



## 2016-17 INTERDISCIPLINARY ELECTIVES FOR BSEE

YOUNG, NICOLE T  
ECE DEPARTMENT  
230 Larsen Hall

**-Advance level Physics courses (3000 level and higher)**

**- Completing the Physics minor**

**- Taking 3 courses that are 3000 level or higher of your choice**

**-Advance level mathematics courses (3000 level and higher)**

**- Completing the Mathematics minor**

**- Taking 3 courses that are 3000 level or higher of your choice**

## **Agricultural and Biological Engineering**

### ABE 3000C Applications in Biological Engineering

Credits: 3; Prereq: BSC 2010 or equivalent.

An overview of the research and applications of biological engineering, such as bioprocessing, biotechnology, transport processes, biosensors, bioremediation, biological materials and biomedicine.

### ABE 3063L Biological Engineering Laboratory

Credits: 2; Prereq: general biology, general chemistry and differential equations or the equivalent.

Quantitative laboratory studies of activities of biological systems, including microbial, plant and animal systems.

### ABE 3212C Land and Water Resources Engineering

Credits: 4; Prereq: ENV 3040C and MAP 2302; Coreq: CWR 3201 or EGN 3353C.

Introduces hydrology, flow through porous media, flood routing, grade control structures and erosion control.

### ABE 3612C Heat and Mass Transfer in Biological Systems

Credits: 4; Prereq: EML 3007; Coreq: ENV 3040C or CGN 3421 or ESI 4567C.

Transport phenomena, steady and unsteady-state heat conduction, radiation, free and forced convection, mass transfer, psychometrics and thermodynamics of biological processes.

### ABE 3652C Physical and Rheological Properties of Biological Materials

Credits: 3; Prereq: CHM 2045, MAC 2313 and PHY 2048.

Theory and use of physical and rheological properties of biological materials in agricultural engineering applications.

### ABE 4000 Nonpoint Source Pollution Modeling

Credits: 2; Coreq: ABE 3212C.

Concepts, principles and application of modeling and monitoring for assessment and management of nonpoint source pollution. Design and implementation of monitoring systems. Concepts of modeling agroecosystems and land use impacts on hydrologic/water quality response of upland catchments. Model selection, calibration, validation and application for comparative analysis. Screening models using geographic information systems. Case studies in current watershed management issues with a focus on agricultural waste and nutrient management using existing field and watershed models.

### ABE 4033 Fundamentals and Applications of Biosensors

Credits: 3; Prereq: Senior standing (4EG).

Provides a broad introduction to the field of biosensors, as well as an in-depth and quantitative view of biosensor design and performance analysis. Fundamental application of biosensor theory will be demonstrated, including: recognition, transduction, signal acquisition, and post processing/data analysis.

### ABE 4171 Power and Machines for Biological Systems

Credits: 3; Prereq: EGM 3520 and EML 3007.

Design and specification of power and machine elements applied to agricultural, biological and land and water resources or food engineering; fundamentals of power units, design of machine elements and power transmission.

### ABE 4231C Irrigation and Drainage Engineering

Credits: 4; Prereq: ABE 3212C.

Irrigation and drainage systems design, including pump sizing and specification, water distribution systems, plant water requirement, drainage systems and flood control.

### ABE 4303C Structural and Environmental Design

Credits: 3; Prereq: ABE 2012C and ABE 3612C.

Design and analysis of structures and environmental modification systems used in agricultural production.

### ABE 4413C Post-Harvest Operations Engineering

Credits: 3; Prereq: ABE 3612C.

Engineering principles and practices of post-harvest operations for the maintenance of quality of agricultural products. Design of systems and facilities.

### ABE 4660 Applied Microbial Biotechnology

Credits: 3.

Principles of microbial biotechnology with emphasis on applications of microorganisms for industrial processes; e.g., energy, environmental, food, pharmaceutical and chemical.

### ABE 4662 Quantification of Biological Processes

Credits: 3; Prereq: ABE 2062 or BSC 2010, EGN 3353 or CWR 3201, and ABE 3612C.

Quantitative description and analysis of biological processes pertaining to microbes, plants, animals and ecosystems. Biological transport phenomena, bioenergetics, enzyme kinetics, metabolism, bioregulation, circulatory and muscle systems, agroecosystems. Analytical and experimental laboratory for development of quantitative skills.

### ABE 4812 Food and Bioprocess Engineering Unit Operations

Credits: 4; Prereq: ABE 3612C, CWR 3201 or EGN 3353C.

Analysis of thermal freezing, evaporation, dehydration, contact equilibrium and mechanical separation processes as governed by the reaction kinetics and rheology of processed foods.

### ABE 4932 Special Topics

Credits: 1 to 4; can be repeated up to 10 credits; Prereq: instructor permission.

Variable subjects provide content for the study of agricultural engineering topics not offered in other courses.

## **Chemical Engineering**

### COT 3502 Computer Model Formulation

Credits: 4; Prereq: ECH 3023, MAP 2302 and MAC 2313.

Solutions of scientific and engineering problems using digital computers. Formulation of models for describing physical processes, numerical analysis and computer programming. (M)

### ECH 3023 Material and Energy Balances

Credits: 4; Prereq: CHM 2046, MAC 2312 and PHY 2048; Coreq: PHY 2049, MAC 2313 and MAP 2302.

Formulation and solution of material and energy balances utilizing physical/chemical properties of matter as applied to analyzing unit operations systems.

### ECH 3101 Process Thermodynamics

Credits: 3; Prereq: CHM 4411, COT 3502 and ECH 3264.

Introduces fundamental principles of classical thermodynamics. Applications to modeling and analysis of physical and chemical processes undergoing change.

### ECH 3203 Fluid and Solid Operations

Credits: 3; Prereq: COT 3502 and ECH 3264.

Characteristics of laminar and turbulent flow, mechanical energy balance, flow through packed beds and fluidization of solids, design of pumping systems and piping networks and metering of fluids.

### ECH 3223 Energy Transfer Operations

Credits: 3; Prereq: COT 3502 and ECH 3264.

Steady state conduction in solids and heterogeneous materials, transient conduction, convection heat transfer, heat transfer during boiling and condensation, radiation heat transfer, design of heat-transfer equipment and heat exchange networks.

### ECH 3264 Elementary Transport Phenomena

Credits: 3; Prereq: ECH 3023, MAP 2302 and MAC 2313.

Flux law and conservation equations of mass, energy and momentum; steady and unsteady states as applied to physical and chemical processing; macroscopic and microscopic analysis.

### ECH 4123 Phase and Chemical Equilibria

Credits: 3; Prereq: ECH 3101, ECH 3203 and ECH 3223.

Application of thermodynamic principles to systems of variable composition including the study of phase and chemical equilibria.

### ECH 4224L Fluid and Energy Transfer Operations Laboratory

Credits: 2; Prereq: ECH 3101, ECH 3203, ECH 3223 and ENC 3246; Coreq: ECH 4714L.

Laboratory work in unit operations involving heat and momentum transfer. (WR)

### ECH 4323 Process Control Theory

Credits: 3; Prereq: COT 3502 or ECH 3023 or MAP 2302; Coreq: ECH 4323L.

The analysis and automatic control of process systems in chemical engineering.

### ECH 4323L Chemical Engineering Laboratory 5

Credits: 1; Coreq: ECH 4323.

Laboratory work associated with ECH 4323.

### ECH 4403 Separation and Mass Transfer Operations

Credits: 3; Prereq: ECH 3101, ECH 3203 and ECH 3223.

Theory, design and evaluation of diffusional and staged mass transfer processes including distillation, absorption and extraction, leaching and membrane separations. Computer-aided design methods.

### ECH 4404L Separation and Mass Transfer Operations Laboratory

Credits: 2; Prereq: ECH 4403, ECH 4224L and ECH 4714L.

Laboratory work in unit operations involving mass transfer. (WR)

#### ECH 4504 Chemical Kinetics and Reactor Design

Credits: 4; Prereq: ECH 3264 and ECH 4123.

Homogeneous and heterogeneous reaction kinetic modeling and data analysis. Analysis and design of ideal batch, mixed, plug and recycle reactors. Heterogeneous catalysis and reactor design.

