommended that the student have at least some previous or concurrent experience with computers. Weekend field trip required.

EFB 519 Geographic Modeling (3)
Students learn how to interface the traditional tools of ecological modeling with the new tools of Geographic Information Systems. Geographical modeling involves the simulation of natural earth systems with special consideration given to spatial position, adjacency, clustering or distribution of system variables. Students will work on a project of their own choosing, learning to write FORTRAN code to model and display system dynamics in both space and time.

EFB 521 Principles of Interpretive Programming (3)
Three hours of lecture and three hours of laboratory per week. This course offers principles, methods, and marketing for comprehensive interpretive programming. Creative approaches to methods for establishing effective programming featuring natural history themes are emphasized. Spring, alternate years.
Prerequisite: EFB 416/EFB 616 or EFB 417/EFB 617.

EFB 522 Biophysical Economics (3)
Three hours of lecture per week. Approaches economics as a biophysical rather than social science, i.e., the ecology of human-dominated ecosystems. Reviews concepts of value and economics (physiocrat, classical and neoclassical approaches), and examines an alternative model emphasizing analysis of energy and material flows and their control instead. Focus is on the developing tropics. Spring.
Prerequisite: A course in ecology and a course in economics.

EFB 523 Tropical Ecology (3)
One hour of lecture coupled with a period of intensive field study over spring break on a tropical island in the Caribbean. Principles of tropical ecology, resource management and island biogeography are presented. Field trips to a variety of tropical ecosystems including: rain forest, coral reefs, crater lakes and montane rain forest. Comparisons with north temperate ecosystems are made. Additional fees required to cover cost of travel and lodging during field portion of course. Requires the ability to swim. Spring.
Prerequisite: EFB 320.

EFB 525 Limnology Practicum (2)
Three hours of field work or laboratory analysis each week. Two additional field trips on weekends; time outside of class devoted to an independent project. Students will become proficient in standard field and laboratory analyses used in limnology; field trips to diverse local aquatic habitats; development of an independent project. Fall.
Prerequisites: EFB 424, 624 or equivalent must be taken concurrently or previously.

EFB 526 Introduction to Plant Tissue Culture (3)
One hour of lecture and six hours of laboratory per week designed to introduce students to the scientific and commercial uses of plant tissue culture. Spring.
Prerequisite: EFB 226.

EFB 530 Plant Physiology (3)
Three hours of lecture per week. Internal processes and conditions in higher plants with emphasis on physiological and biochemical concepts. For students majoring in the biological sciences. Spring.
Prerequisites: EFB 325, EFB 326. Note: EFB 531 also required for plant sciences concentration students.

EFB 531 Plant Physiology Laboratory (2)
Two three-hour laboratory sessions per week. An introduction to methods and procedures of physiological research. Spring.
Pre- or co-requisite: EFB 530 or permission of instructor.

EFB 535 Flowering Plants: Diversity, Evolution, and Systematics (3)
Two hours of lecture and three hours of laboratory per week. Diversity, evolution, and systematics of flowering plants with special emphasis on flower structures and reproductive strategies. Flowering plant identification skills are built from examination of a broad diversity of species from major globally-distributed families with particular focus on flora of the Northeastern U.S. Fall.
Prerequisites: Courses in organismal biology and senior standing.

EFB 542 Freshwater Wetland Ecosystems (3) (3)
Three hours of lecture per week. An examination of the structure and function of various freshwater wetlands. Ecologic principles that broadly apply to all wetland ecosystems are examined and contrasted with terrestrial systems. The effect of management activities on, and the management potential of, wetlands are also examined. Spring.
Prerequisite: EFB 320.

EFB 551 Forest Entomology (3)
Two hours of lecture and three hours of laboratory per week. Diversity, ecology and integrated management of insect pests of forested ecosystems. Additional topics include invasive species, climate change and current research topics. Intended for students in Environmental and Forest Biology and Forest Resources Management. Fall, even years.
Note: Credit will not be granted for both EFB 351 and EFB 55l.

EFB 552 Entomology (3)
Two hours of lecture and three hours of laboratory per week. Basic insect diversity, ecology and pest management with an emphasis on common insect pests of the northeastern United States. Additional topics include invasive species, climate change and current research topics. Intended for students in Environmental Biology and Forest Health. Fall, odd years.
Note: Credit will not be granted for both EFB 352 and EFB 552.

EFB 554 Aquatic Entomology (3)
Two hours of lecture, three hours of laboratory/field work per week and a weekend field trip. An introduction to the identification, life histories and ecology of aquatic insects, with emphasis on genera found in the Northeastern United States. Includes a consideration of the functional role of insects in aquatic systems, and current avenues of research. Intended for seniors and graduate students pursuing interests in entomology, fisheries and wildlife, forestry, limnology and general ecology. Fall.
Prerequisite: One course in entomology or permission of instructor.

EFB 555 Chemical Ecology of Vertebrates (3)
Three hours of lecture per week. A survey of chemical interactions within and among species of fish, amphibia, reptiles, birds and mammals, including humans. Signal production, sensory processes, plant-animal interactions, practical applications of chemical ecology and effects of global and local change on chemical ecology processes. Fall and Spring.
Prerequisites: One semester of organic chemistry and at least two of the following: general ecology, animal behavior, introduction to chemical ecology, and a course in vertebrate biology.

EFB 566 Systematic Entomology (3)
Two hours of lecture and three hours of laboratory per week. Lectures introduce the identification and classification of the important orders and families of insects, along with the concepts and practice of sys-tematics. In laboratories students become familiar with pertinent taxonomic literature and keys, based in part on a required collection. Fall.
Prerequisite: EFB 351 or EFB 352.

EFB 570 Insect Physiology (3)
Two hours of lecture and three hours of laboratory per week. Study of the life processes in insects; introduction to modern physiological instrumentation and laboratory methods. Spring.
Prerequisite: EFB 325.

EFB 600 Toxic Health Hazards (4)
Three hours of lecture and one hour discussion/seminar per week. Introduction to contemporary concepts of toxicology and to scientific basis for regulations and personal decisions about toxic health hazards. For students in natural or social sciences of environmental relevance. Topics include xenobiotic load, co-evolution of plant/animal defenses, chemical interactions, animal tests and risk assessment. Additional reading assignments and discussions. Fall.
Prerequisites: General biology and general chemistry. Note: Credit will not be granted for both EFB 400 and EFB 600.

EFB 601 Molecular Biology Techniques (4)
Two hours lecture and six hours laboratory per week. Theories behind techniques in molecular biology are introduced in lecture. Laboratory includes the extraction and quantification of genomic and plasmid DNA, agarose gel electrophoresis, restriction digestion, ligation, bacterial transformation, DNA sequencing and PCR. Additional topics in molecular biology are presented by the students. Fall.
Prerequisites: EFB 307, EFB 308, EFB 325 or equivalents. Note: Credit will not be granted for both BTC 401 and EFB 601.

EFB 605 Indigenous Issues and the Environment (3)
Three hours of lecture and discussion per week. Introduction to perspectives of indigenous people on environmental and natural resources management issues, including tribal forestry, fisheries, biocultural restoration, conservation strategies, climate change and treaty rights. Integrates scientific and indigenous worldviews and knowledge systems. Spring.
Note: Credit will not be granted for both EFB 305 and EFB 605.

EFB 609 Molecular Basis of Evolution (3)
Two hours of lecture and one hour of discussion per week. The major processes of organic evolution (e.g., such as mutation, natural selection, speciation and extinction) are discussed in a molecular-level context. Coverage ranges from changes to genic and nongenic regions of the genome to the evolution of entire genomes. Methods used to study molecular evolution and to reconstruct phylogenies are described and demonstrated. Students will organize and lead class discussions.

Prerequisites: EFB 307, EFB 308, EFB 325, or similar courses in genetics and cell physiology. Note: Credit will not be granted for both EFB 409 and EFB 609.

EFB 610 Ecological Biogeochemistry (3)
Three hours of lecture and discussion per week. Investigation of the principles of biogeochemistry in ecosystems. The transformations and fluxes of elements in terrestrial and aquatic ecosystems including global cycles are emphasized. Fall.
Prerequisites: Courses in general ecology and introductory chemistry.

EFB 611 Topics in Environmental Toxicology (3)
Three hours of lecture, discussion or seminar per week. In-depth exploration of selected contemporary topics of environmental toxicology in areas such as toxic hazards of societal importance, pollutant monitoring and remediation, fate and ecological impacts of environmental pollutants, biological basis of toxic hazards, and ecological and human risk assessment and regulations. A major term paper and oral presentation required. Spring.
Prerequisite: EFB 400, EFB 600 or an introductory course in toxicology.

EFB 612 Introduction to Chemical Ecology (3)
Three hours of lecture with discussion per week. Centers on chemical signals among organisms from microbes to man as they affect ecology, physiology and behavior; and as they can be utilized for agriculture, pest management and animal husbandry. Spring.
Note: Credit will not be granted for both EFB 612 and EFB 412/ FCH 440.

EFB 616 Introduction to Environmental Interpretation (3)
Three hours of lecture and three hours of laboratory per week. Introductions to popular activities, special projects, and products of nature interpretation such as nature trails and traditional nature walks to explore and illustrate the philosophy, principles and concepts of environmental interpretation. Requires analysis of several interpretive processes and completion of a paper. Fall.
Prerequisite: EFB 320. Note: Credit will not be granted for both EFB 416 and EFB 616.

EFB 617 Perspectives of Interpretive Design (3)
Three hours of lecture and three hours of laboratory per week. Applications of environmental interpretation theory and methods to nature center programming, science education, and various fields of resource management emphasizing procedures for creating and implementing products such as slide presentations, publications, exhibits and nature walks. Includes analysis and articulation of some interpretive processes. Spring.
Prerequisite: EFB 320. Note: Credit will not be granted for both EFB 417 and EFB 617.

EFB 618 Interpretation of Field Biology (5)
This five-week residential course offers introductions to Adirondack flora and fauna in a regional context as subjects for various interpretive programs and products such as nature walks and trailside presentations, and slide presentations. The course provides opportunities to select and test the application of professional interpretive techniques to activities promoting natural history and science education. Summer.
Prerequisite: EFB 320 or permission of instructor. Note: Credit will not be granted for both EFB 418 and EFB 618.

EFB 622 Applications of Interpretation to Science Education (3)
Weeklong residency course with an external project. This course offers practical research strategies for science educators working with their students in local environments. The course builds on forest ecology and wildlife themes as vehicles to teach the process of science. Included within the field-oriented introductions to Adirondack birds, mammals and flora, are ideas to enhance most science curricula. Applications of nature interpretation are used to energize traditional strategies by using nature trails and walks, and trail leaflets, brochures, presentations, and exhibits. Participants must implement, test and document semester-length projects with their students. Summer.

EFB 623 Marine Ecology (5)
Three hours of lecture per week, two hours of laboratory/recitation per week, one hour of graduate discussion per week and one weekend field trip. Introduction to marine organisms and systems, using the principles of population, community and ecosystem ecology. Hands-on demonstrations, discussions, presentations, lectures, and field trip allow study of major marine habitats (e.g., intertidal, pelagic, coral reefs, deep sea), and the increasing human impact on marine environments. Small fee charged for mandatory weekend field trip. Synthetic review paper and short presentation to the EFB 423 class are required. Spring, even years.
Prerequisites: One year general biology and general ecology or equivalents. Note: Credit will not be granted for both EFB 423 and EFB 623.

EFB 624 Limnology: Study of Inland Waters (3)
Three hours of lecture per week, with additional hands-on activities during the semester. An introduction to the geology, physics, chemistry and biology of inland waters (lotic and lentic); effects of natural and anthropogenic perturbations are explored. Students develop a case study or exercise on a limnological issue. Fall.
Prerequisites: Introductory courses in physics, chemistry, and ecology, or permission of instructor. Note: Credit will not be granted for both EFB 424 and EFB 624.

EFB 625 Plant Biotechnology (3)
Two hours of lecture and three hours of laboratory per week. Transgenic plants are currently being produced to improve agriculture, pharmaceuticals, and remediate environmental problems. Students are taught the principles of gene structure and regulation, gene cloning, transformation of plant species, and current applications. Format includes lectures, discussions, student presentations, literature review, and a detailed laboratory project. Spring.
Prerequisites: EFB 307 and EFB 325 or equivalents. Note: Credit will not be granted for both BTC 425 and EFB 625.

EFB 626 Plant Tissue Culture Methods (3)
Two hours of lecture and discussion and three hours of laboratory per week. Introduction to plant tissue culture for biotechnology research and as a propagation method. Emphasis will be on learning laboratory instrumentation and techniques for establishing cell cultures, producing transgenic cell lines, and regenerating whole plants. In addition to the scheduled lab exercises, an independent micropropagation or transformation project will be required. Fall.
Prerequisite: Permission of instructor. Note: Credit will not be granted for BTC 426 and FOR/EFB 626.

EFB 627 Plant Anatomy and Development (3)
Three hours of lecture and three hours of laboratory instruction per week. This course offers a dynamic approach to the study of plant structure by understanding how cells, tissues and organs are formed using concepts and tools from genetics and molecular biology. Laboratory

involves hands-on activities using current techniques. Students will give oral presentation on a topic relevant to the course. Fall.
Prerequisite: one year introductory biology. Note: Credit will not be granted for both EFB 427 and EFB 627.

EFB 628 Mycorrhizal Ecology (3)
Two hours of combined lecture/discussion and three hours of laboratory per week. Introduction to mycorrhizal symbioses, their role in plant nutrient uptake and function in plant community dynamics. Emphasis is on important historical and current literature, and on learning methodological approaches used in mycorrhizal research. Students will present and lead discussions on papers from the primary literature. An independent project is required. Fall, even years.
Prerequisites: General ecology or plant ecology, genetics. Note: Credit will not be granted for both EFB 428 and EFB 628.

EFB 640 Mycology (3)
Two hours of lecture and three hours of laboratory per week. Fundamentals of the morphology, taxonomy, life histories, ecology and symbiotic relationships of fungi. Fall.
Note: Credit will not be granted for both EFB 440 and EFB 640.

EFB 641 Phytopathology (3)
Two hours of lecture and discussion, and three hours of autotutorial laboratory per week. Principles and concepts of plant pathology. Major diseases of ornamental plants, vegetable crops, fruit crops, field crops and trees. This is an introductory plant pathology course for graduate students in all departments. Spring.

EFB 643 Plant Virology (3)
Two hours of lecture and three hours of laboratory per week. History of plant virology, identification and characterization of plant viruses, including transmission mechanisms, vector relationships, purification and serology. Laboratory will present techniques for the identification and characterization of plant viruses. Spring, even years.
Prerequisite: EFB 303 or permission of instructor. Note: Credit will not be granted for both EFB 443 and EFB 643.

EFB 644 Biogeography (4)
Three hours of lecture per week. Earth history (plate tectonics, etc.), topography and geographic variation in environmental conditions influence species and communities. Major geographic patterns in biological diversity and strategies for conserving native species are presented. Students design and conduct independent biogeographic study utilizing information available in the literature. Fall, even years.
Prerequisite: General ecology or permission of instructor. Note: Credit will not be granted for both EFB 444 and EFB 644.

EFB 645 Plant Ecology and Global Change (3)
Three hours of lecture and discussion per week. Impacts of global changes in climate, biodiversity, land-use, and biogeochemical cycles on the structure and function of terrestrial plant communities and ecosystems. Global change impacts are examined across a wide range of spatial and temporal scales, from ecophysiological processes occurring at the scale of a leaf, to global patterns of primary productivity and biodiversity. Spring.
Prerequisite: EFB 320 General Ecology or equivalent. Note: Credit will not be granted for both EFB 445 and EFB 645.

EFB 646 Ecology of Mosses (3)
Two hours of lecture per week and one three-hour laboratory or field trip. A study of taxonomic diversity, ecological adaptations and the roles of bryophytes in ecosystems. Spring.
Note: Credit will not be granted for both EFB 446 and EFB 646.

EFB 650 Landscape Ecology (3)
Two hours of lecture/discussion and three hours of laboratory experience per week. Landscape Ecology focuses on spatial patterning – its development and relevance to ecological processes. Course introduces the foundations, issues, and analytical tools in Landscape Ecology through discussion of literature, GIS exercises, and an independent research project. Fall (even years).
Prerequisites: Introductory course in Geographic Information Systems, or equivalent.

EFB 653 Parasitology (3)
Two hours of lecture/discussion per week, three hours laboratory per week. Diversity, ecology, and impact of parasites of ecological, medical, and veterinary importance. Emphasis on identification, life history, control, host-parasite interactions and evolution, population patterns, and parasite communities. Students write a review paper and present on a parasitic disease. Spring, even years.
Prerequisite(s): One year of Introductory Biology, Ecology. Note: Credit will not be granted for both EFB 453 and EFB 653.

EFB 657 Fish and Wildlife Diseases (3)
Two hours of lecture/discussion per week, three hours laboratory per week. Impacts and diversity of disease causing agents in fish and wildlife. Causation, epidemiology, and patterns of disease. Host pathogen interactions, disease dynamics, control and management in wild species. Students will coordinate and lead a group project on an emerging disease of wild animals. Fall, even years.
Prerequisite(s): One year of Introductory Biology, Ecology. Note: Credit will not be granted for both EFB 457 and EFB 657.

EFB 662 Animal Physiology: Environmental and Ecological (3) (3)
Three hours of lecture, discussion and exercises per week, and an independent project. An introduction to the physiology of adaptation to the physical and biotic environments, including animal energetics, biology of body size, and physiological constraints on animal life history. Fall and Spring.
Note: Credit will not be granted for both EFB 462 and EFB 662.

EFB 681 Aquatic Ecosystem Restoration and Enhancement (2)
One and three-quarter hours of lecture and discussion per week and three field experiences. Guiding principles for ecological restoration of freshwater aquatic ecosystems focusing on effects of nutrient loading, sedimentation, flow alteration, and habitat loss. Factors leading to loss of aquatic resources and effectiveness of techniques to restore habitat and fauna are analyzed. Student presentation of a relevant topic and field excursions to perturbed areas and recent restoration projects are required. Fall, odd years.
Prerequisites: none. Directed toward graduate students in areas involving aquatic sciences and management.

EFB 684 Mammalian Winter Ecology (3)
Ten-day field course conducted during one weekend in February and during March break in the Adirondack Mountains of New York. The

course explores ecological adaptations of mammals for surviving the winter in northern latitudes. Students are in the field daily. There is a course fee. Spring.

EFB 685 Ecology of Mammals of the Adirondack Mountains (2)
One week, field-based course with 15 hours of lecture and 45 hours of field/laboratory work. Focus on Adirondack mammals, their life histories, adaptations and habitat requirements. Emphasis on experiential learning where participants live trap, mark, and release small mammals, mist net bats, and employ radio telemetry techniques to understand the habits of mammals. Course is designed for college teachers and graduate students with teaching responsibilities. Fall (late summer).

EFB 687 Fisheries Science and Management (3)
Three hours of lecture per week. Introduction to the biology, ecology, quantitative assessments, conservation, and management of fish species targeted in fisheries. Includes models and empirical studies of population dynamics, life history theory, population growth, mortality, production, exploitation, and management. Critical synthesis project required. Fall.
Prerequisites: Calculus and either Limnology or Ichthyology or permission of instructor. Note: Credit will not be granted for both EFB 487 and EFB 687.

EFB 692 Ecology and Management of Waterfowl (3)
Three hours of lecture per week. A detailed examination of waterfowl ecology and management. The course is structured around the annual cycle, focusing on strategies of survival and reproduction; management aspects are treated throughout the course. Fall and Spring.
Prerequisite: EFB 483.

EFB 693 Wildlife Habitats and Populations (4)
Three hours of lecture/discussion and one three-hour laboratory per week; one Saturday field trip required. Application of ecological concepts including succession and population biology to wildlife management planning and program assessment. Students are exposed to U.S. Fish and Wildlife Service habitat evaluation procedures and fundamentals of population modeling. Fall.
Note: Credit will not be granted for both EFB 493 and EFB 693.

EFB 733 Techniques in Plant Physiology (2 - 4)
One hour of lecture and variable lengths of laboratory (three to nine hours) per week. Comprehensive study of techniques essential for research in plant physiology. Students may choose the instructors they wish to work with, and should consult the instructors for further details. May be repeated for credit in different specialties. Fall.
Prerequisites: EFB 531 and biochemistry with laboratory.

EFB 796 Topics in Environmental and Forest Biology (1 - 3)
Special instruction, conference, advanced study, and research in selected subject areas. A written report required. Check Schedule of Courses for details. Fall and Spring.

EFB 797 Seminar in Environmental and Forest Biology (1)
Seminar discussions of subjects of interest and importance in environmental and forest biology. Seminar offerings are available in most subdisciplinary areas. Check Schedule of Courses for details. Fall and Spring.

EFB 798 Research Problems in Environmental and Forest Biology (1 - 12)
Individual advanced study of selected special problems in environmental and forest biology. Offered by arrangement with individual faculty. A written report required. Fall and Spring.

EFB 898 Professional Experience (1 - 12)
Professional experience which applies, enriches and/or complements formal coursework. Graded on an "S/U" basis. Fall, Spring and Summer.

EFB 899 Master's Thesis or Project Research (1 - 12)
Investigation leading to the completion of a research-oriented thesis or to an application-oriented project. Graded on an "S/U" basis. Fall, Spring and Summer.

EFB 999 Doctoral Thesis Research (1 - 12)
Investigation leading to the completion of the doctoral thesis. Graded on an "S/U" basis. Fall, Spring and Summer.

ENS - Environmental Science (Graduate)

ENS 519 Spatial Ecology (3)
Two hours of classroom instruction and three hours of laboratory, field trip, workshop, or group studio per week. Geographical modeling is the simulation of natural systems in a spatial context, interfacing the traditional tools of ecological modeling with those of Geographic Information Systems. Students in this course learn the fundamentals of ecological modeling and develop a spatial model using GIS tools to address their own research questions. Spring.
Prerequisites: EFB 518 or computer programming course; GIS course. Co-requisite: GIS course (if not already completed).

ENS 596 Special Topics in Environmental Science (1 - 3)
Experimental or special coursework in Environmental Science for beginning graduate students, fifth year, and seniors with appropriate academic background. Subject matter and methods will vary. Fall or Spring.

ENS 601 Water Resources Management (3)
Three hours of lecture and discussion per week. This course provides an introduction to interdisciplinary water management. It draws upon subject matters from many areas, including water policy, planning, economics, hydrology, law, engineering and water quality. Fall.

ENS 607 Wetland Practicum (2 - 3)
Two hours of lecture and three hours of group learning per week. Provides students with a working knowledge of wetland management, emphasizing wetland delineation, functional assessment and mitigation with module problems with reports required for each module. Two credits for completion of two modules; three credits for completion of three modules. Fall.

ENS 696 Special Topics in Environmental Science and Policy (1 - 3)
Experimental and developmental courses in new areas of interest to environmental studies faculty and graduate students not covered in regularly scheduled courses. Fall and Spring.

ENS 796 Advanced Topics in Environmental Science and Policy (1 - 3)
Lectures and discussions, seminars, conferences and group research on advanced topics of special or current interest, in fields of interest to environmental studies faculty and graduate students. Fall and Spring.

ENS 797 Environmental Science Seminar (1 - 3)
Discussion of current topics and research related to environmental science. Fall and Spring.

ENS 798 Problems in Environmental Science and Policy (1 - 12)
Individualized, special study of environmental science and policy subjects and issues. Comprehensive oral or written report required for some problems. Fall, Spring and Summer.

ENS 898 Professional Experience (1 - 12)
Professional experience which applies, enriches and/or complements formal coursework. Graded on an "S/U" basis. Fall, Spring and Summer.

ENS 899 Master's Thesis Research (1 - 12)
Research and independent study for the master's degree and thesis. Fall, Spring and Summer.

ENS 999 Doctoral Thesis Research (1 - 12)
Research and independent study for the doctoral degree and dissertation. Fall, Spring and Summer.

ERE - Engineering (Environmental and Resource Engineering)

ERE 132 Orientation Seminar: Environmental Resources Engineering (1)
One hour of lecture, discussion and/or exercises per week. Introduction to department and campus resources available to ensure academic success for Environmental Resources Engineering majors. Introduction to engineering as a design profession. Fall.

ERE 133 Introduction to Engineering Design (3)
Two hours of lecture and three hours of group instruction per week. An introduction to the engineering profession, including design, communication, ethical and professional behavior, teamwork and data analysis. Learning is reinforced through study, conduct and critique of design exercises related to environmental resources engineering. Spring.

ERE 221 Engineering Mechanics Statics (3)
Three hours of lecture per week. Forces and vectors, moments, equivalent force systems, free bodies, structures, section properties. Fall.
Prerequisites: Integral calculus and general physics.

ERE 222 Engineering Mechanic Dynamics (2 - 3)
Two hours of lecture per week. Kinematics and kinetics of particles and rigid bodies; rectangular, normal and tangential, radial and transverse components; translation and rotation; force and acceleration; impulse; momentum; work and energy; impact. Spring.
Prerequisites: Statics and Calculus II.

ERE 223 Statics and Dynamics (4)
Four hours of lecture per week. This course provides fundamental principles, methods and applications of engineering mechanics. Development and discussion of analytic models for rigid-body mechanics are used to apply theories. Rigid bodies of a practical nature and at rest or in motion are covered. Fall.
Prerequisites: Algebra, derivative and integral calculus.

ERE 275 Ecological Engineering I (3)
Two hours of lecture and three hours of group instruction per week. Overview of ecological engineering theory and practice. Key concepts, empirical models, and case studies of ecological engineering. Living machines, treatment wetlands, bioremediation, municipal composting, agroforestry, traditional ecological knowledge, emergy analysis, and ecosystem restoration. Spring.
Prerequisites: one semester each of calculus, biology, chemistry, and ecology. Forest Engineering students only or by permission of instructor.

