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ENGINEERS ARE FACED with worldwide problems and expectations awesome in responsibility, yet exciting as professional challenges. These range from the extremes of interplanetary exploration through earth orbiting systems to the problems arising from our population explosion: energy, better productivity, housing, transportation and environmental issues.

As a renewed appreciation develops for the contributions of science and technology, engineering leaders are calling for engineers who are better equipped to tackle the specific, technical problems of the future. They also are calling for engineers who by breadth of education and understanding of other disciplines can convince others of the role of engineers not only in technical matters but in policy decisions to ensure the use of technology to benefit mankind.

Engineering education at Auburn provides in a four-year curriculum both the technical knowledge and the broad general education necessary to equip engineers for their problem-solving challenges. Centered on mathematics and the physical sciences, the curricula also stress the importance of social sciences, humanities and communication skills. Auburn’s engineering programs enable individuals to develop their natural talents and provide knowledge, skills and understanding that will help them to find their places in society as well as in their vocations.

**Admission**

Freshmen eligibility is determined by the Office of Enrollment Services. However, since the requirements for engineering education necessitate high school preparatory work of high intellectual quality and of considerable breadth, the following program is recommended as minimum preparation: English, four units; mathematics (including algebra, geometry, and trigonometry), four units; chemistry, one unit; history, literature, social science, two or three units. Calculus, physics and foreign languages are recommended but not required.

Transfers from other institutions must apply through the Office of Enrollment Services. The exact placement in courses can be determined only upon review of the student's transcript by the Samuel Ginn College of Engineering. See Admission of Transfer Students for complete requirements.

The college allows credit for courses completed with satisfactory grades provided the courses correspond in time and content to courses offered at Auburn. Courses that are taught at the 3000-level or higher at Auburn are generally not transferable from junior colleges.

Many courses required by the Samuel Ginn College of Engineering are highly specialized in their content and potential transfer students need to select courses with care. Therefore, to ensure maximum transferability of credits, students are encouraged to contact the College as soon as possible about acceptable credits.

Transfers from on-campus must be approved by the Samuel Ginn College of Engineering. The requirements for a student to advance from the pre-engineering program into an engineering curriculum are subsequently described in the “Scholastic Requirements” section.

**Programs**

**Pre-Engineering**

The Pre-Engineering Program consists of a freshman program of studies to prepare students for curricula in the Samuel Ginn College of Engineering. It also provides academic and career counseling to assist students in determining the curriculum that best fulfills their personal and educational objectives.

The following describes the requirements for entering freshmen pre-engineering students to move into major. These requirements must be completed by the end of the fourth semester enrolled at Auburn, not including summers.

- Completion of two calculus courses
- Completion of two science courses required by major
• Completion of COMP 1200 Introduction to Programming or COMP 1210 Fundamentals of Computing I
• Completion of ENGR 1100 Orientation to Engineering and ENGR 1110 Introduction to Engineering
• Sophomore standing, the completion of 30 hours
• 2.0 cumulative GPA

Professional Programs

The undergraduate Computer Science program is accredited by the Computing Accreditation Commission of ABET, http://www.abet.org.

These curricula are designed to meet the educational requirements of the engineering professions. The program in the fundamental sciences of mathematics, chemistry and physics is followed by a study of basic engineering sciences. Specialized or departmental courses are taken in the third and fourth years. Flexibility is provided in all degree programs through electives so that the individual may emphasize areas of personal interest.

An ecological engineering option and a forest engineering option are available under the biosystems engineering program. The forest engineering option is offered jointly by the Department of Biosystems Engineering and the School of Forestry and Wildlife Sciences. The environmental science curriculum is offered jointly by the College of Agriculture, the College of Engineering, and the College of Sciences and Mathematics.

Cooperative Education
The Cooperative Education Program is offered in all curricula of the Samuel Ginn College of Engineering. Refer to the program information in the Special Academic Opportunities section of the Bulletin. For additional information, contact: Cooperative Education (Co-Op) Program, 303 Mary Martin Hall, Auburn, AL, 36849. Telephone: (334) 844-4744. Website: career.auburn.edu/coop/.

Graduate
The Samuel Ginn College of Engineering offers masters (thesis and non-thesis) and PhD degrees in aerospace engineering, biosystems engineering, chemical engineering, civil engineering, computer science and software engineering, electrical and computer engineering, industrial and systems engineering, materials engineering, mechanical engineering, and polymer and fiber engineering. The college offers additional masters degrees including the master of engineering management, master of engineering (interdisciplinary), MS in cybersecurity engineering, and MS in data science and engineering (joint with the College of Sciences and Mathematics). The college also offers a dual-degree master of industrial and systems engineering and master of business administration.

Continuing Education
The Engineering Online and Continuing Education Office extends the resources of the Samuel Ginn College of Engineering to the people, businesses and industries of the state. Programs in this service are technical assistance, short courses, conferences, workshops and seminars. For more information, contact: Director, Engineering Online and Continuing Education Programs, 217 Ramsay Hall, Auburn, AL 36849.

Online Courses
The college offers graduate-level courses for credit and non-credit to off-campus students through its Graduate Outreach Program. Graduate-level courses are recorded in the classroom on the Auburn campus and delivered to off-campus students via streaming video. Students enrolled in the program are required to do the same homework assignments and take the same exams as the on-campus students enrolled in the course. For information on admission to the program, fees, course offerings and other particulars, write to Engineering Online and Continuing Education Programs, 217 Ramsay Hall, Auburn, AL 36849 or call (334) 844-5807.

Degree Requirements
To earn the bachelor’s degree in the Samuel Ginn College of Engineering, students must complete the subjects in the curriculum, have a minimum grade-point average of 2.0 in all work attempted at Auburn University and have a cumulative grade-point average of 2.0 on
courses passed in the major at Auburn. The major is defined as all course work shown in bold print on the relevant curriculum model. It is the student’s responsibility to keep informed of course requirements and scheduling. Failure to do so may jeopardize graduation.

**Military Science**

All curricula in the Samuel Ginn College of Engineering permit the use of six hours of basic or advanced ROTC courses passed at Auburn University. For the options, see the specific curriculum. For programs that do not have sufficient electives, credit will be determined on an individual basis. ROTC courses cannot be substituted for university core courses or courses required by the major except as specified in the curriculum model.

**Majors**

- Aerospace Engineering (p. 73)
- Biosystems Engineering (p. 84)
- Biosystems Engineering (Bioprocess Engineering option) (p. 81)
- Biosystems Engineering (Ecological Engineering option) (p. 85)
- Biosystems Engineering (Forest Engineering option) (p. 83)
- Chemical Engineering (p. 95)
- Civil Engineering (p. 112)
- Computer Engineering (p. 137)
- Computer Science (p. 125)
- Computer Science (online) (p. 123)
- Electrical Engineering (p. 138)
- Industrial and Systems Engineering (p. 149)
- Materials Engineering (p. 162)
- Mechanical Engineering (p. 163)
- Software Engineering (p. 126)
- Wireless Engineering (Hardware Option) (p. 139)
- Wireless Engineering (Software Option) (p. 140)

**Minors**

- Automotive Engineering and Manufacturing (p. 148)
- Business-Engineering-Technology (p. 149)
- Computer Science (p. 124)
- Information Technology (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/minorininformationtechnology/)
- Materials Engineering (p. 165)
- Materials Science (p. 165)
- Nuclear Power Generation Systems (p. 150)
- Tribology (p. 166)

**Program**

- Aerospace Engineering - MAE., MS, PhD (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/aerospaceengineeringmaemsphd/)
- Automotive Manufacturing Systems - Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/industrialandsystemsengineeringmisemisembamsphd_major/automotivemfgsystems_certificate/)
- Biosystems Engineering - MS, PhD (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/biosystemsengineeringmsphd_major/)
- Chemical Engineering - MChE, MS, PhD (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/chemicalengineeringmsphd_major/)
- Civil Engineering - MCE, MS, PhD (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/civilengineeringmsphd_major/)
- Computer Science and Software Engineering - MSwE, MS, PhD (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/computerscienceandsoftwareengineeringmswemsphd_major/)
Aero 3040 Elementary Meteorology (3) LECT. 3. Basic principles, causes, effects and phenomena of weather with fundamental techniques of forecasting.

Aero 3110 Aerodynamics I (3) LECT. 3. Pr. MATH 2650 and AERO 2200. C or better in AERO 2200. Properties of fluids, fluid statics, conservation of mass and momentum, atmospheric properties, two dimensional airfoils, three dimensional wings, drag, and flight performance.

Aero 3120 Aerodynamics II (3) LECT. 3. Pr. ENGR 2010 and MATH 2650 and AERO 2200. C or better in AERO 2200. Principles of compressible flow including flows with area changes, friction and heat transfer. Fundamental analysis of aerodynamics and potential flow theory. Correlation of potential flow theory with experimental data.

Aero 3130 Aerodynamics Laboratory (2) LECT. 1. LAB. 3. Pr. P/C AERO 2200. C or better in AERO 2200. Application of fundamental aerodynamic principles to subsonic and supersonic wind tunnel experiments.

Aero 3220 Aerospace Systems (3) LECT. 3. Pr. ENGR 2350 and MATH 2650. C or better in ENGR 2350. Modeling of system elements, classical feedback control techniques used in the analysis of linear systems, analysis of systems undergoing various motions connected with flight.

Aero 3230 Flight Dynamics (4) LECT. 3. LAB. 3. Pr. AERO 3110 and ENGR 2350 and MATH 2650. C or better in ENGR 2350. Airplane performance and stability and control including analytical prediction of performance characteristics, experimental determination of static stability parameters, and analytical prediction of dynamic stability characteristics.

Aero 3310 Orbital Mechanics (3) LECT. 3. Pr. ENGR 2350 and MATH 2650. C or better in ENGR 2350. Geometry of the solar system and orbital motion, mathematical integrals of motion, detailed analysis of two-body dynamics and introduction to artificial satellite orbits; Hohmann transfer and patched conics for lunar and interplanetary trajectories.

Aero 3610 Aerospace Structures I (2) LECT. 1. LAB. 3. Pr. ENGR 2070. Fundamental concepts employed in the mechanical testing of engineering materials and structures. Load, stress, and strain measurement techniques are utilized to determine material properties and structural response.

Aero 3970 Special Topics (1-3) AAB. SU. Departmental approval. Investigation of various topics in Aerospace Engineering. Course may be repeated for a maximum of 6 credit hours.
AERO 4140 AERODYNAMICS III (3) LEC. 3. Pr. AERO 3110 and AERO 3120. Theoretical background essential to a fundamental understanding of laminar and turbulent boundary layers and their relations to skin friction and heat transfer.

AERO 4510 AEROSPACE PROPULSION (4) LEC. 3. LAB. 3. Pr. AERO 3120. Fundamental analysis of airbreathing jet propulsion. Introduction to chemical rocket propulsion.

AERO 4620 AEROSPACE STRUCTURES II (4) LEC. 3. LAB. 3. Pr. AERO 3610 and MATH 2660. Aircraft and space vehicle structures. An introduction to the finite element method and its application to structural analysis. The laboratory will utilize state-of-the-art software numerical solution of aerospace structural systems.

AERO 4630 AEROSPACE STRUCTURAL DYNAMICS (4) LEC. 3. LAB. 3. Pr. AERO 4620. Free, forced and damped vibration of single and multiple degree-of-freedom systems. The laboratory will utilize state-of-the-art software for the analysis of the vibration and dynamic response of structural systems.

AERO 4710 AEROSPACE DESIGN I (3) LEC. 2. LAB. 3. Pr. AERO 3120. Introduction to the principles required to design aerospace vehicles.

AERO 4720 AEROSPACE DESIGN II (3) LEC. 2. LAB. 3. Pr. AERO 4710. This course is continuation of AERO 4710.

AERO 4730 SPACE MISSION DESIGN I (3) LEC. 2. LAB. 3. Pr. AERO 3120. And permission of the department. Introduction to the design of space systems including the identification of launch requirements, spacecraft system components, satellite tracking and orbital analysis to achieve a stated scientific objective.

AERO 4740 SPACE MISSION DESIGN II (3) LEC. 2. LAB. 3. Pr. AERO 4730. A continuation of AERO 4730, Space Mission Design I.

AERO 4970 SPECIAL TOPICS IN AEROSPACE ENGINEERING (1-3) AAB. Departmental approval. Investigation of current state-of-the-art technologies in aerospace engineering. Course may be repeated for a maximum of 9 credit hours.

AERO 4997 HONORS THESIS (1-3) IND. Pr. Honors College. Departmental approval. Membership in the Honors College and departmental approval required; Directed research and writing of an honors thesis. Course may be repeated for a maximum of 3 credit hours.

AERO 4AA0 PROGRAM ASSESSMENT (0) LAB. SU. Pr. P/C AERO 4710 or P/C AERO 4730. Academic program assessment covering the areas of aerodynamics, aerospace structures, orbital mechanics, propulsion and vehicle design.

AERO 5110 MISSILE AERODYNAMICS (3) LEC. 3. Pr. AERO 3120. Coreq. AERO 4140. Aerodynamics of slender wing-body combinations, interference effects, linear and non-linear effects, applications to missile design and performance.

AERO 5120 ROTARY WING AERODYNAMICS (3) LEC. 3. Pr. AERO 3110. Aerodynamics and flight characteristics of rotary-wing aircraft.


AERO 5320 APPLICATIONS OF THE GLOBAL POSITIONING SYSTEM (3) LEC. 3. Departmental approval. Operating principles of the control, space and user segments of the Global Positioning System. Implementation of post-processing and real-time positioning strategies and applications. Field work demonstrating the use of GPS receivers, data processing and position accuracy.

AERO 5330 APPLIED ORBITAL MECHANICS (3) LEC. 3. Pr. AERO 3310. Introduction to general and special perturbations; N-body and restricted three-body problems; C-W equations, targeting and rendezvous; satellite constellations.

AERO 5340 SATELLITE APPLICATION (3) LEC. 3. Pr. AERO 3310. AERO 3310 or departmental approval; Principles related to the application of satellites to remote sensing, telecommunications, navigation and trajectory determination. Principles of space policy applied to both the unmanned and manned space flight programs.

AERO 5410 AEROACOUSTICS (3) LEC. 3. Pr. AERO 3120 or Departmental approval. Fundamental concepts in acoustics: decibel scales, sound propagation and measurement, plane and spherical waves, room acoustics, transmission and reflection, reverberant fields and noise assessment. May count either AERO 5410 or AERO 6410.
AERO 5460 PERTURBATION METHODS (3) LEC. 3. Pr. MATH 2660 or Departmental approval. Analytical solutions of nonlinear problems, ODEs, PDEs, multiple scales, and transcendental equations in engineering, mathematics, and physics using both regular and singular perturbation methods. May count either AERO/MATH 5460 or AERO/MATH 6460.

AERO 5520 ROCKET PROPULSION (3) LEC. 3. Pr. AERO 4510. Analysis of the thermodynamics, gas dynamics and design of liquid and solid propellant rocket engines.