#### ECH 4524 Heterogeneous Chemical Kinetics Reactor Design

Credits: 2; Prereq: ECH 4504.

Theories of catalytic reactions of adsorbed species at solid surfaces, development of rate expressions with heat and mass transport properties through porous catalyst materials for design of heterogeneous chemical reactors.

Back to Top

#### ECH 4604 Process Economics and Optimization

Credits: 3; Prereq: ECH 3203 and ECH 3223; Coreq: ECH 4403.

Introduces the principles of process economics including specifications and costing of equipment, operations costing and economic evaluation of processes.

#### ECH 4644 Process Design

Credits: 3; Prereq: ECH 4403, ECH 4504, ECH 4604 and ECH 4824.

Preliminary design of conventional chemical processes including process specifications, siting and layout, equipment sizing, utility and manpower needs, safety and hazard analysis, environmental considerations and economic evaluation. Planning techniques for detailed engineering, construction and startup.

#### ECH 4714L Safety and Experimental Evaluation

Credits: 2; Prereq: ENC 3254; Coreq: ECH 4224L and STA 3032.

Laboratory and process safety analysis with emphasis on prevention and mitigation. Experiment design, evaluation and presentation of results. Integrated with ECH 4224L.

#### ECH 4824 Materials of Chemical Engineering

Credits: 2; Prereq: ECH 4123.

Relations between microscopic structure and macroscopic mechanical, thermal and electrical properties of organic and inorganic solids. Engineering applications, including corrosion.

#### ECH 4827 Processing of Complex Fluids

Credits: 3; Prereq: ECH 3203, ECH 3223, ECH 4123 and ECH 4824, or instructor permission.

The principles involved in quantitative adoption of chemical engineering unit operations and unit processes for the analysis and design of systems involving complex fluids.

## **Civil and Coastal Engineering**

#### CCE 4015 Civil Engineering Estimating

Credits: 3; Prereq: CCE 4204 and 3EG classification.

Design of systems for estimating and cost control of man-machine productivity for civil engineering projects. Analysis of cost factors required for optimization of engineering-investment efficiency.

### CCE 4204 Construction Equipment, Methods and Management

Credits: 3; Prereq: junior or senior standing, or instructor permission; Coreq: CGN 4101.

Theory and practice of construction operations, equipment utilization and construction methods. Analysis of costs. Optimizing crew and equipment. Heavy equipment costs. New emphasis on planning and executing a construction project.

### CCE 4811 Construction Engineering Design

Credits: 3; Prereq: CCE 4204, CGN 4102 and CES 4034.

Simulation of comprehensive construction project involving all phases of planning, scheduling and control from start to finish, which involves making major decisions. Oral presentation at the end of course.

### CEG 4011 Soil Mechanics

Credits: 4; Prereq: EGM 3520.

Physical properties of soils, compaction, flow of water through soil, distribution of stress within soil and consolidation. Laboratory.

### CEG 4012 Geotechnical Engineering

Credits: 3; Prereq: CEG 4011.

Subsurface exploration settlements analysis, slope stability, earth pressure and an introduction to foundation design.

### CEG 4104 Retaining Wall and Embankment Design

Credits: 3; Prereq: CEG 4012.

The application of soil mechanics to the design and analysis of various types of retaining structures and earthen embankments.

### CEG 4111 Foundation Engineering Design

Credits: 3; Prereq: CEG 4012.

Comprehensive design of geotechnical system, focusing on design of complete project and utilizing CAD programs. Designs, drawings and oral presentations through group effort.

### CES 3102 Mechanics of Engineering Structures

Credits: 4; Coreq: EGM 3520.

Introduces structural load, equilibrium, shear and bending moment diagrams, structural analysis software, classical methods for displacement determination, method of consistent deformations, slope deflection method, moment distribution method.

### CES 4141 Matrix Structural Analysis

Credits: 3; Prereq: CES 3102 and CGN 3421; EG classification or instructor permission.

Determining structural loads, solving matrix equations, direct stiffness method, formulation of element matrices, transformations, modeling realistic frame and truss systems, introduces the finite element method, determining convergence, interpretation of results, model validation.

### CES 4605 Analysis and Design in Steel

Credits: 3; Prereq: CES 3102 and CGN 3501; EG classification.

Elastic and plastic theories of design, design of members subjected to tension, compression, flexure and torsion. Design of connections and rigid frames.

### CES 4608 Advanced Steel Design

Credits: 3; Prereq: CES 4605 and EG classification.

Advanced topics in the design of steel structural building systems, advanced column and beam design, base plate design, moment amplification, second-order analysis, bracing considerations, beam-columns, interaction equations, connection design, composite design, plate girders.

### CES 4702 Analysis and Design in Reinforced Concrete

Credits: 3; Prereq: CES 3012 and CGN 3501C; EG classification.

Ultimate strength analysis and design of reinforced beams and columns, working stress design for flexure, design of footings and retaining walls.

### CES 4704 Advanced Reinforced Concrete Design

Credits: 3; Prereq: CES 4702 and EG classification.

Advanced topics in the design of concrete building systems. Long columns and frames, floor and roof systems, including two-way slabs, continuous beams, spandrel beams, torsion, foundations, introduces pre-stressed concrete.

### CGN 3421 Computer Methods in Civil Engineering

Credits: 4; Prereq: 3EG classification.

Computer programming, use of computers, numerical methods as applied to civil engineering problems, and civil engineering software.

### CGN 3501C Civil Engineering Materials

Credits: 4; Coreq: EGM 3520.

Studies the principal materials used for engineering purposes with special attention to mechanical properties and their importance to the engineer. Hands-on experience in testing of civil engineering materials.

### CGN 3710 Experimentation and Instrumentation in Civil Engineering

Credits: 3; Prereq: PHY 2049.

Fundamentals and applications of measuring systems commonly used in civil engineering. Topics include recording techniques, strain, force, displacement, flow, temperature, humidity and PH measurements.

### CGN 4101 Civil Engineering Cost Analysis

Credits: 3; Prereq: 3EG classification or instructor permission.

Analysis of civil engineering proposals, utilizing time-value and related factors. Feasibility and optimum life comparisons. Utility rate derivation, utility/cost method.

### CGN 4160 Civil Engineering Practice

Credits: 4; Prereq: 3EG classification or instructor permission.

Fundamentals of civil engineering professional practice: project management, construction delivery processes, business concepts, public policy, administration and leadership.

### CGN 4503 Pavement Design

Credits: 3; Prereq: CGN 3501C.

Function and material requirements of different elements of flexible and rigid pavement systems; characterization of soils, materials, traffic loads, and environment for design; flexible and rigid pavement design; new developments.



### CGN 4600 Public Works Engineering and Management Practices

Credits: 3.

Public works profession, organization, administration and management of operating divisions with emphasis on role of engineer.

### CGN 4806 Transportation-Water-Materials Design

Credits: 3; Prereq: senior standing.

Simulation of a design project experience through the completion and presentation of a comprehensive roadway project design. Students work in multi-disciplinary groups to complete a system design that includes traffic, materials, hydrologic and geotechnical considerations.

### CGN 4910 Structures-Geotechnical-Construction Comprehensive System Design

Credits: 3; Prereq: instructor permission.

Simulation of a design office experience through the completion and presentation of a comprehensive building design. Students work in multi-disciplinary groups to complete a system design that includes structural, geotechnical and construction management considerations.

### CWR 3201 Hydrodynamics

Credits: 4; Prereq: EGM 3400 and MAP 2302.

Classification and properties of fluids, hydrostatics, and conservation of mass, momentum and energy in fluid flow. Potential flow, similitude and physical modeling. Laminar and turbulent pipe flow. Introduces turbomachines.

### CWR 4114 Surface Hydrology

Credits: 3; Prereq: CWR 4202.

Occurrence and distribution of water by natural processes, including atmospheric thermodynamics, precipitation, runoff, infiltration, water losses, flood routing and catchment characteristics, analysis and methods of runoff prediction.

### CWR 4120 Groundwater

Credits: 3; Prereq: CWR 4202.

Introduces groundwater hydraulics, including hydrologic cycle, Darcy's equation, Dupuit assumption, well hydraulics, regional flow, freshwater-saltwater interface, flow in the unsaturated zone, fate and transport of contaminants and contaminant plume model.