ERE 296 Special Topics in Engineering (1 - 3)
Provides experimental, interdisciplinary, or special coursework at the freshman and sophomore levels within the field of environmental resources engineering. Subject matter and course format vary from semester to semester and section to section. Fall and Spring.

ERE 311 Ecological Engineering in the Tropics (3)
One hour of discussion per week with intensive spring break field study in a Caribbean country. Principles of ecological engineering for ecosystem restoration and pollution control. Field trips to pristine and degraded ecosystems including: humid tropical cloud forests, coastal mangrove, dry mountain forests, and coral reefs to identify target functions for nature and society, observe degradations, and develop sustainable restoration designs. Spring.
Prerequisite(s): one course in calculus, biology, and chemistry. Note: Credit will not be granted for both ERE 311 and ERE 511.

ERE 335 Numerical and Computing Methods (3)
Three hours of lecture/discussion per week. Introduction to numerical and computing methods for engineers. Writing computer code to analyze and solve engineering problems using state-of-the-art software packages. Fall.
Prerequisite: MAT 485.

ERE 340 Engineering Hydrology and Hydraulics (4)
Three hours of lecture and three hours of laboratory and discussion per week. Introduction to water resources engineering. Hydraulics processes include pipe flow, open-channel flow, flows within control structures, and flow through porous media. Hydrologic processes include watershed storage and flux, rainfall-runoff models, flood routing, and stormwater design. Spring.
Prerequisites: ERE 133, MAE 341, ERE 335, ERE 371. Co-requisite: APM 395. Note: Credit will not be granted for both ERE 340 and ERE 540.

ERE 351 Basic Engineering Thermodynamics (3)
Three hours of lecture per week. Principles of energy conservation and conversion: first and second laws. Relation to PVT behavior, property

functions, equilibria and heat and mass transfer, and applications to energy and power systems. Introduction to engineering problem analysis and computer methods. Spring.
Prerequisite(s): Physics, general chemistry, and calculus.

ERE 362 Mechanics of Materials (3)
Three hours of lecture per week. Theories of stress, deformation and stability of common structural materials subjected to various force systems. Spring.
Prerequisites: Integral calculus and statics.

ERE 365 Principles of Remote Sensing (4)
Three hours of lecture and three hours of laboratory and discussion per week. A qualitative and quantitative introduction to the fundamentals of acquiring, analyzing and utilizing remote sensing data. Introductory concepts and methods in digital image processing and photogrammetry. Spring.
Prerequisite: ERE 371 Surveying for Engineers. Note: Credit will not be granted for both ERE 365 and ERE 565.

ERE 371 Surveying for Engineers (4)
Three hours of lecture and three hours of laboratory per week. The principles of plane surveying and position determination for engineers. Subject matter areas include introduction to the theory of measurement and errors, reference surfaces, coordinate systems and datums, horizontal and vertical measurements, traversing and computations, construction surveying including circular and parabolic curves, property and public land surveys, the analysis and treatment of systematic and random errors, foundations and applications of global positioning systems. Laboratory fieldwork and computations culminate in a topographic map. Fall.
Prerequisite: Calculus.

ERE 385 Mechanical Design (3)
Three hours of lecture per week. The principles of operation and design of mechanical systems common in engineering. Solution of equipment design using such components as springs, gears, motors and transmissions. Strength, reliability and economy are considered. Design projects are oriented to current concerns in construction, environment, and manufacturing. Spring.
Prerequisite: ERE 221; Co-requisites: ERE 222, ERE 362.

ERE 412 River Form and Process (3)
Three hours of lecture per week including river field sites. Field-based data collection methods for river classification. Bankfull flow estimates. Classified river form, suggested evolution sequences and governing fluvial processes. Computational river hydraulics, sediment transport, and issues of channel stability and restoration. Fall.
Prerequisites: ERE340, ERE371, APM395. Note: Credit will not be granted for both ERE 412 and ERE 612.

ERE 430 Engineering Decision Analysis (3)
Three hours of lecture per week. Classical engineering economics: time value of money, nominal and effective interest, and present worth, annual worth, rate of return, and benefit-cost ratio comparison techniques. Identification and evaluation of alternative investment and borrowing decisions, including the role of inflation, depreciation, taxes and uncertainty. Investment theory including the potential risks and rewards associated with investments options. Simulation and optimization techniques to aid in management decisions. Fall.

ERE 440 Water Pollution Engineering (3)
Three hours of lecture per week. Two laboratory exercises and one field trip. Introduction to physical, chemical and biological parameters of water and wastewater quality as well as principles of unit operations and processes for wastewater treatment and reuse. Study of design parameters and design procedures for wastewater treatment and reuse. Spring.
Prerequisites: FCH 152 General Chemistry II; EFB 101 General Biology I. Co-requisite: APM 485 Differential Equations.

ERE 444 Hydro-Meteorology (3)
Three hours of lecture per week. Atmospheric physics, moisture dynamics, and thermodynamics emphasizing feedback loops with precipitation. Quantitative descriptions of stability and dynamics and the development of fronts, cyclones, and thunderstorms. Weather station sensors and data-logger programming. Testing of analysis products, numerical weather models, quantitative precipitation forecasts, and radar precipitation data. Spring.
Prerequisites: Physics 1, Calculus II, permission of instructor.

ERE 445 Hydrologic Modeling (3)
Three hours of lecture per week. An exploration of deterministic and stochastic hydrologic models, model development, and the use of computer programming to construct, calibrate, manipulate, and interpret hydrologic models. Theoretical and analytical approaches to describing hydrologic processes, including precipitation, evapotranspiration, infiltration, surface runoff, percolation, and groundwater discharge. Stochastic techniques include frequency, trend, and regression analyses. Fall.
Prerequisite(s): Introductory computer programming, Probability and Statistics, one year of Calculus. Note: Credit will not be granted for both ERE 445 and ERE 645.

ERE 448 Open Channel Hydraulics (3)
Three hours of lecture per week. Advanced concepts in open channel hydraulics, including the energy and momentum principles, critical flow, uniform flow, flow profiles, and unsteady flow used suitable for engineering practice. Spring.
Prerequisite: FEG 340 or equivalent or consent of instructor. Note: Credit will not be granted for both ERE 448 and ERE 548.

ERE 450 Environmental Hydraulics (3)
Three hours of lecture per week. Theories of open channel flows and dynamics. Hydraulic physical and computational models. Turbulent processes, advection and dispersion components of mixing. Physical and numerical analysis of unsteady flows. Interactions of channel hydraulics with sediment and air interfaces regulating ecosystem functions. Spring.
Prerequisites: FEG133, MAE341, FEG335, FEG340, ERE371, APM 395.

ERE 468 Solid Waste Management (3)
Three hours of lecture and discussion per week. Introduction to solid waste regulations, social economic, environmental and technical factors. Design of solid waste management systems, including collection, recycling, composting, energy recovery, land disposal, leachate treatment, and stormwater control. Field trips. Fall.
Prerequisites: chemistry, biology, soil science, engineering hydrology.

ERE 475 Ecological Engineering II (3)
Three hours of lecture/seminar/discussion per week. Two field trips. Hands-on construction, operation and monitoring of ecological treatment systems. Emphasizing constructed wetlands and ponds for wastewater treatment and reuse, with minor topics selected by students. Design exercises for treatment of sewage, stormwater runoff, landfill leachate, or agricultural wastewater. Fall.
Prerequisite: ERE 440 or equivalent.

ERE 485 Fundamentals of Engineering Preparation (1)
Discussion of content and administation of the Fundamentals of Engineeering (FE) Exam, a comprehensive review of FE-type problems, and a targeted review of specific topics on the FE Exam. Spring.
Prerequisite(s): Senior standing or consent of instructor.

ERE 489 Environmental Resources Engineering Planning and Design (3)
Two hours of lecture and three hours of laboratory per week. A capstone course to integrate engineering coursework with the engineering design process to solve interdisciplinary environmental problems. Semester-long project provides experience in problem analysis, teamwork, project management, engineeering ethics, professional communication and related aspects. Spring.
Prerequisite(s): Senior standing in Forest Engineering, ERE 340, ERE 365.

ERE 496 Special Topics (1 - 3)
Lectures, readings, problems and discussions. Topics in environmental or resource engineering as announced. Fall and/or Spring.

ERE 498 Research Problem in Environmental Resources Engineering (1 - 3)
Independent research in topics in environmental resources engineering for the highly motivated undergraduate student. Selection of subject area determined by the student in conference with appropriate faculty member. Tutorial conferences, discussions and critiques scheduled as necessary. Fall, Spring.
Prerequisite: Permission of instructor.

ERE 506 Hazardous Waste Management (3)
Three hours of lecture and discussion per week. Systematic control of generation, storage, transport, treatment and disposal of hazardous waste. Applicable hazardous waste regulations. Pollutant transport mechanisms. Technology design to investigate, control emissions and remediate sites. Urban economic redevelopment impacts. Fall.
Pre- or co-requisite(s): Chemistry and biology. Permission of instructor for seniors in good standing.

ERE 511 Ecological Engineering in the Tropics (3)
One hour of discussion per week with intensive spring break field study in a Caribbean country. Principles of ecological engineering for ecosystem restoration and pollution control. Field trips to pristine and degraded ecosystems including: humid tropical cloud forests, coastal mangrove, dry mountain forests, and coral reefs to identify target functions for nature and society, observe degradations, and develop sustainable restoration designs. ERE 511 students will perform the additional work of writing a 15-page research paper. Spring.
Prerequisites: 1 course in calculus, biology, and chemistry. Note: Credit will not be granted for both FEG 311 and ERE 511.

ERE 519 Green Entrepreneurship (3)
Three hours of lecture/discussion per week. Explore challenges and goals of creating a start-up venture in environmental science or technology. Recognize trends in the marketplace, and where commercial opportunities can be created. Analyze feasibility and potential to create a sustainable venture. Other topic areas include critical success factors and key start-up issues unique to science and technology firms. Spring.
Pre- or Co-requisites: FOR 207 Introduction to Economics or equivalent; or permission of instructor.

ERE 527 Stormwater Management (3)
Three hours of lecture per week. One Saturday field trip. Techniques for urban stormwater and erosion control and analysis of associated water quality impacts. Review of applicable regulations and design standards. Students will engage in individual and team-oriented activities such as lecture, discussion, observation, computation, reading and writing. In addition, students are required to participate in a Saturday field trip where examples of stormwater management facilities will be reviewed. Students will, in small teams, generate a design for a stormwater management alternative at a local site. Fall.
Prerequisite: FEG 340 or equivalent as determined by instructor.

ERE 530 Numerical and Computing Methods (3)
Three hours of lecture/discussion per week. Programming skills and computing techniques using state-of-the-art software packages. Applications of programming and computing methods for solving geospatial, ecological, and/or water resource engineering problems. Fall.
Prerequisite(s): Differential Equations.

ERE 534 Transport Phenomena (3)
Three hours of lecture per week. Principles of heat and mass transfer as applied to the bioprocess industries. Topics include conduction, convective heat and mass transfer, diffusion of both steady-state and transient situations, analogies for heat and mass transfer, boundary layers, porous media transport, heat and mass transfer analysis. Discussion of specific bioprocess examples. Spring.
Note: Credit will not be granted for both BPE 335 and ERE 534.

ERE 540 Engineering Hydrology and Hydraulics (3)
Three hours of lecture and discussion per week. Introduction to water resources engineering. Hydraulics processes include pipe flow, open-channel flow, flows within control structures, and flow through porous media. Hydrologic processes include watershed storage and flux, rainfall-runoff models, flood routing, and stormwater design. Spring.
Prerequisites: FEG 133, MAE 341, FEG 335, ERE 371, or equivalent. Co-requisite: APM 395 or equivalent. Note: Credit will not be granted for both ERE540 and FEG340.

ERE 548 Open Channel Hydraulics (3)
Three hours of lecture per week. Advanced concepts in open channel hydraulics, including the energy and momentum principles, critical flow, uniform flow, flow profiles, and unsteady flow used suitable for engineering practice. Spring.
Pre-requisites: ERE 340 or permission of instructor. Note: Credit will not be granted for both ERE 448 and ERE 548.

ERE 551 GIS for Engineers (3)
Two hours of lecture and three hours of laboratory per week. Introduction to fundamental concepts in geographic information systems (GISs) with a focus on engineering applications. Fundamental concepts and development of geographic information systems including models and georeferencing systems used to represent and characterize spatial data. Data processing including collection and preprocessing, data management, spatial analysis and manipulation, and data output. Necessity and utility of spatial data in engineering design analysis. Fall.
Prerequisite: Calculus. Co-requisite: ERE 371 or equivalent.

ERE 553 Introduction to Spatial Information (1)
Three hours of lecture per week for the first third of the semester. An introduction to spatial terminology and methods for determining and expressing position. Examination of accuracy and precision in the context of horizontal measurements. Issues with subsequent use of measurements for producing maps and performing analysis. Fall.

ERE 561 Engineering Thermodynamics (3)
Three hours of lecture per week. Principles of classical thermo-dynamics applied to engineering practice. First and second laws; heat effects; property functions and their correlation; physical and chemical equilibrium; solutions and mixtures; equations of state. Compressible flow. Electrolyte solutions. Thermodynamic analysis of processes and systems via case studies and computer simulation. Compressible flow and/or thermodynamics of electrolyte solutions. Spring.
Prerequisites: Physics and Calculus. Note: Credit will not be granted for both PSE 361 and ERE 561.

ERE 565 Principles of Remote Sensing (4)
Three hours of lecture and three hours of laboratory and discussion per week. A qualitative and quantitative introduction to the fundamentals of acquiring, analyzing and utilizing remote sensing data. Introductory concepts and methods in digital image processing and photogrammetry. Spring.
Prerequisite: ERE 371 Surveying for Engineers or permission of instructor. Note: Credit will not be granted for both FEG 365 and ERE 565.

ERE 566 Introduction to Global Positioning Systems (1)
Three hours of lecture per week for the last third of the semester. An introduction to the theory and practice of performing global positioning system (GPS) measurements. Comparison of accuracy potential for different GPS equipment and techniques. Exploration of error sources that reduce the accuracy of GPS measurements. Collection of GPS data. Fall.

ERE 596 Special Topics (1 - 3)
Lectures, conferences, discussions and laboratory. Topics in environmental and resource engineering not covered in established courses. Designed for the beginning graduate student or selected upper-division undergraduate. Fall and/or Spring.

ERE 612 River Form and Process (3)
Three hours of lecture per week including river field sites. Field-based data collection methods for river classification. Bankfull flow estimates. Classified river form, suggested evolution sequences and governing fluvial processes. Computational river hydraulics, sediment transport, and issues of channel stability and restoration. Fall.
Prerequisites: Engineering Hydrology and Hydraulics, Engineering Probability and Statistics. Note: Credit will not be granted for both FEG 412 and ERE 612.

ERE 621 Spatial Analysis (3)
Three hours of lecture and discussion per week. Spatial statistics and modeling as applied to various data formats: single point data, continuous data and area data. First and second order effects, complete spatial randomness, tessellation, kernel, covariograms and variograms, kriging, distance measures, correlation/correlogram. Spring.
Prerequisite(s): APM391, FEG335 or permission of instructor.

ERE 622 Digital Image Analysis (3)
Three hours of lecture and discussion per week. Elements of digital image processing and analysis systems: Digital image representation, visual perception, sampling and quantization, pixel connectivity, Fourier transforms, image enhancement, filtering, image segmentation, edge detection, thresholding, representation schemes, descriptors, morphology, recognition and interpretation. Spring.
Prerequisite(s): APM391, FEG335 or permission of instructor.

ERE 641 Biomass Energy (3)
Three hours of lecture per week. Historical, current and future uses of biomass as a source of renewable energy for the production of bioenergy, biofuels and bioproducts. Characteristics of biomass, their conversion to different forms of energy and end products and an assessment of their sustainability. Spring.
Prerequisite: ESC 525, ESC 535 or permission of instructor; one semester of freshman chemistry or permission of instructor. Note: Credit will not be granted for both BPE 441 and ERE 641.

ERE 643 Water Pollution Engineering (3)
Three hours of lecture per week. Two laboratory exercises, one field trip and group project. Introduction to physical, chemical and biological parameters of water and wastewater quality as well as principles of unit operations and processes for wastewater treatment and reuse. Study of the design parameters and design procedures for wastewater treatment and reuse. Spring.
Prerequisite(s): General Chemistry, microbiology. Co-requisite: Differential equations. Note: Credit will not be granted for both ERE 440 and ERE 643.

ERE 644 Hydro-Meteorology (3)
Three hours of lecture per week. Atmospheric physics, moisture dynamics, and thermodynamics emphasizing feedback loops with precipitation. Quantitative descriptions of stability and dynamics and the development of fronts, cyclones, and thunderstorms. Weather station sensors and data-logger programming. Testing of analysis products, numerical weather models, quantitative precipitation forecasts, and radar precipitation data. Spring. Prerequisites: Physics, Calculus II, permission of instructor
Prerequisites: Physics, Calculus II, permission of instructor.

ERE 645 Hydrologic Modeling (3)
Three hours of lecture per week. An exploration of deterministic and stochastic hydrologic models, model development, and the use of computer programming to construct, calibrate, manipulate, and interpret hydrologic models. Theoretical and analytical approaches to describing hydrologic processes, including precipitation, evapotranspiration, infiltration, surface runoff, percolation, and groundwater

discharge. Stochastic techniques include frequency, trend, and regression analyses. Fall.
Prerequisite(s): Introductory computer programming, Probability and Statistics, 1 year of Calculus. Note: Credit will not be granted for both ERE 445 and ERE 645.

ERE 650 Environmental Hydraulics (3)
Three hours of lecture per week. Theories of open channel flows and dynamics. Hydraulic physical and computational models. Turbulent processes, advection and dispersion components of mixing. Physical and numerical analysis of unsteady flows. Interactions of channel hydraulics with sediment and air interfaces regulating ecosystem functions. Spring.
Prerequisites: FEG133, MAE341, FEG335, FEG340, ERE371, APM 395, or equivalent.

ERE 667 Process Control (3)
Three hours of lecture per week. Presents an introduction to the principles of process control. Linear analysis, LaPlace transforms, and nonlinear simulation are presented and applied to feedback, and feedforward control. Examples of process simulation, accuracy and stability of control are drawn from paper industry processes. Process identification using numerical techniques and MATLAB. Fall.
Prerequisite: Differential Equations. Note: Credit will not be granted for both PSE 477 and ERE 667.

ERE 674 Methods in Ecological Treatment Analysis (3)
Two hours of lecture/seminar/discussion and three hours of lab per week. Introduction to the components and design principles of engineered ecosystems for water quality improvement. Common lab exercises for a comprehensive analysis of an engineered ecosystem, including water quality, reaction kinetics, hydraulic characteristics, vegetation, soil and gravel, and microbial community. Discussion on experimental procedures and data analysis. Spring.

ERE 675 Ecological Engineering for Waste Management (3)
Three hours of lecture/seminar/discussion per week. Hands-on construction, operation and monitoring of engineered ecosystems for waste management. Emphasizing constructed wetlands and ponds for wastewater treatment and reuse, with minor topics selected by students. Design exercises for treatment of sewage, stormwater runoff, landfill leachate, or agricultural wastewater. Fall.
Prerequisite(s): ERE 440/643 or equivalent.

ERE 692 Remote Sensing of the Environment (3)
Three hours of lecture/discussion per week. Understanding of various remote sensing systems, their applications, and advanced digital image processing techniques. Analysis of satellite and airborne-acquired remote sensing data. Spring.
Prerequisite(s): FEG 365 or equivalent introduction to remote sensing.

ERE 693 GIS-Based Modeling (3)
Three hours of lecture/discussion per week. Geographical, temporal, environmental modeling concepts using GIS-based modeling languages and techniques. Various modeling concepts and techniques including spatial interpolation, suitability/capability modeling, hydrologic modeling, diffusion modeling, calibration, optimization, accessibility modeling, and rainfall-runoff modeling. Fall.
Prerequisite(s): ERE 551 or equivalent.

ERE 796 Advanced Topics (1 - 3)
Lectures, conferences, discussions and laboratory. Advanced topics in forest engineering, paper science and engineering, and wood products engineering. Fall and/or Spring.
Prerequisite: Permission of instructor.

ERE 797 Research Methods in Environmental Resources Engineering (1 - 3)
One to three hours of discussion/seminar per week. Introduction to research facilities, opportunities, and responsibilities of graduate scholarship. Discussion of ERE research topics, including journal reading, proposal formulation, funding, and engineering tools. Use of scholarly resources including e-journals, web, proposal development, and presentations. Fall and Spring.

ERE 798 Research in Environmental and Resource Engineering (1 - 12)
Independent research topics in Environmental Resources Engineering. Fall, Spring or Summer.
Credit hours to be arranged.

ERE 898 Professional Experience/Synthesis (1 - 6)
A supervised, documented professional work experience in the Master of Professional Studies degree program. Fall, Spring or Summer.
Prerequisite: Approval of proposed study plan by advisor, Department, and any sponsoring organization.

ERE 899 Master's Thesis Research (1 - 12)
Research and independent study for the master's degree and thesis. Fall, Spring and Summer.

ERE 999 Doctoral Thesis Research (1 - 12)
Research and independent study for the doctoral degree and dissertation. Fall, Spring and Summer.

ESC - Environmental Science

ESC 132 Orientation Seminar (1)
One hour of lecture or discussion each week. Introduction to campus facilities, personnel, lower-division curriculum and upper-division study options within the Environmental Science program. Fall.

ESC 200 Climate Change Science and Sustainability (1)
Climate Change Science and Sustainability is an introduction to climate science, the evidence of modern climate change, and an evaluation of some of the proposed solutions. The course integrates NASA and other web-based climate change media and products with outside readings. NASA's spatial and temporal climate change resources are the basis for most learning activities, which will enable students to continue their exploration of personal and societal climate change solutions.

ESC 296 Special Topics in Environmental Science (1 - 3)
One to three hours of class meetings per week. Special topics of current interest to lower-division undergraduate students in environmental science. A detailed course subject description will be presented as a topic area is identified and developed. Fall and Spring.
Prerequisite: Permission of instructor.

ESC 325 Energy Systems (3)
Three hours of lecture per week. An interdisciplinary overview of human-dominated energy systems. Topics include traditional extractive approaches, sustainable energy systems, energy return on investment, thermodynamics, energy flow analysis, resource supply, utilization rates, and environmental issues. Students are introduced to the multiple disciplines required to evolve more sustainable systems. A full-day field trip. Fall.
Prerequisites: EFB 120, FCH 150, and PHY 211. Note: Credit will not be granted for both ESC 325 and ESC 525.

ESC 335 Renewable Energy (3)
Three hours of lecture/discussion per week providing an overview of the role of renewable energy in the context of energy supply. Sustainable sources of heat, power and fuels will be covered and compared in terms of economic and environmental impacts. A one-day field trip of renewable projects is required. Spring.
Prerequisite: ESC 325. Note: Credit will not be granted for both ESC 335 and ESC 535.

ESC 422 Energy Markets and Regulation (3)
Three hours of lecture/discussion per week concerning markets and regulation of energy. Topics include: the economics of energy markets, industry restructuring, and the development of markets for energy efficiency and renewable power. The role and impacts of energy regulation on markets will also be examined. Fall.
Prerequisite: ESC 325. Note: Credit will not be granted for both ESC 422 and ESC 622.

ESC 450 Renewable Energy Capstone Planning (1)
One-hour group meeting every two weeks. This course will afford the student an opportunity to select a topic, in conjunction with the instructor, for detailed investigation in Capstone II. Each student will work individually with the instructor to arrive at a feasible project. Fall.
Prerequisites: ESC 325 and ESC 335. Co-requisite: ESC 422.

ESC 460 Renewable Energy Capstone Planning (2)
One half-hour meeting per week. Students will synthesize information from courses in the Renewable Energy minor by performing research and preparing a scientific report on topics related to renewable energy and energy. The research will consist of literature review/analysis, modeling, fieldwork or laboratory research. Spring.
Prerequisite: ESC 450.

ESC 494 Capstone Seminar (1)
One hour of lecture/discussion per week. Support and instruction for completion and presentation of the senior synthesis project for Environmental Science. Topics include research skills and literature review, data analysis, scientific writing including editing, and oral presentation. Research or internship must be nearly or fully completed.

ESC 498 Research Problems in Environmental Science (1 - 5)
Independent research in topics in environmental science for undergraduate students. Selection of subject area determined by the student in conjunction with an appropriate faculty member. Tutorial conferences, discussions and critiques scheduled as necessary. Final written report required for departmental record. Fall, Spring and/or Summer.
Prerequisite(s): Consent of instructor.

ESC 525 Energy Systems (3)
Thee hours of lecture per week. An interdisciplinary overview of human-dominated energy systems. Topics include traditional extractive approaches, sustainable energy systems, energy return on investment, thermodynamics, energy flow analysis, resource supply, utilization rates, and environmental issues. Students are introduced to the multiple disciplines to evolve more sustainable systems. A full-day field trip. Fall.
Prerequisites: EFB 120, FCH 150, PHY 211 or equivalent or permission of instructor. Note: Credit will not be granted for both ESC 325 and ESC 525.

ESC 535 Renewable Energy (3)
Three hours of lecture/discussion per week providing an overview of the role of renewable energy in the context of energy supply. Sustainable sources of heat, power and fuels will be covered and compared in terms of economic and environmental impacts. A one- day field trip of renewable projects is required. Spring.
Prerequisite: ESC 325 or equivalent. Note: Credit will not be granted for both ESC 335 and ESC 535.

ESC 622 Energy Markets and Regulation (3)
Three hours of lecture/discussion per week concerning markets and regulation of energy. Topics include: the economics of energy markets, industry restructuring, and the development of markets for energy efficiency and renewable power. The role and impacts of energy regulation on markets will also be examined. Fall.
Prerequisites: ESC 325 or equivalent or permission of instructor. Note: Credit will not be granted for both ESC 422 and ESC 622.