AERO 5530 SPACE PROPULSION (3) LEC. 3. Pr. AERO 4510. Analysis of space propulsion systems. Dynamics of electromagnetic systems, ion engines, photon drives, laser propulsion.


AERO 5630 AEROSPACE APPLICATIONS OF COMPOSITE MATERIALS (4) LEC. 3. LAB. 3. Pr. AERO 3610. Basic material and manufacturing information for laminated composite structures. Computational structural analysis of typical aerospace composite structures coupled with experimental verification of the structural response.

AERO 5750 LEGAL ASPECTS OF ENGINEERING PRACTICE (3) LEC. 3. Pr. PHIL 1020 or PHIL 1023 or PHIL 1027. The role of the law in the manufacture of a product. Ethical issues that may confront designers and engineers.

AERO 6110/6116 MISSILE AERODYNAMICS (3) LEC. 3. Coreq. AERO 4140. Aerodynamics of slender wing-body combinations, interference effects, linear and non-linear effects, applications to missile design and performance.

AERO 6120/6126 ROTARY WING AERODYNAMICS (3) LEC. 3. Aerodynamics and flight characteristics of rotary-wing aircraft.


AERO 6326 APPLICATIONS OF THE GLOBAL POSITIONING SYSTEM (3) LEC. 3. Departmental approval. Operating principles of the control, space and user segments of the Global Positioning System. Implementation of post-processing and real-time positioning strategies and applications. Field work demonstrating the use of GPS receivers, data processing, and position accuracy.

AERO 6330/6336 APPLIED ORBITAL MECHANICS (3) LEC. 3. Special perturbation techniques: N-body perturbations; general and restricted three-body problems; preliminary orbit determination; C-W equations, targeting and rendezvous; constellation design; mission planning.

AERO 6340/6346 SATELLITE APPLICATION (3) LEC. 3. Pr. AERO 3310. Departmental approval. Principles related to the application of satellites to remote sensing, telecommunications, navigation and trajectory determination. Principles of space policy applied to both the unmanned and manned space flight programs.

AERO 6410/6416 AEREOUASIOQUECONS (3) LEC. 3. Pr. AERO 4140 or Departmental approval. Fundamental concepts in acoustics: decibel scales, sound propagation and measurement, plane and spherical waves, room acoustics, transmission and reflection, reverberant fields and noise assessment. May count either AERO 5410/5413 or AERO 6410/6416.

AERO 6460/6466 PERTURBATION METHODS (3) LEC. 3. Pr. MATH 2660. Departmental approval. Analytical solutions of nonlinear problems, ODES, PDEs, multiple scales, and transcendental equations in engineering, mathematics, and physics using both regular and singular perturbation methods. May count either AERO/MATH 5460 or AERO/MATH 6460.

AERO 6520/6526 ROCKET PROPULSION (3) LEC. 3. Analysis of the thermodynamics, gas dynamics and design of liquid and solid propellant rocket engines.

AERO 6530/6536 SPACE PROPULSION (3) LEC. 3. Pr. AERO 4510. Analysis of space propulsion systems. Dynamics of electromagnetic systems, ion engines, photon drives, laser propulsion.


AERO 6630/6636 AEROSPACE APPLICATIONS OF COMPOSITE MATERIALS (4) LEC. 3. LAB. 3. Pr. AERO 3610. Basic material and manufacturing information for laminated composite structures. Computational structural analysis of typical aerospace composite structures coupled with experimental verification of the structural response.
AERO 6756 LEGAL ASPECTS OF ENGINEERING PRACTICE (3) LEC. 3. Pr. PHIL 1020 or PHIL 1023 or PHIL 1027. The role of the law in the manufacture of a product. Ethical issues that may confront designers and engineers.

AERO 7100/7106 ADVANCED SUPersonic Aerodynamics (3) LEC. 3. Pr. AERO 4140. A rigorous development of linearized and nonlinear fluid flow theories and application. Lifting surfaces, lifting bodies, duct flow, boundary layer effects, shock and expansion waves and method of characteristics.

AERO 7116 AIRFOIL AERODYNAMICS (3) LEC. 3. Pr. AERO 3120. Thin airfoil theory, Joukowski transformations, Karman Trefftz transformations, thick airfoil theory, panel methods and comparison with experimental data.

AERO 7120/7126 DYNAMICS OF VISCous FLUIDS I (3) LEC. 3. Pr. AERO 7100 or AERO 7106. Exact solutions to the Navier Stokes equations. Exact and approximate solutions of the laminar boundary layer equations. Incompressible and compressible boundary layers in theory and experiment.

AERO 7130/7136 DYNAMICS OF VISCous FLUIDS II (3) LEC. 3. Pr. AERO 7120 or AERO 7126. Turbulent flows, the Reynolds stresses and turbulence modeling. Computation of incompressible and compressible turbulent boundary layers. Stability theory and transition.

AERO 7140/7146 ADVANCED COMPUTATIONAL FLUID DYNAMICS (3) LEC. 3. Pr. AERO 5140 and AERO 6140. Advanced methods for solving problems in computational fluid dynamics. Topics include: discretization approaches, implicit solution techniques, curvilinear coordinate systems, and upwind schemes.


AERO 7160/7166 PHYSICAL FOUNDATIONS OF TURBULENCE (3) LEC. 3. Pr. AERO 7120 or AERO 7126. Departmental approval. An introduction to turbulence using classical descriptions with a focus on the physics of turbulence phenomena. May count either AERO 7160 or AERO 7166.


AERO 7210/7216 FLIGHT DYNAMICS OF HYPERVELOCITY VEHICLES (3) LEC. 3. Pr. AERO 7200 or AERO 7206. Departmental approval. Development of specialized concepts and methods in dynamics applicable to the modeling of hypersonic flight vehicle motion. Stability concepts and analysis of the stability of steady-state motions of very high speed flight vehicles.


AERO 7236 HELICOPTER DYNAMIC CONTROL (3) LEC. 3. Pr. AERO 7200 or AERO 7206. Departmental approval. Development of specialized concepts and methods in dynamics applicable to the modeling of helicopters. Analysis of helicopter stability and controllability.

AERO 7330/7336 ORBIT DETERMINATION (3) LEC. 3. Pr. AERO 6330 or AERO 6336 or AERO 6230 or AERO 6236. Elements of orbit determination; least squares, minimum norm, minimum variance solutions; batch, sequential and extended sequential filters.

AERO 7340/7346 ADVANCED ORBITAL MECHANICS (3) LEC. 3. Pr. AERO 6330 or AERO 6336 or AERO 6230 or AERO 6236. Elements of time measurements, earth orientation/coordinate system; f and g series; Lambert's Problem; linear orbit theory and circumlunar trajectories.

AERO 7350/7356 OPTIMAL CONTROL OF AEROSPACE VEHICLES (3) LEC. 3. Pr. AERO 3220. Principles of optimization; Pontryagin's principle; Linear quadratic regulator; Observers, state estimation, LQG problem. Optimal output feedback; Synthesis of flight control systems. AERO 3220 or equivalent.

AERO 7376 FUNDAMENTALS OF THE GLOBAL POSITIONING SYSTEM (3) LEC. 3. Pr. AERO 7330 or AERO 7336 or AERO 7230 or AERO 7236. Departmental approval. Principles of the Global Positioning System; GPS overview and historical development; modeling of pseudo-range and carrier phase measurements; positioning solution strategies using kinematic, dynamic, and reduced dynamic techniques.
AERO 7396 SATELLITE REMOTE SENSING (3) LEC. 3. Departmental approval. Topics in satellite remote sensing principles and techniques including active and passive instruments, data processing, and geophysical parameter recovery algorithms.

AERO 7410/7416 LIGHT-FIELD IMAGING (3) LEC. 3. Pr. AERO 7160 or AERO 7166. Departmental approval. An introduction to light-field imaging. Topics include light parameterization, light field cameras, computational photography and Fourier slice photography theorem. May count either AERO 7410 or AERO 7416.

AERO 7420/7426 PARTICLE IMAGE VELOCIMETRY (3) LEC. 3. Pr. AERO 7120 or AERO 7126. Departmental approval. An introduction to particle image velocimetry and its variations including conventional planar PIV, stereo PIV, stereo-PIV and torn-PIV. May count either AERO 7420 or AERO 7426.


AERO 7510/7516 THRUST GENERATION (3) LEC. 3. Pr. AERO 4510. Aerothermodynamics of propulsion. Selected topics in gas dynamics, thermodynamics, and heat transfer as applied to airbreathing and space propulsion.


AERO 7616 ADVANCED AEROSTRUCTURES (3) LEC. 3. Pr. AERO 4620. Departmental approval. Development of the fundamental principles of the analysis of non-linear problems in solid mechanics. Structural problems involving non-linear deflections and/or material properties.

AERO 7620/7626 AEROSPACE COMPUTATIONAL STRUCTURAL ANALYSIS: STATIC STRUCTURES (3) LEC. 3. Pr. AERO 4620. Departmental approval. Advanced techniques for the numerical solution of static elastic and plastic problems, including two and three dimensional solutions.

AERO 7630/7636 AEROSPACE COMPUTATIONAL STRUCTURAL ANALYSIS: STRUCTURAL DYNAMICS (3) LEC. 3. Pr. AERO 4630. Departmental approval. Advanced techniques for the numerical solution to problems in structural dynamics, including steady state and transient response of two-and three-dimensional structures.

AERO 7646 ADAPTIVE AEROSTRUCTURES (3) LEC. 3. Departmental approval. Basic material and manufacturing information for materials employed in adaptive structures. Shape-memory, magnetostrictive, magnetorheological-electrorheological and piezoelectric materials are examined.

AERO 7660/7666 AEROLASTICITY (3) LEC. 3. Pr. AERO 4630. Introduction to the field of aeroelasticity and the interaction therein of structural mechanics and fluid mechanics with dynamics as the "interface adhesive" between them. Flutter, divergence, aileron reversal and related phenomena.

AERO 7676 INTRODUCTION TO LARGE SPACE STRUCTURES (3) LEC. 3. Pr. AERO 4630. Large space structures and their unique concepts, novel on-earth testing requirements, variety of damping schemes and analysis techniques. Concepts and analysis related to shape control, active and passive damping, and structural dynamics/controls interaction.

AERO 7950 SEMINAR (0) SEM. 0. SU. Weekly lectures on current developments in aerospace sciences by staff members, graduate students, and visiting scientists and engineers. Course may be repeated for a maximum of 1 credit hours.

AERO 7970/7976 SPECIAL TOPICS IN AEROSPACE ENGINEERING (1-3) LEC. Course may be repeated for a maximum of 9 credit hours.

AERO 7980/7986 AEROSPACE ENGINEERING PROJECT (3) LEC. 3. SU. Departmental approval. Intended for students in the MAE program. On or off-campus project. The nature of the project is to be determined by the student's major professor. Approval of the project and its final written report by the student's advisory committee is required. Course may be repeated with change in topic.

AERO 7990/7996 RESEARCH AND THESIS (1-10) MST. Credit hours to be arranged. Course may be repeated with change in topics.

AERO 8990/8996 RESEARCH AND DISSERTATION (1-10) DSR. Course may be repeated with change in topics.
Bio Ag Technology Management Courses

BATM 1110 INTRODUCTION TO TECHNOLOGY DESIGN (3) LEC. 2. LAB. 3. Introduction to the design process, 2D and 3D parametric solid modeling, and both manual and automated fabrication processes.

BATM 2110 DIGITAL ANALYTICS IN AGRICULTURE AND TECHNOLOGY (3) LEC. 2. LAB. 3. Pr. BATM 1110. An introduction to creative and analytical methods to solve technological problems. Define the problem, explore strategies, select and implement solutions, and evaluate results.

BATM 3100/3103 COMPUTER AIDED DESIGN TECHNOLOGY (3) LEC. 2. LAB. 1. Introductory course in computer aided design (CAD) and land mapping. Students gain competence in CAD operations used to fabricate parts and to develop field- and watershed-scale maps. Class and project topics include drawing for mechanical part fabrication and scale mapping for construction site development and agricultural field management. Must be in Junior standing Course may be repeated for a maximum of 6 credit hours.

BATM 3500 NATURAL RESOURCE SYSTEMS CONSERVATION (3) LEC. 2. LAB. 3. Pr. MATH 1130 or MATH 1133. Natural resource conservation technologies including rainfall-runoff relationships, sediment transport capacity, runoff control structures, water supply development, surveying techniques including GPS methods.

BATM 3510 AGRICULTURAL POWER AND MACHINERY FUNDAMENTALS (3) LEC. 2. LAB. 3. Pr. MATH 1130 or MATH 1133. Power unit fundamentals with emphasis on diesel and small gasoline engines; mechanics of operation, safety, use, and adjustment of machines used for horticultural and agronomic crop production; and precision agriculture principles and technology.

BATM 3530 AGRICULTURAL PRODUCTION AND PROCESSING FACILITY TECHNOLOGY (3) LEC. 3. Pr. MATH 1130 or MATH 1133. Fundamental requirements for the design and operation of agricultural production and processing facilities.

BATM 4100 PROFESSIONAL PRACTICE IN TECHNOLOGY MANAGEMENT (2) LEC. 1. LAB. 3. Pr. BATM 5110. First in the two-course capstone experience. This course focuses on professional topics that prepare students for technical careers; teamwork, communication, standards and codes, economics, project and time management. Teams initiate the capstone design project.

BATM 4110 TECHNOLOGY CAPSTONE (3) LEC. 1. LAB. 6. Pr. BATM 4100. Development and evaluation of a team-based capstone project using tools from the technology curriculum; emphasizing communication, critical thinking, and technical and economic analyses.

BATM 5110 AGRI-INDUSTRIAL ELECTRICAL APPLICATIONS (3) LEC. 2. LAB. 3. Pr. BATM 2110. An introduction to the fundamentals of electricity and electrical systems used in agricultural and industrial applications. Electricity basics include safety, AC (single and three phase) and DC power. Selecting and sizing components include wiring conductors, safety devices, motors, other loads.

BATM 5120 AGRI-INDUSTRIAL ELECTRONICS AND CONTROLS (3) LEC. 2. LAB. 3. Pr. BATM 5110. An introduction to the fundamentals of electronic control systems used in agricultural and industrial production and processing applications. Electronic control system components include programmable logic controllers (PLCs), switches, relays, sensors, and ladder logic.

BATM 6110 AGRI-INDUSTRIAL ELECTRICAL APPLICATIONS (3) LEC. 2. LAB. 3. Departmental approval. An introduction to the fundamentals of electricity and electrical systems used in agricultural and industrial applications. Electricity basics include safety, AC (single and three phase) and DC power. Selecting and sizing components include wiring conductors, safety devices, motors, other loads.

BATM 6120 AGRI-INDUSTRIAL ELECTRONICS AND CONTROLS (3) LEC. 2. LAB. 3. Pr. BATM 6110. An introduction to the fundamentals of electronic control systems used in agricultural and industrial production and processing applications. Electronic control system components include programmable logic controllers (PLCs), switches, relays, sensors, and ladder logic.