### CWR 4202 Hydraulics

Credits: 3; Prereq: CWR 3201 or instructor permission.

Fundamental equations for pipe and open conduit flow. Development of design oriented formulas for pipes and open channels. Introduces hydrology.

### CWR 4306 Urban Stormwater Systems Design

Credits: 3; Coreq: CWR 4202.

Surface-water system design including: time of concentration, peak runoff rate, open-channel flow, gravity storm sewer, culvert, stormwater pumping, filtration systems, hydrograph generation, flood routing, site layout, site grading and permitting.

### CWR 4542 Water Resources Engineering

Credits: 3; Prereq: CWR 4202.

Study of water resources engineering applications including hydrology and statistics, groundwater, hydraulic machinery, dams and reservoirs, water quality, water quality modeling, water and waste-water treatment and water law and institutions.

### EGS 4034 Professional Ethics

Credits: 1; Prereq: junior standing.

Provides students with an interactive study of ethical, theory and the development of professionalism. Students review case studies of ethical conflicts in engineering practice. Course covers engineering codes of ethics and requires students to resolve theoretical situations through application of ethical codes.

### OCE 3016 Introduction to Coastal and Oceanographic Engineering

Credits: 3.

Introduces important coastal and oceanographic processes. Geophysical fluid motions; waves and tides; air-sea interaction; pollutant transport; coastal hydraulic and sedimentary processes. Not intended for engineering majors.

### TTE 4004C Transportation Engineering

Credits: 4; Prereq: 3EG classification.

Overview of the significance of highway transportation to the social and economic underpinnings of society. Introduces road vehicle performance, geometric design of highways, traffic flow and queuing theory, highway capacity and level of service analysis, traffic control and analysis at signalized intersections, and travel demand and traffic forecasting.

### TTE 4106 Urban Transportation Planning

Credits: 3; Prereq: TTE 4004C.

Overview of the four-step urban transportation planning process; includes analytical techniques for estimating future travel demand and state-of-the-art approaches.

### TTE 4201 Traffic Engineering

Credits: 3; Prereq: TTE 4004C.

General review of the fundamentals of traffic engineering with emphasis on field studies and data analysis.

### TTE 4203 Highway Capacity Analysis

Credits: 3; Prereq: TTE 4004C.

Provide students with detailed instruction on the procedures defined within the 2010 Highway Capacity Manual (HCM), including analytical chapters for uninterrupted and interrupted flow.

### TTE 4300 Transportation Systems Analysis

Credits: 3; Prereq: TTE 4004C.

Systems analysis in transportation planning and engineering, including supply, demand, equilibrium, evaluation and decision analysis.

### TTE 4824 Transportation Facility Design

Credits: 3; Prereq: SUR 4201 and TTE 4004C.

Simulates a comprehensive design of a transportation facility, specifically an arterial-freeway interchange. Utilizes state and national-level design manuals in preparation of standard plans. Applies the theoretical background gained in supporting classes, in areas such as traffic analysis, roadway design, roadway drainage and pavement design. Some review of this material is provided, as well as introduction of several new concepts. Emphasizes teamwork skills and technical communication skills.

## **Computer and Information Science and Engineering**

### CAP 3020 Theory and Practice of Multimedia Production

Credits: 3; Prereq: CAP 3027.

Combines the traditional media production pipeline and software engineering processes to synthesize an approach geared for the production of works incorporating both artistic and computational elements.

### CAP 3027 Introduction to Digital Arts and Sciences

Credits: 3; Prereq: COP 3504 or COP 3503.

Synergy between art and computing through a programming-oriented exploration of fundamental concepts in multimedia.

### CAP 3032 Interactive Modeling and Animation 1

Credits: 3; Prereq: MAC 1147 or equivalent.

Introduces programming and data structures for interactive two-dimensional multimedia applications. Representing form and transforms in two dimensions, capturing user actions and driving application behavior interactively. Graphical interfaces, image processing, automata and basic artificial intelligence.

### CAP 3033 Interactive Modeling and Animation 2

Credits: 3; Prereq: CAP 3032.

Introduces programming and data structures for interactive three-dimensional multimedia applications. Representing form and transforms in three dimensions, capturing user actions and driving application behavior interactively. Rendering, scene graphs, automats and basic artificial intelligence.

### CAP 3034 Introduction to Computer-Aided Animation

Credits: 3; Prereq: MAC 1147 or equivalent.

Introduces topics related to computer-aided animation. Rigging for forward and inverse kinematics. Skin weighting. Morph targets. Expression-driven animation, rigid-body and particle simulation.

### CAP 3220 Introduction to Computer-Aided Modeling

Credits: 3; Prereq: MAC 1147 or equivalent.

Introduces topics related to computer-aided modeling. Polygonal mesh, NURBS and subdivision surface meshes. Materials and shading networks. Lighting, shadows and rendering.

### CAP 4053 Artificial Intelligence for Computer Games

Credits: 3; Prereq: COP 3530.

Examines the use of A.I. in computer games. Topics include general A.I. knowledge, path finding, movement, tactics and planning, strategy, state machines, learning, dialogue, and emotions.

### CAP 4403 Introduction to Aesthetic Computing

Credits: 3; Prereq: COP 3530.

Basic concepts of applying aesthetics to the representation of formal discrete structures found in computing, as well as to their operational behaviors.

### CAP 4410 Digital Image Processing

Credits: 3; Prereq: COP 3530; and MAC 2312, MAC 3473 or MAC 3512.

Survey of techniques used to replicate the human vision process in computer systems. Topics include image formation, image algebra, filtering, range extraction, edge and boundary detection, region growing, and model based vision.

### CAP 4621 Artificial Intelligence and Heuristics

Credits: 3; Prereq: COP 3530.

Introduces artificial intelligence concepts. Heuristic search, clause form logic, knowledge representation, reasoning and inference, overview of computer vision, planning, natural language, Lisp and Prolog. (M)

### CAP 4680 Knowledge-Based System: Theory and Practice

Credits: 3; Prereq: COP 3530.

Concepts, theory and various applications for knowledge-based (expert) systems, reasoning schemes, knowledge representation, knowledge-based system tools, building knowledge bases, knowledge acquisition, reasoning under certainty and inexact reasoning.

### CAP 4730 Computational Structures in Computer Graphics

Credits: 3; Prereq: COP 3530.

Studies the major topics in computer graphics: display and output technology, two and three dimensional manipulations; space curves and surfaces, hidden surface removal and shading models.

### CAP 4770 Introduction to Data Science

Credits: 3; Prereq: COP 3530.

Introduces the basics of data science including programming for data analytics, file management, relational databases, classification, clustering and regression. The foundation is laid for big data applications ranging from social networks to medical and business informatics.

### CAP 4800 Systems Simulation

Credits: 3; Prereq: COP 3530.

Simulation methodology and practice. Covers basic concepts in modeling and analysis for both continuous and discrete systems. Combined simulation methods including integrated qualitative/quantitative system modeling. Uses in-house simulation software. (M)

### CDA 3101 Introduction to Computer Organization

Credits: 3; Prereq: COP 3504 or COP 3503; and MAC 2233, MAC 2311 or MAC 3472.

Organization of computing systems. Logical basis of computer structure. Machine representation of instructions and data, flow of control, and basic machine instructions. Assembly language programming. (M)

### CDA 4102 Computer Architecture

Credits: 3; Prereq: CDA 3101 and COP 3530.

Introduces computer architecture and system organization including virtual memory supports cache, pipeline, vector processing, multiprocessor and RISC architecture.

### CEN 3031 Introduction to Software Engineering

Credits: 3; Prereq: COP 3530.

Topics include software planning, specifications, coding, testing and maintenance. Students gain experience in the team approach to large system development. (M)

### CEN 4072 Software Testing and Verification

Credits: 3; Prereq: CEN 3031.

Concepts, principles and techniques of software testing and verification. Strengths and limitations of black-box and white-box testing methods; techniques for proving the correctness of programs.

### CEN 4721C Human-Computer Interaction

Credits: 3; Prereq: COP 3530.

Studies the major topics in the study, planning and design of the interaction between people and computers. Topics include interface design (principles, theories and guidelines), virtual environments, interactive devices and collaboration.