ESF - College-Wide

ESF 109 Honors Seminar in Environmental Science and Forestry (1)
One hour of lecture/discussion per week. Sequential presentations by ESF faculty and staff members. Exploration of science, engineering, design, management and social science applied to regional, national and global issues. A written report and presentation is required. Fall.
Prerequisite: Admission to the lower division Honors Program.

ESF 200 Information Literacy (1)
Three hours of lecture/discussion per week for five weeks. Introductory course for students of all levels and all curricula to the basic research process for information retrieval and management. Emphasis on electronic bibliographic and Internet research tools. Fall and Spring.

ESF 209 Honors Seminar in Environmental Science and Forestry (1)
One hour of presentation and discussion per week. Sequential presentations by students, or faculty, or both. Exploration of science, engineering, design, management and/or social science applied to regional, national and global environmental issues. A presentation and/or a written report may be required. Fall.
Prerequisite: Admission to the lower division Honors Program.

ESF 300 Introduction to Geospatial Information Technologies (3)
Two hours of lecture and three hours of laboratory per week. A theoretical and practical course providing an introduction to the uses and limitations of geospatial information technologies, including geographic information systems (GIS), global positioning systems (GPS) and remote sensing, for environmental science and natural resources management applications. Fall and Spring.

ESF 309 Honors Exploration Seminar (1)
One hour of group discussion or seminar per week for seven weeks and two additional, individual meetings. Selection and refinement of honors thesis project topic, development of project plan and start of research. Fall and Spring.
Prerequisite: Admission to the ESF Upper Division Honors Program.

ESF 332 Seminar for New Transfer Students (0)
One hour of weekly lectures and discussions per week designed to introduce the transfer student to the College and its academic and social environs. Fall and Spring.

ESF 499 Honors Thesis/Project (1 - 5)
Guided independent study in a topic related to the student's undergraduate major, resulting in a thesis/project. Students will give an honors presentation of their work. Fall and Spring.

ESF 503 Seminar on University Outreach and Public Service (1 - 3)
One- to three-credit seminar examines processes and strategies designed to enhance the scholarship and practice of university-based outreach and public service with an emphasis on relationships with K-12 schools and community organizations. Spring.

ESF 797 Graduate Seminar on Information Resources (1)
One hour of lecture/discussion per week. Searching for and evaluating information resources. Using citation management software. Preparing to write the research proposal and write and defend subsequent thesis/dissertation. Student presentations on information tools, thesis/dissertation research topics, formation of problem statement. Spring.

EST - Environmental Studies

EST 132 Introduction to Environmental Studies (3)
Three hours of lecture, discussion and analytical activities per week. Gateway course for EST majors. Introduction to the study of environmental problems in the social sciences and humanities. Topics: pollution, conservation, preservation, human health, ecosystem health, limits to growth, sustainability, ecosystems, population, energy, risk and traditional knowledge. Fall.

EST 140 Introduction to Native Peoples, Lands & Cultures (3)
Three hours of lecture/discussion per week. Introductory survey of the history, geography, economy, and culture of Native Americans from prehistory to present, with special attention to the Great Lakes region/upstate New York and environmental topics. Draws on texts, films, guest speakers, and other resources. Spring.

EST 200 Cultural Ecology (3)
Three hours of lecture/discussion/oral presentations per week. Students develop skills and fluency in preparing, delivering and evaluating multicultural and traditional environmental management and decision-making. Emphasis is on situations encountered in the environmental professions. Case studies pose ethical questions, which challenge students to apply theory and analysis to each case. Topics also include interactions of culture and environment, relationship between traditional and scientific knowledge and co-management as multicultural decision making. Self-evaluation and peer evaluations are emphasized. Fall or Spring.

EST 201 US History Reconstruction to the Present (3)
Three hours of lecture/discussion per week. History of changes occurring in America post 1865 including land use, government, economic and international relations. Spring.

EST 220 Urban Ecology (3)
Two hours lecture/discussion, three hours of outdoor laboratory per week. Explores the city from an ecosystems perspective. Addresses the role and importance of science, engineering, the design professions, and community participation in creating livable communities. Environmental equity and justice are addressed. Fall.

EST 221 Introduction to American Government (3)
Three contact hours per week. Describes American political system and its roles and functions in society. Examines how political processes change over time, including the role of rhetoric and argumentation in policy development. Explores critical analysis of political phenomena. Fall.

EST 230 China Experience (3)
Forty five hours (equivalent) of lecture and field studies. General survey of the history of China from ancient societies through the current time, with attention to cultural, ecological and natural resource issues focused on selected localities of China. The locality and/or hot spots will be selected from: the invention of paper; printing technology; renewable energy; anaerobic digestion of manual / plant biomass; wastewater treatment; Great Walls; Forbidden City; Three Gorges area; Canals; Chinese gardens; Sichuan; Dujianyang Irrigation Dam/Channels; Panda preservation; Hakka culture; Tibetan culture; plants and vegetation, etc. Analysis of the evolution of the Chinese culture. Historical and contemporary influences of China. Spring, Fall or Summer.

EST 231 Environmental Geology (3)
Three hours of lecture and discussion per week. Environmental Geology is an applied field of study that uses geological information to assist in resolving human conflicts related to land use issues, environmental damage, and resource use. Topics include natural resources, energy, environmental pollution, waste disposal, geological hazards and climate change. Spring.

EST 245 Nature and Popular Culture (3)
Three hours of lecture and discussion per week. An interdisciplinary exploration of the meanings of nature expressed in North American popular culture and of the implications of those meanings for environmental affairs. The expression of dominant 20th century Western ideologies of humanism and consumerism through such phenomena as advertising, nature shows, tourism, theme parks, zoos, rodeos, feature films, weather reports, lawns and the World Wide Web are identified using a mix of cultural studies and philosophy. Fall.

EST 296 Special Topics in Environmental Studies (1 - 3)
Experimental, interdisciplinary or special coursework at the freshman or sophomore levels. Subject matter and course format vary from semester to semester or offering on the basis of needs and objectives of the course. Fall or Spring.

EST 301 Leadership through Mentoring (1)
Biweekly meetings with instructors and with first-year student groups. Advanced leadership training for students in the ESF Peer Mentoring Program. Use of online resources to augment person-to-person interactions and group meetings. Fall.
Prerequisites: Upper division class standing, participation in the Peer Review Mentoring Program, and successful completion of Orientation Leader training.

EST 321 Government and the Environment (3)
Three contact hours per week. Examines the relationship between government and the environment, primarily in the U.S. Introduces environmental policy, including the policy making process. Reviews legal framework and current issues in several thematic areas (e.g., air, water, hazardous waste, and endangered species protection). Spring

EST 353 Environmental Psychology (3)
Three hours of lecture per week. Overview of theory, research, and methods in environmental psychology and sustainable behavior. Explores the role of human behavior as a root cause of environmental degradation and examines the contribution of individual and societal processes. The cognitive-behavioral perspective is emphasized in understanding these issues. Fall, odd years.
Prerequisites: Introductory psychology; junior status or permission of instructor.

EST 361 History of the American Environmental Movement (3)
Three hours of lecture and discussion per week. The historic and cultural origins and evolution of this complex, multifaceted social phenomenon called the environmental movement and its influence on public policies, values and lifestyles. The events, personages, philosophies and historical/cultural processes that marked and continue to drive various, competing attitudes toward nature, even within the United States environmental movement. Fall.

EST 366 Attitudes, Values and the Environment (3)
Three hours of lecture per week. Historical roots of environmental attitudes, values, and ethics with special emphasis on how individual attitudes impact environmental issues. Perspectives on man's relationship and responsibility to nature. Value implications of ecological principles and concepts. Examples of current environmental issues are examined in this context. Fall, even years.
Prerequisites: Junior status or permission of instructor.

EST 388 Psychological Principles of Risk Communication (3)
Three hours of lecture and discussion per week. Presents socio-psychological principles and theoretical underpinnings guiding the applied social science approach to environmental risk communication issues. Three overlapping themes will be considered and linked: how communities cope with environmental hazards, how risk information is cognitively processed and evaluated and how risk communication influences perception, evaluation and behavior. Spring, even years.
Prerequisite: Upper-division status.

EST 390 Social Processes and the Environment (3)
Three hours of lecture/discussion per week. Explores alternative ways of explaining the relationship between social processes and environmental conditions. Analyzes classical and modern social theories and applies their insights to questions of human-environment interaction. Introduces qualitative social science research methods and the social construction of environmental meaning. Fall or Spring.

EST 393 Environmental Discourse and Communication (3)
Three hours of lecture and discussion per week. Considers the role of communication and political discourse in shaping perceptions of nature and environmental issues/problems. Explores a variety of interpersonal, group, organizational and mass communication theories and a wide range of environmental discourses using examples of written, visual, broadcast, and electronic communication. Spring.
Prerequisite: Junior standing, and either EST 245 or permission of instructor.

EST 400 Senior Paper (3)
Individual study of an environmental topic resulting in a formal report that meets the requirements for an environmental studies synthesis experience. These requirements are identified in course meetings. Enrollment is restricted to environmental studies seniors. Fall and Spring.

EST 426 Community Planning and Sustainability (3)
Three hours of lecture and demonstration per week. Presents ecological planning and development concepts and theory guiding local and global initiatives for sustainable development. Overlapping themes are considered and linked: the relationship between landscape patterns reflecting wealth, poverty and environmental quality; the role of efficiency in reducing environmental impacts; and the questions of environmental equality, and the quality of development. Fall.

EST 427 Environmental and Energy Auditing (3)
Three hours of lecture, demonstration, and discussion per week. Presents environmental and energy auditing concepts and theory guiding local and regional initiatives for greenhouse gas production and energy use reduction. This course utilizes a practicum approach through use of inventory and analysis tools by student teams for project application. Spring.
Note: Credit will not be granted for both EST 427 and EST 627.

EST 450 Sustainable Enterprise (3)
Three hours of classroom/presentation per week. Economic, social, and environmental dimensions of sustainability and their interdependence. Influences on organizations to adopt sustainable approaches to operations and activities. Tools to validate organizational sustainability. Transdisciplinary emphasis. Fall.
Note: This course is cross-listed at SU School of Management as LPP/SHR 450.

EST 460 Land Use Law (3)
Three hours of lecture and discussion per week. This course provides an understanding of U.S., state and local laws affecting land use in New York in the context of current environmental policy debates. Students learn to recognize and analyze legal issues involving land use in varying contexts. Spring.
Prerequisites: EST 221 or permission of the instructor. Note: Credit will not be granted for both EST 460 and EST 660.

EST 494 Senior Seminar in Environmental Studies (1)
Two-hour seminar every two weeks. For all seniors in Environmental Studies. Students will prepare portfolios and give capstone presentations on their senior synthesis project and develop career goals and plans. Spring.
Prerequisites: Limited to graduating seniors in the Department of Environmental Studies.

EST 495 Selected Readings in Environmental Studies (1 - 3)
An in-depth and independent exploration of selected readings from the environmentally related literature. Emphasis is placed on gaining insights and understanding from the readings, rather than producing an extensive bibliography. Fall, Spring and Summer.
Prerequisite: Approval of study plan by instructor.

EST 496 Special Topics in Environmental Studies (1 - 3)
Special topics of current interest to undergraduate students in environmental studies and related fields. A detailed course subject description will be presented as the topic area is identified and developed. Fall, Spring and Summer.
Prerequisite: Permission of instructor.

EST 498 Introductory Research Problems (1 - 3)
Guided individual study of an environmental topic. Emphasis is on the study procedure and the methods employed. Enrollment is possible at various times during the semester. Fall, Spring and Summer.
Prerequisite: Approval of study plan by instructor.

EST 499 Environmental Studies Internship (1 - 12)
Internships provide students with a supervised field experience to apply and extend their academic abilities in a professional working environment. Enrollment is possible at various times during the semester. Fall, Spring and Summer.
Prerequisites: Environmental Studies senior status and written approval of an internship contract by major professor, curriculum director and field supervisor.

EST 550 Environmental Impact Analysis (3)
Three hours of lecture per week. The law, administration and natural/social science basis of the environmental impact assessment process in the federal government and New York state. Spring.
Prerequisite: Graduate matriculation or permission of instructor.

EST 600 Foundations of Environmental Studies (3)
Three hours of lecture/discussion per week. Examines frameworks for understanding and solving environmental problems. Familiarizes students with the epistemological foundations of environment-society relations. Considers multiple methodological and analytical strategies. Uses a case study method to exemplify key principles. Fall.
Prerequisites: Undergraduate courses in general ecology, environmental science and policy or communication theory.

EST 603 Research Methods and Design (3)
Three hours of lecture/discussion per week. Comprehensive survey of research methods and design for Environmental Studies. Topics covered include the scientific method; research design; quantitative, qualitative, and mixed research methods; sampling; data collection techniques; data analysis and interpretation; research ethics; and research proposal development. Fall.

EST 604 Social Survey Research Methods for Environmental Issues (3)
Three hours of lecture and discussion per week. Provides a critical overview of survey methods used to study human dimension of environmental problems. Explores fundamental theories, techniques, and applications of environmentally related social survey research processes. Design of original survey research and critical assessment of existing research. Spring, odd years.
Prerequisite: Undergraduate basic statistics course.

EST 605 Qualitative Methods (3)
Three hours of lecture and discussion per week. Survey of the generally recognized paradigms and methods that qualitative researchers use to better understand, evaluate, and perhaps influence complex social phenomenon. Research proposal, pilot study, final report and oral presentation required. Spring, even years.

EST 606 Environmental Risk Perception: Implications for Communication and Policy (3)
Three hours of lecture and discussion per week. Concepts, problems and research related to the assessment and management of environmental hazards in our society. Current psychological, sociological and cultural theories in risk perception, communication, and policy. Emphasis on the interplay between science, politics, law, values and public opinion. Fall.
Prerequisites: Coursework in psychology, sociology or policy recommended.

EST 608 Environmental Advocacy Campaigns and Conflict Resolution (3)
Three hours of lecture and discussion per week. Addresses complex dynamics, strategies, and tactics of 1) organized campaigns by grassroots to international organizations to advocate for particular environmental policy and 2) processes that seek to resolve, manage, or prevent environmental conflicts when appropriate. Readings, simulations, projects, and case study analysis. Fall.

EST 609 Collaborative Governance Processes for Environmental and Natural Resource Management (3)
Three hours of lecture and discussion per week. Introduces the evolution of innovative multistakeholder processes that characterize collaborative governance (CG). Distinguishes CG from traditional public involvement and dispute resolution approaches, and explores its challenges and opportunities. Provides knowledge and introductory tools to design and be more productive participants in collaborative processes. Spring, odd years.

EST 612 Environmental Policy and Governance (3)
Three hours of lecture and discussion per week. Examination of the dynamic relationships present in the creation and implementation of environmental policies. Considers the roles of the state, the private sector, and nongovernmental organizations. Explores background and implications of recent trends in environmental management. Spring.

EST 625 Wetland Management Policy (3)
Three hours of lecture and discussion per week. International, national, and local wetland management and conservation issues. Application of methods of policy research, critical evaluation and design of wetland management issues including delineation, functional evaluation, wetland

banking, and property rights issues. Research paper required. Fall, odd years.
Prerequisite: EFB 542 or equivalent.

EST 626 Concepts and Principles of Sustainable Development (3)
Three hours of lecture and discussion per week. Presents ecological and development concepts and theory guiding local and global initiatives for sustainable development. Four overlapping themes are considered and linked: the relationship between patterns of wealth, poverty and environmental quality; the role of efficiency in reducing environmental impacts; the theme of frugality and sufficiency in advancing development; the questions of environmental equality, and the quality of development. Fall or Spring.

EST 627 Environmental and Energy Auditing (3)
Three hours of lecture, demonstration, and discussion per week. Presents environmental and energy auditing concepts and theory guiding local and regional initiatives for greenhouse gas production and energy use reduction. This course utilizes a practicum approach through use of inventory and analysis tools by student teams for project application. Spring.
Note: Credit will not be granted for both EST 427 and EST 627.

EST 628 Great Lakes Policy and Management (3)
Three hours of lecture and discussion per week. Provides a comprehensive understanding of environmental policy and management in the Great Lakes. Emphasizes how scientific knowledge of conditions in the Great Lakes is used by policy makers in the Canadian and U.S. federal governments and the states and provinces. Intended both for policy- and science-oriented students. Spring, even years.

EST 635 Public Participation and Decision Making: Theory and Application (3)
Three hours of discussion, presentation and exercises per week. Provides a student with fundamental theories and techniques for developing and applying citizen participation strategies and conflict resolution as they relate to environmental science and planning decision making. Spring.

EST 640 Environmental Thought and Ethics (3)
Three hours of discussion per week. Critical interdisciplinary introduction to philosophical, religious, cultural and historical dimensions of environmental affairs. How ecologically significant cultural assumptions, ideologies, representations, and institutionalized practices contribute to human meanings and relationships to other-than-human-nature. Special attention to the role of language and questions of environmental ethics and ontology. Spring.

EST 645 Mass Media and Environmental Affairs (3)
Three hours of discussion per week. Introduces the mass media's role in environmental affairs. Relationships between media organizations, technology, content, and audiences frame examination of how nature and environmental issues and problems are engaged by the media and with what consequences. News and current affairs, advertising and entertainment genres are considered. Fall.

EST 650 Environmental Perception and Human Behavior (3)
Three hours of lecture and discussion per week. Application of environmental perception and human behavior paradigms and theories in understanding the causes and potential solution strategies to environmental issues. Interdisciplinary approach utilizes concepts, theories and research from disciplines including environmental psychology, sociology, anthropology, and risk perception to understand the myriad influences on human behavior as it relates to environmental impacts. Spring.

EST 660 Land Use Law (3)
Three hours of lecture and discussion per week. This course provides an understanding of U.S., state and local laws affecting land use in New York, in the context of current environmental policy debates. Students learn to recognize and analyze legal issues involving land use in varying contexts. Spring.

EST 695 Environmental Journalism (3)
Three hours of lecture per week. This course covers a range of topics related to journalism: interviewing, writing the lead, style, writing and organizing the story, layout, editing and revising, writing features and follow-up stories, covering speeches, etc. In addition, students explore how the media covers scientific and environmental issues. Students work on writing skills--from basic editing techniques to more sophisticated areas of style. Spring.

EST 696 Special Topics in Environmental Studies (1 - 3)
One to three hours of lecture and discussion per week. Experimental and developmental courses in new areas of interest to environmental studies faculty and graduate students not covered in regularly scheduled courses. Fall and Spring.

EST 702 Environmental and Natural Resource Program Evaluation (3)
Three hours of lecture and discussion per week. The systematic analysis of public environmental programs with an emphasis on the evaluation of resultant environmental outcomes. Topics include evaluation contexts, objective setting, environmental monitoring, and analysis of agency organization and procedures. Spring.

EST 796 Advanced Topics in Environmental Studies (1 - 3)
One to three hours of classroom instruction per week. Lectures and discussions, seminars, conferences and group research on advanced topics of special or current interest to environmental studies faculty and graduate students. Fall and Spring.

EST 797 Environmental Studies Seminar (1 - 3)
One to three hours of classroom instruction/discussion per week. Discussion of current topics and research related to environmental studies. Fall and Spring.

EST 798 Problems in Environmental Studies (1 - 3)
One to three hours of supervised individual activity per week. Individualized, special study of environmental studies subjects and issues. Comprehensive oral or written report required for some problems. Fall, Spring and Summer.

EST 898 Professional Experience (1 - 12)
Variable number of hours of professional experience per week. Professional experience which applies, enriches and/or complements formal coursework. Graded on an "S/U" basis. Fall, Spring, and Summer.

EST 899 Master's Thesis Research (1 - 12)
One to 12 hours of supervised individual activity per week. Research and independent study for the master's degree and thesis. Fall, Spring, and Summer.

EWP - Environmental Writing Program

EWP 190 Writing and the Environment (3)
Three hours of lecture, discussion, and workshops per week. Introduction to academic writing, reading, and research, reflecting college-level literacy skills of analysis, argument, and critical thinking. The course includes frequent informal writing assignments and three formal writing projects requiring revision. An oral presentation is required. Fall.

EWP 220 Public Presentation Skills (3)
Three hours of lecture per week. Development of skills and fluency needed by environmental professionals in preparing, delivering and evaluating effectiveness of expository and persuasive oral presentations. Communication theory, rhetorical analysis, and visualizations of complex and technical data, self and peer evaluation, listening skills. Fall and Spring.

EWP 290 Writing, Humanities, and the Environment (3)
Three hours of lecture, discussion, and workshops per week. Students will critically examine the rhetoric of nature and the environment and the literary expectations of their disciplines. Students will engage in a sustained research project involving writing and graphics. Frequent informal and formal writing assignments, research and documentation, and an oral presentation are required. Spring.

EWP 291 Writing, Humanities, and the Environment (Honors) (3)
Three hours of discussion and lecture per week. Focusing on food politics, this course builds on critical reading and writing skills developed in EWP 190. Students complete a 20-hour service project with a community food organization, while researching and writing about food politics and their community service experience. Spring.
Prerequisite(s): EWP 190 or equivalent.

EWP 296 Special Topics in Writing, Literature, and Public Presentation Skills (1 - 3)
Experimental, interdisciplinary or special course work at the freshman or sophomore levels. Subject matter and course format vary from semester to semester or offering on the basis of needs and objectives of the course. Fall or Spring.

EWP 300 Survey of Environmental Writing (3)
Three hours of classroom instruction per week. Students will explore forms of environmental writing including but not limited to journalism, poetry, memoir, field notes, historical research, natural histories and polemics. Students will analyze these writings rhetorically and create a range of texts including creative pieces, factually-based reporting, nature writing, and writing about science. Fall.
Prerequisites: EWP 190 and EWP 290.

EWP 311 Urban Environmental Literature (3)
Three hours of discussion and lecture per week. Development of reading, writing, and critical thinking skills that illustrate the flora, fauna, geology, and climate that shape urban life. Evaluation and discussion of poetry and prose by contemporary authors who use urban nature as their subjects. Spring.
Prerequisite: Upper division status or permission of instructor.

EWP 390 Literature of Nature (3)
Three hours of discussion and lecture per week. Examination of views of nature and the environment as seen through works of 19th and 20th century writers, poets, and essayists. Readings, discussions, and written assignments explore aesthetics, socio-political climate, and prevailing attitudes toward the environment that formed the backdrop for readings. Fall and Spring.

EWP 405 Writing for Science Professionals (3)
Three hours of lecture, discussion, and workshops per week. Principles and practice of writing skills required of science professionals. Develop proficiency in determining the purpose of a document; analyzing audience; selecting, developing and organizing information in an appropriate design; and writing clearly, precisely and effectively. Writing assignments done weekly; rewriting is routinely required. Fall and Spring.
Prerequisite: EWP 290 and junior or senior status, or permission of instructor.

EWP 410 Writing for Environmental Professionals (3)
Three hours of lecture, discussion, and workshops per week. Includes principles and practices of writing and communication skills relevant to environmental professionals. Emphasizes proficiency in analyzing audience and purpose; selecting, developing and organizing information in an appropriate design; and writing clearly, precisely and effectively. Fall and Spring.
Prerequisite: EWP 290 and junior or senior status, or permission of instructor.

EWP 420 Advanced Public Presentation Skills (3)
Three hours of lecture/discussion/student presentations per week. Emphasizes both theory and practice in effectively delivering, interpreting, and responding to public presentations. Social, cultural, and political dimensions of public addresses are examined. Issues of diversity and power are discussed. Small group communication is viewed as a site for creative problem solving. Audience analysis, adaptation, strategic arrangement, and concept development are explored. Fall and Spring.
Prerequisite: Junior or senior status, or permission of instructor.

EWP 490 Contemporary Literature of Nature (3)
Three hours of discussion and lecture per week. This writing-intensive literature course takes an ecocritical approach to nature literature, both poetry and prose, written by contemporary authors. Coverage includes ecofeminism, science literature, and native American literature. Spring.

EWP 494 Creative Non-fiction in the Sciences (3)
Three hours of classroom instruction per week. Students in the course will read and write creative nonfiction, a genre that reflects a harmonious movement among subjective experience, factual research, and public interest in science and the environment. The course focuses on the writing processes and techniques used to write ideas, theories, and experiences to a lay audience. Spring.
Prerequisite: EWP 190. Note: Credit will not be granted for both EWP 494 and EWP 694.

EWP 495 Environmental Journalism (3)
Three hours of lecture per week. This course covers a range of topics related to journalism: interviewing, writing the lead, style, writing and organizing the story, layout, editing and revising, writing features and follow-up stories, covering speeches, etc. In addition, students explore how the media covers scientific and environmental issues. Students work on writing skills--from basic editing techniques to more sophisticated areas of style. Spring.

EWP 496 Special Topics in Writing, Literature, and Public Presentation Skills (1 - 3)
Special topics of current interest to undergraduate students in writing, literature, and public presentation skills. A detailed course description will be presented as the topics area is identified and developed. Fall and Spring.

EWP 498 Independent Study in Writing, Literature and Public Presentation Skills (1 - 3)
Guided individual study of a topic in composition, literature and public presentation skills. Enrollment is possible at various times during the semester. Fall and Spring.

EWP 620 Public Presentation Skills for Environmental Professionals (3)
Three hours of lecture per week. Development of skills and fluency needed by environmental professionals in preparing, delivering and evaluating effectiveness of expository and persuasive oral presentations. Communication theory, rhetorical analysis, and visualizations of complex and technical data, self and peer evaluation, listening skills. Fall/Spring.

EWP 694 Creative Non-fiction in the Sciences (3)
Three hours of classroom instruction per week. Students in the course will read and write creative nonfiction, a genre that reflects a harmonious movement among subjective experience, factual research, and public interest in science and the environment. The course focuses on the writing processes and techniques used to write ideas, theories, and experiences to a lay audience. Spring.
Note: Credit will not be granted for both EWP 494 and EWP 694.

FCH - Chemistry

FCH 132 Orientation Seminar: Chemistry (1)
One hour of lecture and discussion per week. Introduction to campus resources available to ensure academic success. Introduction to chemistry as a field of inquiry. Introduction to laboratory safety. Fall.