Biosystems Engineering Courses

BSEN 2210 ENGINEERING METHODS FOR BIOLOGICAL SYSTEMS (2) LEC. 1. LAB. 3. Pr. (ENGR 1110 or ENGR 1113) and (PHYS 1600 or PHYS 1607) or Departmental approval. Introduction to experimental design methodology, basic engineering design and problem solving methodology for Biological Engineering. Visualization skills, computer-aided 3-D solid modeling of parts, 3-D assembly of solid part geometries, computation of mass properties, 2-D engineering drawings, engineering design process, safety, tools and fabrication processes and design, and hands-on shop fabrication of semester project.
BSEN 2240 BIOLOGICAL AND BIOENVIRONMENTAL HEAT AND MASS TRANSFER (3) LEC. 3. Pr. (MATH 2630 or MATH 2637) and (PHYS 1600 or PHYS 1607) and P/C ENGR 2010. Basic principles of heat and mass transfer with special applications to biological and environmental systems. Introduction to steady state and transient heat conduction. Convection, radiation, diffusion, simultaneous heat and mass transfer, and generation and depletion of heat and mass in biological systems.

BSEN 3210 MECHANICAL POWER FOR BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. ENGR 2010 and MATH 2650 and P/C ENGR 2350. Basic engineering analysis, synthesis, and design concepts applied to power sources, mobile equipment, and machinery applications for agricultural, forestry, and natural resource systems.

BSEN 3230 NATURAL RESOURCE CONSERVATION ENGINEERING (3) LEC. 2. LAB. 3. Pr. BSEN 3310. Departmental approval. Engineering analysis applied to natural resource systems. Design principles and practices in rainfall-runoff relationships, soil erosion and its prediction and control, hydraulic structures, and open channel hydraulics.

BSEN 3240 PROCESS ENGINEERING IN BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. BSEN 2240. Departmental approval. Theory and application of process operations in biological, food and agricultural systems. Heat transfer, fluid flow, thermal processing, evaporation, psychrometrics, refrigeration, drying freezing.

BSEN 3260 ENGINEERING FOR PRECISION AGRICULTURE AND FORESTRY (3) LEC. 2. LAB. 3. Pr. ELEC 3810 and MATH 2650. Departmental approval. Engineering aspects of spatial technologies applied to agricultural and forest production. Data collection in the field using GPS and use of field data in site specific applications. Fall.

BSEN 3310 HYDRAULIC TRANSPORT IN BIOLOGICAL SYSTEMS (4) LEC. 3. LAB. 3. Pr. (ENGR 2050 or ENGR 2053) and MATH 2650 or Departmental approval. Fluid properties, Non-Newtonian fluids and biological systems, Fluid statics, Energy equation, mass and momentum balance, pipe flow for Newtonian and Non-Newtonian fluids, dimensional analysis, compressible flows.

BSEN 3560 TURF SYSTEMS IRRIGATION DESIGN (3) LEC. 3. Pr. MATH 1120. Irrigation system design for turf-based systems including residential lawns, commercial properties, athletic fields, and golf courses. Irrigation scheduling and water demand are presented to provide management capabilities.

BSEN 3610 INSTRUMENTATION AND CONTROLS FOR BIOLOGICAL SYSTEMS (3) LEC. 2. LAB. 3. Pr. MATH 2650 and BSEN 2210. Departmental approval. Understanding of fundamentals of electrical circuits, sensing and sensors, simple digital electronics, analog measurement circuits, introductory digital signal processing, computer data acquisition.

BSEN 4200 POLYMERS FROM RENEWABLE RESOURCES (2) LEC. 2. Fundamental aspects of natural, biodegradable polymers, including fibers, adhesives, films and coatings, their synthesis, their structure/properties relationships, and the microbiology of their degradation.

BSEN 4210 IRRIGATION SYSTEM DESIGN (3) LEC. 2. LAB. 3. Pr. BSEN 3230. Departmental approval. Theory and design of irrigation systems for the application of water and wastewater including surveying techniques for system design. Systems include solid-set, traveler, center-pivot, and trickle. Fall.

BSEN 4240 BULK BIOLOGICAL SOLIDS BEHAVIOR AND PROCESSING (3) LEC. 2. LAB. 3. Pr. BIOL 1020 and (STAT 2510 or STAT 3010 or BSEN 3310). The course is designed to enable students to develop fundamental understanding of the properties of bulk biological solids and how these properties influence the behavior and processability of bulk solids.

BSEN 4250 HYDRAULIC CONTROL SYSTEMS DESIGN (3) LEC. 2. LAB. 3. Pr. BSEN 3310 or Departmental approval. Principles of energy transfer by means of fluid power. Design of hydraulic control systems using prime movers, valves, actuators, and accessories. Spring.

BSEN 4300 PROFESSIONAL PRACTICE IN BIOSYSTEMS ENGINEERING (2) LEC. 1. LAB. 3. Pr. ENGR 2070 and (BSEN 4240 or BSEN 3230). This course focuses on issues related to the professional practice of biological engineering including preparing students for transition to careers as professional engineers.

BSEN 4310 ENGINEERING DESIGN FOR BIOSYSTEMS (3) LEC. 1. LAB. 6. Pr. BSEN 4300. Departmental approval. Capstone design course in biosystems engineering emphasizing teamwork, communication, safety engineering, and economic analysis to complete an engineering design project. Spring.

BSEN 4960 SPECIAL PROBLEMS IN BIOSYSTEMS ENGINEERING (1-4) AAB/IND. Departmental approval. Faculty supervision of individual student investigations of specialized problems in biosystems engineering. May be repeated with change in problem. Course may be repeated with change in topics.
BSEN 4967 HONORS SPECIAL PROBLEMS (1-3) IND. Pr. Honors College. Course may be repeated for a maximum of 3 credit hours.

BSEN 4970 SPECIAL TOPICS IN BIOSYSTEMS ENGINEERING (1-4) LEC. Departmental approval. Individual or small group study of a specialized area in biosystems engineering. Course may be repeated for a maximum of 12 credit hours.

BSEN 4980 UNDERGRADUATE RESEARCH (2-4) IND. Departmental approval. Directed research in the area of specialty within the department. Course may be repeated for a maximum of 4 credit hours.

BSEN 4997 HONORS THESIS (1-3) IND. Pr. Honors College. Course may be repeated for a maximum of 3 credit hours.

BSEN 5220 GEOSPATIAL TECHNOLOGIES IN BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. STAT 2510 or STAT 2513 or STAT 2610 or STAT 3010 or CSES 2040 or CSES 2043 or AGRN 2040 or AGRN 2043 or Departmental approval. Geospatial technologies including GPS, GIS, and remote sensing systems applied to biosystems. Collecting, managing, and analyzing spatial data for agricultural and forest systems. Spring.

BSEN 5230 WASTE MANAGEMENT AND UTILIZATION FOR BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. (CHEM 1040 and BIOL 3200) and (P/C BSEN 3230 or P/C BSEN 4240). Introduction to animal waste management problems of confined production systems, and characterization of animal waste types. Design of biological treatment and processing systems. Departmental approval. May count either BSEN 5230 or BSEN 6230.

BSEN 5250 DETERMINISTIC MODELING FOR BIOSYSTEMS (3) LEC. 3. LAB. 2. Pr. MATH 2650. Modeling of biosystems, methods to deal with complexity, and validation tools.

BSEN 5260 RENEWABLE ENERGY IN BIOSYSTEMS PROCESS OPERATIONS (3) LEC. 2. LAB. 3. Pr. BSEN 3310. Application and use of renewable energy in biological, food, forest and agricultural systems including bioenergy, solar energy, wind power and geothermal. Departmental approval. May count either BSEN 5260 or BSEN 6260.

BSEN 5270 METABOLIC ENGINEERING FOR BIOPROCESS (3) LEC. 3. Pr. BIOL 3200 and CHEM 1040. Or with the consent of the instructor. Introduction of basic principles of bioprocess engineering and metabolic engineering, to prepare engineers and scientists for biotechnology and bioeconomy industries.

BSEN 5280 LIFE-CYCLE ASSESSMENT FOR BIOLOGICAL SYSTEMS (3) LEC. 2. LAB. 3. Pr. BSEN 2240 and BSEN 3310. Introduces the concept of life cycle assessment (LCA) in in the context of biological engineering. Examples will include LCA applications to engineered biological systems and other engineering processes and products.

BSEN 5450 COMMERCIAL POULTRY & LIVESTOCK HOUSING (3) LEC. 2. LAB. 3. An introduction to the basic design, operation, and maintenance of modern commercial animal housing systems. Emphasis will be placed on poultry and swine systems with elements of dairy and beef when applicable.

BSEN 5510 ECOLOGICAL ENGINEERING (3) LEC. 3. Pr. BSEN 3230. Ecological engineering non-point source transport of nutrients, sediment, pesticides, pathogens, and chemicals from agricultural, forestry, and urban activities. Departmental approval. May count either BSEN 5510 or BSEN 6510.

BSEN 5520 WATERSHED MODELING (3) LEC. 3. Pr. BSEN 5510. Modeling of non-point source pollution at watershed scale using Soil and Water Assessment Tool model including underlying processes that control movement of pollutants. Departmental approval. May count either BSEN 5520 or BSEN 6520.

BSEN 5540 BIOMASS AND BIOFUELS ENGINEERING (3) LEC. 2. LAB. 3. Pr. CHEM 1040 and MATH 2650 and BSEN 3310. This course introduces the various processes and engineering principles in converting biomass into biofuels and chemicals. The focus will be on thermochemical and biochemical conversion platforms. May count either BSEN 5540 or BSEN 6540.

BSEN 5550 PRINCIPLES OF FOOD ENGINEERING TECHNOLOGY (4) LEC. 3. LAB. 3. Pr. (MATH 1130 or MATH 1133 or MATH 1150 or MATH 1153 or MATH 1610 or MATH 1613 or MATH 1617) and (PHYS 1000 or PHYS 1007) or PHYS 1500 or (PHYS 1600 or PHYS 1607). Engineering concepts and unit operations used in processing food products. Fall.

BSEN 5560 SITE DESIGN FOR BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. BSEN 3230. Development of student skills in computer-aided site design and restoration by using rural and urban best management practices to reduce environmental impacts. Departmental approval. May count either BSEN 5560 or BSEN 6560.
BSEN 6220 GEOSPATIAL TECHNOLOGIES IN BIOSYSTEMS (3) LEC. 2. LAB. 3. Departmental approval. Geospatial technologies including GPS, GIS, and remote sensing systems applied to biosystems. Collecting, managing, and analyzing spatial data for agricultural and forest systems. Spring.

BSEN 6230 WASTE MANAGEMENT AND UTILIZATION FOR BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. CHEM 1040 or CHEM 1041. Departmental approval. Coreq. BSEN 3230. Introduction to the animal waste management problems of confined production systems and characterization of animal waste types. Design of biological treatment and processing systems.

BSEN 6250 DETERMINISTIC MODELING FOR BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. MATH 2650. Modeling of biosystems, methods to deal with complexity, and validation tools.

BSEN 6260 RENEWABLE ENERGY IN BIOSYSTEMS PROCESS OPERATIONS (3) LEC. 2. LAB. 3. Pr. BSEN 3310. Departmental approval. Application and se of renewable energy in biological, food forest and agricultural systems including biomass and bioenergy, solar energy, wind power and geothermal.

BSEN 6270 METABOLIC ENGINEERING FOR BIOPROCESS (3) LEC. 3. Department/instructor approval. An introduction of basic principles of bioprocess engineering and metabolic engineering, to prepare engineers and scientists for biotechnology and bioeconomy industries. May count either BSEN 5270 or BSE 6270.

BSEN 6280 LIFE-CYCLE ASSESSMENT FOR BIOLOGICAL SYSTEMS (3) LEC. 2. LAB. 3. Pr. BSEN 2240. Departmental approval. This course introduces the concept of life cycle assessment (LCA) in in the context of biological engineering. Examples will include LCA applications to engineered biological systems and other engineering processes and products.

BSEN 6450 COMMERCIAL POULTRY AND LIVESTOCK HOUSING (3) LEC. 2. LAB. 3. An introduction to the basic design, operation, and maintenance of modern commercial animal housing systems. Emphasis will be placed on poultry and swine systems with elements of dairy and beef when applicable.

BSEN 6510 ECOLOGICAL ENGINEERING (3) LEC. 3. Pr. BSEN 3230. Departmental approval. The course introduces students to ecological engineering non-point source transport of nutrients, sediment, pesticides, pathogens, and chemicals from agricultural, forestry, and urban activities.

BSEN 6520 WATERSHED MODELING (3) LEC. 3. Departmental approval. The course covers modeling of non-point source pollution at the watershed scale using Soil and Water Assessment Tool model including underlying processes that control movement of pollutants.

BSEN 6540 BIOMASS AND BIOFUELS ENGINEERING (3) LEC. 2. LAB. 3. This course introduces the various processes and engineering principles in converting biomass into biofuels and chemicals. The focus will be on thermochemical and biochemical conversion platforms. May count either BSEN 5540 or BSEN 6540.

BSEN 6550 PRINCIPLES OF FOOD ENGINEERING TECHNOLOGY (4) LEC. 3. LAB. 3. Pr. (MATH 1130 or MATH 1133) and (PHYS 1000 or PHYS 1007). Engineering concepts and unit operations used in processing food products. Fall.

BSEN 6560 SITE DESIGN FOR BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. BSEN 3230. Departmental approval. The course is designed to develop student skills in computer-aided site design and restoration by using rural and urban best management practices to reduce environmental impacts.

BSEN 7016 QUANTITATIVE AGRICULTURAL REMOTE SENSING (3) LEC. 3. Departmental approval. Theory and application of remote sensing to quantifying soil and vegetation characteristics, with emphasis on agriculture but also relevant to natural biosystems.

BSEN 7020/7026 SITE-SPECIFIC TECHNOLOGIES FOR AGRICULTURE AND FORESTRY SYSTEMS (3) LEC. 2. LAB. 3. Departmental approval. Introduction to advanced concepts of off-highway vehicle equipment for use in agricultural and forestry production with emphasis on site-specific management (Precision Agriculture/Forestry). The course will overview new concepts and technologies for equipment usage and technologies applied for site-specific crop management.

BSEN 7050 SOIL DYNAMICS OF TILLAGE AND TRACTION (3) LEC. 3. Pr. CIVL 4300 and CSES 7590. Departmental approval. Analyses and measurements of soil reactions as affected by physical properties of soil when subjected to forces imposed by tillage implements and traction devices.
BSEN 7110/7116 FUNDAMENTALS OF INSTRUMENTATION FOR BIOLOGICAL SYSTEMS (3) LEC. 2. LAB. 3. Departmental approval. Students will gain an understanding of the fundamentals of sensing and sensors, simple digital electronics and measurement circuits, introductory digital signal processing, and computer data acquisition. They will be required to build and test instrumentation to collect data on biological systems that might include fluid flow, pressure, force, or other transducers.