### CEN 4725 Natural User Interaction

Credits: 3; Prereq: COP 3530 with minimum grade of C.

Introduces the design, development and evaluation of Natural User Interaction (NUI) technologies (e.g., non-keyboard and mouse technologies such as touchscreen interaction, gesture interaction, speech interaction, etc.). Discussion of the hardware-to-software NUI pipeline and key considerations when developing NUI software, including existing platforms, toolkits and APIs used to create NUI software.

### CGS 3063 Computers and Modern Society

Credits: 3.

Impact of computers on society. Discussion includes specific cases from many areas, but does not include problem solution by the student. This course does not teach how to use the computer but gives an understanding of the implications of computers. (S) (WR)

### CGS 3065 Legal and Social Issues in Computing

Credits: 3; Prereq: previous experience in Unix environment.

Explores the history, the myth, the ethics, the law and the risks of computer-based technology in modern society. Emphasizes critical analysis of hypotheticals and case studies. Published material is supplemented with online references..

### CIS 4204 Penetration Testing: Ethical Hacking

Credits: 3; Prereq: COP 3530.

Introduces principles and techniques associated with the cybersecurity practice known as penetration testing or ethical hacking. The course covers planning, reconnaissance, scanning, exploitation, post-exploitation and result reporting. The student discovers how system vulnerabilities can be exploited and learns to avoid such problems.

### CIS 4301 Information and Database Systems 1

Credits: 3; Prereq: COP 3504, or COP 3503 and COT 3100.

The first part of a two-course sequence that studies the essential concepts, principles and techniques of modern database systems. Topics include modeling and querying of data using conceptual data models as well as the development of a database application. (M)

### CIS 4360 Computer and Information Security

Credits: 3; Prereq: COP 4600 or equivalent.

Covers systematic threat and risk assessment; programmed threats and controls in hardware, software, and human procedures; security policies, models, and mechanisms; theoretical limitations and practical implementations; certification and accreditation standards; and case study reviews. Coursework includes projects.

### CIS 4362 Introduction to Cryptology

Credits: 3; Prereq: COT 3100 or the equivalent.

Introduces classical and modern cryptography and cryptanalysis, including symmetric and asymmetric (public key) ciphers. The course covers cryptographic hash functions, block and stream ciphers, as well as differential and linear cryptanalysis. Reviews applications of cryptography, cryptographic standards and protocols, and analyzes case studies of failed implementations.

### CIS 4930 Special Topics in CISE

Credits: 1 to 4; can be repeated with change in content up to 12 credits. Prereq: departmental approval.

Variable content course providing an opportunity for in-depth study of topics not offered in other courses and of topics of current significance.

### CNT 4007C Computer Network Fundamentals

Credits: 4; Prereq: COP 4600.

The fundamental concepts, principles and standards of computer networks. Topics are introduced in bottom-up approach, starting from physical layer in OSI system architecture with a stronger focus on data link, mac, network and transport layers.

(M)

### CNT 4409 Network and System Security

Credits: 3; Prereq: CNT 4007C and COP 4600 or equivalent.

Examines networked threats and vulnerabilities; trust, identification, authentication, and authorization in networked and distributed systems; secure network protocols and standards; certification of network products; firewall configurations, intrusion detection, and anomaly detection; security flaws in network protocols and distributed applications. Coursework includes projects.

### COP 3229 Computer Programming Using C++

Credits: 3; Prereq: COP 3504 or COP 3503.

In-depth treatment of the C++ programming language. Introduces Windows programming using Visual C++.

### COP 3502 Programming Fundamentals 1

Credits: 3; Coreq: MAC 2311.

The first course of a two-semester introductory sequence for students planning further study in computer science, digital arts and sciences or computer engineering. Concepts of computer science and the process of computer programming, including object-oriented programming, procedural and data abstraction and program modularity.

### COP 3503 Programming Fundamentals 2

Credits: 3; Prereq: COP 3502 with a minimum grade of C or an AP exam in computer science with a minimum grade of 4; and MAC 2311.

The second course of a two-semester introductory sequence for students planning further study in computer science, digital arts and sciences or computer engineering. Concepts of computer science and the process of computer programming, including object-oriented programming, procedural and data abstraction and program modularity.

### COP 3530 Data Structures and Algorithm

Credits: 4; Prereq: COP 3504 or COP 3503 with minimum grade of C, COT 3100, and MAC 2234, MAC 2312, MAC 3473 or MAC 3512.

Algorithm development using pseudo languages, basic program structures, program design techniques, storage and manipulation of basic data structures like arrays, stacks, queues, sorting and searching and string processing. Linked linear lists. Trees and multilinked structures. (M)

### COP 4020 Programming Language Concepts

Credits: 3; Prereq: COP 3530.

Introduces programming language principles, including language constructs, design goals, run-time structures, implementation techniques and exposure to a wide variety of programming paradigms.

### COP 4331 Object-oriented Programming

Credits: 3; Prereq: COP 3530.

Fundamental conceptual models for programming languages illustrated with specific programming languages and application problems. Specific topics include class and object models, inheritance among classes, objects and static and dynamic systems and implementations.

### COP 4600 Operating Systems

Credits: 3; Prereq: CDA 3101 and COP 3530; knowledge of C or C++ recommended.

The design and implementation of various components of a modern operating system, including I/O programming, interrupt handling, process and resource management, computer networks and distributed systems. (M)

### COP 4620 Translators and Translator Writing Systems

Credits: 3; Prereq: COP 3530.

Translation of languages, scanning and parsing techniques. Translator writing systems. The implementation of a compiler. (M)

### COP 4720 Information and Database Systems 2

Credits: 3; Prereq: CIS 4301 and COP 3530.

Part two of a two-course sequence. Provides a basic understanding of the internals of a modern database system. Topics include data storage, indexing, query processing and advanced concepts such as database tuning, alternate data models and emerging applications. (M)

### COT 3100 Applications of Discrete Structures

Credits: 3; Prereq: MAC 2233 or MAC 2311 or MAC 3472; Coreq: COP 3504 or COP 3503.

Covers the mathematics of discrete events; i.e., events that involve distinct elements, finite structures of distinct elements or finite sampled versions of continuous phenomena (such as movement). (M)

### COT 4501 Numerical Analysis: A Computational Approach

Credits: 3; Prereq: COP 3504 or COP 3503 and MAS 3114.

Numerical integration, nonlinear equations, linear and nonlinear systems of equations, differential equations and interpolation.

### CTS 4348 UNIX System Administration

Credits: 3; Prereq: COP 4600.

Studies the underlying concepts and techniques employed in the installation, administration and tuning of UNIX operating systems. Topics covered include operating system installation, simple network configuration, file backup and restore, account administration, device management, scheduling, file systems, network management, and basic system and network security.

## **Engineering**

### EGN 4641 Engineering Entrepreneurship

Credits: 3; Prereq: junior or senior standing.

Engineering Entrepreneurship introduces engineering students to the concepts and practices of technological entrepreneurial thinking and entrepreneurship. Using lectures, case studies, business plans and student presentations, the course teaches life skills in entrepreneurial thought and action that students can utilize when starting technology companies or executing research and development projects in large companies.

### EGN 4643 Engineering Innovation

Credits: 3; Prereq: junior or senior standing.

Engineering Innovation introduces students to the concepts of innovative thinking and innovation practices. Using lectures, case studies, team exercises and guest speakers, the course teaches life skills in innovative thought and action that students can use in careers ranging from starting companies to executing research and development projects in large companies.

### EGN 4932 Special Topics

Credits: 1 to 4.

Covers selected, rotating topics in engineering.



### EGS 4038 Engineering Leadership

Credits: 3; Prereq: junior or senior standing.

Engineering Leadership introduces engineering graduate students to the concepts, theory and practice of engineering leadership; effective written and oral communications and presentations; engineering leadership characteristics, individual differences and self-awareness; developing and building teams; managing change, conflicts, and crises; and understanding real-world ethics and core values.

### EGS4625 Fundamentals of Engineering Project Management

Credits: 3, Pre-req None

This course provides engineering students with a comprehensive understanding of how to plan, optimize and efficiently manage projects (or tasks) to implement products, services or developments. This includes building the structure, processes, components and linkages with a team for successful project delivery within schedule, budget and quality requirements.