FCH 150 General Chemistry I (3)
Three hours of lecture per week. This first semester general chemistry course is organized around the physical and chemical properties of matter. It introduces the atomic structure of elements, the kinds of bonds in chemical compounds, how atomic ratios in molecules from the basis for the stoichiometry of reactions, begins a treatment of thermodynamics and discusses the principles of chemical reactivity. Fall.
Prerequisite(s): APM 104 (may be taken concurrently) or equivalent (ex. Precalculus).

FCH 151 General Chemistry Laboratory I (1)
Three hours of laboratory per week. Basic laboratory techniques will be emphasized through experiments dealing with the density of solids and liquids, atomic ratios and mass combining ratios, atomic structure and the periodic table, calorimetry, chemical reactivity, geometric structure of molecules, formation of coordination compounds, and paper chromatography. Fall.
Prerequisite: FCH 150.

FCH 152 General Chemistry II (3)
Three hours of lecture. The second course in general chemistry continues the development of chemical reactivity by focusing on chemical kinetics and chemical equilibrium. Aqueous phase processes are emphasized and are applied to precipitation and solubility equilibria, acid/base dissociation phenomena, and fundamental electrochemical reactions. Spring.
Prerequisite: FCH 150 and APM 104 (or equivalent (minimum Precalculus)).

FCH 153 General Chemistry Laboratory II (1)
Three hours of laboratory per week. Concepts of chemical kinetics and equilibrium processes will be reinforced through experiments in titrimetric analyses, determinations of Ka and Ksp values, investigation of rate constants and reaction orders, buffer preparations, oxidation/reduction reactions and qualitative analyses. Spring.
Prerequisites: FCH 150, FCH 151. Co-requisite: FCH 152.

FCH 210 Elements of Organic Chemistry (4)
Three hours of lecture and four hours of laboratory per week including pre-laboratory instruction. Nomenclature, preparation, and important reactions of functional groups and classes of organic compounds including examples relevant to biology. Isomerism and stereochemistry topics of biomolecules. Quantative study of weak acids and weak bases. Lab techniques include compound manipulations, extractions, distillations, chromatography, synthesis, and calculation of yields. Spring.
Prerequisite: One year of General Chemistry.

FCH 221 Organic Chemistry I * (3)
Three hours of lecture per week. The structure, properties and fundamental reactivity of organic compounds will be studied with emphasis on the reaction mechanisms and stereochemistry. In combination with FCH 223, this course provides a full survey of common classes of carbon compounds. Fall.
Prerequisite: FCH 150, FCH 151, FCH 152, FCH 153. *This course description was added to the on-line catalog on October 21, 2009.

FCH 222 Organic Chemistry Laboratory I (1)
Four hours of laboratory including pre-laboratory instruction per week. Laboratory safety. Melting and boiling points, distillation, recrystallization, thin-layer and column chromatography, isolation of natural products, organic synthesis and spectroscopy. Fall.
Co-requisite: FCH 221.

FCH 223 Organic Chemistry II (3)
Three hours of lecture per week. The structure, properties and fundamental reactivity of organic compounds will be studied with emphasis on the reaction mechanisms and stereochemistry. In combination with FCH 221, this course provides a full survey of common classes of carbon

compounds. Spring.
Prerequisite: FCH 221.

FCH 224 Organic Chemistry Laboratory II (1)
Four hours of laboratory including pre-laboratory instruction per week. Continuation of FCH 222. Simple physical and instrumental techniques applied to organic chemistry. Gas chromatography, polarimetry, spectroscopy. Introduction to classical literature synthesis. Topics from natural products chemistry including chemical ecology, biomimetic synthesis, and the synthesis of an anticancer drug from birch bark. Spring.
Prerequisite: FCH 222. Co-requisite: FCH 223.

FCH 290 Chemistry Teaching Assistant Experience for Undergraduates (1 - 3)
Undergraduate students will gain experience with the management, evaluation and assessment of undergraduate courses in chemistry. Assistants will assist the instructor with course activities and mentor students on how to succeed in the respective course. Teaching Assistant responsibilities vary by section and instructor. Fall and Spring.
Prerequisite(s): Consent of Instructor.

FCH 325 Organic Chemistry III (4)
Two hours of lecture, one six-hour laboratory per week. Classical and recent literature synthesis or organic compounds, employing advanced techniques. Fall.
Prerequisite: Two semesters of elementary organic chemistry.

FCH 360 Physical Chemistry I (3)
Three hours of lecture per week. An introduction to the properties of gases and liquids, the laws of thermodynamics, phase, phase transitions, solutions and colligative properties, and reaction equilibria. Fall.
Prerequisite(s): MAT 295 and 296, and PHY 211 and 212, or their equivalents.

FCH 361 Physical Chemistry II (3)
Three hours of lecture per week. Includes discussion on electrochemistry, principles of quantum mechanics, statistical mechanics, chemical kinetics, and basic spectroscopy. Spring.
Prerequisite: FCH 360.

FCH 380 Analytical Chemistry I: Gravimetric, Titrimetric and Potentiometric Analysis (3)
Two hours of lecture and one three-hour laboratory per week. Equilibrium concepts and practical implementations of precipitation, complexation, acid-base and oxidation-reduction processes in quantitative chemical analysis. Fall.
Prerequisites: Two years of undergraduate chemistry and FCH 360 taken concurrently or permission of instructor.

FCH 381 Analytical Chemistry II: Spectroscopic, Chromatographic and Electroanalytical Instrumental Technique (3)
Two hours of lecture and one three-hour laboratory per week. Theory and practice of technology applications to UV/VIS, AAS, AES, XES, ASV, GLC and HPLC. Spring.
Prerequisites: Two years of undergraduate chemistry and FCH 361, FCH 380 taken concurrently or permission of instructor.

FCH 384 Spectrometric Identification of Organic Compounds (1 - 2)
Two hours of lecture and discussion per week. The first-half semester (1 credit) will deal with common classes of organic compounds; the second-half semester (1 credit) will deal with more complex structures. The use of complementary information from mass, infrared, nuclear magnetic resonance and ultraviolet spectrometry will be applied to identification of organic natural products. Spring.
Prerequisites: Organic chemistry; one semester of advanced organic chemistry for second credit.

FCH 390 Drugs from the Wild (3)
Three hours of lecture and discussion per week. This course is designed to give students a comprehensive understanding of the variety of medicinal agents available from natural sources. Economic and societal aspects will be explored as well as scientific ones. In addition to curative agents, discussions will include toxic substances, folk medicinal (including herbal) preparations, and the so-called "recreational drugs." Fall, odd years.
Prerequisites: Introductory courses in chemistry and biology.

FCH 399 Introduction to Atmospheric Sciences (3)
Three hours of lecture and discussions per week. Atmospheric composition, mass and structure; solar radiation and the global energy budget; atmospheric moisture budget, cloud and precipitation; photolysis, gas-phase oxidation, aqueous chemistry, and gas-to-particle conversion; physical and chemical mechanisms driving environment phenomena such as acid rain, the greenhouse effect, the ozone hole, remote and urban air pollution, and haze.
Prerequisite(s): General physics I, 1 year each of general chemistry and calculus. Co-requisite(s): General physics II.

FCH 410 Inorganic Chemistry (3)
Three hours of lecture per week. An introduction to the bonding, structure and reactivity of transition metals and main group elements. Topics will include but are not limited to covalent molecular structures, coordination chemistry, organometallic chemistry, catalysis, bioinorganic chemistry and solid state materials. Spring, even years.
Prerequisite: One year of general chemistry, one year of organic chemistry.

FCH 440 Introduction to Chemical Ecology (3)
Three hours of lecture with discussion per week. Centers on chemical signals among organisms from microbes to man as they affect ecology, physiology and behavior; and as they can be utilized for agriculture, pest management and animal husbandry. Spring.
Prerequisites: Biology (one year), and organic chemistry (one year). Note: Credit will not be granted for both FCH 440 and EFB 412.

FCH 495 Introduction to Professional Chemistry (1)
The professional chemist's relationship with industry, government and universities. Employment opportunities for the chemist, professional organizations and unions will be discussed. The selection of a senior research topic and a literature survey will be required. Fall.
Prerequisite: Senior status.

FCH 496 Special Problems in Chemistry (1 - 3)
An opportunity for a special problem, technique development, independent or unstructured study in an area related to the chemical profession. The work may be technical, professional, or interdisciplinary. Advisors outside this department may be solicited. A brief proposal must be

presented for approval with specific arrangements outlined including faculty advisor and objectives of the study. A written report will be expected. Fall and Spring.
Prerequisite: Upper-division status.

FCH 497 Undergraduate Seminar (1)
One hour per week. Literature surveys and seminars on topics of current research interest and recent advances in chemistry. Spring.

FCH 498 Introduction to Research (5)
Eighteen hours of laboratory, library search and report writing. Solution of a selected research problem using special laboratory techniques. A written report on data, procedures, results and conclusions. Fall and Spring.

FCH 510 Environmental Chemistry I (3)
Three hours of lecture per week. Introduction to the processes that control chemical behavior in aquatic environments, including precipitation, gas exchange, acid-base, redox, complexation and adsorption reactions. Emphasis will be on explanation and prediction of chemical behavior, using computer models where appropriate. Examples will be from the areas of water and wastewater treatment, pollutant fates and geo-chemistry. Spring.
Prerequisites: An introductory course in physical chemistry is required and a short course in computer programming is recommended.

FCH 511 Environmental Chemistry II (3)
Three hours of lecture per week. Includes a detailed chemical explanation of current topics of concern in environmental chemistry and the chemistry of pollution. Lectures will cover topics relating to air, soil and biota pollutional impact. Fall.
Prerequisite: Chemistry through physical chemistry or permission of instructor.

FCH 515 Methods of Environmental Chemical Analysis (3)
One hour of lecture and six hours of laboratory per week. An introduction to sampling, analytical and quality control procedures necessary to obtain reliable water quality data. All analyses will be performed on a single aquatic system with the purpose of developing a final report characterizing the water quality of that system. Fall.
Prerequisite: A course in quantitative chemical analysis.

FCH 524 Topics in Natural Products Chemistry (3)
Three hours of lecture and discussion per week. A course intended to introduce the student to various types of secondary metabolites including several of past and current interest because of their pronounced biological activities. Modes of chemical reactivity and means of structure determination and syntheses are covered. Spring.

FCH 530 Biochemistry I (3)
Three hours of lecture per week. General biochemistry with emphasis on cellular constituents and metabolic reactions. The chemical, physical and biological properties of amino acids, proteins, carbohydrates and their intermediary metabolism will be discussed. The chemistry of enzymes, energy transfers and biological oxidations will also be covered. Fall.
Prerequisite: One year of organic chemistry.

FCH 531 Biochemistry Laboratory (3)
One hour lecture and six hours of laboratory per week on the basic techniques used in biochemical research with an emphasis on proteins and enzymes. Techniques include spectrometry, chromatography, electrophoresis, amino acid analysis, coupled assays, and the isolation and characterization of enzymes. Fall.
Prerequisite: One semester of quantitative analysis with laboratory. Co-requisite: FCH 530 with permission of instructor.

FCH 532 Biochemistry II (3)
Three hours of lecture per week. Topics discussed are biosynthesis and degradation of amino acids and nucleic acids, protein biosynthesis, and an introduction to molecular biology. Spring.
Prerequisites: FCH 530 and its pre- and co-requisites.

FCH 540 Carbohydrates I: Structure, Reactions and Analysis (2)
Two hours of lecture/discussion per week on the structure, reactions, and analysis of carbohydrates and polysaccharides. Introduction to carbohydrate structure and nomenclature. Overview of important oligosaccharides and major classes of polysaccharides. Reactions of carbohydrates-derivatization, polymerization, degradation. Analysis of carbohydrate molecules' sequence and linkages size, shape, distribution of functional groups. Fall.
Prerequisite: One year of introductory organic chemistry, or permission of instructor.

FCH 550 Polymer Science: Synthesis and Mechanisms (3)
Three hours of lecture per week. Introduction to the synthesis of polymers and the mechanism of polymerization processes. Addition homopolymerization and copolymerization by radical, ionic, and coordination type catalysts. Synthesis of block and graft copolymers. Stepwise polymerization, network formation and gelation. Structure of polymers and steroregular polymerization. Degradation of polymers, reactions on polymers, polyelectrolytes. Three hours of lecture. Spring.
Prerequisites: One year of organic chemistry and one year of physical chemistry.

FCH 551 Polymer Techniques (3)
Two hours of lecture/discussion and four hours of laboratory per week; laboratory reports, final exam. Twelve experiments covering the main topics of polymer synthesis (four weeks), molecular weight determination (four weeks), and characterization (four weeks) are selected from areas such as the following: free-radical solution, bulk and emulsion polymerizations; ionic and condensation polymerizations, copolymerization and reactivity ratio determination; osmometry, viscometry, light scattering, gel permeation chromatography, polarized light microscopy, X-ray diffraction, differential scanning calorimetry, thermogravimetric analysis, dynamic mechanical analysis, stress-strain analysis; nuclear magnetic resonance spectroscopy, Fourier transform infrared spectroscopy, ultraviolet/visible spectroscopy. The lecture component will include discussions of the laboratory activities as well as related topics such as the preparation of monomers, safe handling methods for monomers, polymers, solvents, catalysts, etc. Fall.
Prerequisites: One year of organic and one year of physical chemistry, or permission of instructor. Co-registration in FCH 552 is recommended.

FCH 552 Polymer Science: Properties and Technology (3)
Three hours of lecture per week. Introduction to physical chemistry, physics, processing and technology of synthetic polymers. Polymer

solutions, including molecular weight determinations and chain statistics. Polymer solid states, including rubber elasticity, visco-elasticity, the glassy state and the crystalline state. Properties, processing, and technology of films, fibers, elastomers, and foams. Fall.
Prerequisites: One year of organic chemistry and one year of physical chemistry.

FCH 560 Chromatography and Related Separation Sciences (3)
Three hours of lecture and discussion per week. A course designed to give the student a thorough understanding of analytical and isolation chemistry by modern chromatographic, distributive and molecular sieving techniques. The chemistry of the systems discussed will be stressed as well as the important physical aspects. Spring.
Prerequisites: Two semesters each of organic and general chemistry.

FCH 571 Wood Chemistry I: General Wood Chemistry (2)
Two hours of lecture per week. Introduction to carbohydrate chemistry. Chemistry of cellulose, hemicelluloses, and lignin. Cellulose derivatives. Distribution of polysaccharides and lignin in wood. Wood extractives. Chemistry of bark. Formation of heartwood. Wood as a chemical raw material. Fall.
Prerequisite: One or two semesters of a three-credit undergraduate course in organic chemistry.

FCH 630 Plant Biochemistry (3)
Three hours of lecture and discussion per week. Includes the biochemistry of photosynthetic electron transport and phosphorylation, photosynthetic carbon fixation, photorespiration, nitrogen fixation, nitrate reduction, photochrome, and plant hormones. The economic, ecological and environmental aspects of plant biochemistry will also be discussed. Spring.
Prerequisites: FCH 530, FCH 532.

FCH 650 Statistical Physics and Chemistry of Macromolecules (3)
Three hours of lecture per week. Topics to be discussed are chain statistics, polymer thermodynamics, scaling theory, colloidal particles, viscoelasticity and the glass transition. Spring, even years.
Prerequisites: FCH 360 and FCH 552 or equivalent; consent of instructor.

FCH 796 Special Topics in Chemistry (1 - 3)
Lectures, conferences and discussion. Advanced topics in physical chemistry, organic chemistry or biochemistry. Fall and Spring.

FCH 797 Graduate Seminar (1)
Presentation and discussion of a selected topic in chemistry. Topics to be selected by participating faculty each semester. Fall and Spring.

FCH 798 Research in Chemistry (1 - 12)
Independent research in physical and organic chemistry of synthetic polymers, physical and organic chemistry of natural polymers, organic chemistry of natural products, ecological chemistry and biochemistry. One written report required. Fall, Spring and Summer.

FCH 899 Master's Thesis Research (1 - 12)
Research and independent study for the master's degree and thesis. Fall, Spring and Summer.

FCH 997 Seminar (1)
Seminars scheduled weekly; an average of 20 to 30 seminars are given annually. Discussion of recent advances in chemistry. Credit is given only once to a student. Fall and Spring.

FCH 999 Doctoral Thesis Research (1 - 12)
Research and independent study for the doctoral degree and dissertation. Fall, Spring and Summer.

FOR - Forestry (Resource Management)

FOR 106 Introduction to Green Entrepreneurship (3)
One-week short-course. An introduction to the challenges and goals of creating a start-up venture in environmental science or technology. Recognize marketplace trends and creating commercial opportunities. Analyze feasibility and potential to create a sustainable venture. Topics include critical success factors and key start-up issues unique to science and technology. Summer.
Prerequisite(s): Completed 11th grade.

FOR 132 Orientation Seminar: F&NRM (1)
Thirteen hours of lecture and six hours of field time. An introduction to forest and natural resource management and related career paths. Indoor and outdoor lectures expand student awareness of ESF's educational opportunities, properties, and faculty in FNRM. Fall.

FOR 201 Introduction to Watershed Hydrology (2)
One hour of online lecture per week. Introductory survey of the distribution of water throughout the atmosphere, biosphere, and the physical earth. Topics include major storages and flows of water including precipitation, evaporation, runoff, urban stormwater, and soil storage, as well as water budgets and watershed management. Spring, fall, summer.

FOR 202 Introduction to Sociology (3)
Three hours of lecture per week. General introductory principles and methods of sociology including group dynamics and development, different structural arrangement of social groups, community development and adjustment processes, relationships with the natural environment. Fall and Spring.

FOR 203 Western Civilization and the Environment (3)
Three hours of lecture per week. General survey of the history of Western civilization from ancient societies through the seventeenth century, with attention to environmental and natural resource issues and perspectives. Analysis of the rise of the West. Historic and contemporary influences of the Western tradition. Fall and Spring.

FOR 204 Natural Resources in American History (3)
Three hours of lecture/discussion per week. Introductory survey of American history from colonization through the twentieth century, with attention to natural resources use, allocation, and management. Environmental history and introduction to historiography. Fall and Spring.

FOR 207 Introduction to Economics (3)
Three hours of lecture per week. Coverage of basic theory in microeconomics and macroeconomics. Application of theory and economic models

to problems at the firm and national policy levels. Exploration of topics in money and banking, globalization and economic development. Fall and Spring.

FOR 232 Natural Resources Ecology (3)
Two hours of lecture/discussion and three hours of laboratory per week. Introduction to basic principles of ecology as they relate to terrestrial ecosystems and natural resources. The physical environment, genetics and adaptation, ecosystem structure and function, competition and community dynamics, human impacts from local to global levels. Physiology of tree growth and development from a whole plant perspective. Spring.
Prerequisites: EFB 101/EFB 102 or equivalent (organismal biology).

FOR 296 Special Topics in Resource Management/Forestry (1 - 3)
Experimental, interdisciplinary or special coursework at the freshman or sophomore levels. Subject matter and course format vary from semester to semester. Fall or Spring.

FOR 301 Adirondack Forest Ecology and Dendrology (1)
Intensive field study, presented as the first portion of the Summer Program in Field Forestry. Field identification and ecology of common trees and some shrub and herbaceous species of the Adirondack region. Natural and cultural history of the area as it affects the growth and development of forest vegetation. Summer.

FOR 303 Introduction to Forest Resources Measurements (3)
Ten hours of lecture and 30 hours of laboratory per week for approximately three weeks. Summer Program in Field Forestry. Principles and methods used in the measurement of spatial and vegetative attributes of forest landscapes. Course stresses development of field ability in the areas of overland navigation, timber measurements, and habitat measurements. Summer.
Prerequisite: FOR 301.

FOR 304 Adirondack Field Studies (4)
Four-week field course with five hours of lecture and 30 hours of field laboratory per week. Introduction to silvics, forest ecology and natural and cultural history as a basis for understanding forest vegetation and other natural resources. Principles and methods for the measurement of spatial and vegetative attributes of forested landscapes. Course stresses development of field ability in common plant identification, overland navigation and timber, tree, forest and habitat measurements, and synthesis of field data. Summer.

FOR 312 Sociology of Natural Resources (3)
Three hours of lecture per week. The concepts and principles of sociology as applied to natural resource questions. Concepts of community, forest-dependent communities, shared identity, and social structures of resource-based groups. The forest as an integrated social and biological community. Spring.

FOR 321 Forest Ecology and Silviculture (3)
Two hours of classroom lecture with weekly three-hour trips and labs to forests across Central New York. Survey of forest tree and stand ecology (silvics) and silviculture concepts, applications and implications for treatment of forest stands for various values. Experiential learning emphasized through a strong field component of assessing vegetation, site quality and land use history variables, and treatment alternatives to create different forest conditions. For students outside forest resources management curriculum; not open to students taking FOR 332 and FOR 334. Fall.
Prerequisite: Botany or general biology. Note: Credit will not be granted for both FOR 321 and FOR 521.

FOR 322 Forest Mensuration (3)
Two hours of lecture and three hours of laboratory per week. Principles and methods used in the measurement of standing trees, forest stands, forest products and growth. Application of sampling designs and analysis for forest valuation and inventory planning. Fall.
Prerequisites: FOR 304 or equivalent. Co-requisite: APM 391 or equivalent. Note: Credit will not be granted for both FOR 322 and FOR 522.

FOR 323 Forest Biometrics (3)
Three hours lecture per week. Statistical techniques for analyzing problems in forest resource management including hypothesis testing, analysis of variance, simple and multiple linear regressions, and weighted least squares regression. Spring.
Prerequisite: APM 391 or equivalent.

FOR 324 Natural Resources Information Systems (3)
Two hours of lecture and three hours of laboratory per week. Introduction to, and foundation in the use of, the concepts and principles of geographic information systems, remote sensing, and global positioning systems, with particular emphasis in forest resource management applications. Spring.

FOR 330 Studies in Silviculture (3)
Three hours of lecture per week, with reading assignments, exams, and projects. Students gain an appreciation of silviculture and its use for influencing the character, composition, and development of forest stands, and the conceptual framework for those practices. Projects provide opportunities to explore techniques for analyzing forest stands and developing prescriptions. Fall

FOR 332 Forest Ecology (3)
Two hours of lecture/discussion and three hours of laboratory per week. Principles of ecology and their application to the understanding and analysis of forest ecosystems. The role of human activities and management interventions on the ecosystem functions of forest communities from local to global levels. Fall.
Prerequisite: EFB 232 Natural Resources Ecology or equivalent. Note: Credit will not be granted for both FOR 332 and FOR 532.

FOR 333 Natural Resources Managerial Economics (3)
Three hours of lecture per week. Applying economic tools and models to natural resource management decisions. Identifying and defining the economic information necessary to help in making better business decisions with respect to managing natural resources. Spring.
Prerequisite: FOR 207 or equivalent. Note: Credit will not be granted for both FOR 333 and FOR 533.

FOR 334 Silviculture (4)
Three hours of lecture and three hours of lab per week. The practice of silviculture in managing stands to serve various landowner interests. Field trips and exercises provide opportunities to see examples of silvicultural methods under different management scenarios, and to learn

and practice techniques for analyzing forest stands and developing prescriptions for their treatment. Fall.
Note: Credit will not be granted for both FOR 334 and FOR 534.

FOR 338 Meteorology (3)
Three hours of lecture/discussion per week. This is a shared resource course with FOR 538. An introduction to the atmospheric physical processes important to understanding weather and weather forecasting at the surface of the earth and macro-, synoptic-, meso-, and micro-climates. The emphasis is on synoptic and microscale phenomena. Students will learn how to access weather data on the Internet and use the data to forecast weather. At the microscale, emphasis is on describing conditions and projecting change. Fall.
Note: Credit will not be granted for both FOR 338 and FOR 538.

FOR 340 Watershed Hydrology (3)
Three hours of lecture per week. Basic principles of physical hydrology, including the movement of water through hydrologic reservoirs on global and watershed scales, measurement and quantification of hydrological data, runoff generation processes and water quality in the natural environment. Course content includes precipitation, evapotranspiration, streamflow generation, and fundamentals of groundwater flow. Fall.
Prerequisites or Co-requisites: Soils and/or Introductory Geology. Note: Credit will not be granted for both FOR 340 and FOR 540.

FOR 345 Introduction to Soils (3)
Two hours of lecture and three hours of lab per week. Introduction to the fundamentals of soil science in the context of soil as an ecosystem component. Fall.
Prerequisite or Co-requisite: 1 semester of Introductory Chemistry. Note: Credit will not be granted for both FOR 345 and FOR 545.

FOR 356 Introduction to Raster GIS Analysis (3)
Two hours of lecture/discussion and three hours of laboratory per week. An application of raster Geographic Information System technology to the solution of spatial problems in the fields of planning, forest management, landscape architecture, biology, ecology, and engineering. Students learn how to obtain raster geographic data, convert it to different spatial coordinates, carry out series of spatial overlay analyses, produce effective maps, and write effective reports. Spring.
Note: Credit will not be granted for both FOR 356 and FOR 556.

FOR 357 Practical Vector GIS (3)
Two hours of lecture/discussion and three hours of laboratory per week. This course teaches the application of vector Geographic Information System technology to the solution of spatial problems and the analysis of spatial data in the fields of planning, forest management, landscape architecture, biology, ecology, and engineering. Students will learn how to obtain geographic data, convert it to different spatial coordinates, carry out spatial queries and overlay analyses, produce effective maps, and write effective reports. Fall.
Note: Credit will not be granted for both FOR 357 and FOR 557.

FOR 360 Principles of Management (3)
Three hours of lecture per week. This course focuses on the basic theories, concepts, principles and functions of modern management and administration, with an emphasis on the four functions of management: leading, planning, organizing, controlling. The four functions of management are applied to the public and private sectors, as well as for profit and not-for-profit organizations. Environmental management systems, corporate ethics and social responsibility and systematic problem solving are among the principal topics emphasized. Fall.
Note: Credit will not be granted for both FOR 360 and FOR 560.