BSEN 7120 STOCHASTIC MODELING FOR BIOSYSTEMS (3) LEC. 3. Pr. CIVL 3020. Departmental approval. Solving problems in biosystems engineering and related fields by modeling data with probability distributions, spatial statistics, autoregressive models, Monte-Carlo simulation, and reliability methods.

BSEN 7136 GIS APPLICATIONS IN PRECISION AGRICULTURE (1) LEC. 1. Departmental approval. Exploration of geographic information systems (GIS) and its applications in precision agriculture. Topics include file structure and formatting, interfacing with precision agriculture equipment, georeferencing maps, merging and clipping farm data, data field calculations, designing management zones, variable rate prescriptions, and basic data analysis.

BSEN 7140 ALGAE SYSTEMS ENGINEERING (3) LEC. 2. LAB. 1. This course is a study of engineered systems for cultivating algae for various uses in society. To develop an understanding of engineering principles applied to growing, cultivating, and producing algal biomass for a number of applications, study into the biology, physiology, and ecology of algae and similar species will be a major part of the course. Departmental Approval.

BSEN 7216 BIOMASS TO RENEWABLE ENERGY PROCESSES (3) LEC. 3. Pr. (CHEM 2070 or CHEM 2077) and (CHEM 2080 or CHEM 2087) or CHEM 5180 and BIOL 3200. Departmental approval. This will introduce fundamental principles and practical applications of biomass-to-renewable energy processes.

BSEN 7220 RENEWABLE ENERGY SYSTEMS DESIGN, ANALYSIS AND APPLICATIONS (3) LEC. 3. Understanding of the basic principles, applications, modeling, energetic and economic analysis of renewable energy resources namely solar, biomass, wind, hydropower and geothermal. Design of renewable energy systems.

BSEN 7240 BULK SOLIDS STORAGE, HANDLING AND TRANSPORTATION (3) LEC. 3. Sampling of particulate materials, bulk solids characterization, flow properties, particle and bulk solid flow, dynamics of fluid/solids systems, hydraulic and pneumatic conveyor design, storage bin and hopper design and geometry, safety issues.

BSEN 7260 ADVANCED UNIT OPERATIONS IN BIOSYSTEMS ENGINEERING (3) LEC. 2. LAB. 3. The course is an advance analysis of the unit operations used to process and enhance the value of biological materials.

BSEN 7280 FOOD THERMAL PROCESSING (3) LEC. 2. LAB. 3. Departmental approval. Insight of technologies and approaches used in food thermal processing for commercial purposes. Application of fundamentals of heat transfer, thermo-bacteriology, physical and chemical kinetics of food, and plant layout.

BSEN 7310 NONPOINT SOURCE POLLUTION (3) LEC. 3. Departmental approval. Non-point source (NPS) transport of nutrients, sediment, pesticides, and pathogens from agricultural, forestry, and urban activities. Basic concepts of pollutant transport through soils and with overland flow. Evaluation, management, and prevention of non-point pollution of surface and groundwater.

BSEN 7320 NON-POINT SOURCE POLLUTION MODELING (3) LEC. 3. Pr. BSEN 7310 or Departmental approval. Non-point source (NPS) modeling of nutrients, sediment, pesticides, and pathogens from agricultural, forestry, and urban activities. Underlying processes (climate, hydrology, nutrients and pesticides, erosion, channel), land cover/plants best management practices. Sensitivity and uncertainty analyses.

BSEN 7330 SOIL-PLANT-ENVIRONMENTAL SYSTEM DESIGN SOIL-PLANT-ENVIRONMENTAL SYSTEM DESIGN (3) LEC. 3. Study of systems that incorporate plant uptake of nutrients and/or heavy metals for remediation of soil-based contaminants. Design applications of environmental remediation include constructed wetlands, drip irrigation of wastewater effluent, disposal of municipal sludge, and phytoremediation of contaminants in shallow groundwater.

BSEN 7350 ENGINEERING ANALYSIS OF LAKES AND RESERVOIRS (3) LEC. 3. Departmental approval. Knowledge and understanding of the causes, impacts, and methods of restoring water quality impairments, with emphasis placed on impounded water bodies and perennial streams.

BSEN 7366 INTEGRATING AUTOCAOD CIVIL3D & GIS (3) LEC. 3. Departmental approval. Accessing and importing GIS data into C3D. Exporting C3D objects to GIS for subsequent manipulation and display. Emphasis on applications in environmental engineering projects such as stream restoration and wetland design.

BSEN 7516 INTRODUCTION TO LAND AND WATER ENGINEERING (3) LEC. 3. This course aims at equipping students with the engineering tools and knowledge needed for advanced courses in land and water engineering.

BSEN 7526 INTRODUCTION TO FLUVIAL GEOMORPHOLOGY (3) LEC. 3. Pr. BSEN 3230. This course provides an overview of stream geomorphology as it relates to natural stream physical processes.

BSEN 7536 DRAINMOD (3) LEC. 3. Pr. BSEN 3230. This course presents the principles of water movement and fate in shallow water table systems and application of the drainage water management model DRAINMOD to a wide variety of problems.

BSEN 7616 AGRICULTURAL WASTE MANAGEMENT (3) LEC. 3. This course covers principles of managing, handling, treating and applying animal and poultry manures and organic byproducts from an engineering perspective. Departmental approval.

BSEN 7626 STORMWATER BMP DESIGN (3) LEC. 3. Pr. BSEN 3230. Departmental approval. This course is designed to introduce students to several innovative stormwater practices including stormwater wetlands, bioretention, green roofs, permeable pavement, cisterns, and others.

BSEN 7636 STREAM RESTORATION STRUCTURE RISK AND FAILURE ASSESS (1) LEC. 1. Pr. BSEN 3230. Departmental approval. Critical thinking about the use of various stream restoration structures and providing the tools needed to investigate further into failure analysis and risk assessment.

BSEN 7646 OPEN CHANNEL HYDRAULICS (3) LEC. 3. Pr. BSEN 3310. Departmental approval. Theory and application of hydraulics in open channels with an emphasis on natural systems (natural streams and rivers).

BSEN 7666 WETLANDS DESIGN AND RESTORATION (3) LEC. 3. Departmental approval. Fundamental understanding of hydrology, soils and ecology of natural wetland systems to serve as the basis of designing wetland systems for water treatment and restoring degraded natural wetlands.

BSEN 7900 SPECIAL PROBLEMS IN BIOSYSTEMS ENGINEERING (1-4) IND. Departmental approval. Faculty supervision of individual student investigations of advanced specialized problems in biosystems engineering at the graduate level. Pr., Course may be repeated with change in topics.

BSEN 7950 SEMINAR (1) SEM. SU. Reviews and discussions of research techniques, current scientific literature, and recent developments in biosystems engineering. Course may be repeated for a maximum of 12 credit hours.

BSEN 7970 SPECIAL TOPICS IN BIOSYSTEMS ENGINEERING (1-4) IND. Departmental approval. Individual or small group study of an advanced specialized area in biosystems engineering at the graduate level. Course may be repeated with change in topics.

BSEN 7990 RESEARCH AND THESIS (1-10) MST. Course may be repeated with change in topic.

BSEN 8990 RESEARCH AND DISSERTATION (1-12) DSR.

Chemical Engineering Courses

CHEN 2100 PRINCIPLES OF CHEMICAL ENGINEERING (4) LEC. 3. LAB. 3. Pr. (CHEM 1110 or CHEM 1117 or CHEM 1030 or CHEM 1033) and (MATH 1610 or MATH 1613 or MATH 1617) and (P/C CHEM 1120 or P/C CHEM 1127 or P/C CHEM 1040 or P/C CHEM 1043) and (P/C MATH 1620 or MATH 1623 or P/C MATH 1627) and (P/C PHYS 1600 or P/C PHYS 1607). Application of multicomponent material and energy balances to chemical processes involving phase changes and chemical reactions.

CHEN 2110 CHEMICAL ENGINEERING THERMODYNAMICS (3) LEC. 3. Pr. (CHEM 1030 or CHEM 1033 or CHEM 1110 or CHEM 1117) and (MATH 1620 or MATH 1623 or MATH 1627) and (CHEN 2100) and (P/C PHYS 1600 or P/C PHYS 1607) and (P/C CHEN 2650). This course is intended to comprehensively introduce the thermodynamics of single- and multi-phase, pure systems, including the first and second laws of thermodynamics, equations of state, simple processes and cycles, and their applications in chemical engineering.

CHEN 2610 TRANSPORT I (3) LEC. 3. Pr. (PHYS 1600 or PHYS 1607) and CHEN 2100 and (P/C MATH 2630 or P/C MATH 2637) and (P/C ENGR 2010 or P/C CHEN 2110). CHEN 2100 requires a grade of C or better. Introduction to fluid statics and dynamics; dimensional analysis; compressible and incompressible flows; design of flow systems; introduction to fluid solids transport including fluidization, flow through process media and multiphase flows.
CHEN 2650 CHEMICAL ENGINEERING APPLICATIONS OF MATHEMATICAL TECHNIQUES (3) LEC. 3. Pr. CHEN 2100 and P/C CHEN 2610 and (P/C MATH 2630 or P/C MATH 2637) and P/C MATH 2650 and COMP 1200. CHEN 2100 requires a grade of C or better. CHEN 2610 and MATH 2650 are Prerequisites with Concurrency. COMP 1200 should be the Matlab section, if it is possible to specify this. Otherwise just COMP 1200. Application of a broad range of mathematical techniques to chemical engineering problems. Emphasis on engineering significance and interpretation of mathematical operations.

CHEN 2AA0 CHEMICAL ENGINEERING PROGRESS ASSESSMENT I (0) LAB. SU. Pr. CHEN 2100. Progress assessment examination in basic science, general chemistry, physics, basic math principles (geometry, algebra), multivariable calculus, chemical engineering process principles (mass and energy balances). Course may be repeated with change in topics.

CHEN 3090 PULP AND PAPER TECHNOLOGY (3) LEC. 3. Pr. (CHEM 1030 or CHEM 1110 or CHEM 1117) and ENGR 2010. An introductory course on the technology of pulp and paper manufacturing with emphasis on raw materials, pulping, bleaching, paper making, coating and environmental control. For students with no previous formal pulp and paper background.

CHEN 3370 PHASE AND REACTION EQUILIBRIA (3) LEC. 3. Pr. (MATH 2630 or MATH 2637) and ENGR 2010 and CHEN 2100 and P/C CHEN 3600 and P/C CHEN 2650. Molecular thermodynamics of phase and chemical reaction equilibria including non-ideal thermodynamics and multicomponent applications. (ENGR 2010 and CHEN 2100 require a grade of C or better).

CHEN 3410 CREATIVITY AND CRITICAL THINKING IN ENGINEERING (3) LEC. 3. Application of creativity and critical thinking principles to effectively approach solving engineering problems. Convincing presentation of information to technical audiences.

CHEN 3600 COMPUTER-AIDED CHEMICAL ENGINEERING (3) LEC. 2. LAB. 3. Pr. COMP 1200 and MATH 2650 and CHEN 2610 and P/C CHEN 2650 and (MATH 2630 or MATH 2637) and CHEN 2110 and CHEN 2100. CHEN 2650 is prerequisite with concurrency. General and structured programming concepts, numerical methods, and introductory probability and statistics concepts. Application to chemical engineering problems involving material and energy balances and transport process, data validation, and analysis. (CHEN 2610 requires a grade of C or better).

CHEN 3620 TRANSPORT II (3) LEC. 3. Pr. (MATH 2630 or MATH 2637) and (ENGR 2010 or CHEN 2110) and CHEN 2100 and P/C CHEN 2650 and P/C CHEN 3600 and MATH 2650 and P/C CHEN 2650. Fundamentals and applications of heat and mass transfer in chemical processes including conduction, convection, and radiation, heat exchange, evaporation, chemical reaction gas absorption, drying and humidification. (ENGR 2010 and CHEN 2610 require a grade of C or better).

CHEN 3650 CHEMICAL ENGINEERING ANALYSIS (3) LEC. 2. LAB. 3. Pr. CHEN 2650 and CHEN 3600 and CHEN 3620 and CHEN 2AA0 and MATH 2650. CHEN 2650, CHEN 3600 and CHEN 3620 all require a grade of C or better. Mathematical modeling, analytical, numerical and statistical analysis of chemical processes.

CHEN 3660 CHEMICAL ENGINEERING SEPARATIONS (3) LEC. 3. Pr. CHEN 3370 and CHEN 3620 and CHEN 3600. Separations processes including distillation, extraction, membrane separation, and other separation operations. (CHEN 3370 and CHEN 3620 require a grade of C or better).

CHEN 3700 CHEMICAL REACTION ENGINEERING (3) LEC. 3. Pr. MATH 2650 and CHEN 2610 and (ENGR 2010 or CHEN 2110) and P/C CHEN 3620 and P/C CHEN 3700. Design of chemical reactors with homogeneous reaction systems. (CHEN 2610 and ENGR 2010 require a grade of C or better).

CHEN 3820 CHEMICAL ENGINEERING LABORATORY I (2) LEC. 1. LAB. 3. Pr. CHEN 3600 and CHEN 3620 and MATH 2650. Experimental study of chemical thermodynamics, heat and momentum transfer with analytical, numerical, and statistical analysis.

CHEN 3AA0 CHEMICAL ENGINEERING PROGRESS ASSESSMENT II (0) LAB. SU. Pr. CHEN 2AA0 and P/C CHEN 3370 and P/C CHEN 3650 and P/C CHEN 3700 and P/C CHEN 3660 and CHEN 2650. Progress assessment examination in thermodynamics, linear differential equations, organic chemistry, transport phenomena (fluid mechanics, heat, mass transfer), phase and reaction equilibria, reaction engineering, design and conduction of experiments, analysis and interpretation of data, professional, ethical, societal and contemporary issues. Course may be repeated with change in topics.

CHEN 4100 PULP AND PAPER PROCESSING LABORATORY (2) LAB. 6. Pr. CHEN 5090 or Departmental approval. Experimental study of pulping and papermaking operations. Departmental approval.

CHEN 4160 PROCESS DYNAMICS AND CONTROL (3) LEC. 2. LAB. 3. Pr. CHEN 3600 and (CHEN 3650 or CHEN 3653). Dynamic modeling of chemical processes, feedback systems and analog controller tuning and design, sequential control systems. (CHEN 3600 and CHEN 3650 require a grade of C or better).
CHEN 4170 DIGITAL PROCESS CONTROL (3) LEC. 3. Pr. (CHEN 3650 or CHEN 3653) and CHEN 3600 and CHEN 3660.
Introduction of basic concepts and principles for control system. Analysis of open loop and closed-loop processes using transfer functions.

CHEN 4180 ADVANCED DIGITAL PROCESS CONTROL (3) LEC. 2. LAB. 3. Pr. CHEN 4170. Application of sequential, closed loop and open loop process control principles to actual industrial and experimental control laboratory process. (CHEN 4170 requires a grade of C or better).