## **Environmental Engineering Sciences**

### EES 3000 Environmental Science and Humanity

Credits: 3.

Interaction of technology and industrialization with earth's resources and the resultant effect on environmental quality. Identification of air, water and land pollution: causes, effects, and controls. Concepts of environmental management and the socioeconomic and institutional factors influencing environmental quality. Intended for non-ENV majors. (B)

### EES 3000L Environmental Science and Humanity Laboratory

Credits: 1; Coreq: EES 3000.

Field and laboratory instruction on ecosystems, environmental treatment and control systems, and methods of environmental analysis. Intended for junior level environmental science majors and minors. (B)

### EES 3008 Energy and Environment

Credits: 3.

Consideration of the energy basis for man and nature including principles of energy analysis, systems ecology and public policy. (P)

### EES 4021 Modeling Environmental Systems Dynamics

Credits: 3; Prereq: ENV 3040C and EES 4102, or the equivalent.

Relationship of feedback to dynamics, and its use in computer modeling of the causes of dynamics in bio-environmental systems to achieve engineering goals. Environmental models developed, tested and alternative solutions analyzed.

### EES 4027 Spatial Analysis Using Geographic Information Systems

Credits: 3.

Principles and applications of geographic information systems, spatial analysis and spatial modeling in environmental engineering sciences.

### EES 4050 Environmental Planning and Design

Credits: 3.

Principles and practices of environmental planning. Planning for and designing sustainable communities and regions. Exploration of quantitative methods for the evaluation of environmental impacts and analysis of carrying capacity of economic development. Exploration of theories of spatial and temporal organization of systems of humanity and nature.

### EES 4102 Wastewater Microbiology

Credits: 2; Prereq: CHM 2046.

General concepts in microbiology and cell biology with major emphasis on the role of microorganisms in polluted environments. (B)

### EES 4102L Environmental Biology Laboratory

Credits: 1.

Focuses on the biota (microorganisms, algae, zooplankton, fish, and plants) found in natural (lakes and wetlands) and engineered systems, ecological engineering approach to management of surface waters and ecological modeling.

### EES 4103 Applied Ecology

Credits: 2.

Application of ecological principles to technological resource management and problem solving. (B)

### EES 4201 Water Chemistry

Credits: 3; Prereq: CHM 2046 or CHM 2096 and MAC 2311 or MAC 2233.

Kinetics and equilibrium of aqueous chemistry including acid-base, complexation, precipitation and redox equilibria. (P)

### EES 4203 Phase Partitioning in the Environment

Credits: 4; Prereq: CHM 2046 or CHM 2096.

A study of the fate of organic pollutants in the environment through application of principles of organic chemistry and chemical thermodynamics, including phase partitioning between environmental media.

### EES 4241C Water Analysis

Credits: 3; Coreq: EES 4201.

Basic procedures of chemical analysis applied to natural and waste waters, including sampling and interpretation of water quality. (P)

### EES 4316 Industrial Ecology

Credits: 3.

Linkage of industrial activity with environmental and social sciences. Corporate environmental management and environmental ethics. Resources, laws and economics. Environmental account. Industrial products and processes and life cycle assessments. Case studies of corporate environmental policies.

### EES 4401 Public Health Engineering

Credits: 3.

Application of engineering principles to protect public health. Areas covered include water supply, waste treatment, air pollution, radiological health, occupational health, milk and food sanitation, vector control, solid wastes, and housing hygiene. (P)

### ENV 3040C Computational Methods in Environmental Engineering

Credits: 3; Prereq: MAC 2313; Coreq: MAP 2302.

Numerical modeling techniques and their application to environmental engineering. Use of personal computers and spreadsheets to solve numerical models. Solution techniques include numerical methods and their implementation using Excel and Visual Basic for Applications (VBA).

### ENV 4041C Environmental Analysis

Credits: 3; Prereq: CHM 2046 and STA 3032.

Theory and laboratory techniques for the analysis of air and water pollutants and basic concepts of ecosystems structure and analysis.

### ENV 4042 Environmental Data Analysis

Credits: 3; Prereq: MAC 2313.

Techniques and tools from sampling theory through laboratory QA and calibration, presentation of results, and legal aspects. In addition to standard statistical techniques, log normal distributions, censored data, limits of detection, etc. are presented.

### ENV 4101 Elements of Atmospheric Pollution

Credits: 3; Prereq: EES 4203 and PHY 2049.

Sources, effects and regulation of air pollutants. Meteorology and dispersion of pollutants. Sampling and analysis of gaseous and particulate air pollutants. Photochemical air pollution and mobile sources. (P)

### ENV 4112C Air Sampling and Analysis

Credits: 3; Prereq: ENV 4101.

Application of physical and chemical principles to measurement of gaseous and particulate pollutants in ambient air. Emphasis on federal reference methods for criteria pollutants.

### ENV 4121 Air Pollution Control Design

Credits: 3; Prereq: ENV 4101.

Principles of particulate and gaseous emission control; design and operation of particulate and gas control equipment to meet federal emission standards.

### ENV 4122 Design of Air Pollution Control System

Credits: 3; Prereq: ENV 4101 and ENV 4121.

Design of a complete air pollution control system including the industrial ventilation system needed to capture, transport and condition the hot, corrosive gases from an industrial process.

### ENV 4212 Nuclear Power Radioactive Waste Technology

Credits: 3; Prereq: refer to the department.

Characterization and description of low and high level radwastes, regulatory requirements and method of treatment. Transportation, burial and surveillance of radwaste. Decommissioning of nuclear facilities.

### ENV 4300 Solid Waste Containment Design

Credits: 3; Prereq: ENV 4351; Coreq: ENV 4561 or CWR 4202.

Design fundamentals of solid and hazardous waste landfills, waste piles, monofills and surface impoundments. Regulations, site requirements, sizing, liner design, leachate and gas management system design, operations and closure.

#### ENV 4351 Solid and Hazardous Waste Management

Credits: 4; Prereq: EES 4201.

Generation of solid and hazardous wastes. Collection, methods, equipment, costs and disposal. Rules, regulations and management systems for proper control of solid and hazardous wastes. Evaluation of engineering systems to minimize costs and regulatory problems. (P)

#### ENV 4353 Solid Waste Systems Design

Credits: 3; Prereq: ENV 4351.

A capstone design experience focusing on the design of solid waste management systems such as landfills, waste-to-energy facilities, compost operations, recycling facilities and hazardous waste treatment/storage/disposal facilities.

#### ENV 4405 Nutrient Control and Water Reuse

Credits: 3.

Biological and physicochemical processes for advanced treatment of municipal wastewater. Reuse guidelines and applications.

#### ENV 4411 Stormwater Control Systems

Credits: 3; Prereq: EES 4201 or instructor permission.

Chemical, physical, biological and hydrologic aspects of rainfall runoff and control through unit operations and processes (UOPs). Stormwater physical and chemical loads. Interactions between hydrologic processes, water chemistry, sediment transport, infrastructure materials and UOPs for treatment and reuse.

#### ENV 4430 Water Treatment Process Design

Credits: 3; Prereq: ENV 4514C and EES 4201; Coreq: ENV 4430L.

Design of selected water treatment processes including disinfection, air stripping, adsorption, ion exchange and membrane processes.

#### ENV 4430L Water Treatment Process Design Laboratory

Credits: 1; Coreq: ENV 4430.

Development of water treatment design parameters by performing bench scale experiments on selected treatment processes.

#### ENV 4432 Potable Water System Design

Credits: 3; Prereq: EES 4201 and ENV 4514C.

Design of conventional water treatment operations, including reactor design, coagulation, flocculation, mixing, sedimentation, filtration, softening, disinfection and sludge management.

#### ENV 4501 Environmental Hydrology 1

Credits: 3; Prereq: ENV 3040C, or STA 3032 or the equivalent, or CWR 3201, or EGN 3353C.

Surface and atmospheric hydrology. Hydrologic processes controlling streamflow events. Practical application to stormwater management.

#### ENV 4506 Environmental Hydrology 2

Credits: 3; Prereq: ENV 3040C or CWR 3201 or EGN 3353C.