FOR 370 Forest Management Decision Making and Planning (3)
Two hours of lecture/discussion and three hours of laboratory per week. Introduction to the components of forest management decision making and planning. The topics include forest regulation, growth and yield, and harvest scheduling given that a landowner's goals may include more than just commercial timber production. Spring.
Prerequisites: FOR 322 and FOR 334. Note: Credit will not be granted for both FOR 370 and FOR 570.

FOR 372 Fundamentals of Outdoor Recreation (3)
Three hours of lecture/discussion per week. Introduction to the programs and practices of federal, state and local agencies and private organizations involved in planning, administration and management of outdoor recreation areas. Emphasis is placed on common resource and social problems faced by area managers, and how they integrate solutions into their plans. Spring.

FOR 373 Forest Operations (3)
Two hours of lecture and three hours of lab per week. Overview of forest roads and timber harvesting; planning, construction, and maintenance of forest roads; economic and environmental characteristics of harvesting systems; safety and health; wood procurement systems; and the role of forest operations in the broader context of forest management. Fall.
Prerequisite: FOR 322 or FOR 334 or permission of instructor.

FOR 402 Professional Forestry Mentoring Program (1)
One-hour session per week supplemented by a one-day internship with a professional forester. Sessions will focus on contemporary issues in forestry including a historical perspective of the forestry profession, what it means to be a forester today, the role of certification and licensing, and professional ethics. It will serve to increase the professionalism of the forestry students. Fall.
Prerequisites: Junior status or permission of instructor.

FOR 403 Humans and the Environment: New Zealand (4)
Three and one-half week study-abroad program examines the natural and cultural history and resource management of New Zealand's South Island. Through class lecture/discussion and field excursions, students obtain an understanding of integrated resource management and sustainability in protected areas. Spring.

FOR 415 Forestry Consulting and Wood Procurement (3)
Two hours of lecture, two hours of laboratory, and one hour of independent study per week. This course is designed to provide the skills and professionalism to succeed as forestry consultants and wood procurement foresters. Introduction to the structure of the forest products industry in the United States and more specifically the issues and challenges surrounding wood supply and forest management. Field exercises provide students the opportunity to assume the role of both a forestry consultant and wood procurement forester. Fall.
Note: Credit will not be granted for both FOR 415 and FOR 615.

FOR 430 Agroforestry (3)
Two hours of lecture and three hours of laboratory per week. The productivity of stands of trees as well as aggregations of agricultural and forest tree crops in tropical and temperate agroforestry systems are examined from an ecophysiological perspective with an emphasis upon species and species-site interactions. Quantitative techniques and local agroforestry field trips are integrated with lecture material to develop an ecological understanding of the basis for sound agroforestry as well as plantation management. Fall, odd years.
Prerequisites: FOR 332, FOR 323 or equivalent. Note: Credit will not be granted for both FOR 430 and FOR 630.

FOR 433 Silviculture Workshop (3)
Three hours of classroom or six hours field instruction, and three hours independent study per week. Advanced study of silviculture in managing stands to serve a variety of landowner objectives. Enhanced problem-solving skills related to stand analysis and prescription making. Field exercises provide practical experience in implementing silvicultural prescriptions. Spring.
Prerequisite: One prior course in silviculture.

FOR 442 Watershed Ecology and Management (3)
Three hours of lecture and discussion per week. Introduction to watershed ecology and stream ecosystems. Interactions and linkages among upland, riparian and stream processes. Management and restoration associated with multiple uses of forest and rangelands. Explore influences of spatial and temporal scale, watershed and network position, disturbance regimes, and global change. Fall.
Note: Credit will not be granted for both FOR 442 and FOR 642.

FOR 455 Forest Genetics and Tree Improvement (3)
Two hours of lecture and three hours of lab per week. General principles of genetics as applied to conservation and utilization of genetic diversity of forest tree species. Topics include selection of elite trees, pollen testing, tissue culture and seed propagation, field-test design, and germplasm conservation and utilization. Spring.
Prerequisite: EFB 307, or FOR 334, or FOR 321 or permission. Note: Credit will not be granted for both FOR 455 and FOR 655.

FOR 460 Managing Vegetation Using Integrated Pest Management (3)
Two hours of lecture, two hours of laboratory, and one hour of independent study per week. Understanding and managing vegetation using principles and practices of Integrated Pest Management. A variety of problem plants (pests or weeds) is considered, including trees, in the context of various terrestrial, non-crop ecosystems; natural areas; cultural landscapes and historic sites; and recreational trails, roadside, railroad, pipeline and powerline corridors. Individual research and management projects. Regular field trips and labs. Spring.
Note: Credit will not be granted for both FOR 460 and FOR 660. This course was added to the on-line catalog on October 23, 2009.

FOR 465 Natural Resources Policy (3)
Three hours of lecture/discussion per week. Examination of US and NYS government roles in natural resource policy, and how government policies influence the management of public and private lands. Analysis of institutions, participants, and drivers of public lands, forest, water, wetlands, wildlife, fisheries, and fire policies. Fall.

FOR 475 Human Behavior and Recreation Visitor Management (3)
Three hours of lecture per week and a one-day field trip. Applies sociological and psychological concepts to: 1) individual preferences for recreation activities and settings, 2) description of recreation visitor behavior, 3) sources of management problems, 4) developing direct and indirect visitor management practices, and 5) recreation planning decisions necessary to manage recreation settings and experiences. Students have the opportunity to apply concepts to personal recreation experiences. Spring.
Prerequisite: FOR 372 or equivalent. Note: Credit will not be granted for both FOR 475 and FOR 675.

FOR 476 Ecotourism and Nature Tourism (3)
Three hours of instruction per week. Overview of ecotourism and nature tourism programs and efforts around the world. Community, business, and organizational structures necessary for managing ecotourism and nature tourism programs are discussed, as are related environmental, social, and economic impacts. One-day field trip. Fall.
Prerequisite: FOR 372. Note: Credit will not be granted for both FOR 476 and FOR 676.

FOR 478 Wilderness and Wildlands Management (3)
Three hours of lecture per week. One, two-day, overnight field trip. Review of the state and federal legislation and agency policies that frame the planning and management of public lands designated as wilderness or wildlands. Emphasizes stewardship and management for protection of natural resources and human values. Concepts include carrying capacity, preservation of ecological conditions and processes, visitor management, dispersed recreation management, human values and benefits, and planning frameworks. Fall.
Prerequisite: FOR 372 or equivalent. Note: Credit will not be granted for both FOR 478 and FOR 678.

FOR 480 Urban Forestry (3)
Three hours of lecture per week. Evaluation and management of urban greenspace resources, with emphasis on urban trees, in the context of other values and management processes in urban areas. Class practice in evaluating urban greenspace and tree resources. Spring.
Prerequisite: Junior or senior status in any Forest and Natural Resources Management programs or permission of instructor for juniors and seniors in other programs. Note: Credit will not be granted for both FOR 480 and FOR 680.

FOR 481 Introduction to Arboriculture (3)
Two hours of lecture and one three-hour laboratory per week. Overview of the practice of arboriculture. Emphasis will be on site evaluation for species selection, planting, pruning, fertilization and removal of trees in an urban environment. Spring.
Prerequisite: Botany or Ecology.

FOR 485 Business and Managerial Law (3)
Three hours lecture/discussion per week. An introduction to the law governing business and management. Examination of sources of law, constitutional foundations, ethics, court systems and trials, contracts, agency, consumer law, security interests, bankruptcy, entrepreneurship law, corporations, torts, criminal law, personal property, real property, and wills and estates. Spring.

FOR 487 Environmental Law and Policy (3)
Three hours of lecture/discussion per week. Introduction to the approaches used in US environmental law. Analysis of common law and statutory designs and strategies used to address environmental problems. Examination of common law environmental remedies, Clean Air Act, Clean Water Act, Endangered Species Act, hazardous waste, and other environmental laws. Fall.
Prerequisite: Junior or Senior standing. Note: Credit will not be granted for both FOR 487 and FOR 687.

FOR 488 Natural Resources Agencies and Administration (3)
Three hours of lecture per week. Advanced examination of the public agencies responsible for the management of natural resources and the political and legal constraints on their powers and procedures. Analysis of agency rule making, agency adjudication, disclosure of information, political controls over agencies, judicial review of agency action, and laws administered by natural resource agencies. Spring.
Prerequisite: Junior or senior status and a course in American government or American history, or natural resources or environmental policy.
Note: Credit will not be granted for both FOR 488 and FOR 688.

FOR 489 Natural Resources Law and Policy (3)
Three hours of lecture/discussion per week. An introduction to the law governing the management of natural resources. Examination of the history and constitutional basis of natural resources law, wildlife and biodiversity law, protected lands law, water law, marine fisheries law, rangelands law, minerals law, and forest law. Spring.
Prerequisites: Junior or senior standing. Note: Credit will not be granted for both FOR 489 and FOR 689.

FOR 490 Integrated Resources Management (3)
One hour of lecture, three hours of laboratory, and three hours of supervised work per week. This capstone course emphasizes the assimilation, integration, and interpretation of the biophysical and socioeconomic sciences. It provides students with the opportunity to integrate skills and knowledge accumulated from professional and supporting coursework. A written comprehensive management plan, also presented orally in the field and classroom, provides the central vehicle by which students demonstrate their abilities as future natural resource managers. Spring.
Prerequisite: Senior status in Forest and Natural Resources Management.

FOR 495 Undergraduate Teaching Assistance (1 - 3)
Undergraduate students gain experience as teaching assistants. They assist the instructor with the teaching and learning experience, assist students with learning course concepts, and mentor students on how to succeed in an undergraduate course. Responsibilities vary by section and instructor. Fall and Spring.
Prerequisite: Permission of instructor. Prior completion of course to be assisted with grade of B or better.

FOR 496 Special Topics in Resource Management/Forestry (1 - 3)
Experimental and developmental courses in new areas of resource management/forestry or areas not covered in regularly scheduled courses. Topics may include but are not limited to the biological, physical, and social dimensions and the many and varied resources of forest lands and forestry. Specific detailed course descriptions for each course taught under the FOR 496 designation are available for student perusal. Fall, Spring and Summer.

FOR 498 Independent Study in Forest Resources Management (1 - 6)
Independent research or study in resource management/forestry for selected undergraduate students. Selection of subject area, nature of the research or study, and number of credit hours determined by student in conference with appropriate faculty member; initiative in taking FOR 498 rests with the student. Final written report is required for record. Fall, Spring and Summer.
Prerequisite: Cumulative GPA of at least 2.50 and approval of the adviser and instructor.

FOR 499 Independent Study/Internship in Forest Resources Management (7 - 12)
Independent research or study in resource management/forestry for selected undergraduate students; especially designed for internships spent off campus working for a resource management or forestry oriented firm or organization while also pursuing an academically oriented project. The selection of the study topic will be determined by the student in consultation with his/her adviser. Guidance will be provided by a faculty committee. Final written report is required for record. Limited to seniors in forest resources management. Fall, Spring and Summer.
Prerequisite: Must have a cumulative GPA of at least 3.00.

FOR 501 Introduction to Environmental Resources Management (2)
Two-week, field-based examination of forest, water, wildlife, recreation, and mineral resources and their management in New York State and surrounding states, framed by public administration, political science, economic, human dimension, and biophysical concepts. Emphasis is on experiential learning via a series of field trips. Fall (mid-August).
Prerequisite(s): Enrollment in the ERM MPS degree program.

FOR 513 Adirondack Forest Ecology and Management (2 - 3)
One-week, field-based examination of sustainable forest management in the Adirondacks, framed by concepts and issues associated with plant and wildlife ecology, silviculture, and forest management. Contemporary research on central Adirondack forests is featured based on work at the Huntington Wildlife Forest. Emphasis is on experiential learning via a series of trips to, and laboratories in, the forest. Fall (late summer).
Note: Credit will not be granted for both EFB 513 and FOR 513.

FOR 519 Green Entrepreneurship (3)
Three hours of lecture/discussion per week. Explore challenges and goals of creating a start-up venture in environmental science or technology. Recognize trends in the marketplace, and where commercial opportunities can be created. Analyze feasibility and potential to create a sustainable venture. Other topic areas include critical success factors and key start-up issues unique to environmental science and technology firms. Spring.
Prerequisite(s): FOR 207 Introduction to Economics or equivalent; or permission of instructor.

FOR 521 Forest Ecology and Silviculture (3)
Two hours of classroom lecture with weekly three-hour trips and labs to forests across Central New York. Study of the conceptual underpinnings and application of forest ecology via explorations of the environmental complex and silvicultural systems. Experiential learning is emphasized through a strong field component of assessing vegetation, site and land use history variables, and treatment alternatives to create different forest conditions. Provides a study of trees as individuals and communities, and how we can manipulate them both using planned methods and techniques to affect sustained production of a wide variety of forest ecosystem benefits, services, and values. Fall.
Prerequisite(s): Botany or general biology. Note: Credit will not be granted for both FOR 321 and FOR 521. Note: Not open to students taking FOR 534.

FOR 522 Forest Mensuration (3)
Two hours of lecture and three hours of laboratory per week. Principles and methods used in the measurement of standing trees, forest stands, forest products and growth. The application of sampling designs and analysis for forest valuation and inventory planning. Graduate students

will be required to complete two additional term projects in addition to those required of undergraduate students. Fall.
Prerequisites: FOR 304 or equivalent. Co-requisites: APM 391 or equivalent. Note: Credit will not be granted for both FOR 322 and FOR 522.

FOR 523 Tropical Ecology (3)
Preparatory lectures(1.5 hr/wk) coupled with intensive spring break field study on a tropical island in the Caribbean. Principles of tropical ecology, resource management, and island biogeography are presented. Field trips to a variety of tropical ecosystems including rain forest, coral reefs, crater lakes, montane rain forest with comparison to north temperate ecosystems. Additional fee covers costs of travel, lodging. Spring. Prerequisite(s): General Ecology
Prerequisite: General Ecology.

FOR 524 Forest Biometrics (3)
Three hours of lecture per week. Statistical methods and techniques including hypothesis testing, analysis of variance, simple and multiple linear regressions used for analyzing forest resource management problems and developing forest growth and yield models. Graduate students will be required to write a research paper in addition to those required of undergraduate students. Spring.
Prerequisite: APM 391 or equivalent. Note: Credit will not be granted for both FOR 323 and FOR 524.

FOR 530 Studies in Silviculture (3)
Three hours of lecture per week, with reading assignments, exams, and projects. Students gain an appreciation of silviculture and its use for influencing the character, composition, and development of forest stands, and the conceptual framework for those practices. Projects provide opportunities to explore techniques for analyzing forest stands and developing prescriptions. Fall

FOR 532 Forest Ecology (3)
Two hours of lecture/discussion and three hours of laboratory per week. Principles of ecology and their application to the understanding and analysis of forest ecosystems. The role of human activities and management interventions on the ecosystem functions of forest communities from local to global levels. Emphasis on application of knowledge, requiring a written report with a problem-solving focus. Fall.
Prerequisites: EFB 101, EFB 102 or equivalent and FOR 232 or equivalent. Note: Credit will not be granted for both FOR 332 and FOR 532.

FOR 533 Natural Resources Managerial Economics (3)
Three hours of lecture per week. An introductory course applying economic tools and models to natural resource management decisions. Identifying and defining economic information necessary to help in making better business decisions with respect to managing natural resources. Systematically analyzing the economic tools and models used in natural resources management. Spring.
Prerequisite(s): FOR 207 or equivalent and APM 105 or equivalent or permission of the instructor. Note: Credit will not be granted for both FOR 333 and FOR 533.

FOR 534 Silvicultural Practice (4)
Three hours of lecture and three hours of laboratory per week. The practice of silviculture in managing stands to serve various landowner interests, and explore the conceptual framework for those practices. Field trips and exercises provide opportunities to see examples of silvicultural methods under different management scenarios and to learn and practice techniques for analyzing forest stands and developing prescriptions for their treatment. Laboratory projects include reports that explore the conceptual and technical rationale for silvicultural decisions. Fall.
Note: Credit will not be granted for both FOR 334 and FOR 534.

FOR 535 Advanced Forest Soils (3)
Three hours of lecture/discussion per week concerning the current state-of-the-art in forest soils. Effect of intensive forest management on soil, soil-site-species relationships, forest fertilization tree nutrition. Application of forest soils information to silviculture. Spring.
Prerequisite: FOR 332 or beginning courses in soils and silviculture.

FOR 538 Meteorology (3)
Three hours of lecture/discussion per week. An introduction to the atmospheric physical processes important to understanding weather and weather forecasting at the surface of the earth and macro-, synoptic-, meso-, and micro-climates. The emphasis is on synoptic and micro-scale phenomena. Students will learn how to access weather data on the Internet and use that data to forecast weather. At the micro-scale, emphasis is on describing conditions and projecting change. Fall.
Note: Credit will not be granted for both FOR 338 and FOR 538.

FOR 540 Watershed Hydrology (3)
Three hours of lecture per week. The course covers basic principles of physical hydrology, including the movement of water through hydrologic reservoirs on global and watershed scales, measurement and quantification of hydrological data, runoff generation processes and water quality in the natural environment. Course content includes precipitation, evapotranspiration, streamflow generation, and fundamentals of groundwater flow. Students are expected to apply course concepts to an independent research project. Fall.
Prerequisite or Co-requisite: Soils and/or Introductory Geology. Note: Credit will not be granted for both FOR 340 and FOR 540.

FOR 545 Introduction to Soils (3)
Two hours of lecture and three hours of laboratory per week. Introduction to the fundamentals of soil science in the context of soil as an ecosystem component. Fall.
Prerequisite or Co-requisite: one semester of Introductory Chemistry or permission of instructor. Note: Credit will not be granted for both FOR 345 and FOR 545.

FOR 546 Forest Soil Genesis, Classification, and Mapping (3)
Three hours of lecture per week during the first two-thirds of the semester. The last third of the semester is devoted to fieldwork and production of a soil map. Models of soil genesis, application of the U.S. system of soil taxonomy, and soil mapping. Spring.
Prerequisite: Introductory course in soil science.

FOR 556 Introduction to Raster GIS Analysis (3)
Two hours of lecture/discussion and three hours of laboratory per week. An application of raster Geographic Information System technology to the solution of spatial problems in the fields of planning, forest management, landscape architecture, biology, ecology, and engineering. Students learn how to obtain raster geographic data, convert it to different spatial coordinates, carry out spatial overlay analyses, produce effective maps, and write effective reports. Students complete a final project, prepare a comprehensive report and present the results to the

class. Spring.
Note: Credit will not be granted for both FOR 356 and FOR 556.

FOR 557 Practical Vector GIS (3)
Two hours of lecture/discussion and three hours of laboratory per week. This course teaches the application of vector Geographic Information System technology to the solution of spatial problems and the analysis of spatial data in the fields of planning, forest management, landscape architecture, biology, ecology, and engineering. Students will learn how to obtain geographic data, convert it to different spatial coordinates, carry out spatial queries and overlay analyses, produce effective maps, and write effective reports. Students complete a final project, prepare a comprehensive report and present the results to the class. Fall.
Note: Credit will not be granted for both FOR 357 and FOR 557.

FOR 558 Advanced Topics in GIS (3)
Two hours of lecture/discussion and three hours of laboratory per week. This course builds on knowledge gained in introductory vector GIS courses and provides instruction in data structures, data models, between layer topologies, and geographic editing. Spring.
Prerequisite: FOR 357 or FOR 557 or equivalent experience with vector GIS.

FOR 560 Principles of Management (3)
Three hours of lecture per week. This course focuses on the basic theories, concepts, principles and functions of modern management and administration, with an emphasis on the four functions of management: leading, planning, organizing, controlling. The four functions of management are applied to the public and private sectors, as well as for profit and not-for-profit organizations. Environmental management systems, corporate ethics and social responsibility and systematic problem solving are among the principal topics emphasized. Graduate students lead the discussion of case studies and have a separate recitation section. Fall.
Prerequisite: graduate status. Note: Credit will not be granted for both FOR 360 and FOR 560.

FOR 570 Forest Management Decision Making and Planning (3)
Two hours of lecture/discussion and three hours of laboratory per week. Introduction to the components of forest management decision making and planning. The topics include forest regulation, growth and yield, and harvest scheduling given that a landowner's goals may include more than just commercial timber production. Sensitivity analysis of parameters used in forest management planning. Spring.
Prerequisites: FOR 322/522 and FOR 334/534 or permission of the instructor. Note: Credit will not be granted for both FOR 370 and FOR 570.

FOR 573 Forest Operations (3)
Two hours lecture and three hours of laboratory per week. Overview of forest roads and timber harvesting; planning, construction, and maintenance of forest roads; economic and environmental characteristics of harvesting systems; safety and health; wood procurement systems; and the role of forest operations in the broader context of forest management. Emphasis on application of knowledge, requiring a written report with a problem-solving focus. Fall.
Prerequisite: FOR 322 and FOR 334 or permission of instructor. Note: Credit will not be granted for both FOR 373 and FOR 573.

FOR 601 Environmental Resources Management Workshop (2)
Three-week examination of a current topic in environmental resources management. Synthesis course that applies environmental resources management knowledge and techniques through a group consulting assignment for a government or non-government environmental resource organization. Spring (late Spring).
Prerequisite(s): 501: Introduction to Environmental Resources Management and completion of majority of ERM MPS coursework.

FOR 607 Restoration Ecology (3)
Three hours of lecture per week. Students investigate and apply major ecological concepts to ecosystem restoration, including abiotic and biotic resource limitation, ecophysiology, trophic webs, disturbance, climate change, and alternative ecosystem states. Diverse readings and interactive class discussions have broad relevance to restoration practitioners, conservation biologists, and environmental engineers. Fall.
Prerequisite(s): an ecology course or permission of instructor.

FOR 610 Environmental Resources Business (3)
Three hours of lecture per week. This course introduces the student to the fundamentals of business accounting and finance and their application to environmental management. The course is small enterprise oriented with emphasis on practical applications and problem solving techniques. The primary objective is to provide the student with the tools to understand and solve the basic accounting and financial problems confronting businesses and organizations in the environmental management field. Topics covered include basic accounting techniques, financial analysis, time value of money, valuation of assets, capital budgeting techniques, capital structure theory. Spring.

FOR 615 Forestry Consulting and Wood Procurement (3)
Two hours of lecture, two hours of laboratory, and one hour of independent study per week. This course is designed to provide the skills and professionalism to succeed as forestry consultants and wood procurement foresters. Introduction to the structure of the forest products industry in the United States and more specifically the issues and challenges surrounding wood supply and forest management. Field exercises provide students the opportunity to assume the role of both a forestry consultant and wood procurement forester. Fall.
Note: Credit will not be granted for both FOR 415 and FOR 615.

FOR 620 Silvicultural Concepts and Applications (3)
Three hours of lecture or six hours of field studies and three hours of independent study per week. Advanced study of silviculture, including the conceptual basis for designing prescriptions to serve a variety of landowner objectives. Concurrent independent work on assigned projects enhances problem-solving skills related to stand analysis and prescription making. Reports articulate the conceptual basis for recommendations, and discuss likely outcomes based upon findings from research and computer simulations. Field exercises provide practical experience in implementing silvicultural prescriptions. Spring.
Prerequisite: previous studies in silviculture at the baccalaureate or higher level.

FOR 626 Plant Tissue Culture Methods (3)
Two hours of lecture and discussion and three hours of laboratory per week. Introduction to plant tissue culture for biotechnology research and as a propagation method. Emphasis will be on learning laboratory instrumentation and techniques for establishing cell cultures, producing transgenic cell lines, and regenerating whole plants. In addition to the scheduled lab exercises, an independent micropropagation or transformation project will be required. Fall.
Prerequisite: Permission of instructor. Note: Credit will not be granted for both BTC 426 and FOR/EFB 626.

FOR 630 Agroforestry (3)
Two hours of lecture and three hours of laboratory per week. The productivity of stands of trees as well as aggregations of agricultural and forest tree crops in tropical and temperate agroforestry systems are examined from an ecophysiological perspective with an emphasis upon species and species-site interactions. Quantitative techniques and local agroforestry field trips are integrated with lecture material. Critically analyze ecological factors as the basis for sound agroforestry as well as plantation management. Fall, odd years.
Prerequisite: FOR 332 or FOR 323 or equivalent. Note: Credit will not be granted for both FOR 430 and FOR 630.

FOR 635 Forest Soils and Their Analyses (3)
One hour of lecture, one hour of recitation, four hours of field and laboratory study of forest soils, emphasizing plant-soil relationships per week. Stress on quantification of plant-soil diagnostic techniques and their interpretation. Spring (odd years).
Prerequisite: FOR 446. Note: Background in physical and biological sciences recommended.

FOR 642 Watershed Ecology and Management (3)
Three hours of lecture and discussion per week. Introduction to watershed ecology and stream ecosystems. Interactions and linkages among upland, riparian and stream processes. Management and restoration associated with multiple uses of forest and rangelands. Explore influences of spatial and temporal scale, watershed and network position, disturbance regimes, and global change. Students will apply course concepts to an independent research project. Fall.
Note: Credit will not be granted for both FOR 442 and FOR 642.

FOR 645 Hydrological Techniques (2)
One hour of lecture and three hours of laboratory per week. Course will provide a hands-on learning experience in current instrument and measuring techniques in hydrology, meteorology and hydrogeology, necessary for research in the environmental sciences. The objective will be to explore the principles that govern the use of sensors and the operation of data acquisition systems. Spring.
Prerequisite: FOR 643. Note: Credit will not be granted for both FOR 445 and FOR 645.

FOR 655 Advanced Forest Genetics and Tree Improvement (3)
Two hours of lecture and three hours of laboratory per week. General principles of genetics as applied to conservation and utilization of genetic diversity of forest tree species. Topics include selection of elite trees, pollen testing, tissue culture and seed propagation, field-test design, and germplasm conservation and utilization. An independent research problem will be undertaken by the student. Spring.
Prerequisite: permission of instructor. Note: Credit will not be granted for both FOR 455 and FOR 655.