CHEN 4450 PROCESS ECONOMICS AND SAFETY (3) LEC. 2. LAB. 3. Pr. (CHEM 2080 or CHEM 2087) and CHEN 3370 and (CHEN 3650 or CHEN 3653) and CHEN 3660 and CHEN 3700 and CHEN 3600. Fundamentals and applications of process economics and design, computer-aided cost estimation, profitability analysis and process improvement. Application of chemical process safety, risk assessment and management, hazard and operability analysis, chemical engineering principles for risk reduction. (CHEN 3370, CHEN 3650, CHEN 3660 and CHEN 3700 require a grade of C or better).

CHEN 4460 PROCESS SIMULATION SYNTHESIS AND OPTIMIZATION (2) LEC. 1. LAB. 3. Pr. (CHEM 2080 or CHEM 2087) and CHEN 3370 and CHEN 3650 and CHEN 3660 and CHEN 3700 and CHEN 3600. Fundamentals of computer-aided simulation and synthesis. Process integration and optimization principles including their applications in design, retrofitting and operation of chemical processes. (CHEN 3370, CHEN 3650, CHEN 3660 and CHEN 3700 require a grade of C or better).

CHEN 4470 PROCESS DESIGN PRACTICE (3) LEC. 2. LAB. 3. Pr. CHEN 3AA0 and CHEN 4450 and CHEN 4460 and CHEN 3650 and CHEN 3660 and CHEN 3700 and PHYS 1610. Flow sheet simulation and techno-economic analysis applied to complex, open-ended chemical processes. Screening of alternatives and economic optimizations. Capstone design course.

CHEN 4560 PULP AND PAPER PROCESS SIMULATION (2) LEC. 1. LAB. 3. Pr. (CHEM 2080 or CHEM 2087) and CHEN 3090 and CHEN 3370 and (CHEN 3650 or CHEN 3653) and CHEN 3660 and CHEN 3700 and P/C CHEN 4100 and P/C CHEN 5110. Fundamentals of microcomputer process simulation with applications to the pulp and paper industry. Design of pulp and paper unit operations and small scale processes using commercial simulation software. (CHEN 3090, CHEN 3370, CHEN 3650, CHEN 3660 and CHEN 3700 require a grade of C or better).

CHEN 4570 PULP AND PAPER PROCESS DESIGN (3) LEC. 2. LAB. 3. Pr. CHEN 3AA0 and CHEN 4450 and CHEN 4560.
Application of process simulation and process economics to complex, open-ended design, retrofitting and operation problems in pulp and paper. Design of pulp and paper unit operations and processes. Screening of alternatives and economic optimizations.

CHEN 4630 INTRODUCTION TO TRANSPORT PHENOMENA (3) LEC. 3. Pr. CHEN 3620 and (CHEN 3650 or CHEN 3653).
Application of chemical engineering analysis to momentum, heat and mass transport problems for advanced undergraduate students preparing for graduate school. (CHEN 3620 and CHEN 3650 require a grade of C or better).

CHEN 4860 CHEMICAL ENGINEERING LABORATORY II (2) LEC. 1. LAB. 3. Pr. CHEN 3660 and CHEN 3820 and P/C CHEN 3700 and CHEN 3650 and P/C CHEN 4170. Experimental study of mass transfer, separations and reaction engineering. Emphasis is on open-ended laboratory projects with electronic instrumentation; experimental design with numerical and statistical analysis of data.

CHEN 4880 PULP AND PAPER ENGINEERING LABORATORY (3) LAB. 9. Pr. CHEN 4100 and CHEN 5110. Comprehensive open-ended projects on pulp and paper topics.

CHEN 4930 DIRECTED STUDIES (1) LEC. 1. Supervised study in specialized areas of chemical engineering. Topic must be arranged with instructor during preregistration. Project report.

CHEN 4970 SPECIAL TOPICS IN CHEMICAL ENGINEERING (1-10) AAB. Departmental approval. Topical courses in special areas. Topic must be arranged with instructor during pre-registration. Course may be repeated for a maximum of 10 credit hours.

CHEN 4980 UNDERGRADUATE RESEARCH (1-3) IND. Pr. 3.00 GPA. Departmental approval. GPA of 3.0 or higher. Individual and small group projects. Topic must be arranged with instructor during preregistration. Research Report. Course may be repeated for a maximum of 3 credit hours.

CHEN 4997 HONORS THESIS (1-6) IND. Pr. Honors College. Departmental approval. Course may be repeated for a maximum of 6 credit hours.

CHEN 5090 PULP AND PAPER TECHNOLOGY (3) LEC. 3. Pr. (ENGR 2010 or CHEN 2110) and (CHEM 1030 or CHEM 1033) and (CHEM 1110 or CHEM 1117) and MATH 2650. An introductory course on the technology of pulp and paper manufacturing with emphasis on raw materials, pulping, bleaching, paper making, coating and environmental control. For students with no previous formal pulp and paper background.
CHEN 5110 PULP AND PAPER ENGINEERING (3) LEC. 3. Pr. CHEN 3620 and CHEN 3700 and P/C CHEN 4450. Chemical and engineering principles in the manufacturing of pulp and paper. (CHEN 3090, CHEN 3620, and CHEN 3700 require a grade of C or better).

CHEN 5120 SURFACE AND COLLOID SCIENCE (3) LEC. 3. Pr. CHEN 3620 and CHEN 4100. Fundamentals of surface and colloid science with applications in pulping and papermaking, including sizing, retention and drainage, charge measurements, dry/wet strength additives, fillers, colorants, foams, pitch and deposits. (CHEN 3620 and CHEN 4100 require a grade of C or better).

CHEN 5400 MOLECULAR ENGINEERING (3) LEC. 3. Pr. (CHEM 2080 or CHEM 2087) and CHEN 3370 and P/C CHEN 3700. Introduction to how molecular structure and long range microstructure affect the properties of chemical engineering products and how this knowledge can be used to design chemical engineering products for specific applications. (CHEN 3370 requires a grade of C or better).

CHEN 5410 MACROMOLECULAR SCIENCE AND ENGINEERING (3) LEC. 3. Pr. (CHEM 2080 or CHEM 2087) and CHEN 3370. Statistical mechanics of chain molecules; thermodynamics of polymer solutions; dilute, semi-dilute, and concentrated solutions and gels; polymer physics; scaling concepts in polymer physics; reputation theory (deGennes, Doi, Edwards) and molecular dynamics; phase separations; crystallization of polymers; rubber elasticity theory; mechanical analysis; viscoelasticity; diffusion theory of polymers; surface properties of polymers. (CHEN 3370 requires a grade of C or better).

CHEN 5420 POLYMER CHEMICAL ENGINEERING (3) LEC. 2. LAB. 3. Pr. (CHEM 2070 or CHEM 2077) and CHEN 3620 and CHEN 5410. Polymer rheology, transport phenomena, thermodynamics, membranes, conducting polymers, surfaces, interfaces and processing. (CHEN 3620 and CHEN 5410 require a grade of C or better).

CHEN 5430 BUSINESS ASPECTS OF CHEMICAL ENGINEERING (3) LEC. 3. Pr., Departmental Approval. The procession of activities required to successfully commercialize and market new chemical-engineering-based technologies to the consumer and process industries.

CHEN 5440 ELECTROCHEMICAL ENGINEERING (3) LEC. 3. Pr. CHEN 3370 and CHEN 3620 and CHEN 3700. Thermodynamics, electrode kinetics and transport phenomena of electrochemical systems, current and potential distributions, double layer theory, electrochemical processes, power sources, synthesis, corrosion. (CHEN 3370, CHEN 3620, and CHEN 3700 require a grade of C or better).

CHEN 5650 HAZARDOUS MATERIALS MANAGEMENT AND ENGINEERING (3) LEC. 3. Pr. (CHEM 2030 or CHEM 2080 or CHEM 2087) and (CHEN 3820 or CIVL 5210). Fundamental principles and regulatory information related to hazardous material and process safety management and engineering, dispersion of chemicals, hazard and operability analysis, chemical engineering principles for risk education.

CHEN 5660 MACROS SCALE ASSEMBLY AND APPLICATIONS OF NANOMATERIALS (3) LEC. 3. Departmental approval. Production of macroscopic assemblies and structures from nanomaterials. Processing and applications of inorganic, organic, biological and hybrid nanomaterials.

CHEN 5670 POLLUTION PREVENTION ENGINEERING (3) LEC. 3. Pr. (CHEM 2080 or CHEM 2087) and CHEN 3370 and CHEN 3620 and CHEN 3660 and CHEN 3700. Chemical and engineering principles applied to pollution prevention. Theory and practice of basic separation methods, reaction engineering, process controls, and other fundamental chemical engineering disciplines as well as regulatory requirements to prevent unnecessary waste generation. Case studies. (CHEN 3370, CHEN 3620, CHEN 3660, and CHEN 3700 require a grade of C or better).

CHEN 5700 ADVANCED SEPARATION PROCESSES (3) LEC. 3. Pr. CHEN 3370 and CHEN 3660. Advanced treatment of modern chemical engineering separation processes. Theory and practice of staged multi-component mass transfer operations, non-ideal multi-phase separations and continuous rate processes. (CHEN 3370 and CHEN 3660 require a grade of C or better).


CHEN 5810 BIOMEDICAL ENGINEERING (3) LEC. 3. Pr. CHEM 2087 and P/C CHEN 3620. Application of chemical engineering principles to the study of medical physiology. Human biochemistry, anatomy and physiology, rheological properties of blood and synovial fluid, rheology of cell membranes. Biomedical fluid mechanics and heat and mass transfer. (CHEN 3620 and CHEN 3700 require a grade of C or better).
CHEN 5820 ADVANCED TOPICS IN ENVIRONMENTAL BIOTECHNOLOGY (3) LEC. 3. Application of biotechnology to environmental process treatment, bioremediation and bioreactor development.

CHEN 5970 ADVANCED SPECIAL TOPICS IN CHEMICAL ENGINEERING (1-6) LEC. Departmental approval. Topical courses in areas for advanced undergraduate and graduate students. Topics must be arranged with instructor during preregistration. Course may be repeated for a maximum of 24 credit hours.

CHEN 6090/6096 PULP AND PAPER TECHNOLOGY (3) LEC. 3. An introductory graduate level course on the technology of pulp and paper manufacturing with emphasis on raw materials, pulping, bleaching, paper making, coating and environmental control. For students with no previous formal pulp and paper background, CHEN Department Approval and Alabama Center for Paper and Bioresource Engineering Director approval.

CHEN 6110/6116 PULP AND PAPER ENGINEERING (3) LEC. 3. Chemical and engineering principles in the manufacturing of pulp and paper.

CHEN 6120/6126 SURFACE AND COLLOID SCIENCE (3) LEC. 3. Fundamentals of surface and colloid science with applications in pulping and papermaking, including sizing, retention and drainage, charge measurements, dry/wet strength additives, fillers, colorants, foams, pitch and deposits.

CHEN 6400/6406 MOLECULAR ENGINEERING (3) LEC. 3. Introduction to how molecular structure and long range microstructure affect the properties of chemical engineering products and how this knowledge can be used to design chemical engineering products for specific applications.

CHEN 6410/6416 MACROMOLECULAR SCIENCE AND ENGINEERING (3) LEC. 3. Statistical mechanics of chain molecules; thermodynamics of polymer solutions; dilute, semi-dilute, and concentrated solutions and gels; polymer physics; scaling concepts in polymer physics; reptation theory (deGennes, Doi, Edwards) and molecular dynamics; phase separations; crystallization of polymers; rubber elasticity theory; mechanical analysis; viscoelasticity; diffusion theory of polymers; surface properties of polymers.

CHEN 6420/6426 POLYMER CHEMICAL ENGINEERING (3) LEC. 3. Polymer rheology, transport phenomena, thermodynamics, membranes, conducting polymers, surfaces, interfaces and processing.

CHEN 6430/6436 BUSINESS ASPECTS OF CHEMICAL ENGINEERING (3) LEC. 3. Departmental approval. The procession of activities required to successfully commercialize and market new chemical-engineering-based technologies to the consumer and process industries.

CHEN 6440/6446 ELECTROCHEMICAL ENGINEERING (3) LEC. 3. Thermodynamics, electrode kinetics and transport phenomena of electrochemical systems, current and potential distributions, double layer theory, electrochemical processes, power sources, synthesis, corrosion.

CHEN 6650/6656 HAZARDOUS MATERIALS MANAGEMENT AND ENGINEERING (3) LEC. 3. Fundamental principles and regulatory information related to hazardous material and process safety management and engineering, dispersion of chemicals, hazard and operability analysis, chemical engineering, principles for risk education.

CHEN 6660/6666 MACROSCALE ASSEMBLY AND APPLICATIONS OF NANOMATERIALS (3) LEC. 3. Production of macroscopic assemblies and structures from nanomaterials. Processing and applications of inorganic, organic, biological and hybrid nanomaterials. Or departmental approval. May count either CHEN 6660 or CHEN 6666.


CHEN 6810/6816 BIOMEDICAL ENGINEERING (3) LEC. 3. Application of chemical engineering principles to the study of medical physiology. Human biochemistry, anatomy, and physiology, rheological properties of blood and synovial fluid, rheology of cell membranes. Biomedical fluid mechanics and heat and mass transfer.
CHEN 6820/6826 ADVANCED TOPICS IN ENVIRONMENTAL BIOTECHNOLOGY (3) LEC. 3. Departmental approval. Application of biotechnology to environmental process treatment, bioremediation and bioreactor development.

CHEN 6970/6976 ADVANCED SPECIAL TOPICS IN CHEMICAL ENGINEERING (1-6) LEC. Departmental approval. Topical courses in areas for advanced undergraduate and graduate students. Topics must be arranged with instructor during preregistration. Course may be repeated for a maximum of 24 credit hours.

CHEN 7020/7026 INTERFACIAL PHENOMENA (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Fundamental analyses of interfacial phenomena at liquid/gas, liquid/liquid and solid/liquid interfaces.


CHEN 7110/7116 CHEMICAL ENGINEERING ANALYSIS AND ADVANCED TRANSPORT PHENOMENA (3) LEC. 3. Pr. CHEN 7100 or CHEN 7106. Analytical solutions of ordinary and partial differential equations pertaining to transport phenomena and other areas of chemical engineering.

CHEN 7120/7126 ADVANCED TOPICS IN PAPER PROCESSING OPERATIONS (3) LEC. 3. Pr. CHEN 6120 or CHEN 6126. Surface and colloidal interactions in the wet end of paper manufacturing. Colloidal stability theory, absorption of macromolecules, flocculation and retention of particles. Wet-end chemistry process control.

CHEN 7130/7136 ADVANCED PULP AND PAPER ENGINEERING (3) LEC. 3. Topics in pulping, chemical recovery and papermaking.