Subsurface hydrology. Properties of porous media governing flow and chemical transport in the subsurface. Environmental site evaluation methods.

ENV 4514C Water and Wastewater Treatment

Credits: 3.

Design of water and wastewater treatment units.

ENV 4532 Wastewater System Design

Credits: 3; Prereq: ENV 4514C; Coreq: ENV 4561 or CWR 4202.

Detailed design and layout of gravity wastewater collection systems, pumping facilities, force mains, and a wastewater treatment plant. Emphasis on the preparation of design drawings and estimating costs.

ENV 4561 Hydraulic Systems Design

Credits: 3; Prereq: CWR 3201.

Hydraulic design of water distribution systems, wastewater collection and disposal systems, and water and wastewater treatment plants.

ENV 4601 Environmental Resources Management

Credits: 2. Prereq: ENV 3040C.

Theory and application of engineering economics and systems analysis to the design of environmental management systems.

ENV 4612 Green Engineering Design and Sustainability

Credits: 3; Prereq: EES 4201 and ENV 4514C.

Design of products and processes from a *green* engineering perspective, where one of the primary objectives is minimization of environmental impacts. Three scales of pollution prevention will be covered: macroscale (life-cycle assessments), mesoscale (unit operations design) and microscale (molecular level).

ENV 4932 Special Problems in Environmental Engineering Sciences

Credits: 1 to 4; can be repeated with a change in content up to 4 credits.

Special problems in environmental engineering science.

## **Industrial and Systems Engineering**

EIN 3101C Introduction to Industrial and Systems Engineering

Credits: 2; Prereq: ENC 3254 with a minimum grade of C.

Introduction and overview of the profession, including career planning, professionalism and communication, ethics, teamwork, industry site visits, industrial speakers, and selected solution methods for problems in coordination and planning.

EIN 4321 Industrial Energy Management

Credits: 3; Prereq: EIN 4354 and PHY 2049 with minimum grades of C.

Introduces energy conservation. Supply-demand data, energy economics, investment analysis and energy legislation. Audits, waste heat recovery, cogeneration and computerized energy management systems.

### EIN 4343 Inventory and Supply Chain Systems

Credits: 3; Prereq: ESI 4321 and ESI 4313 with minimum grades of C.

Develops analytic abilities to formulate and solve inventory and logistics problems faced by today's firms. Learn to take a comprehensive view of complex inventory and supply-chain systems; develop abilities to model, optimize and design such systems.

### EIN 4354 Engineering Economy

Credits: 3; Prereq: MAC 2312 with a minimum grade of C.

Basic principles and applications of economic decision-making between alternatives encountered in engineering systems projects. Analysis includes methodologies of economics and finance in addition to engineering fundamentals.

### EIN 4360C Facility Planning and Work Design

Credits: 4; Prereq: ENC 3250 or ENC 3254 and EML 2023 or equivalent with minimum grades of C; Coreq: EIN 4354.

Introduces fundamental concepts in several main areas of industrial engineering such as facility planning, material handling systems, work analysis and design. Covers topics such as analysis and design of work space and flow, facility location and layout, material handling systems, motion and time studies and work sampling.

### EIN 4451 Lean Production Systems

Credits: 3. Prereq: ESI 4312 and STA 4321.

Design of flow line, cellular and flexible manufacturing systems. Design and control of lean manufacturing systems. Continuous improvement, small lot production, setup-time reduction, equipment improvement and maintenance. Principles and control of push and pull manufacturing systems. Production planning and operations scheduling.

### ESI 4221C Industrial Quality Control

Credits: 3; Prereq: STA 4321 and STA 4322 with minimum grades of C.

Factors affecting variation in product quality; use of control charts to evaluate and control manufacturing processes. Techniques for acceptance and reliability testing. Laboratory exercises illustrate the operation and control of manufacturing processes and hazard function. Typical failure distributions, redundant systems, models of repair and maintenance.

### ESI 4312 Operations Research 1

Credits: 4; Prereq: ESI 4327C with minimum grade of C.

Introduces optimization modeling, algorithms and software to aid in the analysis and solution of decision-making problems.

### ESI 4313 Operations Research 2

Credits: 4; Prereq: ESI 4327C and STA 4321 with minimum grades of C.

Introduces stochastic models and methodologies for analyzing and providing solutions to decision-making problems with uncertainties.

### ESI 4327C Matrix and Numerical Methods in Systems Engineering

Credits: 4; Prereq: MAC 2313 and MAP 2302 with minimum grades of C.

Theory and application of vector, matrix and other numerical methods to systems problems. Simultaneous linear equations, characteristic values, quadratic forms, error analysis, use of series, curve fitting, nonlinear equations, discrete methods. Laboratory emphasize numerical solutions using MATLAB.

ESI 4356 Decision Support Systems for Industrial and Systems Engineers

Credits: 3; Prereq: COP 2271 and ESI 4312 with minimum grades of C.

Applications of decision support systems in industrial and systems engineering; developing and implementing decision support systems arising in industrial and systems engineering using popular database management and spreadsheet software.

ESI 4357 Web-Based Decision Support Systems for Industrial and Systems Engineers

Credits: 3; Prereq: COP 2271 and ESI 4312 with minimum grades of C.

Introduces the Internet and e-commerce; Internet tools and technologies necessary for the development of web-based decision support systems; designing and implementing web-based decision support systems arising in the practice of industrial and systems engineering using popular software packages.

ESI 4523 Industrial Systems Simulation

Credits: 3; Prereq: COP 2271, STA 4322 and ESI 4313 with minimum grades of C.

Simulation methodology and languages (such as General Purpose Simulation System - GPSS). Design and analysis of simulation experiments as well as applications to solutions of industrial and service system problems.

EIN4905-Advance Engineering Project Management

Credits: 3

Advanced Engineering Project Management expands on foundational project management practices to include complex as well as new project delivery concepts. Topics include project acquisition; negotiation skills; advanced risk planning and management; program management; project life cycle models and their applicability; and diagnostics and remedies for problem projects.

## **Mechanical and Aerospace Engineering**

The prerequisites for all courses offered by the Department of Mechanical and Aerospace Engineering may require classification as a student in good standing in aerospace engineering, mechanical engineering and/or another engineering program for which the particular course is required.

EAS 3020C Introduction to Flight

Credits: 3; Prereq: PHY 2048 or PHY 2053, MAC 2311, or instructor permission.

Introduction to the science and engineering of aircraft. Overview of applied aerodynamics, performance, stability, propulsion and structures. Includes lab sessions flying and making measurements in a general aviation aircraft.

EAS 4101 Aerodynamics

Credits: 3; Prereq: CGS 2425, EGN 3353C or other introductory fluid mechanics course, and EML 3100.

Incompressible aerodynamics: airfoils and finite wings. Includes compressible aerodynamics, normal and oblique shocks, Prandtl-Meyer expansion waves and supersonic airfoils.

EAS 4132 Compressible Flow

Credits: 3; Prereq: EGN 3353C and EML 3100.

One-dimensional and quasi one-dimensional compressible fluid flows. Includes mach waves, normal shocks, oblique shocks, Prandtl-Meyer expansions, isentropic flow with area change, Fanno flow and Rayleigh flow.

### EAS 4200C Aerospace Structures

Credits: 3; Prereq: EGM 3520.

Review of plane states of stress and strain. Includes analysis of thin-walled beams with open and closed section, unsymmetrical bending of wing sections, torsion of skin-stringer and multi-cell sections, flexural shear in open and closed sections, Shear Center and failure criteria. Also includes introduction to composite materials and demonstration of behavior of some simple structural elements.

### EAS 4240 Aerospace Structural Composites 1

Credits: 3; Prereq: EGM 3520.

Various types and applications of structural composites used in flight structures. Also includes an introduction to analysis of structural composites.

[Back to Top](#)

### EAS 4300 Aerospace Propulsion

Credits: 3; Prereq: EGN 3353C and EML 3100.

Basics of air-breathing and rocket engines used in flight systems.

### EAS 4400 Stability and Control of Aircraft

Credits: 3; Prereq: EAS 4101 and EML 4312.

Static stability and control, equations of motion, stability derivatives, stability of longitudinal and lateral motion of aircraft.