FOR 660 Managing Vegetation Using Integrated Pest Management (3)
Two hours of lecture, two hours of laboratory, and one hour of independent study per week. Understanding and managing vegetation using principles and practices of Integrated Pest Management. Variety of problem plants (pests or weeds) are considered, including trees, in the context of terrestrial, non-crop ecosystems: natural areas; cultural landscapes and historic sites; and recreational trail, roadside, railroad, pipeline and powerline corridors. Individual research and management projects. Regular field trips and labs. Spring.
Note: Credit will not be granted for both FOR 460 and FOR 660.

FOR 665 Natural Resources Policy (3)
Three hours of lecture per week. Analysis and application of political, policy formation, and policy administration theories to natural resources. Examination of drivers of U.S. natural resources policies. Analysis of private lands, public lands, forest, wildlife, endangered species, water, fire, and certification policies. Focus is on U.S. natural resources policies. Spring.
Prerequisite: graduate standing.

FOR 670 Resource and Environmental Economics (3)
Three hours of lecture per week. An introductory course in resource and environmental economics. Apply economic theories and models to analyze decisions concerning the use of forest, marine, and water resources and to analyze policy tools for mitigating pollution created as a result of production and consumption. Fall.
Prerequisite: A course in economics.

FOR 675 Human Behavior and Recreation Visitor Management (3)
Three hours of lecture per week and a one-day field trip. Applies sociological and psychological concepts to: 1) individual preferences for recreation activities and settings, 2) description of recreation visitor behavior, 3) sources of management problems, 4) developing direct and indirect visitor management practices, and 5) recreation planning decisions necessary to manage recreation settings and experiences. Students have the opportunity to apply concepts to personal recreation experiences. Lectures concurrent with FOR 475, additional lectures, reading, and data analysis required. Spring.
Prerequisite: graduate standing, instructor permission. Note: Credit will not be granted for both FOR 475 and FOR 675.

FOR 676 Ecotourism and Nature Tourism (3)
Three hours of instruction per week. Overview of ecotourism and nature tourism programs and efforts around the world. Community, business, and organizational structures necessary for managing ecotourism and nature tourism programs. Environmental, social, and economic impacts. One-day field trip. Graduate level readings, assignments, and exams. Fall.
Prerequisite: FOR 372. Note: Credit will not be granted for both FOR 476 and FOR 676.

FOR 677 Recreation Research Theory and Application (3)
Three hours of lecture per week. The major components of this course are: 1) how to apply a theoretical construct to create operational definitions used in social science, 2) identification of the inter-disciplinary approaches/theories used to investigate social/recreation behavior, and 3) a comparison of the various methods used in social research. Students have the opportunity to apply class objectives to their personal research. Fall.
Prerequisite: graduate standing, instructor permission.

FOR 678 Wilderness and Wildlands Management (3)
Three hours of lecture per week and one, two-day, overnight field trip. Reviews the state and federal legislation and agency policies that frame the planning and management of public lands designated as wilderness or wildlands. Emphasizes the use of wilderness research information for adaptive management approaches to stewardship of and planning for protection of natural resources and human values. Fall.
Prerequisite: FOR 372 or equivalent. Note: Credit will not be granted for both FOR 478 and FOR 678.

FOR 680 Urban Forestry (3)
Three hours of lecture per week. Evaluation and management of urban greenspace resources, with emphasis on urban trees, in the context of other values and management processes in urban areas. Class practice in evaluating urban greenspace and tree resources, development of a research paper on urban forestry. Spring.
Prerequisite: Permission of instructor. Note: Credit will not be granted for both FOR 480 and FOR 680.

FOR 685 Business and Managerial Law (3)
Three hours lecture/discussion per week. An introduction to the law governing business and management. Examination of sources of law, constitutional foundations, ethics, court systems and trials, contracts, agency, consumer law, security interests, bankruptcy, entrepreneurship law, corporations, torts, criminal law, personal property, real property, and wills and estates. Spring.

FOR 687 Environmental Law and Policy (3)
Three hours of lecture/discussion per week. Introduction to the approaches used in US environmental law. Analysis of common law and statutory designs and strategies used to address environmental problems. Examination of common law environmental remedies, Clean Air Act, Clean Water Act, Endangered Species Act, hazardous waste, and other environmental laws. Analysis and application of primary and secondary legal sources to business and management problems. Fall.
Note: Credit will not be granted for both FOR 487 and FOR 687.

FOR 688 Natural Resources Agencies and Administration (3)
Three hours of lecture per week. Advanced examination of the public agencies responsible for the management of natural resources and the political and legal constraints on their powers and procedures. Analysis of agency rule making, agency adjudication, disclosure of information, political controls over agencies, judicial review of agency action, and laws administered by natural resource agencies. Analysis and application of natural resource law agencies and public administration peer-review literature. Spring.
Prerequisite: A course in American government, American history, or natural resources or environmental policy. Note: Credit will not be granted for both FOR 488 and FOR 688.

FOR 689 Natural Resources Law and Policy (3)
Three hours of lecture/discussion per week. An introduction to the law governing the management of natural resources. Examination of the history and constitutional basis of natural resources law, wildlife and biodiversity law, protected lands law, water law, marine fisheries law, rangelands law, minerals law, and forest law. Analysis and application of natural resources law research and commentary. Spring.
Note: Credit will not be granted for both FOR 489 and FOR 689.

FOR 690 Integrated Resources Management (3)
One hour of lecture, three hours of laboratory and three hours of supervised work per week.This capstone course emphasizes the assimilation, integration and interpretation of the biophysical and socioeconomic sciences. It provides students with the opportunity to integrate skills and knowledge accumulated from professional and supporting coursework. The final deliverable is a written management plan. Spring.

FOR 692 Capstone in Forest and Natural Resources Management (3)
Three hours of seminar discussions and presentations per week. Students will integrate and apply their knowledge of forest natural resources management to practical problems of their own design in their areas of interest, in consultation with clients whom they identify to be in need of their professional services. Class sessions include opportunities to develop advanced knowledge and professional skills, such as research, analysis, management, and communication. The final project outcomes are delivered through written reports and oral presentations. Fall.

FOR 694 Writing for Scientific Publication (3)
Three hours of lecture and discussion per week. Students will improve their skills in technical reporting by preparing a manuscript suitable for submission to a scientific journal. Topics include selection of an appropriate journal, design of effective figures and tables, sequential preparation of sections of the manuscript, writing tips, peer review and ethical issues. Spring.

FOR 695 Research Methods for Natural Resources (3)
Three hours of lecture and discussion per week. The conduct of scientific research in natural resources. Students design research questions and write a feasible research proposal. Issues include researchable questions, scientific literature, theory, practice, design, measurement, and analysis. Fall.
Pre- or co-requisite(s): Graduate student standing.

FOR 753 Advanced Natural Resource and Environmental Policy (3)
Three hours of lecture and discussion per week. Course takes a social history approach to examine the working principles forming the foundation for natural resource and environmental policies. These principles will be directed toward an appreciation of the institutional context for the domestic and global natural resource and environmental issues, and an understanding of the values, institutions, policies and rules, which govern societies and their relationship to their environment. Fall.
Note: Highly desired is previous coursework in public policy, natural resource or environmental policy, environmental law, public administration or property law.

FOR 770 Ecological Economics and Policy (3)
Three hours of seminar per week. A transdisciplinary approach to understand the interface of human and ecological systems, includes concepts and methods of ecologists, economists, and social scientists. Focus is on historical, conceptual and epistemological foundations. Draws on contemporary economic and policy thought, evolutionary biology, ecology, systems theory, social psychology, and environmental ethics. Spring.
Prerequisite: Graduate coursework in ecology or economics; doctoral student standing, or permission of instructor.

FOR 796 Special Topics in Forest Resources Management (1 - 3)
Lectures, seminars, and discussion. Advanced topics in resource management and policy. Check schedule of classes for details of subject matter. Fall and/or Spring.

FOR 797 Seminar (1)
Individual presentation and group discussion concerning current topics of concern to natural resources or their management. Fall and Spring.

FOR 798 Research Problems in Forest and Natural Resources Management (1 - 12)
Special investigation and analysis of forest and natural resources management topics. A study plan and a final written report are required. Fall and Spring.

FOR 898 Professional Experience/Internship (1 - 6)
Professional experience/internship which applies, enriches, or complements formal coursework. All professional experiences/internships must have a signed experience/internship agreement on record with the advisor. Graded on an "S/U" basis. Fall, Spring, and Summer.

FOR 899 Master's Thesis Research (1 - 12)
Investigation leading to the completion of a Master's thesis. Graded on an "S/U" basis. Fall, Spring, and Summer.

FOR 999 Doctoral Thesis Research (1 - 12)
Investigation leading to the completion of the doctoral thesis. Graded on an "S/U" basis. Fall, Spring and Summer.

FTC - Forest Technology

FTC 101 Trigonometry for Natural Resource Technicians (3)
Forty hours of lecture and sixteen hours of recitation conducted over a four-week period. A review of selected geometry and algebra topics, and an introduction to trigonometry and its applications. Emphasis on pythagorean theorem, quadratic equations, rectangular coordinate systems, right triangle trigonometry, oblique triangle trigonometry, the Law of Sines, the Law of Cosines and the graphing of trigonometric functions. Graphic calculator required. Summer.

FTC 105 Tree and Forest Biology (4)
A four-week summer program having 45 hours of lecture and 45 hours of lab. An introduction to the biology of trees and the diversity of animal life commonly found in forests. Field labs concentrate on biological relationships in Adirondack forests. Summer.
Pre- or co-requisite(s): Four credits in biology.

FTC 200 Dendrology (3)
Thirty eight hours of lecture, and forty hours of field laboratory. Characteristics, distribution, and uses of tree species in North America. Identifying plant species using common and scientific names, from leaf, twig, fruit, or bark samples. Habitats, species associates, and succession of plants, including some invasive species. Fall.

FTC 202 Introduction to Surveying (3)
Fifty hours of lecture and 80 hours of laboratory and field exercises. The course is an introduction to the theory and practice of plane surveying. Emphasis is on developing individual skills and techniques through small crew projects where it is necessary to handle typical surveying equipment in actual field situations. Lecture topics include the theory of measurements and errors, field record keeping procedures, mathematics for plane surveying, introduction to field problems, introduction to map use and preparation, concepts of land tenure systems and basic computer aided drafting. Students tour the various offices found at the County courthouse and participate in a research exercise. Field projects include traversing using common forester's and surveyor's tools and instruments, mapping including field and office procedure, and proficiency projects in handling various surveying instruments. Fall.

FTC 204 Introduction to Natural Resources Measurements (4)
Sixty hours of lecture and forty-five hours of field/laboratory. A study of the tools and techniques used to measure primary forest products and inventory natural resources, such as timber, biomass, carbon stocks, wildlife habitat, recreation use and impact, and plant diversity. Professional presentation of forest inventory data in the form of technical reports. Basic forest sampling methods are used and compared, and associated statistical analyses are learned and applied. Fall.
Co-requisites: FTC 200, FTC 202, FTC 208.

FTC 206 Forest Ecology (4)
Fifty-one hours of lecture and fifty-six hours of laboratory and field. Study of interactions between forest vegetation and the environment. Considers how sunlight, moisture, soils and climate impact species presence, composition and growth. Human dimension of forest ecology, including critical thinking and evaluation of environmental issues. Fall.

FTC 207 Forest Safety (1)
Ten hours lecture and twenty two hours laboratory provides students with technical competence and decision-making abilities. Students receive training on the proper use and maintenance of forest hand tools and chainsaws. First Aid and CPR/AED are covered. Safety hazards, and prevention, classification, and reporting of accidents are covered. Fall.

FTC 208 Geographic Information Technology (3)
Thirty-four hours of lecture and forty-nine hours of laboratory. An introduction to geographic theory and applications. Use and interpretation of topographic and other paper maps, aerial photographs, and digital imagery. Proficiency in hand-lettering and creation of scaled field maps including required map elements. Transfer mapping skills to computer using geographic information system software. Fall.

FTC 209 Adirondack Cultural Ecology (3)
Thirty hours of lecture and forty-six hours of field laboratory. A study of the changing perceptions for using the natural resources associated with the Adirondack Mountain region. An historical review of past exploitations of minerals and timber, the development of the Adirondack Park, and the evolution of economic and political issues regulating the Park. Fall.

FTC 210 Leadership and Forest Technology (3)
Thirty-two hours of lecture and thirty-six hours of laboratory time. Provides students with technical competence and decision-making abilities. Students receive training in the proper design and maintenance of forest hand tools, chainsaws, and skidding equipment. Maps, route surveys, and trail development are covered. Students learn about company and agency organization; the selection, placement, training, and evaluation of workers; managing crews and the techniques of foremanship; and human relations in the workplace, with emphasis on the special personnel problems of the forest and surveying industry. Fall.

FTC 211 Silviculture (4)
Forty-five hours lecture and sixty hours field lab. Regeneration and tending of forest stands. Physical and chemical treatments used for growing forests in the northeastern states. Introduction to silviculture in the southern and western states. Methods for quantifying and predicting forest growth. Marking timber stands for harvesting. Establishing new stands. Spring.
Prerequisites: FTC 200, FTC 204, and FTC 206.

FTC 213 Forest Inventory Practicum (2)
Six hours of lecture and sixty four hours of field/laboratory. A practical field problem requiring students to use professional methods of collecting, analyzing, and presenting forest inventory data. Inventory of the timber/biomass resource and the development of a forest type map are emphasized. Spring.
Prerequisites: FTC 200, FTC 202, FTC 204, and FTC 208.

FTC 215 Timber Harvesting (2)
Fifteen hours of lecture and forty-five hours of field and laboratory time. Student learns basic harvesting methods with Northeast emphasis and its relationship to other forest uses. A technical competence in timber sale contract administration and basic timber appraisal is gained. Spring.
Prerequisites: FTC 208, FTC 210.

FTC 217 Wildland Firefighting and Ecology (2)
Twenty-five hours of lecture and sixteen hours of laboratory and field. An introduction to fire science. Learn basic principles of fire ecology, behavior, danger rating and control. Practical experience conducting a prescribed burn. Spring.
Prerequisite(s): FTC 200, FTC 204, FTC 206, FTC 210.

FTC 219 Introduction to Forest Recreation (1)
Fourteen hours of lecture and twenty hours field and laboratory time. A study of forest-recreation resources, their importance to humans, and of the basic history, laws and principles underlying forest-recreation management in the United States. The technical aspects of recreation management are emphasized, as is the study of public-land management, including wilderness. Spring.
Pre-requisites: FTC 207.

FTC 221 Natural Resources Management (3)
Thirty-five hours of lecture and thirty hours of laboratory and field. Addresses common issues in organizing a forest property to meet stakeholder goals. Techniques of growth and resource measurement, monitoring, and evaluation are emphasized. Examples and case studies of forest management and production activities are presented. A final project involves the application of knowledge accumulated at the ESF Ranger School in a management plan for an assigned forest property. Spring.
Prerequisites: FTC 204, FTC 206 and FTC 208.

FTC 223 Water Measurements (1)
Ten hours of lecture and sixteen hours of laboratory time. An introduction to water resources covering measurements taken at weather stations, snow courses, stream gauging stations, and other stream sample points. The hydrologic cycle, concept of flow, and the water balance equation are studied in detail. Students learn the management practices used to control erosion and water quality. Spring.
Prerequisite: FTC 202.

FTC 225 Timber Transportation and Utilization (3)
Forty three lecture hours and forty three laboratory hours. Students gain knowledge of graveled forest road administration, location, design, construction, and maintenance. Differences in wood structure, and their effects on wood products of various species are studied. Spring.
Prerequisites: FTC 208, and FTC 210. Co-requisite: 259.

FTC 232 Wildlife Techniques (2)
Fourteen hours of lecture and forty-eight hours field and laboratory time. Standard methods and techniques for measuring, monitoring, controlling and evaluating wildlife populations are discussed, demonstrated and/or practiced. Further practice in measuring and evaluating wildlife habitat. Identification of common birds, amphibians, reptiles and mammals by sight and sound.
Prerequisites: FTC 200, FTC 202, and FTC 204.

FTC 234 Wildlife Conservation (3)
Thirty-eight hours of lecture and twenty hours field and laboratory time. An introduction to the history and evolution of wildlife-related policies and laws, and to the biological, ecological, economical and sociological principles underlying wildlife management and conservation efforts in the United States. Terrestrial vertebrate animals serve as the basis of discussions and case studies. Students improve their communication skills by presenting papers and speeches on wildlife-related topics. Spring.
Prerequisite: FTC 206.

FTC 236 Interpretive Techniques in Forest Recreation (2)
Twenty-eight hours of lecture and twenty-four hours field and laboratory time. Students complete NAI's Certified Interpretive Guide course, and more closely study the relationship between interpretation and recreation management. Students improve their communication skills by presenting papers, speeches and interpretive posters. Spring.
Pre-requisites: FTC 200, FTC 202, FTC 204, and FTC 208.

FTC 237 Introduction to Water and Soil Resources (3)
Thirty-seven hours of lecture and twenty-four hours of laboratory and field. Introduction to watershed ecology and soil science. Interactions among upland, riparian, stream and wetland systems, including the hydrologic cycle. Study and measurement of soil physical, chemical and biological characteristics and processes. Recognize soil and water resource management and protection issues associated with multiple uses of forest lands. Spring.
Prerequisites: FTC 202, FTC 206, and FTC 208.

FTC 238 Forest Insects and Disease (3)
Thirty-five hours of lecture and twenty-six hours of laboratory and field. An introduction to forest insects and diseases. Explore ecological roles and identify selected insects and pathogens based on morphology, signs and symptoms. Discuss integrated pest management and other control measures. Spring.
Prerequisites: FTC 200, and FTC 206.

FTC 239 GIS Applications (2)
Fifteen hours of lecture and forty-five hours of laboratory. Introduction to acquisition, manipulation, and creation of geospatial data using geographic information systems. Build geodatabases, use geoprocessing tools, work with attribute data in both Excel and ArcGIS. Plan and conduct a simple geospatial analysis project. Spring.
Prerequisites: FTC 202, and FTC 208.

FTC 251 Advanced Surveying Measurements and Computations (5)
Fifty-five hours of lecture and sixty hours of field and laboratory time. Advanced survey measurements and computational techniques including traverse calculations, rectangular coordinates, statistical analysis of surveying data, state plane coordinates, meridian determination, partition of land, trigonometric leveling and horizonal control are explored. Students will make the necessary surveying measurements in the field and be expected to complete various surveying measurements using a calculator and computer. Spring.
Prerequisite: FTC 202. Co-requisite: FTC 257.

FTC 253 Survey Law (3)
Thirty five hours of lecture and 30 hours of laboratory time. The course is a study of courthouse real property research, property boundary determination by various methods, case and statute law as it relates to real property and land surveying, legal research and the liability and professionalism of the practicing land surveyor. Spring.
Prerequisite: FTC 202.

FTC 255 Boundary Surveying (3)
Thirty hours of lecture and forty-five hours of field and laboratory time. A study of the procedures necessary to conduct a retracement survey including preliminary office procedures, field practices, and preparation of final survey documents. Students will complete a retracement survey and use the compiled data in a mock trial. Spring.
Prerequisite: FTC 202. Co-requisite: FTC 253.

FTC 256 Subdivision Surveys (2)
Twenty hours of lecture and 30 hours of laboratory time. An introduction to the preparation of a multi-lot subdivision of a parcel of real estate. Development of a subdivision in relation to topography, zoning requirements, utility services, existing and proposed roads or streets and client requests. Students learn to design minor storm drain facilities in relation to the subdivisions. The student will incorporate all of the above while using survey software. Spring.
Prerequisite: FTC 202. Co-requisite: FTC 259.

FTC 257 Construction and Topographic Surveys (3)
Twenty-five hours lecture and sixty hours field and laboratory. A study of the various methods and techniques used to perform construction and topographic surveys and develop topographic maps. Theory, mathematics, and layout of circular, spiral and vertical curves. Layout of various construction projects including buildings, roads, pipelines and bridges will be discussed. Earthwork, staking and cross-section calculations will also be covered. Students complete a topographic mapping project and develop maps using appropriate surveying and mapping software. Spring.
Co-requisites: FTC 252 and FTC 259.

FTC 259 Introduction to Computer Aided Drafting and Design (4)
Fifty hours of lecture and 60 hours of field and laboratory time. An introduction to the concepts and procedures of using AutoCAD in conjunction with surveying programs to produce boundary, topographic and construction survey maps. Significant laboratory time dedicated to hands-on experience with software and hardware. Spring.

FTC 298 Independent Study in Forest Technology (1 - 6)
Independent study in forest technology to apply, enhance or supplement forest technology or related natural resource education. Objectives and scope of the project are negotiated in a learning contract between the student and instructor(s), with course admission based on permission of the instructor(s). Limited to those who have attended the complete regular SFT program, or those who have graduated from another forest technology program or a related natural resource program, or to students enrolled in any ESF program other than SFT. A maximum of six credit hours may be taken by any student in total. Semesters as arranged. Fall, Spring or Summer.

GNE - General Engineering

GNE 160 Computing Methods for Engineers and Scientists (3)
Two hours lecture and three hours laboratory per week. Introduction to algorithm design, programming structures, and data structures. Engineering calculation software including programming languages, spreadsheets, and simulation software. Application of computing methods to engineering problems and data analysis. Fall.

GNE 171 Engineering Mechanic Dynamics (2)
Two hours of lecture per week. Kinematics and kinetics of particles and rigid bodies; rectangular, normal and tangential, radial and transverse components; translation and rotation; force and acceleration; impulse; momentum; work and energy; impact. Spring.
Prerequisites: Statics and Calculus II.

GNE 172 Statics and Dynamics (4)
Four hours of lecture per week. This course provides fundamental principles, methods and applications of engineering mechanics. Development and discussion of analytic models for rigid-body mechanics are used to apply theories. Rigid bodies of a practical nature and at rest or in motion are covered. Fall.
Prerequisites: Algebra, derivative and integral calculus.

GNE 273 Mechanics of Materials (3)
Three hours of lecture per week. Theories of stress, deformation and stability of common structural materials subjected to various force systems. Spring.
Prerequisites: Integral calculus and statics.

GNE 330 Professional Engineering Skills Seminar (0.5)
Two hour seminar approximately every other week. Professional skills needed by engineers to be successful in their profession including teamwork, ethics, communications, impact of engineering solutions, life-long learning, and contemporary issues. Seminar topics include industry outlook, professional organizations, networking, finance, management, personnel issues, among other topics. Topics will typically be covered on a three-year cycle. Fall and Spring.

GNE 410 Structures (4)
Three hours of lecture, three hours of computation laboratory and discussion per week. Engineering principles in the analysis, planning design

and construction of components and framed structures under various types of loadings. The proportioning of wood, steel and composite members and the design of statically determinate structural systems. Emphasis is placed on the relationship between theoretical stress analysis and codes and specifications for appropriate materials and structural design practices. Fall.
Prerequisite(s): GNE 273 and scientific computing.

GNE 461 Air Pollution Engineering (3)
Three hours of lecture and discussion per week. Study of physical, chemical, legislative, and meteorological aspects of air pollution and its control. Air quality and emission standards. Local and global effects of air pollution and atmospheric dispersion modeling. Design principles of air pollution control devices. Fall.
Prerequisites: 1 year of college-level physics, chemistry and calculus. Note: Credit will not be granted for both GNE 461 and GNE 661.

GNE 530 Professional Engineering Skills Seminar (0.5)
Two hour seminar approximately every other week. Professional skills needed by engineers to be successful in their profession including teamwork, ethics, communications, impact of engineering solutions, life-long learning, and contemporary issues. Seminar topics include industry outlook, professional organizations, networking, finance, management, personnel issues, among other topics. Topics will typically be covered on a three-year cycle. A project is required. Fall and Spring.

GNE 661 Air Pollution Engineering (3)
Three hours of lecture and discussion per week. Study of physical, chemical, legislative, and meteorological aspects of air pollution and its control. Air quality and emission standards. Local and global effects of air pollution and atmospheric dispersion modeling. Design principles of air pollution control devices. Fall.
Prerequisites: 1 year of college-level physics, chemistry and calculus. Note: Credit will not be granted for both GNE 461 and GNE 661.

LSA - Landscape Architecture

LSA 132 Orientation Seminar: Landscape Architecture (1)
One hour of lecture, discussion and/or exercises per week. Occasional field trips. Orientation to campus resources available to ensure academic success. Introduction to the professional culture and some topics of interest to landscape architects. Fall.

LSA 182 Drawing Studio (3)
Six hours of studio and one hour of lecture per week. This drawing course introduces the students to materials, techniques and components of drawing, architectural elements and figure drawing. Fall and Spring.
Prerequisite: Landscape architecture students or permission of instructor.

LSA 190 Clashing Perspectives in the Built Environment* (3)
Three hours of lecture/discussion per week. Can obesity, depression, and other public health issues be linked to the design of cities and suburbs? Examine how past and present social behavior, societal needs and cultural values shape the environment. Explore the complex array of public and private decisions--and their unintended consequences--on our physical communities. Spring and Fall.
*This course description was added to the on-line catalog on October 21, 2009.

LSA 200 Basic Computing (1)
Three hours of lab per week for the first five weeks of the semester. Students learn skills for digital data storage (flash drives, HDs, externals, CD/DVD writing); data management (file formats, file versions, compression and backups); networking (throughput, e-mail, Blackboard, online storage and FTP); typefaces/fonts; scanning; printing; and basic office applications. Software training emphasizes Word, Excel, PowerPoint and scanning software. Summer or Fall.
Prerequisite(s): Undergraduate standing in Landscape Architecture or permission of the instructor.

LSA 205 Art, Culture and Landscape I (3)
Three hours of lecture per week. The course will examine the evolution of cultural expression in the arts and allied design professions. Lectures will emphasize the interrelationships between the arts and their cultural contexts from prehistory to the Renaissance. Fall.