CHEN 7250/7256 CHEMICAL REACTION ENGINEERING (3) LEC. 3. Pr. P/C CHEN 7100 or P/C CHEN 7106. Analysis and design of homogeneous and heterogeneous chemical reactors. Physicochemical factors and analysis of non-ideal chemical reactor behavior.

CHEN 7600/7606 ENVIRONMENTAL TRANSPORT (3) LEC. 3. Pr. (CHEN 7100 or CHEN 7106) and (CHEN 7200 or CHEN 7206) and (P/C CHEN 7110 or P/C CHEN 7116). Environmental chemodynamics, interphase equilibrium, reactions, boundary layers, transport mechanisms and models or movement of substances across natural interfaces (air-water-sediment-soil).

CHEN 7710 INTRODUCTION TO RESEARCH SEMINAR (1) LEC. 1. SU. Pr. P/C CHEN 7100 or P/C CHEN 7106. Introductory graduate research seminars for entering graduate students.

CHEN 7720 ADVANCED PROCESS DESIGN SEMINAR (1) LEC. 1. Pr. (P/C CHEN 7100 or P/C CHEN 7106) and (P/C CHEN 7200 or P/C CHEN 7206). Fundamentals of advanced process design including process synthesis, simulation, analysis, optimization and integration. Systematic process synthesis tools for screening potential flow sheets.

CHEN 7900/7906 INDEPENDENT STUDY (1-10) IND. SU. Departmental approval. Supervised study in specialized areas of chemical engineering. Topic must be arranged with instructor during pre-registration. Course may be repeated for a maximum of 20 credit hours.

CHEN 7950 GRADUATE SEMINAR (1) SEM. 1. SU. Seminar. Course may be repeated for a maximum of 12 credit hours.

CHEN 7970/7976 ADVANCED SPECIAL TOPICS IN CHEMICAL ENGINEERING (1-6) IND. Departmental approval. Topical courses for graduate students. Topics must be arranged with instructor during preregistration. Course may be repeated for a maximum of 12 credit hours.

CHEN 7990 RESEARCH AND THESIS (1-20) MST. Credit hours to be arranged. Course may be repeated with change in topics.

CHEN 8000/8006 GRADUATE CHEMICAL ENGINEERING ANALYSIS (2) LEC. 2. Pr. CHEN 7100 or CHEN 7106. Applications of advanced numerical methods to the analysis of complex chemical engineering problems.

CHEN 8010 ADVANCED CHEMICAL ENGINEERING NUMERICAL ANALYSIS (2) LEC. 2. Pr. CHEN 7100 or CHEN 7106. Advanced numerical methods for the analysis of chemical engineering problems. Computer applications.

CHEN 8020 ADVANCED TOPICS IN THE CHARACTERIZATION OF SURFACE PROPERTIES OF MATERIALS (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Nature of surface and intermolecular forces. Surface chemical characterization of solid surfaces. Adhesion and the role of chemical, physical and mechanical properties of solid surfaces. Modern characterization techniques including scanning probe microscopy, thermodynamic and spectroscopic methods.
CHEN 8100 ADVANCED TOPICS IN CHEMICAL ENGINEERING PROCESSES (3) LEC. 3. Pr. CHEN 7110 or CHEN 7116. Advanced concepts in fluid dynamics with special emphasis on applications to chemical engineering, creeping flow, multiphase instabilities, computational fluid mechanics and turbulence.

CHEN 8110 ADVANCED TOPICS IN HEAT AND MASS TRANSFER (3) LEC. 3. Pr. CHEN 7110 or CHEN 7116. Application of transport operations to chemical engineering problems containing physical and chemical rate processes. Chemically reacting boundary layers, heat and mass transfer, eddy diffusion, phase change and separation processes.

CHEN 8210 ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Application of advanced thermodynamics to complex chemical engineering problems including advanced models for electrolyte solutions, critical and supercritical phenomena, high pressure equilibrium, non-equilibrium and surface thermodynamics and molecular modeling.

CHEN 8220 POLYMER THERMODYNAMICS (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Fundamentals and applications of macromolecular thermodynamics to industrial polymer problems.

CHEN 8230 CHEMICAL ENGINEERING STATISTICAL THERMODYNAMICS (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Applications of molecular theory and models to the properties of non-ideal gases and liquids using advanced statistical mechanics and chemical thermodynamics.

CHEN 8270 HETEROGENEOUS CATALYSIS (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Advanced concepts, techniques, applications and principles for the use of heterogeneous catalysts in chemical and environmental processes. Departmental approval.

CHEN 8280 SURFACE CHARACTERIZATION/SOLIDS (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Advanced concepts and techniques in the physical and chemical characterization of solid surfaces by microscopic, spectroscopic and chemical methods including various photon and/or electron spectroscopies, thermal desorption.

CHEN 8300 PROCESS DYNAMICS AND CONTROL (3) LEC. 3. Pr. CHEN 7100 or CHEN 7106 and (P/C CHEN 7110 or P/C CHEN 7116). Advanced linear and nonlinear chemical process dynamics and control systems.

CHEN 8310 PROCESS DYNAMICS AND CONTROL II (2) LEC. 2. Advanced chemical process dynamics and control.

CHEN 8320 ADVANCED TOPICS IN CHEMICAL PROCESS COMPUTER CONTROL SYSTEMS (3) LEC. 2. LAB. 3. Pr. CHEN 7100 or CHEN 7106. Analysis and design of advanced digital control systems for chemical processes. Introduction to computer communications through dynamic data exchange and peripheral linkage. Experimental application of advanced digital control algorithms to chemical processes.

CHEN 8340/8346 PROCESS MODELING AND SIMULATION (3) LEC. 2. LAB. 3. Advances in computer-aided process synthesis, simulation, analysis and optimization including systematic process integration tools for developing and screening potential flow sheets using advanced process simulators.

CHEN 8990 RESEARCH AND DISSERTATION (1-20) DSR. Credit hours to be arranged. Course may be repeated with change in topics.

Civil Engineering Courses

CIVL 2010 SURVEYING (3) LEC. 2. LAB. 3. Pr. (ENGR 1110 or ENGR 1113) and (MATH 1610 or MATH 1613 or MATH 1617) and COMP 1200. Civil engineering surveying theory and practice including history of land surveys and U.S. datums; field measurements, office calculations and graphical/digital presentation of spatial data.

CIVL 3010 CIVIL ENGINEERING ANALYSIS (4) LEC. 3. LAB. 3. Pr. MATH 2650 and COMP 1200 and (ENGR 2050 or ENGR 2053) and STAT 3010. Applications of calculus and ordinary differential equations, numerical methods, vector algebra, and linear algebraic expressions to practical civil engineering problems. Heavy emphasis on computerized techniques and civil engineering software.

CIVL 3110 HYDRAULICS (4) LEC. 3. LAB. 3. Pr. (ENGR 2010 or ENGR 2200) and MATH 2650 and P/C ENGR 2350 and P/C CIVL 3010. Pr. ENGR 2010 is only allowed for students who transfer into Civil Engineering. Students already enrolled in Civil Engineering should take ENGR 2200. Introduction to fluid mechanics, fluid properties, hydrostatics, kinematics, dynamics, energy equation, ideal flow and energy losses. Applications of fluid mechanics, pipe flow, fluid measurements, pumps, open channel flow, dimensional analysis and theory of modeling.
CIVL 3220 WATER AND WASTE TREATMENT (4) LEC. 3. LAB. 3. Pr. CHEM 1040 and BIOL 3200. Fundamentals of potable water treatment and wastewater treatment and disposal. Treatment systems; operation/ process physics, chemistry, and biology; operation and maintenance issues; regulatory requirements. Credit will not be given to students majoring in Civil Engineering.

CIVL 3230 ENVIRONMENTAL ENGINEERING (4) LEC. 3. LAB. 3. Pr. (CHEM 1040 or CHEM 1043) and (ENGR 2200 and P/C CIVL 3010) or P/C BSEN 3310. Fundamental principles of environmental engineering, including basic environmental chemistry and microbiology; materials and energy balances; diffusion; chemical equilibrium; kinetics; and chemical reaction engineering.

CIVL 3310 GEOTECHNICAL ENGINEERING I (4) LEC. 3. LAB. 3. Pr. (CHEM 1040 or CHEM 1043) and ENGR 2070. Soil-forming processes, physical properties of soils, subsurface investigations, clay mineralogy, soil classification, permeability, effective stress, consolidation theory, time-settlement analysis, compaction, shear strength, geosynthetics.

CIVL 3410 CONSTRUCTION ENGINEERING (3) LEC. 3. Pr. CIVL 2010 and P/C CIVL 3010. Basic concepts of the construction industry, contractual methods, estimating and scheduling.

CIVL 3510 TRANSPORTATION ENGINEERING (4) LEC. 4. Pr. CIVL 2010 and STAT 3010. Introduction to transportation engineering practice with emphasis on highway facility design, traffic operations, and life-cycle costing.


CIVL 3820 CIVIL ENGINEERING MATERIALS (3) LEC. 2. LAB. 3. Pr. CIVL 3310. Introduction to common materials used in construction of civil facilities including highways; aggregate, concrete, asphalt, and steel.

CIVL 4210 WATER AND WASTEWATER TREATMENT AND DESIGN (3) LEC. 3. Pr. CIVL 3230. Departmental approval. The fundamentals of theory, design, and operation of water and wastewater treatment systems are covered.

CIVL 4211 WATER AND WASTEWATER LABORATORY (1) LAB. 3. Pr. CHEM 1040 and BIOL 3200. Coreq. CIVL 4210. Introduction to analytical techniques used to assess water quality. Credit will not be given to students majoring in Civil Engineering.

CIVL 4220 ENVIRONMENTAL ENGINEERING DESIGN (3) LEC. 3. Pr. CIVL 4210 or CIVL 4230. Process design of environmental engineering systems.

CIVL 4230 URBAN HYDRAULIC SYSTEM DESIGN (3) LEC. 3. Pr. CIVL 3230 and CIVL 3110. Engineering approaches to designing and managing urban water supply, sanitary sewer, storm water collection systems and flood control works.

CIVL 4310 GEOTECHNICAL ENGINEERING II (3) LEC. 3. Pr. CIVL 3310. Analysis and design in geotechnical engineering based on principles of soil mechanics and soil behavior. Problems of slope stability, earth pressure and design of earth retaining structures, foundation bearing capacity and settlement.

CIVL 4420 PROJECT MANAGEMENT (3) LEC. 3. Pr. CIVL 3410. Planning and management of construction/engineering projects and organizations, project management techniques, skills, and applications.

CIVL 4490 DESIGN-BUILD PROJECT (3) LEC. 3. Pr. CIVL 4420. Develop a design-build proposal for a civil engineering improvement including engineering study, consideration of alternative designs, and formal written and oral presentation.

CIVL 4500 TRAFFIC ENGINEERING FUNDAMENTALS (3) LEC. 3. Pr. CIVL 3510. The fundamental elements of traffic engineering including traffic operations and traffic control devices.

CIVL 4520 AIRPORT DESIGN (3) LEC. 3. Pr. CIVL 3510. Departmental approval. An analysis of the elements affecting the design of airports including forecasting, runway configuration, capacity analyses, geometric design of runways and taxiways, pavement design and airfield drainage.

CIVL 4530 GEOMETRIC DESIGN (3) LEC. 3. Pr. CIVL 3510. An analysis of the elements affecting the location and design of rural highways, urban highways and arterial streets including design controls and criteria.

CIVL 4590 TRANSPORTATION DESIGN PROJECT (3) LEC. 3. Pr. CIVL 4530. Individual senior design project requiring the development of plans for a roadway over a large land segment: horizontal and vertical curves in accord with State and AASHTO standards; topographic terrain features; historical preservation area; minimum elevation; intersection design; earthwork balance.
CIVL 4600 REINFORCED CONCRETE DESIGN (3) LEC. 3. Pr. CIVL 3610. Concrete and reinforcing steel properties; analysis and design of reinforced concrete beams, one-way slabs, columns and footings; anchorage of reinforcement.


CIVL 4690 STRUCTURAL DESIGN PROJECT (3) LEC. 3. Pr. CIVL 4600. Execution of a comprehensive design of a major structure. Emphasis on the design process, creative thinking, analysis, synthesis, teamwork and communications.

CIVL 4960 SPECIAL PROBLEMS (1-3) LEC. Departmental approval. Individual student endeavor under staff supervision involving advanced special problems in civil engineering. Course may be repeated for a maximum of 6 credit hours.

CIVL 4997 HONORS THESIS (1-3) IND. Pr. Honors College. Departmental approval. Course may be repeated for a maximum of 6 credit hours.

CIVL 5110 OPEN CHANNEL HYDRAULICS (3) LEC. 3. Pr. CIVL 3110. Application of continuity, energy, and momentum analyses to problems of open channel flow. Topics include rapidly and gradually varied flow, unsteady flow, flood routing, computational methods, design concepts and applications. Credit will not be given for both CIVL 5110 and CIVL 6110/ CIVL 6116.

CIVL 5120 HYDROLOGIC ANALYSIS AND MODELING (3) LEC. 3. Pr. CIVL 3110 and STAT 3010. Hydrologic cycle, hydrologic frequency analysis, precipitation, infiltration, runoff hydrograph, flood routing, urban hydrology, watershed hydrologic modeling, and computer modeling applications. Departmental approval. May count either CIVL 5120 or CIVL 6120.

CIVL 5130 HYDRAULIC DESIGN OF PRESSURIZED SYSTEMS (3) LEC. 3. Pr. CIVL 3110. Pressurized flow applications; pump-pipeline design optimization; multiple reservoir operation; flow measurement/control systems; distribution manifolds; fundamentals of unsteady flows. Departmental approval. May count either CIVL 5130 or CIVL 6130.

CIVL 5150 GROUNDWATER HYDRAULICS (3) LEC. 3. Pr. CIVL 3110. Mechanics of groundwater flow, definitions, conservation of mass, Darcy’s law, confined and unconfined flow, steady and transient flow, groundwater transport. Credit will not be given for both CIVL 5150 and CIVL 6150/CIVL 6156.

CIVL 5160 STORMWATER MANAGEMENT AND MODELING (3) LEC. 3. Pr. CIVL 3110. Introduction of current stormwater management practices (e.g., lower impact development and green infrastructures) and polices, rainfall analysis with different inter-event dry period, flood analysis, stormwater runoff hydrograph modeling (rainfall loss, overland flow hydrograph, unit hydrograph theory, and hydrograph routing), stormwater quality modeling (pollutant buildup, washoff, and transport), peak discharge control using detention ponds, and various best management practices for stormwater volume and quality control. May count either CIVL 5160, CIVL 6160, or CIVL 6166.

CIVL 5170 NUMERICAL SOLUTIONS FOR HYDRO-ENVIRONMENTAL APPLICATIONS (3) LEC. 3. Pr. CIVL 3110 and CIVL 3230. Theoretical and numerical solutions of various problems in water resources and environmental engineering using computational tools. Development of simple codes and spreadsheet-based tools for the description and prediction of flows, contaminant spreading, and other relevant processes in natural and built systems. May count either CIVL 5170 or CIVL 6170/6176.