### EAS 4412 Dynamics and Control of Space Vehicles

Credits: 3; Prereq: EGM 4313 or instructor permission.

Review of aerospace applications in current guidance and control systems. Includes synthesis of open and closed loop guidance and control systems using classical and modern control theory.

### EAS 4510 Astrodynamics

Credits: 3; Prereq: EGM 3401 and EGM 4313.

Introduction to the solar system. Includes study of two-body motion, Hohmann transfer, patched conics for interplanetary and lunar trajectories, and the restricted three-body problem. Also includes an introduction to powered flights and artificial satellite orbits.

### EAS 4530 Space Systems Design

Credits: 3; Prereq: EAS 4510.

A discussion of the component systems of a spacecraft and a typical mission's requirements. The operation and character of different spacecraft hardware is presented as well as typical mission timelines from early conception to final operations. Topics include the space environment, guidance/control/navigation systems, spacecraft sensors and actuators, propulsion systems, thermal systems, power systems, launch systems, communication systems, structural systems and mission operations. This course is useful to engineers, scientists, computer scientists and any profession that uses data.

### EAS 4700 Aerospace Design 1

Credits: 3; Prereq: EAS 4510 and EML 4312.

Applications of the principles of analysis and design to aerospace vehicles.



### EAS 4710 Aerospace Design 2

Credits: 3; Prereq: EAS 4101 and EAS 4400.

Second part of the aerospace design sequence, applying the principles of analysis and design to aerospace vehicles.

### EAS 4939 Special Topics in Aerospace Engineering

Credits: 1 to 4; can be repeated with change in content up to 12 credits. Prereq: instructor permission.

Special topics in aerospace engineering.

### EGM 3344 Introduction to Numerical Methods of Engineering Analysis

Credits: 3; Prereq: MAC 2313 and CGS 2421, or equivalent; Coreq: MAP2302.

Methods for numerical solution of mathematical problems with emphasis on engineering applications using MATLAB. Includes roots, optimization, linear algebraic equations, matrices, curve fitting, differentiation, integration and ordinary differential equations.

### EGM 3400 Elements of Dynamics

Credits: 2; Prereq: EGM 2511 or EGM 2500, and MAC 2313.

Dynamics of particles and rigid bodies for rectilinear translation, curvilinear motion, rotation and plane motion. Also includes principles of work and energy, and impulse and momentum.

### EGM 3401 Engineering Mechanics: Dynamics

**Credits: 3; Prereq: EGM 2511 or EGM 2500, and MAC 2313.**

Continues the dynamics sequence begun in EGM 3400 plus extended coverage of three-dimensional rigid-body dynamics and orbital motion.

### EGM 3520 Mechanics of Materials

Credits: 3; Prereq: EGM 2511 (not EGM 2500) and MAC 2313.

Stress and strain at a point, stress-strain-temperature relations and mechanical properties of materials. Systems subject to axial load, torsion and bending. Design concepts, indeterminate structures and applications.

### EGM 4313 Intermediate Engineering Analysis

Credits: 3; Prereq: MAP 2302 and EGM 3344.

Ordinary differential equations, systems of ordinary differential equations, partial differential equations, Fourier series and complex analysis. Also includes equations of heat conduction, wave propagation and Laplace.

### EGM 4473 Experimental Optimum Engineering Design

Credits: 3; Prereq: MAP 2302.

Formulation of design objectives as optimization problems and application of optimization techniques to design. Includes response surface techniques for analytical and experimental optimum engineering design as well as experimental optimization applied to a design project.

### EGM 4590 Biodynamics

Credits: 3; Prereq: EGM 3400 or EGM 3401, or instructor permission.

Dynamic analysis of the human musculoskeletal system. Includes development of lumped mass, planar rigid body and 3-D rigid body models of human movement. Also includes calculation of internal forces in muscles and joints and analysis of muscle function using dynamics principles and musculoskeletal geometry.

### EGM 4592 Bio-Solid Mechanics

Credits: 3; Prereq: EGM 3520.

Introduction to solid and fluid mechanics of biological systems. Includes rheological behavior of materials subjected to static and dynamic loading, the mechanics of cardiovascular, pulmonary and renal systems, and the mathematical models and analytical techniques used in biosciences.

### EGM 4853 Bio-Fluid Mechanics and Bio-Heat Transfer

Credits: 3; Prereq: EGN 3353C.

A study of biothermal fluid sciences with an emphasis on the physiological processes occurring in human blood circulation and the underlying mechanisms from an engineering perspective.

### EGN 3353C Fluid Mechanics

Credits: 3; Prereq: MAC 2313, EGM 2511 and EML 3100, or EML 3007.

Statics and dynamics of incompressible fluids. Application to viscous and inviscid flows. Dimensional analysis. Compressible flow.

### EML 3005 Mechanical Design

Credits: 3; Prereq: EGM 3520 and **EML 2023**.

Design process, kinematics, gear trains and standard mechanical components.

### **EML 3007 Elements of Thermodynamics and Heat Transfer**

**Credits: 3; Prereq: CHM 2045, MAC 2313 and PHY 2048.**

**Applications of first and second laws of thermodynamics to closed and open systems. Steady one-dimensional conduction, lumped parameter analysis, convection, radiation. Intended for non-mechanical engineering students.**

### EML 3100 Thermodynamics

Credits: 3; Prereq: CHM 2045, MAC 2313 and PHY 2048.

Application of the first and second laws of thermodynamics to closed and open systems and to cyclic heat engines. Includes the development of procedures for calculating the properties of multiphase and singlephase pure substances.

### EML 3301C Mechanics of Materials Laboratory

Credits: 3; Prereq: EGM 3520, EGM 3344, and ENC 2210 or ENC 3254.

Experimental characterization of the mechanical properties of engineering materials, precision instruments, computer-based data acquisition, statistical uncertainty analysis, preparation of engineering reports.

### EML 4140 Heat Transfer

Credits: 3; Prereq: CGS 2425, EGM 4313 and EML 3100.

Steady state and transient analysis of conduction and radiation heat transfer in stationary media. Also discusses heat transfer in fluid systems, including forced and free convection.

### EML 4147C Thermo-Heat Transfer Design and Laboratory

Credits: 3; Prereq: EML 3100, EML 3301C and EML 4140.

Thermodynamics and heat transfer integrated with design and laboratory, including heat exchange design, phase-change heat transfer, thermodynamics of mixtures, psychrometry, mass transfer and sensible heat recovery.

#### EML 4220 Vibrations

Credits: 3; Prereq: EGM 3400 or EGM 3401, CGS 2425, EGM 352 and EGM 4313.

Single and multiple degree of freedom systems, including application to mechanical systems with problems employing computer techniques.

#### EML 4304C Thermo/Fluid Design and Laboratory

Credits: 3; Prereq: EGN 3353C, EML 3100 and EML 3301C.

Design and laboratories for turbomachinery, compressible flow, chemical reactions and thermodynamic cycles.

#### EML 4312 Control of Mechanical Engineering Systems

Credits: 3; Prereq: EGM 3401 and MAP 2302.

Theory, analysis and design of control systems, including mechanical, electromechanical, hydraulic, pneumatic and thermal components and systems.

#### EML 4314C Dynamics and Controls System Design Laboratory

Credits: 3; Prereq: EML 3301C; Coreq: EML 4312.

Experiments on dynamic systems in mechanical and aerospace engineering and design of relevant control systems.

#### EML 4321 Manufacturing Engineering

Credits: 3; Prereq: EMA 3010 and EGM 3520; Coreq: EML 4140, EML 4220 and EML 4312.

Descriptive and analytical treatment of manufacturing processes and production equipment, automation, computer control and integrated systems. Applications of mechanics stress analysis, vibrations, controls, heat transfer. Discrete time simulation.

#### EML 4410 Combustion Engineering

Credits: 3.

Fundamentals of combustion processes and systems; including thermochemistry, rates and mechanisms, pollutant analysis, premixed and diffusion flames and applications to engines and turbomachinery.

#### EML 4450 Energy Conversion

Credits: 3.

Thermomechanical and thermoelectric energy conversion, conventional and unconventional techniques and analysis of energy systems interactions.