LSA 206 Art, Culture and Landscape II (3)
Three hours of lecture per week. The course will examine the evolution of cultural expression in the arts and allied design professions. Lectures will emphasize the interrelationships between the arts and their relation to cultural contexts from the Renaissance to the present day. Spring.

LSA 220 Introduction to Landscape Architecture (3)
Three hours of lecture per week. LSA 220 presents an overview and introduction to the profession of landscape architecture. It presents a survey of the development of the profession in the United States and how the profession responds to societal needs in providing services to various public and private clients. Emphasis is placed on understanding the significance of environmental, socio/cultural, physical/visual, and aesthetic factors in developing intervention strategies and designs. Contemporary landscape architectural issues, practitioners and work are presented. Fall.

LSA 226 Foundation Design Studio I (4)
Five hours of studio and one hour of lecture per week. Studio time devoted to demonstrations, exercises and projects. Content focuses on skills and knowledge necessary to visualize and communicate 2-D and 3-D design ideas using appropriate traditional or digital graphic tools, techniques and technology. An emphasis is placed on the development of a working graphic and spatial design vocabulary and an introduction and application of fundamental design principles and the design process. Fall.
Prerequisite: LSA 182 or permission of instructor.

LSA 227 Foundation Design Studio II (4)
Five hours of studio and one hour of lecture per week. Studio time is devoted to demonstrations, exercises and projects. Content focuses on the expansion of skills and knowledge necessary to visualize and communicate 2-D and 3-D design ideas. An emphasis is placed on the development of a working understanding of the design process and its application toward the synthesis of design form in the landscape. Spring.
Prerequisite: LSA 226 or permission of instructor.

LSA 300 2D Digital Graphics and Documents (3)
Two hours of lecture and three hours of lab per week. Students learn skills in digital production methods for producing 2D graphics and

documents as posters, reports, and electronic presentations. Content includes image processing, vector drawing, desktop publishing, interactive and presentation document design, and basic computer use and digital workflow management. Software training emphasizes Adobe Creative Suite. Fall and Spring.
Prerequisites: Fall, none. Spring, undergraduate standing in landscape architecture or permission of the instructor. Note: Credit will not be granted for both LSA 300 and LSA 500.

LSA 301 Digital Graphics and Documents (2)
Two hours of lecture and three hours of lab per week for the first ten weeks of the semester. Students learn skills for producing digital graphics and documents (posters, reports and electronic presentations). Content includes image processing, vector drawing, desktop publishing, portable digital documents, presentation documents, and digital workflow management. Software training emphasizes Photoshop, Illustrator, InDesign and Acrobat. Spring.
Prerequisite(s): Undergraduate standing in the DLA Bachelor of Landscape Architecture program or the EFB Natural History and Interpretation program, or permission of the instructor. Note: Credit will not be granted for both LSA 301 and LSA 501.

LSA 302 3D Modeling (1)
Two hours of lecture and three hours of lab per week for the last five weeks of the semester. Students learn skills for producing graphic depictions from 3D digital models. Content includes 3D vector modeling and 2D bitmap image rendering to produce graphic output suitable for use in electronic presentations and digital print documents. Software training emphasizes Google SketchUp and Adobe Photoshop applications. Spring.
Prerequisite(s): Undergraduate standing in the DLA Bachelor of Landscape Architecture program, the EFB Natural History and Interpretation program, or permission of the instructor. Completion of LSA 301 recommended.

LSA 303 Computer Aided Design (2)
Two hours of lecture and three hours of lab per week for the first ten weeks of the semester. Students learn skills for producing digital technical drawings used mainly for construction documentation. Content emphasizes production of scale-specific vector drawings for print and portable electronic documents, and addresses digital workflow management. Software training emphasizes AutoCAD by Autodesk. Fall.
Prerequisite(s): Undergraduate standing in the DLA Bachelor of Landscape Architecture program or permission of the instructor. Completion of LSA 301 and 302 recommended.

LSA 304 Integrated Digital Graphic Methods (1)
Two hours of lecture and three hours of lab per week for the last five weeks of the semester. Students learn skills for producing graphics derived from collaborative digital processing (CAD, vector drawing, bitmap image processing, 3D modeling and GIS software). Content emphasizes graphics for print, report documents, and electronic display and distribution. Software training emphasizes AutoCAD, Adobe Creative Suite and SketchUp. Fall.
Prerequisite(s): Undergraduate standing in the DLA Bachelor of Landscape Architecture degree program or permission of the instructor. Completion of LSA 301, 302 and 303 recommended.

LSA 305 History of Landscape Architecture I (3)
Three hours of lecture per week. This course offers a survey of landscape architecture and urban design in the context of the cultural history of the western world. Prior to taking this class, students should have passed at least one semester of college-level art (LSA 206) or architectural history.

LSA 306 History of Landscape Architecture II (3)
Three hours of lecture per week. Survey of landscape design in the modern era, emphasizing the 20th century through the emergence of contemporary practice. Lectures and readings on significant movements, works and designers in the cultural, social and environmental context of the period. Fall.
Prerequisites: LSA 305, or permission of instructor.

LSA 311 Natural Processes in Design and Planning (3)
Three hours of lecture per week. An overview of basic principles and processes of physical and biological landscape systems with respect to their roles in landscape design and planning. Emphasizes landform, soil, slope, hydrology, climate, energy and general ecological issues as common elements influencing landscape design and the land use decision-making process. Sources and uses of environmental data are discussed. Fall.
Note: Credit will not be granted for both EST 311 and LSA 311.

LSA 312 Place/Culture/Design (3)
Three hours of lecture/discussion per week. Introduction to the interpretation of common places (streets, plazas, shopping malls, neighborhoods, parks, etc.) as expressions of culture. The course uses an interdisciplinary cultural studies approach to analyze the cultural processes and practices that shape places and applies these understandings in the context of design professions. Course requirements include readings, discussions, projects, reports and examinations. Field trips may be scheduled. Fall.

LSA 321 Ecological Applications in Planning and Design (3)
Three hours of lecture per week. Introduction to concepts of ecology and landscape ecology related to sustainable land planning and design. Emphasis on using theory to guide planning and design decision making, with a goal of greater integration of ecological concepts into professional work. Fall.
Prerequisite(s): Junior standing in the Bachelor of Landscape Architecture program or permission of the instructor.

LSA 326 Landscape Architectural Design Studio I (5)
Seven hours of studio and one hour of lecture per week. This course will instruct those enrolled in the processes of measuring various physical qualities of a site or landscape, and then how to apply knowledge of ecology, natural processes, and human behavior and culture to assess the viability of potential design uses and forms. The material addressed will include land measurement and measurement systems, physiography and landform, soils, hydrology, climate, and plant, animal and human ecology. A variety of manual and computer techniques for data collection, analysis and synthesis of natural and cultural systems information will be explored. The course will concentrate on the comparison of synthesis techniques and their use in land use and site design decision-making. Occasional local field trips will be utilized. Fall.
Prerequisites: LSA 182, LSA 226, LSA 227 and LSA 311 (or their equivalent) with grades of "C" or better, or permission of instructor.

LSA 327 Landscape Architectural Design Studio II (5)
Seven hours of studio and one hour of lecture per week. This course addresses intermediate to advanced level site design, including skill development, theory and strategies as they relate to design issues and process. Emphasis is placed on in-depth investigation of concept and form expression in small-scale site design. Focus is on the form implications of applying specific materials, plantings and structural systems through design development and detailing. Occasional field trips to illustrate various design solutions. (Student field trip and materials expenses $300-$400).
Prerequisite: LSA 326 with a minimum grade of "C" or better, or permission of instructor. Co-requisite: LSA 342.

LSA 333 Plants Materials (2)
One hour of lecture followed by three hours of field identification lab per week. Course provides an introduction to the identification, site requirements, natural and cultural history, community ecology, and landscape value of native and exotic woody and herbaceous plant materials typical of landscape architectural practice. Field identification labs include on-campus site walks and trips to local gardens, arboreta and natural areas to demonstrate the use of plants in designed and ecological settings. Fall.

LSA 342 Landscape Architectural Construction Technology (4)
Three hours of lecture and three hours of studio/laboratory per week. Lectures, project, and assigned readings. This course provides an introduction to important site construction basics, including landscape grading and landform manipulation. Topics addressed will include appropriate slopes for various site uses, surface and subsurface drainage, principles of cut/fill analysis, pedestrian and vehicular circulation design, horizontal and vertical road alignment, storm water management, and soil erosion control. Appropriate methods and technologies will be demonstrated through studio projects and exercises. Spring.
Prerequisite: College math (with algebra and trigonometry), LSA 326, or permission of instructor.

LSA 343 Landscape Materials and Structures (3)
Three hours of lecture and discussion per week. This course introduces the properties of various ”hardscape” design materials used in landscape architectural construction, as well as the appropriate structural systems and design detailing typical for design elements. Occasional local field trips. Spring.

LSA 422 Landscape Architectural Design Studio III (5)
Seven hours of studio and one hour of lecture per week. This course introduces and applies concepts urban and regional planning, environmental planning, and landscape ecology, in the context of large-scale landscape architectural, community, and urban design. Emphasis will be placed upon the application of appropriate technologies and strategies to foster environmentally and economically sustainable community forms, as well as greater environmental and social equity. Occasional field trips to illustrate various design solutions. (Student field trip and materials expenses $300-$400). Spring.
Prerequisites: LSA 327 with a minimum grade of "C" or better, or permission of instructor.

LSA 423 Landscape Architectural Design Studio IV (5)
Seven hours of studio and one hour of lecture per week. LSA 423 addresses the final refining stages of small-scale site design, design detailing, precise layout and grading, selection of individual plant specimens and other materials, and the production of "working drawings" or contract documentation. Projects will include development of a complete set of working "contract documents," including layout plans, grading plans, planting plans and design details and specification. Occasional field trips to illustrate various design solutions. (Student field trip and materials expenses $300-$400). Spring.
Prerequisite: LSA 422 with a minimum grade of "C" or better, or permission of instructor.

LSA 424 Preparation for Off-Campus Design Thesis Studio (1)
One hour of lecture and discussion per week. The initial orientation and exploration of suitable landscape architecture or environmental studies topics for study during LSA 460. Students will tentatively select topics, form off-campus groups and be assigned a faculty advisor. Fall.
Prerequisite: Senior BLA standing, or permission of instructor.

LSA 425 Orientation for Off-Campus Design Thesis Studio (3)
Three hours of lecture and/or discussion per week. The initial orientation and exploration of suitable landscape architecture or environmental studies topics for study during LSA 460. Students undertake a detailed literature review, identify and refine research/study methods and prepare a detailed study proposal, including logistical details for LSA 460 (Off-Campus Design Thesis Studio). Spring.
Prerequisite: LSA 424 and senior BLA standing, or permission of Off-Campus Program Director.

LSA 433 Planting Design and Practice (3)
Two hours of lecture and three hours of lab/studio exercises per week. This course concentrates on the ecological, aesthetic and technical considerations of woody and herbaceous plant use in landscape architectural design. Concepts covered include ecological relationships among plants, cultural requirements of plants, nursery production, planting design and composition, planting plans and specifications, and plant establishment and maintenance. Course utilizes field trips to gardens, arboreta and natural areas to demonstrate planting design concepts. Fall.
Prerequisite: LSA 333 or permission of instructor. Note: Credit will not be granted for both LSA 433 and LSA 633.

LSA 451 Comprehensive Land Planning (3)
Three hours of lecture per week. Introduction to the planning process including survey and analysis techniques, the comprehensive plan, political context, and land use controls. Selected functional planning areas such as land use, environmental, growth management, regional planning, and economic development planning. Legal and historical basis. Spring.
Prerequisite: LSA 311 or permission of instructor. Note: Credit will not be granted for both LSA 451 and LSA 651.

LSA 455 Professional Practice in Landscape Architecture (3)
Three hours of lecture per week. This course examines the historic and contemporary modes of landscape architectural practice including practice types, ethics, operations, and client systems. Particular emphasis is given to the projected trends of professional practice and with impact on future roles for the landscape architect. Professional development is reviewed as it relates to internship, licensing, and continuing education. Spring.
Prerequisites: Upper division standing in landscape architecture or permission of the instructor. Note: Credit will not be granted for both LSA 455 and LSA 655.

LSA 458 Off-Campus Design Thesis Studio: Faculty Advisor Visit, Weekly Reports and Field Studies (4)
Twelve hours of individual field study per week conducted in an international or domestic location. Short field studies executed through on-site

observation, sketching and analysis exercises. Study progress is communicated through weekly reports to an advisor and presented during the advisor's visit, the fifth week of the Off-Campus semester. Summer or Fall.
Prerequisites: LSA 423 and LSA 425 with a minimum grade of "C". Co-requisites: LSA 459, LSA 460.

LSA 459 Off-Campus Design Thesis Studio: Design Journal and Project Notebook (4)
Twelve hours of individual field study per week conducted in an international or domestic location. Field observations and travel experiences documented through daily graphic and narrative entries in a design journal/sketchbook. Thesis project studies and research documented through daily entries in a project notebook. Summer or Fall.
Prerequisites: LSA 423 and LSA 425 with a minimum grade of "C". Co-requisites: LSA 458, LSA 460.

LSA 460 Off-Campus Design Thesis Studio: Thesis Project (7)
Twenty-one hours of individual field research and studio per week conducted in an international or domestic location. The completion of a thesis project as delineated in a proposal prepared by the student and approved by the Off-Campus faculty advisor in LSA 425. Summer or Fall.
Prerequisites: LSA 423 and LSA 425 with a minimum grade of "C". Co-requisites: LSA 458 and LSA 459.

LSA 461 Off-Campus Final Presentation Seminar (1)
One hour of seminar per week. Seminar time devoted to individual presentations and critique. Content focuses on individual projects undertaken as a component of LSA 460. Spring.
Prerequisite: LSA 460.

LSA 470 Thematic Landscape Design Studio (6)
Eight and one-half hours of studio and one hour of lecture per week. Studio time devoted to demonstrations, exercises and projects. Content focuses on different themes, topics, and scales each year, traditionally addressing sub-disciplines in landscape architecture such as urban design, community design and planning, ecological design and restoration and cultural landscape preservation. Spring.
Prerequisite: LSA 423 or permission of the instructor. Note: Credit will not be granted for both LSA 470 and LSA 670.

LSA 480 Seminar in Urban Design (3)
Three hours of seminar per week. This course is an exploration of literature and case studies that address the history, theories, principles and practice of 19th and 20th century North American and European urban design. The format includes readings, discussion and presentations, papers, and a three-day field trip. Fall.
Prerequisite: Permission of instructor. Note: Credit will not be granted for both LSA 480 and LSA 680.

LSA 481 Cultural Landscape Preservation (3)
Two hours of presentation and one hour of discussion per week. The course provides an overview and introduction to cultural landscape preservation and the general preservation movement in the United States. Philosophy, history, and legislation of the preservation movement will be presented. The focus will be on preservation terminology and application, standards, guidelines and procedures. Research, identification, evaluation of significance, and integrity and treatment of cultural resources will be explored. Limited enrollment. Spring.
Prerequisite: Permission of instructor. Note: Credit will not be granted for both LSA 481 and LSA 681.

LSA 495 Selected Readings in Landscape Architecture (1 - 3)
Exploration of selected readings in depth with individual independent study upon a plan submitted by the student and related to credit hours assigned. Upon approval of the instructor, the student may systematically investigate some subject area encountered in regularly scheduled courses or may initiate research on a variety of subject areas of determined relevance. Fall and Spring.
Prerequisite: Permission of instructor.

LSA 496 Special Topics in Landscape Architecture (1 - 6)
One to three hours of class meetings per week. Special topics of current interest to undergraduate students in landscape architecture and related fields. A detailed course subject description will be presented as a topic area is identified and developed. Fall and Spring.
Prerequisite: Permission of instructor. Note: Credit will not be granted for the same topic in LSA 496 and LSA 696.

LSA 498 Introductory Research Problem (1 - 3)
Guided study of a selection of problems relating to landscape architecture and environmental design. Emphasis on study procedure and methods employed. Enrollment at periodic intervals throughout the semester. Fall, Spring and Summer.
Prerequisite: Permission of instructor.

LSA 500 2D Digital Graphics and Documents (3)
Two hours of lecture and three hours of lab per week. Students learn skills in digital production methods for producing 2D graphics and documents as posters, reports, and electronic presentations. Content includes image processing, vector drawing, desktop publishing, interactive and presentation document design, and basic computer use and digital workflow management. Students prepare and present a comprehensive digital portfolio designed for electronic display and distribution. Software training emphasizes Adobe Creative Suite. Fall and Spring.
Prerequisite: Fall, none; Spring, graduate standing in landscape architecture, or permission of instructor. Note: Credit will not be granted for both LSA 300 and LSA 500.

LSA 501 Computer Graphics II (3)
Three hours of lecture and lab per week. Knowledge and skills are developed in advanced processing techniques for digital photography, photorealistic visual simulation and 3-D modeling. Methods include 2-D drawing and image processing; 3-D modeling, rendering, animation, video and VR; and content assembly and conveyance using electronic publishing and business presentations. Additional readings and a supplementary research component. Fall and Spring.
Prerequisite: LSA 500 or permission of instructor. Note: Credit will not be granted for both LSA 301 and LSA 501.

LSA 552 Graphic Communication (3)
Two three-hour studios and one one-hour lecture per week. Studio time devoted to demonstrations, exercises, and projects focusing on sketching, drafting, drawing construction and rendering techniques used in the landscape architecture field. Introduction to drawing reproduction and technologies. Emphasis on skill development, use of graphics in the design process. Drawings, examinations and a final project constitute basis for grades. Fall.
Prerequisite: Graduate status in landscape architecture or permission of instructor.

LSA 596 Special Topics in Landscape Architecture (1 - 3)
Experimental or special coursework in landscape architecture for graduate and undergraduate students. Subject matter and method of presentation vary from semester to semester. Fall and Spring.
Prerequisite: Permission of instructor.

LSA 600 Design Studio I (4)
Nine hours of studio and one hour of lecture/discussion per week. The first in a sequence of studios focusing on the concepts, skills and methods of design. This course introduces students to the basic vocabulary of theoretical design principles, to the application and operation of these in the physical environment, and to the development of three-dimensional spatial concepts in community scale patterns. The requirements for the course include readings, examinations, field trips, design exercises and projects. Fall.
Prerequisite: Graduate status in landscape architecture or permission of instructor.

LSA 601 Design Studio II (4)
Five hours of studio and one hour of lecture per week. The second in a sequence of studios applying the concepts, skills and methods of design in a critical analysis of various natural and human systems in community scale environments. Concentration is on the evaluation of options concerning a variety of land use activities, with special emphasis on landscape analysis and the functional and spatial quality of built environments. The requirements for this course include readings, examinations, field trips, design exercises and projects. Spring.
Prerequisites: Graduate status in landscape architecture and LSA 600, LSA 552, or permission of instructor.

LSA 605 History of Landscape Architecture (3)
Three hours of lecture per week. Historical study and style analysis of Western culture on environmental design, and changing attitudes and relationships to the environment. Non-Western influences on Western culture. Study of historical personalities as well as periods that are of environmental concern up to the modern period. Additional readings and a supplementary research/writing component. Spring.
Note: Credit will not be granted for both LSA 405 and LSA 605.

LSA 610 Computer-Aided Design and Drafting (3)
One-half hour of lecture, two and one-half hours of laboratory, and a minimum of six hours additional laboratory per week are required. This course introduces the student to the fundamentals of computer-aided design and drafting. It covers the commands needed to create a two-dimensional drawing, with particular emphasis on techniques used in the design profession applications. The requirements for the course include completing self-tutorials, creating drawings and the completion of two major projects. Fall and Spring.
Prerequisite: General knowledge of manual drafting. Note: Credit will not be granted for both LSA 410 and LSA 610.

LSA 611 Natural Processes in Planning and Design (3)
Two hours and 40 minutes of lecture and one hour of discussion per week. This course addresses basic principles and processes of physical landscape systems with respect to their roles in landscape design and planning. Sources and uses of environmental data are discussed and illustrated. An emphasis is placed on landform, soil, slope, hydrology, climate and general ecological issues as common elements influencing landscape design and the land use decision making process. Fall.
Prerequisite: Graduate status in landscape architecture or permission of instructor.

LSA 615 Site Construction Grading, Drainage and Road Layout (3)
One hour of lecture and six hours of studio per week. This course provides an introduction to important site construction basics, including landscape grading and landform manipulation to achieve appropriate slopes for use and positive surface drainage, principles of cut/fill analysis and subsurface drainage, horizontal and vertical alignment for road design, storm water management, and soil erosion control. Appropriate analysis methods and technologies will be employed through studio projects and exercises. Spring.
Prerequisite: Graduate status in landscape architecture, concurrent enrollment in LSA 601 or permission of instructor.

LSA 620 Design Studio II--Advanced Site Design (4)
One hour of lecture and nine hours of studio per week. This course is the third in a sequence of landscape architectural design studios. It focuses on advanced issues in site design and on the integration of project programming and design development into the design process. Concentrations include detailed designing for site layout, grading, storm water management, interior and exterior planting, site furnishing, and site lighting. Design exploration and project communication techniques are pursued such as CAD, reprographics, and computer-based visual simulation. Course requirements include readings, field trips, exercises, and design projects. Fall.
Prerequisites: Graduate status in landscape architecture, LSA 601, LSA 611, LSA 615, or permission of instructor.

LSA 621 Design Studio IV--Community Design and Planning (4)
Nine hours of studio and one hour of lecture and discussion per week. Design studio problems addressing principles and practice of community design, the structure and language of human settlements, community design process, natural systems and community design, and an introduction to the history, traditions and literature of the field. Spring.
Prerequisite: LSA 620 or permission of instructor.

LSA 625 Orientation for Off-Campus Experiential Studio (2)
This course includes two hours of lecture and discussion per week. It is an exploration of cultural, logistical and academic issues relevant to a research, internship or self-directed study experience abroad. The format also includes research and readings. Open to MLA and MS candidates. Spring.

LSA 632 Plants and Landscapes (2)
Twenty hours of instruction per week for two weeks.This course provides an introduction to the identification and use of native and exotic plants typical of landscape architectural practice. It also introduces students to a range of landscape contexts ranging from natural areas to urban settings and establishes a foundation for the discussion of the social, historical and ecological themes and issues of each. Field trips required. Fall.
Prerequisite: Entering MLA status or permission of the instructor.

LSA 633 Planting Design and Practice (3)
Two hours of lecture and three hours of lab/studio exercises per week. This course concentrates on the ecological, aesthetic and technical considerations of woody and herbaceous plant use in landscape architectural design. Concepts covered include ecological relationships among plants, cultural requirements of plants, nursery production, planting design and composition, planting plans and specifications, and plant establishment and maintenance. Course utilizes field trips to gardens, arboreta and natural areas to demonstrate planting design concepts.

Students complete a final research project that explores current and emerging trends in the use of plant materials in landscape architectural design. Fall.
Prerequisite: LSA 632 or permission of instructor. Note: Credit will not be granted for both LSA 433 and LSA 633.

LSA 640 Research Methods (3)
Three hours of seminar per week. Students learn skills for: (1) performing scholarly activities associated with learning what is known about topics, (2) using accepted methods for producing new knowledge which possesses qualities of validity and reliability, and (3) preparing documents which meet expectations for academic rigor. Parallels between scholarship, research and design are emphasized. Spring.
Prerequisite(s): Graduate standing in DLA graduate programs in Landscape Architecture or permission of the instructor.

LSA 645 Construction Documentation Studio (3)
Six hours of studio and one hour of lecture per week. This course covers the production of traditional contract documents for bidding and construction of landscape architectural projects. Taught as a shared resource with LSA 445, students enrolled in LSA 645 participate in a separate studio section. Spring.
Note: Credit will not be granted for both LSA 445 and LSA 645.

LSA 650 Behavioral Factors of Community Design (3)
Three hours of lecture and discussion per week. An introduction to the contribution of the behavioral sciences to community design and planning is provided. Readings and discussions concern both theoretical and methodological aspects. Case studies are used to illustrate a variety of current behavioral science applications. Course assignments familiarize the student with basic behavioral science methods including questionnaires, observations and interviews. A final project provides an opportunity to synthesize course materials. Fall or Spring.
Prerequisite: Graduate status in landscape architecture or permission of instructor.

LSA 651 Comprehensive Land Planning (3)
Three hours of lecture per week. Survey of urban planning and design and environmental management in terms of contemporary challenges; legal, technological, administrative and political processes; human and ecological processes; the role of design; case studies, and current and projected best practices. Lectures, readings, discussions and presentations. Required field trip. Spring.
Note: Credit will not be granted for both LSA 451 and LSA 651.

LSA 652 Community Development and Planning Process (3)
Three hours of lecture per week. This course introduces planning and community development as connected, interdependent processes. Community dynamics, the participants in the planning and development processes, theories, principles and practices, and the role of design will be explored. Lectures, seminars, guest speakers, research projects, readings and discussion will be used to engage the course material. Fall.

LSA 655 Professional Practice in Landscape Architecture (3)
Three hours of lecture per week. This course examines the historic and contemporary modes of landscape architectural practice including practice types, ethics, operations and client systems. Particular emphasis is given to the projected trends of professional practice and with impact on future roles for the landscape architect. Professional development is reviewed as it relates to internship, licensing and continuing education. Students enrolled in LSA 655 will also produce a graduate project portfolio. Spring.
Prerequisite: Graduate status in landscape architecture or permission of instructor. Note: Credit will not be granted for both LSA 455 and LSA 655.

LSA 670 Thematic Landscape Design Studio (6)
Eight and one-half hours of studio and one hour of lecture per week. Studio time devoted to demonstrations, exercises and projects. Content focuses on different themes, topics, and scales each year, traditionally addressing sub-disciplines in landscape architecture such as urban design, community design and planning, ecological design and restoration and cultural landscape preservation. Additional readings and a supplementary research/writing component. Spring.
Prerequisite: LSA 423 or permission of instructor. Note: Credit will not be granted for both LSA 470 and LSA 670.