CIVL 5210 CHEMICAL PRINCIPLES OF ENVIRONMENTAL ENGINEERING (3) LEC. 3. Pr. CIVL 3230. Fundamentals of aquatic chemistry as applied to environmental engineering: chemical thermodynamics, acid/base equilibrium, solution/dissolution chemistry, redox equilibrium, and chemical kinetics. Departmental approval. Credit will not be given for both CIVL 5210 and CIVL 6210/CIVL 6216.

CIVL 5220 ENVIRONMENTAL ENGINEERING PROCESSES LABORATORY (1) LAB. 3. Pr. CIVL 3230. Laboratory exploration of the fundamentals and applications of aquatic chemistry, physical-chemical processes and biological processes, as employed in water and wastewater treatment. Departmental approval. Credit will not be given for both CIVL 5220 and CIVL 6220.

CIVL 5230 ENVIRONMENTAL HEALTH ENGINEERING (3) LEC. 3. Application of engineering methodology in environmental health; communicable disease control, insect and rodent control, solid and hazardous wastes, noise, radiological health, legal and administrative considerations, etc. Departmental approval. Credit will not be given for both CIVL 5230 and CIVL 6230/CIVL 6236.

CIVL 5240 AIR POLLUTION (3) LEC. 3. Nature, sources and effects of air pollutants; effects of atmospheric conditions on dispersion; dispersion modeling, theory and design of control devices; legal/ administrative control. Departmental approval. Credit will not be given for both CIVL 5240 and CIVL 6240/CIVL 6246.
CIVL 5250 BIOLOGICAL PRINCIPLES OF ENVIRONMENTAL ENGINEERING (3) LEC. 3. Pr. CIVL 3230. Fundamentals of aquatic biology and microbiology as applied to environmental engineering: microbial growth, microbial metabolism, microbial population dynamics, wastewater treatment microbiology, environmental impacts, toxicity testing, and biomonitoring. Departmental approval. Credit will not be given for both CIVL 5250 and CIVL 6250/CIVL 6256.

CIVL 5260 SURFACE WATER QUALITY MODELING (3) LEC. 3. Pr. CIVL 3230. Water uses and water quality goals, objectives, and criteria of natural aquatic systems. Principles of surface water quality modeling and waste load allocation. Physical, chemical, biological, and hydrological considerations relating to the fate and transport of pollutants in water environment.

CIVL 5330 LANDFILLS (3) LEC. 3. Pr. CIVL 3310. Landfill siting design, construction and operational practices; regulations, terminology, closure regulations and procedures. Credit will not be given for both CIVL 5330 and CIVL 6330/CIVL 6336.

CIVL 5340 GEOSYNTHETICS AND SOIL IMPROVEMENT (3) LEC. 3. Pr. CIVL 3310. Use of geosynthetics in civil engineering design: reinforcement, retaining walls, filtration, slopes, roads and erosion control. Evaluation and testing of geosynthetics. Improvement of soil properties for civil engineering design: principles and practice of densification, grouting, reinforcement, stone columns, soil nailing. Credit will not be given for both CIVL 5340 and CIVL 6340/CIVL 6346.

CIVL 5350 EARTH RETAINING STRUCTURES (3) LEC. 3. Pr. CIVL 3310. Analysis and design of earth retaining structures. Shear strength; earth pressure theory; gravity, mechanically stabilized, flexible sheet, and anchored structures. May count either CIVL 5350 or CIVL 6350/CIVL 6356.

CIVL 5410 GEOGRAPHIC INFORMATION SYSTEMS IN CIVIL ENGINEERING (3) LEC. 3. Pr. CIVL 2010. Departmental approval. Basic principles and the development of geographic information systems and practical experiences in the field of civil engineering. Credit will not be given for both CIVL 5410 and CIVL 6410.


CIVL 5430 CONSTRUCTION SAFETY AND HEALTH MANAGEMENT (3) LEC. 3. Pr. CIVL 3410. Departmental approval. Various causes of construction accidents and adopted strategies for preventing worksite injuries and illness are investigated. Emphasis on OSHA standards, insurance, and health and safety hazards. Credit will not be given for both CIVL 5430 and CIVL 6430/CIVL 6436.

CIVL 5440 CONSTRUCTION EQUIPMENT AND METHODS (3) LEC. 3. Pr. CIVL 3410 and CIVL 3310 and CIVL 3510. Selection of equipment for heavy construction operations, production rates, owning and operating costs, fleet management. May count either CIVL 5440 or CIVL 6440/CIVL 6446.

CIVL 5450 EROSION & SEDIMENT CONTROL (3) LEC. 3. Pr. CIVL 3310 and CIVL 3410. Process of erosion, sediment transport, and sedimentation along with strategies adopted to prevent and manage erosion on construction sites. May count either CIVL 5450 or CIVL 6450.

CIVL 5460 PROJECT ESTIMATING (3) LEC. 3. Pr. CIVL 3410. Conceptual and definitive estimates, overhead and profit determination; claim change order pricing. May count either CIVL 5460 or CIVL 6460.

CIVL 5480 LEGAL ASPECTS OF CIVIL ENGINEERING PRACTICE (3) LEC. 3. Pr. CIVL 3410. Covered is the law of contracts, agency, association, property, and labor law, studied generally and in the context that the practicing civil engineer encounters them. Departmental approval. May count either CIVL 5480 or CIVL 6480/CIVL 6486.

CIVL 5500 TRAFFIC ENGINEERING ANALYSIS (3) LEC. 3. Pr. CIVL 3510. Capacity analysis of rural and suburban highways, 2-lane highways, freeways, weaving sections, ramps and intersections. May count either CIVL 5500 or CIVL 6500/CIVL 6506.

CIVL 5510 TRAFFIC CONTROL SYSTEMS DESIGN (3) LEC. 3. Pr. CIVL 3510 and STAT 3010. Fundamental design concepts for highway traffic control systems. Control requirements and warrants; hardware operation and equipment selection; development and implementation of timing plans for isolated intersections and intersection networks. May count either CIVL 5510 or CIVL 6510/CIVL 6516.

CIVL 5560 PLANNING FOR MULTIMODAL TRANSPORTATION SYSTEMS (3) LEC. 3. Pr. CIVL 3510 and STAT 3010. Departmental approval. The planning process for urban and regional transportation development. Topics include planning objectives and data requirements; planning inventories; modeling of trip-making behavior, development and evaluation of alternate plans; multimodal applications, including railway operations.
CIVL 5580 INTELLIGENT TRANSPORTATION SYSTEMS (3) LEC. 3. Pr. CIVL 3510. Departmental approval. Introduction to intelligent transportation systems, covering applications of information and communication technologies to transportation, with emphasis on operations of traffic management and traveler information systems. Credit will not be given for both CIVL 5580 and CIVL 6580/CIVL 6586.

CIVL 5600 ADVANCED REINFORCED CONCRETE DESIGN (3) LEC. 3. Pr. CIVL 4600. Analysis and design of continuous beams and one-way slabs, bond and development length, torsion, slenderness effects in columns, two-way slabs, footings, and retaining walls. May count either CIVL 5600 or CIVL 6600/CIVL 6606.

CIVL 5620 PRESTRESSED CONCRETE DESIGN (3) LEC. 3. Pr. CIVL 4600. Properties and behavior of pre-stressed concrete, pre-stressing systems and end anchorages, analysis and design of beams for flexure and shear, camber and deflection, cable lay-out, pre-stressed concrete slabs. May count either CIVL 5620 or CIVL 6620/CIVL 6626.

CIVL 5630 ADVANCED CONCRETE MATERIALS (3) LEC. 3. Pr. CIVL 3820. Comprehensive coverage of concrete materials. Topics include cement and aggregate properties; concrete microstructure; mechanical properties; supplementary cementing materials; chemical admixtures; durability issues; special concretes. May count either CIVL 5630 or CIVL 6630/CIVL 6636.

CIVL 5640 STRUCTURAL MASONRY DESIGN (3) LEC. 3. Pr. CIVL 4600. Properties of masonry component materials; behavior and design of unreinforced and reinforced masonry assemblages and structures. May count either CIVL 5640 or CIVL 6640/CIVL 6646.

CIVL 5650 ADVANCED STEEL DESIGN (3) LEC. 3. Pr. CIVL 4650. Composite construction, open web joists, torsion, plate girders, plastic analysis and design, highway bridges, computer applications. May count either CIVL 5650 or CIVL 6650/CIVL 6656.

CIVL 5660 BRIDGE ENGINEERING (3) LEC. 3. Pr. CIVL 4600 and CIVL 4650. The modern approach to design, evaluation, and rehabilitation of bridges, including design of abutments, piers, concrete deck slabs, non-composite and composite steel girders, and prestressed concrete girders.


CIVL 5690 TIMBER DESIGN (3) LEC. 3. Pr. CIVL 3610. Properties and behavior of timber and plywood; design of timber beams, columns, floor and wall assemblies and wood formwork; timber trusses and laminated arches. May count either CIVL 5690 or CIVL 6690/CIVL 6696.

CIVL 5700 DESIGN FOR LATERAL LOADS (3) LEC. 3. Pr. CIVL 3610 and (CIVL 4600 or CIVL 4650). Wind meteorology and loadings, effects of wind loadings, building code wind pressures and load provisions, fundamentals of structural vibrations, earthquake characteristics and loadings, building code earthquake provisions, building lateral load resisting systems. May count either CIVL 5700 or CIVL 6700/CIVL 6706.

CIVL 5710 STRUCTURAL REPAIR (3) LEC. 3. Pr. CIVL 4600. Evaluation of causes of distress; condition; repair materials; methods of repair; protection methods; and structural strengthening in structural concrete applications. May count either CIVL 5710 or CIVL 6710/CIVL 6716.

CIVL 5720 RELIABILITY OF STRUCTURES (3) LEC. 3. Pr. CIVL 4600 or CIVL 4650. Reliability-based methods of structural analysis including review of probability and statistics, reliability analysis methods, development of design codes, load and resistance models, system reliability, and practical applications. May count either CIVL 5720 or CIVL 6720/6726.

CIVL 5810 PAVEMENT DESIGN AND CONSTRUCTION (3) LEC. 3. Pr. CIVL 3820 and CIVL 3310 and CIVL 3510. General concepts, traffic factors, material characterization, layer thickness selection, earthwork, base and sub-base construction, surface course construction, quality control/assurance. May count either CIVL 5810 or CIVL 6810/CIVL 6816.

CIVL 5820 DESIGN AND PRODUCTION OF ASPHALT PAVING MIXTURES (3) LEC. 2. LAB. 3. Pr. CIVL 3820. Selection and optimization of component materials based on physical properties, specification criteria, performance expectations, and costs. Production and quality assurance. May count either CIVL 5820 or CIVL 6820.

CIVL 5970 CIVIL ENGINEERING SPECIAL TOPICS (3) LEC. 3. Special topics of an advanced undergraduate nature pertinent to civil engineering. Specific prerequisites will be announced for each course offering. Credit will not be given for both CIVL 5970 and CIVL 6970. Course may be repeated for a maximum of 6 credit hours.
CIVL 6110/6116 OPEN CHANNEL HYDRAULICS (3) LEC. 3. Pr. CIVL 3110. Application of continuity, energy, and momentum analyses to problems of open channel flow. Topics include rapidly and gradually varied flow, unsteady flow, flood routing, computational methods, design concepts and applications. Credit will not be given for both CIVL 5110 and CIVL 6110/CIVL 6116.

CIVL 6120/6126 HYDROLOGIC ANALYSIS AND MODELING (3) LEC. 3. Pr. CIVL 3110 and STAT 3110. Departmental approval. Hydrologic cycle, hydrologic frequency analysis, precipitation, infiltration, runoff hydrograph, flood routing, urban hydrology, watershed hydrologic modeling, and computer modeling applications.

CIVL 6130/6136 HYDRAULIC DESIGN OF PRESSURIZED SYSTEMS (3) LEC. 3. Pr. CIVL 3110. Pressurized flow applications; pump-pipeline design optimization; multiple reservoir operation; flow measurement/control systems; distribution manifolds; fundamentals of unsteady flows. Departmental approval. May count either CIVL 5130 or CIVL 6130.


CIVL 6160/6166 STORMWATER MANAGEMENT AND MODELING (3) LEC. 3. Introduction of current stormwater management practices (e.g., lower impact development and green infrastructures) and polices, rainfall analysis with different inter-event dry period, flood analysis, stormwater runoff hydrograph modeling (rainfall loss, overland flow hydrograph, unit hydrograph theory, and hydrograph routing), stormwater quality modeling (pollutant buildup, washoff, and transport), peak discharge control using detention ponds, and various best management practices for stormwater volume and quality control. Approval by the instructor (e.g., undergraduate hydraulics).

CIVL 6170/6176 NUMERICAL SOLUTIONS FOR HYDRO-ENVIRONMENTAL APPLICATIONS (3) LEC. 3. Pr. CIVL 3110 and CIVL 3230. Theoretical and numerical solutions of various problems in water resources and environmental engineering using computational tools. Development of simple codes and spreadsheet-based tools for the description and prediction of flows, contaminant spreading, and other relevant processes in natural and built systems. May count either CIVL 5170 or CIVL 6170/6176.

CIVL 6210/6216 CHEMICAL PRINCIPLES OF ENVIRONMENTAL ENGINEERING (3) LEC. 3. Pr. CIVL 3230. Fundamentals of aquatic chemistry as applied to environmental engineering: chemical thermodynamics, acid/base equibrium, solution/dissolution chemistry, redox equilibrium, and chemical kinetics. Departmental approval. Credit will not be given for both CIVL 5210 and CIVL 6210/CIVL 6216.

CIVL 6220 ENVIRONMENTAL ENGINEERING PROCESSES LABORATORY (1) LAB. 3. Pr. CIVL 3230. Laboratory exploration of the fundamentals and applications of aquatic chemistry, physical-chemical processes and biological processes, as employed in water and wastewater treatment. Departmental approval. May count either CIVL 5220 or CIVL 6220.

CIVL 6230/6236 ENVIRONMENTAL HEALTH ENGINEERING (3) LEC. 3. Application of engineering methodology in environmental health; communicable disease control, insect and rodent control, solid and hazardous wastes, noise, radiological health, legal and administrative considerations, etc. Departmental approval. Credit will not be given for both CIVL 5230 and CIVL 6230/CIVL 6236.

CIVL 6240/6246 AIR POLLUTION (3) LEC. 3. Nature, sources and effects of air pollutants; effects of atmospheric conditions on dispersion; dispersion modeling theory and design of control devices; legal/administrative control. Departmental approval. Credit will not be given for both CIVL 5240 and CIVL 6240/CIVL 6246.