#### EML 4501 Mechanical System Design

Credits: 3; Prereq: EML 3005; Coreq: EML 4321 and EML 4507.

Integrated design and presentation of a mechanical system.

#### EML 4507 Finite Element Analysis and Design

Credits: 3; Prereq: CGS 2425, EGM 4313 and EGM 3520.

Stress-strain analysis and design of machine elements and finite element analysis.

#### EML 4600 Refrigeration and Air Conditioning Fundamentals

Credits: 3; Prereq: EML 3100.

Fundamentals of refrigeration theory, vapor compression and absorption, refrigeration components and systems, psychrometric theory, analysis of cooling and dehumidifying coils.

### EML 4601 Heating and Air Conditioning System Design

Credits: 3; Prereq: EML 3100.

Heating and air conditioning systems: equipment selection, system arrangement, load calculations, advanced psychrometrics, duct and piping system design, air distribution system design and indoor air quality.

### EML 4737 Hydraulics and Pneumatics for Building Systems

Credits: 3; Prereq: EGN 3353C.

Applications, design, maintenance and operations of various pneumatic, hydronic and other process systems. Includes in-depth design concepts and techniques as well as preparation of specifications and cost estimates.

### EML 4738 Hydraulic and Mechanical Power Transmission

Credits: 3; Prereq: EML 3005C.

Transmission of power in machines by hydraulic and mechanical means, including analytical design of components and their functions.

### EML 4930 Special Topics in Mechanical Engineering

Credits: 1 to 3; can be repeated with a change in content up to 12 credits. Prereq: instructor permission.

Variable content in mechanical engineering not offered in other courses.

## **Nuclear and Radiological Engineering**

### ENU 4001 Nuclear Engineering Analysis 1

Credits: 4; Prereq: MAP 2302; Coreq: CGS 2421.

Four one-hour lectures discussing continuous and discrete variable solution methods for the statistical, algebraic, differential and integral equations important in nuclear engineering. Problems involving neutron, photon, fluid and temperature distributions in configuration, time and velocity are mathematically modeled, solved and interpreted.

### ENU 4103 Reactor Analysis and Computation 1: Statics

Credits: 4; Prereq: ENU 4001 and ENU 4605 with minimum grades of C.

Three one-hour lectures discussing neutron reactions, fission chain and criticality and neutron transport/diffusion for nuclear reactors. Neutron thermalization and thermal scattering kernels. Dynamic analysis of reactors including point and space-time models. Feedback and reactor dynamics and control. Short-term transient analysis and long-term time-dependence.

### ENU 4104 Reactor Analysis and Computation 2: Dynamics

Credits: 3; Prereq: ENU 4103.

A continuation of ENU 4103. Three one-hour lectures discussing neutron thermalization and thermal scattering kernels. Treatment of resonances and Doppler broadening. Dynamic analysis of reactors including point model and space-time models. Feedback and reactor dynamics and control. Short-term transient analysis and long-term time dependence.

### ENU 4133 Reactor Thermal Hydraulics 1

Credits: 3; Prereq: EML 3100.

Fundamentals of thermodynamics, fluid mechanics and heat transfer with application to design and safety of nuclear power plants. Thermal hydraulic characteristics of nuclear power plants, energy conversion cycles, applications of first and second law of thermodynamics, nuclear heat generation, fluid mechanics, conservation laws and governing equations for inviscid and viscous single-phase flow, conduction and convection heat transfer and thermal design of fuel elements.

### ENU 4134 Reactor Thermal Hydraulics

Credits: 4; Prereq: EML 4140, and ENU 4133 or EGN 3353C.

Nuclear applications of fluid mechanics, heat transfer and thermodynamics. Two-phase flow and boiling heat transfer. Heat transfer mechanisms in reactor core and sub-channel thermal hydraulics. Steam generator, power cycles, and balance of plant. Introduction to thermal design for reactors.

### ENU 4144 Nuclear Power Plant Reactor Systems 1

Credits: 3; Prereq: EML 3100, ENU 4605 and ENU 4001 with minimum grades of C.

Three one-hour lectures discussing the basis for light water reactor (LWR) design; the NRC design criteria for LWRs. Study of the major systems, components and performance characteristics of LWRs including fuels, primary and secondary coolant systems, emergency and auxiliary systems.

### ENU 4145 Risk Assessment for Radiation Systems

Credits: 3; Prereq: ENU 4605 with a minimum grade of C and STA 3032.

Three one-hour lectures discussing the study of radiation management systems, including reliability and probabilistic risk assessment.

### ENU 4194 Control of Nuclear Reactors and Power Plants

Credits: 3; Prereq: ENU 4104.

Three one-hour lectures discussing the analysis of the control and dynamic characteristics of nuclear reactors, including the effects of feedback. Analysis of the control and dynamic characteristics of the integrated nuclear power plant.

### ENU 4505L Nuclear and Radiological Engineering Laboratory 1

Credits: 3; Prereq: ENU 4612.

Two one-hour lectures discussing experimental procedures used in reactor operation, personnel monitoring, radiation detection devices and the statistics of nuclear counting systems. Also includes a four-hour laboratory experience that integrates practical applications of radiation sources, radiation interactions, radiation transport and radiation detection. (WR)

### ENU 4605 Radiation Interactions and Sources 1

Credits: 4; Coreq: ENU 4001.

Three one-hour lectures discussing interaction of ionizing radiation with matter; cross sections and radiation fields with emphasis on photons, heavy charged particles and electrons.

### ENU 4606 Radiation Interactions and Sources 2

Credits: 3; Prereq: ENU 4001 with a minimum grade of C and ENU 4605.

Continuation of ENU 4605. Three one-hour lectures discussing the study of photon-charged particle and electron interactions with matter, attenuation, energy transfer and energy absorption in matter. X-ray production, accelerators and neutron sources, and applications in nuclear and radiological engineering

#### ENU 4612 Nuclear Radiation Detection and Instrumentation

Credits: 3; Prereq: ENU 4605 with a minimum grade of C and EEL 3003.

Three one-hour lectures discussing the physics and electronics of radiation detection and instrumentation systems for application to nuclear energy, radiological sciences, radiation protection, medical physics and imaging, and industrial safety and control systems.

#### ENU 4612L Nuclear Radiation Detection and Instrumentation Laboratory

Credits: 1; Prereq: ENU 4605 with a minimum grade of C and EEL 3003; Coreq: ENU 4612.

Laboratory experiments related to the physics and electronics of radiation detection and instrumentation systems for application to nuclear energy, radiological sciences, radiation protection, medical physics and imaging, and industrial safety and control systems.

#### ENU 4630 Fundamental Aspects of Radiation Shielding

Credits: 3; Prereq: ENU 4605 with a minimum grade of C.

Three one-hour lectures discussing basic principles of radiation shielding. Study of radiation sources and shielding design for radiation facilities.

#### ENU 4641C Applied Radiation Protection

Credits: 2; Prereq: ENU 4605 with a minimum grade of C and ENU 4630.

Two one-hour lectures of introduction to practical radiation protection techniques and practices, including laboratory experiences. Examination of pertinent regulations, current practice, ethics and instrumentation/measurement practices. Design of facilities and controls to optimize benefits of radiation applications and minimize exposure risks. (WR)

#### ENU 4800 Introduction to Nuclear Reactor Materials

Credits: 3; Prereq: EMA 3010.

Provides a comprehensive knowledge on the types of materials used in nuclear reactors, their response to the reactor environments and most of the materials problems encountered in the operation of nuclear power reactors for energy production.

#### ENU 4930 Special Topics in Nuclear and Radiological Engineering

Credits: 1 to 4; can be repeated with change in content up to 8 credits. Prereq: instructor permission.

Special courses covering selected topics in nuclear engineering.

#### ENU 4934 Fundamentals of Nuclear and Radiological Engineering

Credits: 1; Prereq: junior/senior standing in NES.

Presentations and discussions on topics of current and continuing interest in nuclear engineering sciences.

#### ENV 4212 Nuclear Power Radioactive Waste Technology

Credits: 3; Prereq: refer to the department.

Characterization and description of low- and high-level radwastes, regulatory requirements and methods of treatment. Transportation, burial and surveillance of radwastes. Decommissioning of nuclear facilities.