LSA 680 Seminar in Urban Design (3)
Three hours of seminar per week. This course is an exploration of literature and case studies that address the history, theories, principles and practice of 19th and 20th century North American and European urban design. The format includes readings, discussion, oral presentations, papers and a three-day field trip. This course fulfills the seminar requirement for students in the Community Design and Planning area of study. Fall.
Prerequisite: Permission of instructor. Note: Credit will not be granted for both LSA 480 and LSA 680.

LSA 681 Cultural Landscape Preservation (3)
Two hours of presentation and one hour of discussion per week. This course provides an overview and introduction to cultural landscape preservation and the general preservation movement in the United States. The philosophy, history and legislation of the preservation movement will be presented. The focus will be on preservation terminology and application, standards, guidelines and procedures. Research, identification, evaluation of significance and integrity, and treatment of cultural resources will be explored. A major research project and presentation are required. Spring.
Prerequisite: Permission of instructor. Note: Credit will not be granted for both LSA 481 and LSA 681.

LSA 696 Special Topics in Landscape Architecture (1 - 6)
One to three hours of class meetings per week. Special topics of current interest to graduate students in landscape architecture and related fields. A detailed course subject description will be presented as a topic area is identified and developed. Additional readings, supplementary research and writing assignments. Fall and Spring.
Prerequisite: Permission of instructor. Note: Credit will not be granted for the same topic in LSA 496 and LSA 696.

LSA 697 Topics and Issues of Landscape Architecture (1)
Two hours of lecture and discussion every other week. Topics for discussion are selected to acquaint the entering graduate student with a generalized view and current issues facing landscape architects. Fall.
Pre- or co-requisite: Audit LSA 220 and graduate status in landscape architecture or permission of instructor.

LSA 699 Landscape Architecture Internship (1 - 12)
Internships provide students with a supervised field experience to apply and extend their academic abilities in a professional working environment. Enrollment is possible at various times during the semester. Fall, Spring and Summer.

Prerequisites: Fast Track BLA/MS status and written approval of an internship contract by major professor, curriculum director and field supervisor.

LSA 700 Design Studio V - Integrative Studio (4)
One hour of lecture and nine hours of studio per week. This studio requires the integration of design/planning processes, research methods and information, and technical skills through focus on large-scale, community-based or multicommunity-based projects. Studio work will require individual and teamwork, as well as consideration of multidisciplinary contributions and interdisciplinary work. This studio is the final studio for all MLA students. Fall.
Prerequisite: LSA 621 or permission of instructor.

LSA 760 Off-Campus Experiential Studio (12)
This course involves research, internship or self-directed study abroad with faculty guidance. Activities include field analysis, research, documentation, or directed fieldwork based on faculty-approved student proposals. Immersion in the host culture is a required aspect of this course. A final report is required. The course is open to MLA and MS candidates. Summer and Fall.
Prerequisites: LSA 625 and LSA 799 with a grade of B or better. Note: Credit will not be granted for both LSA 460 and LSA 760.

LSA 796 Special Topics in Landscape Architecture (1 - 3)
One to three hours of lecture per week. Special topics of current interest to graduate students in landscape architecture and related fields. A detailed course subject description will be presented as a topic area is identified and developed.
Prerequisite: Permission of instructor.

LSA 798 Research Problem (1 - 12)
Special study of assigned problems relating to landscape architecture or planning, with emphasis on critical thinking. Fall, Spring and Summer.
Prerequisite: Permission of instructor.

LSA 799 Capstone or Thesis Proposal Development (3)
One hour of lecture/seminar and two hours of tutorial per week. Students develop and defend a proposal for their MLA capstone projects or MS thesis. Fall or Spring.
Prerequisite: LSA 640 or permission of instructor.

LSA 800 Capstone Studio (6)
One hour of lecture/seminar and 15 hours of studio per week. Students complete an academic landscape architecture investigation or professional-level project. Public presentations and comprehensive project documentation are required. Grades on an "S/U" basis. This is the final MLA studio prior to graduation. Fall or Spring.
Prerequisite: LSA 799.

LSA 898 Professional Experience (1 - 12)
A supervised external professional work experience that satisfies Option 2 of the master's study integration requirement. Graded on an "S/U" basis. Fall, Spring and Summer. Prerequisites: Formation of committee, approval of proposed experience by committee, and the sponsor of the professional experience.

LSA 899 Master's Thesis Research (1 - 12)
Research and independent study for the master's degree and thesis. Graded on an "S/U" basis. Fall, Spring and Summer.

PSE - Paper Science and Engineering

PSE 132 Orientation Seminar: Paper Science and Engineering (1)
One hour lecture per week or three-hour lab/field trip per week. Introduction to campus resources available to ensure academic success. Introduction to paper engineering as a field of inquiry and career path. Fall.
Note: Credit will not be granted for both BPE 132 and PSE 132.

PSE 200 Introduction to Papermaking (3)
Three hours of lecture per week. Historical and commercial consideration of the paper industry. Topics include wood handling, pulping, stock furnish, stock preparation and paper machine operation. Introductory discussions of papermaking technology, materials and paper making processes including environmental aspects. Fall.

PSE 201 The Art and Early History of Papermaking (3)
Two hours of lecture and three hours of studio per week. This papermaking course provides a historical (Asia - Far East) and artistic perspective in both lecture and studio formats. History lectures will include the influence of paper in non-western cultures as a practical medium for human communication and as a versatile medium for expression of various paper art forms. Studio sessions will vary but generally will focus on historical papermaking by hand using non-western techniques and those paper art forms of far eastern origin. More modern techniques in the creation of paper art forms will also be explored in studio sessions. Fall.

PSE 202 Pulp and Paper Laboratory Skills (1)
Three hours of laboratory per week provide a working knowledge of fundamental papermaking concepts. "Survival" skills learned enable students to perform well in subsequent PSE courses as well as summer employment. Operations and skills include: pulp preparation and analysis, papermaking, paper testing, report writing and team work. Spring.
Pre- or co-requisite: PSE 200 (concurrent registration).

PSE 223 Introduction to Lignocellulosics (3)
Three hours of lecture and three hours of laboratory per week. Topics included: structure and chemistry of lignocellulosic materials such as wood, including bark, agriculture residues, and grasses; major (cellulose, hemicelluloses, lignin) and minor constituents (extractives, proteins, ash); biosynthesis, distribution, structure, properties, conversion into energy, chemicals, and other products. Spring.

PSE 296 Special Topics in Engineering (1 - 3)
Provides experimental, interdisciplinary, or special coursework at the freshman and sophomore levels within the field of environmental resources engineering. Subject matter and course format vary from semester to semester and section to section. Fall and Spring.

PSE 300 Introduction to Papermaking (3)
Three hours of lecture per week. Historical and commercial consideration of the paper industry. Topics include wood handling, pulping, stock furnish, stock preparation and paper machine operation. Introductory discussions of papermaking technology, materials and paper making processes including environmental aspects. Fall.

PSE 302 Pulp and Paper Laboratory Skills (1)
Three hours of laboratory per week provide a working knowledge of fundamental papermaking concepts. "Survival" skills learned enable students to perform well in subsequent PSE courses as well as summer employment. Operations and skills include: pulp preparation and analysis, papermaking, paper testing, report writing and team work. Spring.
Pre- or co-requisite: PSE 300 (concurrent registration).

PSE 304 Mill Experience (2)
Twelve weeks full time pulp or paper mill employment approved by the Department between the junior and senior years. The student must submit a comprehensive report and give a presentation to fulfill this requirement. Fall, Spring and Summer.
Pre- or co-requisites: PSE 300, PSE 302.

PSE 305 Co-op Experience (2)
One semester full-time pulp or paper mill experience. Work experience as an engineering intern on company-assigned projects. Traditionally, the student works for a semester and adjacent summer also taking PSE 304. The student must submit a comprehensive report and give a presentation to fulfill this requirement. Fall and Spring.
Pre- or co-requisites: PSE 300, PSE 302.

PSE 350 Pulping and Bleaching Processes (3)
Two hours of lecture, three hours of laboratory per week. Discussion of the principles and fundamental chemistry applied in chemical pulping, chemical bleaching, and deinking processes. Transport and physical operations involved in fiber dispersion, washing, screening and refining. Conduct experiments in chemical pulping, chemical bleaching, de-inking, fiber refining and pulp evaluation. Spring.
Prerequisites: PSE 300, FCH 223 or PSE 223. Note: Credit will not be granted for both PSE 350 and PSE 550.

PSE 351 Pulping and Bleaching Laboratory Skills (3)
One hour of lecture per week provides background and information necessary for the three hours of laboratory per week. Students learn basic principles of chemical pulping and bleaching in a practical research format. Relative success in laboratory pulping and bleaching is determined by comparing results using over twenty standard test methods. Spring.
Pre- or co-requisites: FCH 223, FCH 360, FCH 380 with PSE 350 (concurrent registration).

PSE 361 Engineering Thermodynamics (3)
Three hours of lecture per week. Principles of classical thermodynamics applied to engineering practice. First and second laws; heat effects; property functions and their correlation; physical and chemical equilibrium; solutions and mixtures; power and refrigeration cycles. Thermodynamic analysis of processes and systems via case studies and computer simulation. Spring.
Prerequisites: MAT 296, FCH 152, PHY 211. Note: Credit will not be granted for both PSE 361 and ERE 561.

PSE 370 Principles of Mass and Energy Balance (3)
Three hours of lecture per week. Conservation of mass and energy applied to steady-state and dynamic process units and systems. Problem analysis and solution; computational techniques. Thermodynamic data and their use; real vs. perfect gases; steam properties; psychrometry. Fall.
Pre- or co-requisite(s): PHY 211, MAT 296 (or concurrent), FCH 152.

PSE 371 Fluid Mechanics (3)
Three hours of lecture per week. Fluid statics. Principles of mass, energy and momentum balance. Bernoulli's equation. Application to pipe flows, flow measurement and porous media. Movement of particles in fluid media. Rheology of fluids and suspensions typical in the pulp and paper industry (pulps, black liquor, etc.). Filtration and sedimentation of fibrous and particulate suspensions. Characteristics of pumps. Flow systems with economic considerations. Fall.
Prerequisites: PHY 211, FCH 152, MAT 296 or APM296. Note: Credit will not be granted for both PSE 371 and PSE 571.

PSE 436 Pulp and Paper Unit Operations (3)
Two hours of lecture and three hours of laboratory per week. Applications of momentum, heat, and mass transfer to operations in the pulp and paper industry. Topics include pulp flow, heater and heat exchanger design, black liquor evaporation, humidification, steam systems, paper and pulp drying, gas absorption, pulp washing, leaching, and extraction. Laboratory exercises include paper drying, pulp washing and cleaning, heat exchanger operations, and gas absorption for liquor preparation. Spring.
Prerequisites: PSE 361, PSE 370, PSE 371, BPE 335.

PSE 437 Equipment Troubleshooting and Maintenance (3)
Two hours of lecture and three hours of laboratory and/or recitation discussions per week, plus literature study of assigned topics. Provides students with fundamental knowledge in troubleshooting and maintenance of industrial machines, processes and systems used in pulp and paper, bioprocess, and chemical engineering field. Spring and/or Fall.
Note: Credit will not be granted for both PSE 437 and PSE 637.

PSE 438 Biorenewable fibrous and nonfibrous products (3)
Three hours of lecture per week. Three credit-hour advanced science course through the topics in the production and properties of lignocellulosic products. Topics cover fibrous products including different paper grades, nanocellulose and cellulose derivatives, and nonfibrous products including products of enzymatic and/or chemical conversion of biomass constituents. Spring and/or Fall.
Prerequisite(s): PSE465 Fiber and Paper Properties and/or PSE237 Introduction to Lignocellulosics or consent of instructor. Note: Credit will not be granted for both PSE 438 and PSE 638.

PSE 450 Pulping and Bleaching Processes (3)
Two hours of lecture, three hours of laboratory per week plus a critical review of recent literature on assigned topics including a technical write-up and presentation. Discussion of principle and fundamental chemistry in pulping and bleaching processes. Conducted experiments in pulping, bleaching and pulp evaluation. Spring.
Prerequisites: PSE 350. Note: Credit will not be granted for both PSE 450 and PSE 650.

PSE 456 Management in the Paper Industry (3)
Three hours of lecture per week. Provides the student with inter-active contact with active executives in the paper and allied industries. The student will develop and present studies of business cases in discussion forum to the class. An understanding of how general managers operate to manage an entire organization will be presented by visiting experts, class participation, group presentations, written papers and examinations. Spring.
Note: Credit will not be granted for both PSE 456 and PSE 656.

PSE 465 Fiber and Paper Properties (3)
Two hours of lecture and three hours of laboratory per week. Evaluation, study, and discussion of the physical, optical, and chemical properties of fibers, non-fibrous paper additives, and paper. The interrelationships between papermaking fibers, nonfibrous additives, and manufacturing methods, and their effects on the final quality of paper are discussed in correlation with different test methods. Spring and/or Fall.
Prerequisite: PSE 202 Introduction to Papermaking. Note: Credit will not be granted for both PSE 465 and PSE 665.

PSE 466 Paper Pigment and Barrier Coating (3)
Two hours of lecture/discussion per week. Evaluation and study of surface sizing, various pigment coating formulations, and introduction to polymers used in barrier coating. Study of equipment used in coating operations, fundamentals and parameters, which control their use and effects on final paper properties. Spring and/or Fall.
Prerequisite: PSE 465 Fiber and Paper Properties. Note: Credit will not be granted for both PSE 466 and PSE 666.

PSE 467 Papermaking Wet End Chemistry (3)
Three hours of lecture per week. Provides the student with the fundamental principles of colloid and surface chemistry as they relate to the interaction of papermaking materials and chemical additives in the wet end of a papermachine system. The topics of retention of fine solids and dewatering are addressed in detail. Application of the various topics presented during the course are made during a pilot papermachine trial. Spring.
Note: Credit will not be granted for both: PSE 467 and BPE 310.

PSE 468 Papermaking Processes (6)
One hour of lecture, six hours of laboratory per week. Laboratory study of the papermaking process, with emphasis on operation of the semi-commercial Fourdrinier paper machine. Emphasis is on the fundamentals of pulping, stock preparation, paper machine operation, evaluation of the finished product, and the collection and analysis of data to develop material and energy balances. Results of each paper machine run are evaluated in seminar-type discussions. Spring.
Prerequisites: PSE 300, PSE 370, PSE 465. Note: Credit will not be granted for both PSE 468 and PSE 668.

PSE 469 Functional and Nano Additives (3)
Two hours of lecture and three hours of laboratory and/or recitation discussions per week, plus literature study of assigned topics. Provides the student with fundamental knowledge of structure, occurrence and preparation of mineral materials, the concepts of mineralogy -with an emphasis on carbonates, silicates (clay, talcum), titanium dioxide, sulphates, aluminum compounds, as well as pigments. The use of mineral materials in paper making applications. Consideration of ecological and economic aspects in relation to the mineral applications. Spring and/or Fall.
Pre- or co-requisites: PSE 465. Note: Credit will not be granted for both PSE 469 and PSE 669.

PSE 477 Process Control (3)
Three hours of lecture per week. Presents an introduction to the principles of process control. Linear analysis, LaPlace transforms, and nonlinear simulation are presented and applied to feedback, and feedforward control. Examples of process simulation, accuracy and stability of control are drawn from paper industry processes. Fall.
Prerequisite: APM 485 or equivalent. Note: Credit will not be granted for both PSE 477 and PSE 677.

PSE 480 Engineering Design Economics (3)
Three hours of lecture per week. Steps of process design, engineering economic analysis, estimation of capital investment, operating costs, profitability measures, evaluation of alternatives, inflation. Modeling and computer simulation of process units and systems; use of software. Design exercises and case studies. Spring.
Prerequisites: PSE 370, MAT 296.

PSE 481 Engineering Design (3)
Three hours of lecture per week. Design-project procedure; data sources and development. Application of simulation and computer-aided design to process synthesis and plant layout. Formulation and solution of original design problems. Fall.
Prerequisites: PSE 371, PSE 372, PSE 480. Pre- or co-requisite: PBE 335.

PSE 492 Research Practice (3)
One hour of lecture per week and six hours of laboratory and/or recitation discussions, plus literature study of assigned topics, with emphasis on managing and executing a research project in the pulp and paper, bioprocess, chemical and environmental sector. Provides the student with in-depth knowledge of literature and patent search, correct research techniques, research planning, data gathering techniques and reporting. Fall.
Note: Credit will not be granted for both PSE 492 and PSE 792. Student needs to register for PSE 498 in Spring for research project execution.

PSE 496 Special Topics (1 - 3)
Lectures, conferences and discussions. Specialized topics in chemistry, chemical engineering and physics as well as topics pertaining to management as related to the pulp, paper, paperboard and allied industries. Fall and Spring.

PSE 498 Research Problem (1 - 4)
The student is assigned a research problem in pulping, bleaching, refining, additives, quality control of paper or paper products, or chemical engineering. The student must make a systematic survey of available literature on the assigned problem. Emphasis is on application of correct research technique rather than on the results of commercial importance. The information obtained from the literature survey, along with the data developed as a result of the investigation, is to be presented as a technical report. Fall, Spring and Summer.

PSE 550 Pulping and Bleaching Processes (3)
Two hour of lecture, three hours of laboratory per week. Discussion of the principles and fundamental chemistry applied in chemical pulping, chemical bleaching, and deinking processes. Transport and physical operations involved in fiber dispersion, washing, screening and refining.

Conduct experiments in chemical pulping, chemical bleaching, de-inking, fiber refining and pulp evaluation. Spring.
Prerequisites: Graduate student standing or consent of instructor. Note: Credit will not be granted for both PSE 350 and PSE 550.

PSE 552 Recycling (3)
Two hours of lecture and three hours of laboratory and/or recitation discussions per week, plus literature study of assigned topics. Topics include advanced process operation and calculations for deinking, dispersion, washing, cleaning and bleaching of recycled fiber raw materials including related chemistry used in the paper processing industry. Spring and or Fall.

PSE 570 Principles of Mass and Energy Balances (3)
Three hours of lecture per week. Conservation of mass and energy applied to steady-state and dynamic process units and systems. Problem analysis and solution; computational techniques. Thermodynamic data and their use; real vs. perfect gases; steam properties; psychrometry. Computer simulation of steady and non-steady state process systems. Fall.
Prerequisites: Physics, Calculus, and General Chemistry. Note: Credit will not be granted for both PSE 370 and PSE 570.

PSE 571 Fluid Mechanics (3)
Three hours of lecture per week. Fluid statics. Principles of mass, energy and momentum balance. Bernoulli's equation. Application to pipe flows, flow measurement and porous media. Movement of particles in fluid media. Rheology of fluids and suspensions typical in the pulp and paper industry (pulps, black liquor, etc.) Filtration and sedimentation of fibrous and particulate suspensions. Characteristics of pumps. Flow systems with economic considerations. Analysis of some papermaking operations such as drainage, dewatering, vacuum dewatering and wet pressing. Fall.
Prerequisites: Physics, Chemistry, Calculus. Note: Credit will not be granted for both PSE 371 and PSE 571.

PSE 596 Special Topics (1 - 3)
Lectures, conferences, discussions and laboratory. Topics in environmental and resource engineering not covered in established courses. Designed for the beginning graduate student or selected upper-division undergraduate. Fall and/or Spring.

PSE 637 Equipment Troubleshooting and Maintenance (3)
Two hours of lecture and three hours of laboratory and/or recitation discussions per week, plus literature study of assigned topics. Provides students with fundamental knowledge in troubleshooting and maintenance of industrial machines, processes and systems used in pulp and paper, bioprocess, and chemical engineering field. Spring and/or Fall.
Note: Credit will not be granted for both PSE 437 and PSE 637.

PSE 638 Biorenewable Fibrous and Nonfibrous Products (3)
Three hours of lecture per week. Three credit-hour advanced science course through the topics in the production and properties of biorenewable products for graduate students. Topics include fibrous products such as different paper grades; printing and writing paper, paper board, tissue, and specialty papers, and nanocellulose and cellulose derivatives and nonfibrous products such as hemicelluloses, lignin, pectins, extractives and products of enzymatic and chemical conversion of carbohydrates. Independent academic research component required. Spring and/or Fall.
Prerequisite(s): PSE 465 Fiber and paper Properties and/or, PSE 223 Introduction to Lignocellulosics or consent of instructor. Note: Credit will not be granted for both PSE 438 and PSE 638.

PSE 650 Pulping and Bleaching Processes (3)
Two hours of lecture, three hours of laboratory per week plus a critical review of recent literature on assigned topics including a technical write-up and presentation. Discussion of principle and fundamental chemistry in pulping and bleaching processes. Conducted experiments in pulping, bleaching and pulp evaluation. Spring.
Prerequisite(s): Organic, physical and analytic chemistry. Note: Credit will not be granted for both PSE 450 and PSE 650.

PSE 656 Management in the Paper Industry (3)
Three hours of lecture per week. Provides the student with interactive contact with active executives in the paper and allied industries. The student will develop and present studies of business cases in discussion forum to the class. An understanding of how general managers operate to manage an entire organization will be presented by visiting experts, class participation, group presentations, written papers, and examinations. The student will critically review selected literature and present their findings. Spring.
Note: Credit will not be granted for both PSE 456 and PSE 656.

PSE 665 Fiber and Paper Properties (3)
Two hours of lecture and three hours of laboratory per week. Advanced science course in evaluation, study, and discussion of the physical, optical, and chemical properties of fibers, non-fibrous paper additives, and paper. The interrelationships between fibers and nonfibrous paper additives, and manufacturing methods, and their effects on the final paper quality of paper are discussed. Independent academic research required. Spring and/or Fall.
Prerequisite: PSE 202 Introduction to Papermaking. Note: Credit will not be granted for both PSE 465 and PSE 665.

PSE 666 Paper Pigment and Barrier Coating (3)
Two hours of lecture per week. Advanced course in materials and processes used in surface sizing, pigment coating, and barrier coating for graduate students. Study of equipment used in coating operations, fundamentals and parameters, which control their use and effects on final paper properties. Independent literature research with report and presentation on a selected topic. Spring and/or Fall.
Prerequisite: PSE 465 Fiber and Paper Properties. Note: Credit will not be granted for both PSE 466 and PSE 666.

PSE 667 Colloidal and Interface Science Applications in Papermaking (3)
Three hours of lecture per week. Provides the student with the fundamental principles of Colloidal and Interface Science as it relates to the interaction of papermaking materials and chemical additives in the wet end of a paper machine system. The topics of retention of fine solids and dewatering are addressed in detail. Spring.
Pre- or co-requisite: Physical chemistry.

PSE 668 Papermaking Processes (3)
Two hours of lecture and three hours of laboratory per week. Study of the papermaking process from theoretical and practical standpoints featuring the operation of the pilot paper machines. Emphasis is on the fundamentals of stock preparation and paper machine operations, papermaking process and product design, evaluation of the finished product, and the collection and analysis of process data. An independent

project is required in conjunction with the undergraduate paper machine runs. Spring.
Pre- or co-requisite(s): PSE 300, PSE 370, PSE 665. Note: Credit will not be granted for both PSE 468 and PSE 668.

PSE 669 Functional and Nano Additives (3)
Two hours of lecture and three hours of laboratory and/or recitation discussions per week, plus literature study of assigned topics. Provides the student with fundamental knowledge of structure, occurrence and preparation of mineral materials, the concepts of mineralogy -with an emphasis on carbonates, silicates (clay, talcum), titanium dioxide, sulphates, aluminum compounds, as well as pigments. The use of mineral materials in paper making applications. Consideration of ecological and economic aspects in relation to the mineral applications. Spring and/or Fall.
Pre- or co-requisites: PSE465 Note: Credit will not be granted for both PSE 469 and PSE 669.

PSE 677 Process Control (3)
Three hours of lecture per week. Presents an introduction to the principles of process control. Linear analysis, LaPlace transforms, and nonlinear simulation are presented and applied to feedback, and feedforward control. Examples of process simulation, accuracy and stability of control are drawn from paper industry processes. Process identification using numerical techniques and MATLAB. Fall.
Prerequisite: Differential Equations. Note: Credit will not be granted for both PSE 477 and PSE 677.

PSE 792 Research Practice (3)
One hour of lecture per week and six hours of laboratory and/or recitation discussions, plus literature study of assigned topics. with emphasis on managing and executing a research project in the pulp and paper, bioprocess, chemical and environmental sector. Provides the student with in depth knowledge of literature and patent search, correct research techniques, research planning, data gathering techniques and reporting. Fall.
Note: Credit will not be granted for both PSE 492 and PSE 792. Student needs to register for PSE 798 in Spring for research project execution.

PSE 796 Advanced Topics (1 - 3)
Lectures, conferences, discussions and laboratory. Advanced topics in forest engineering, paper science and engineering, and wood products engineering. Fall and/or Spring.
Prerequisite: Permission of instructor.

PSE 797 Seminar (1 - 3)
Discussion of assigned topics in the fields related to Paper Science Engineering. Spring and Fall.

PSE 798 Research in Paper Science Engineering (1 - 12)
Independent research topics in Paper Science Engineering. Fall, Spring or Summer.
Credit hours to be arranged.

PSE 898 Professional Experience/Synthesis (1 - 6)
A supervised, documented professional work experience in the Master of Professional Studies degree program. Fall, Spring, or Summer.
Pre- or co-requisite(s): Approval of proposed study plan by advisor, Faculty, and any sponsoring organization.

PSE 899 Master's Thesis Research (1 - 12)
Research and independent study for the master's thesis. Fall, Spring or Summer.
Credit hours to be arranged.

PSE 999 Doctoral Thesis Research (1 - 12)
Research and independent study for the doctoral dissertation. Fall, Spring or Summer.
Credit hours to be arranged.