CIVL 6250/6256 BIOLOGICAL PRINCIPLES OF ENVIRONMENTAL ENGINEERING (3) LEC. 3. Pr. CIVL 3230. Fundamentals of aquatic biology and microbiology as applied to environmental engineering: microbial growth, microbial metabolism, microbial population dynamics, wastewater treatment microbiology, environmental impacts, toxicity testing, and biomonitoring. Departmental approval. Credit will not be given for both CIVL 5250 and CIVL 6250/CIVL 6256.

CIVL 6260/6266 SURFACE WATER QUALITY MODELING (3) LEC. 3. Water uses and water quality goals, objectives, and criteria of natural aquatic systems. Principles of surface water quality modeling and waste load allocation. Physical, chemical, biological, and hydrological considerations relating to the fate and transport of pollutants in water environment

CIVL 6330/6336 LANDFILLS (3) LEC. 3. Pr. CIVL 3310. Landfill siting design, construction and operational practices; regulations, terminology, closure regulations and procedures. Credit will not be given for both CIVL 5330 and CIVL 6330/CIVL 6336.
CIVL 6340/6346 GEOSYNTHETICS AND SOIL IMPROVEMENT (3) LEC. 3. Pr. CIVL 3310. Use of geosynthetics in civil engineering design: reinforcement, retaining walls, filtration, slopes, roads and erosion control. Evaluation and testing of geosynthetics. Improvement of soil properties for civil engineering design: principles and practice of densification, grouting, reinforcement, stone columns, soil nailing. Credit will not be given for both CIVL 5340 and CIVL 6340/CIVL 6346.

CIVL 6350/6356 EARTH RETAINING STRUCTURES (3) LEC. 3. Pr. CIVL 3310. Analysis and design of earth retaining strictures. Shear strength; earth pressure theory; gravity, mechanically stabilized, flexible sheet, and anchored structures. May count either CIVL 5350 or CIVL 6350/CIVL 6356.

CIVL 6410 GEOGRAPHIC INFORMATION SYSTEMS IN CIVIL ENGINEERING (3) LEC. 3. Pr. CIVL 2010. Departmental approval. Basic principles and the development of geographic information systems and practical experiences in the field of civil engineering. Credit will not be given for both CIVL 5410 and CIVL 6410.


CIVL 6430/6436 CONSTRUCTION SAFETY (3) LEC. 3. Pr. CIVL 3410. Departmental approval. Various causes of construction accidents and adopted strategies preventing worksite injuries and illnesses are investigated. Emphasis on OSHA standards, insurance, and health and safety hazards. Credit will not be given for both CIVL 5430 and CIVL 6430/CIVL 6436.

CIVL 6440/6446 CONSTRUCTION EQUIPMENT AND METHODS (3) LEC. 3. Pr. CIVL 3410 and CIVL 3310 and CIVL 3510. Selection of equipment for heavy construction operations, production rates, owning and operating costs, fleet management. May count either CIVL 5440 or CIVL 6440/CIVL 6446.

CIVL 6450 EROSION AND SEDIMENT CONTROL TECHNOLOGIES IN CONSTRUCTION (3) LEC. 3. Pr. CIVL 3310 and CIVL 3410. Process of erosion, sediment transport, and sedimentation along with strategies adopted to prevent and manage erosion on construction sites. May count either CIVL 5450 or CIVL 6450.

CIVL 6460 PROJECT ESTIMATING (3) LEC. 3. Pr. CIVL 3410. Conceptual and definitive estimates, overhead and profit determination; claim change order pricing. May count either CIVL 5460 or CIVL 6460.

CIVL 6480/6486 LEGAL ASPECTS OF CIVIL ENGINEERING PRACTICE (3) LEC. 3. Pr. CIVL 3410. Covered is the law of contracts, agency, association, property, and labor law, studied generally and in the context that the practicing civil engineer encounters them. Departmental approval. May count either CIVL 5480 or CIVL 6480/CIVL 6486.

CIVL 6500/6506 TRAFFIC ENGINEERING ANALYSIS (3) LEC. 3. Pr. CIVL 3510. Capacity analysis of rural and suburban highways, 2-lane highways, freeways, weaving sections, ramps and intersections. May count either CIVL 5500 or CIVL 6500/CIVL 6506.

CIVL 6510/6516 TRAFFIC CONTROL SYSTEMS DESIGN (3) LEC. 3. Pr. CIVL 3510 and STAT 3010. Fundamental design concepts for highway traffic control systems. Control requirements and warrants: hardware operation and equipment selection; development and implementation of timing plans for isolated intersections and intersection networks. May count either CIVL 5510 or CIVL 6510/CIVL 6516.

CIVL 6560/6566 PLANNING FOR MULTIMODAL TRANSPORTATION SYSTEMS (3) LEC. 3. Pr. CIVL 3510 and STAT 3010. The planning process for urban and regional transportation development. Topics include planning objectives and data requirements; planning inventories; modeling of trip-making behavior, development and evaluation of alternate plans; multimodal applications, including railway operations. Departmental approval. May count either CIVL 5560.

CIVL 6580/6586 INTELLIGENT TRANSPORTATION SYSTEMS (3) LEC. 3. Pr. CIVL 3510. Introduction to intelligent transportation systems, covering applications of information and communications technologies to transportation, with emphasis on operations of traffic management and traveler information systems. Departmental approval. May count either CIVL 5580 or CIVL 6580/CIVL 6586.

CIVL 6600/6606 ADVANCED REINFORCED CONCRETE DESIGN (3) LEC. 3. Pr. CIVL 4600. Analysis and design of continuous beams and one-way slabs, bond and development length, torsion, slenderness effects in columns, two-way slabs, footings, and retaining walls. May count either CIVL 5600 or CIVL 6600/CIVL 6606.

CIVL 6620/6626 PRESTRESSED CONCRETE DESIGN (3) LEC. 3. Pr. CIVL 4600. Properties and behavior of pre-stressed concrete, pre-stressing systems and end anchorages, analysis and design of beams for flexure and shear, camber and deflection, cable layout, pre-stressed concrete slabs. May count either CIVL 5620 or CIVL 6620/CIVL 6626.
CIVL 6630/6636 ADVANCED CONCRETE MATERIALS (3) LEC. 3. Pr. CIVL 3820. Comprehensive coverage of concrete materials. Topics include cement and aggregate properties; concrete microstructure; mechanical properties; supplementary cementing materials, chemical admixtures; durability issues; special concretes. May count either CIVL 5630 or CIVL 6630/CIVL 6636.

CIVL 6640/6646 STRUCTURAL MASONRY DESIGN (3) LEC. 3. Pr. CIVL 4600. Properties of masonry component materials; behavior and design of unreinforced and reinforced masonry assemblages and structures. May count either CIVL 5640 or CIVL 6640/CIVL 6646.

CIVL 6650/6656 ADVANCED STEEL DESIGN (3) LEC. 3. Pr. CIVL 4650. Composite construction, open web joists, torsion, plate girders, plastic analysis and design, highway bridges, computer applications. May count either CIVL 5650 or CIVL 6650/CIVL 6656.

CIVL 6660/6666 BRIDGE ENGINEERING (3) LEC. 3. Pr. CIVL 4600 and CIVL 4650. The modern approach to design, evaluation, and rehabilitation of bridges, including design of abutments, piers, concrete deck slabs, non-composite and composite steel girders, and prestressed concrete girders. May count either CIVL 5660 or CIVL 6660/6666.


CIVL 6690/6696 TIMBER DESIGN (3) LEC. 3. Pr. CIVL 3610. Properties and behavior of timber and plywood; design of timber beams, columns, floor and wall assemblies and wood formwork; timber trusses and laminated arches. May count either CIVL 5690 or CIVL 6690/CIVL 6696.

CIVL 6700/6706 DESIGN FOR LATERAL LOADS (3) LEC. 3. Pr. CIVL 3610 and (CIVL 4600 or CIVL 4650). Wind meteorology and loadings, effects of wind loadings, building code wind pressures and load provisions, fundamentals of structural vibrations, earthquake characteristics and loadings, building code earthquake provisions, building lateral load resisting systems. May count either CIVL 5700 or CIVL 6700/CIVL 6706.

CIVL 6710/6716 STRUCTURAL REPAIR (3) LEC. 3. Pr. CIVL 4600. Evaluation of causes of distress; condition; repair materials; methods of repair; protection methods; and structural strengthening in structural concrete applications. May count either CIVL 5710 or CIVL 6710/CIVL 6716.

CIVL 6720/6726 RELIABILITY OF STRUCTURES (3) LEC. 3. Pr. CIVL 4600 or CIVL 4650. Reliability-based methods of structural analysis including review of probability and statistics, reliability analysis methods, development of design codes, load and resistance models, system reliability, and practical applications. May count either CIVL 5720 or CIVL 6720/6726.

CIVL 6810/6816 PAVEMENT DESIGN AND CONSTRUCTION (3) LEC. 3. Pr. CIVL 3820 and CIVL 3310 and CIVL 3510. General concepts, traffic factors, material characterization, layer thickness selection, earthwork, base and sub-base construction, surface course construction quality control/assurance. May count either CIVL 5810 or CIVL 6810/CIVL 6816.

CIVL 6820/6826 DESIGN AND PRODUCTION OF ASPHALT PAVING MIXTURES (3) LEC. 2. LAB. 3. Pr. CIVL 3820. Selection and optimization of component materials based on physical properties, specification criteria, performance expectations, and costs. Production and quality assurance. May count either CIVL 5820 or CIVL 6820 or CIVL 6826.

CIVL 6970/6976 CIVIL ENGINEERING SPECIAL TOPICS (3) LEC. 3. Departmental approval. Special topics of an advanced undergraduate nature pertinent to civil engineering. Specific prerequisites will be announced for each course offering. Credit will not be given for both CIVL 5970 and CIVL 6970. Course may be repeated for a maximum of 6 credit hours.


CIVL 7130 SOCIAL-ECOLOGICAL-ENGINEERED SYSTEMS (3) LEC. 3. This course explores foundational scholarship on the Social-Ecological Systems (SES) approach to understanding complex environmental problems with emphasis on the role of engineering in human interactions with natural systems. Students are expected to apply SES concepts and theories to analyses in their own areas of research. Note: This class is intended to be cross-listed with ESSI 7300.

CIVL 7140/7146 ECODYHROLOGY (3) LEC. 3. Pr. P/C CIVL 6120 or P/C CIVL 6126 or P/C GEOL 6100 or P/C FORY 7550. This course covers current theory, methods, and issues in ecohydrology. Topics include the soil-plant-atmosphere continuum; stochastic modeling of soil moisture; vadose zone hydrology; theory, measurement, and modeling of evapotranspiration; ecological competition in water-limited systems; and current issues and research topics.
CIVL 7170/7176 NUMERICAL METHODS IN HYDRAULICS AND HYDROLOGY (3) LEC. 3. Pr. CIVL 3230. Numerical approximations of ordinary and partial differential equations representing problems common to civil engineering including groundwater flow, soil consolidation, and mass transport. The formulation and computational solution of diffusion and equilibrium problems are emphasized. Computer programming is required.

CIVL 7210/7216 METHODS OF POLLUTANT ANALYSIS IN ENVIRONMENTAL ENGINEERING (3) LEC. 2. LAB. 3. Pr. CIVL 6210 or CIVL 6216. Fundamentals of identifying and quantifying environmental pollutants: review of pollutant chemistry, quality and quantity of pollutants, statistical basis of sampling, environmental sampling techniques, analytical techniques, and data analysis.


CIVL 7230/7236 WATER AND WASTEWATER OPERATIONS AND PROCESSES II (3) LEC. 3. Pr. CIVL 7220 or CIVL 7226. Departmental approval. Rigorous analysis of unit operations and processes used in modern water and wastewater treatment systems. Mixing, coagulation, sedimentation, filtration, and chemical precipitation.

CIVL 7240/7246 WATER AND WASTEWATER OPERATIONS AND PROCESSES III (3) LEC. 3. Pr. CIVL 7220 or CIVL 7226. Departmental approval. Design and analysis of unit operations and processes used in modern water and wastewater treatment systems are rigorously examined: adsorption, ion exchange, membrane filtration, reverse osmosis, gas transfer, corrosion, and treatment residuals processing.


CIVL 7260/7266 ENVIRONMENTAL NUTRIENT CONTROL PROCESSES (3) LEC. 3. Pr. CIVL 7250 or CIVL 7256. The nature, sources, and impacts of aquatic nutrients in the environment: microbial nutrient cycles, biological nutrient removal processes, chemical nutrient control processes, natural systems for nutrient removal.


CIVL 7280/7286 SURFACE WATER QUALITY MODELING (3) LEC. 3. Pr. CIVL 3230. Departmental approval. Physical, chemical, biological and hydrological considerations relating to the degradation and self-purification of streams, lakes, and estuaries. Water uses and water quality goals, objectives and criteria. Principles of water quality modeling and waste load allocation.

CIVL 7310/7316 FOUNDATION ENGINEERING (3) LEC. 3. Pr. CIVL 3310 and CIVL 4600. Analysis, design and construction of shallow and deep foundation systems.

CIVL 7330/7336 SOIL PROPERTIES (3) LEC. 3. Pr. CIVL 3310. Soil behavior, shear strength, compressibility, hydraulic conductivity, and measurement of soil properties.

CIVL 7340/7346 SOIL DYNAMICS (3) LEC. 3. Pr. CIVL 3310. Soil behavior during dynamic loads, wave propagation, dynamically loaded foundations, geotechnical earthquake engineering.


CIVL 7390/7396 IN SITU TESTING OF SOILS (3) LEC. 3. Pr. CIVL 4310. In situ tests used in geotechnical engineering: test procedures, interpretation of results, and designing from in situ geotechnical data.

CIVL 7410/7416 TEMPORARY STRUCTURES AND FACILITIES (3) LEC. 3. Pr. STAT 3010 and CIVL 3310 and CIVL 3610. Construction loads, applicable codes and standards, and design principles for temporary structures; planning and implementation of construction facilities; economic analysis of alternatives.

CIVL 7500/7506 TRAFFIC FLOW THEORY (3) LEC. 3. Pr. CIVL 6500 or CIVL 6506. Departmental approval. Basic phenomena underlying traffic stream movement and individual vehicle behavior. Topics include flow parameters and relationships; microscopic and macroscopic flow models; equations of motion and state; single and multi-regime flow models.
CIVL 7520/7526 PUBLIC TRANSPORTATION (3) LEC. 3. Pr. CIVL 3510. Departmental approval. Technology and characteristics of public transportation; transportation demand analysis; transit users; innovative technologies.

CIVL 7540/7546 TRANSPORTATION SAFETY (3) LEC. 3. Pr. CIVL 6500 or CIVL 6506. Departmental approval. Transportation safety problems and the engineer's role in developing and administering safety programs. Topics include hazardous location identification; analysis of accident data; development and evaluation of accident countermeasures and safety programs.

CIVL 7550/7556 ROADSIDE DESIGN (3) LEC. 3. Pr. CIVL 6500 or CIVL 6506. Departmental approval. Concepts of roadside design that can prevent or reduce crash severity. Topics include design, selection, placement and construction of longitudinal barriers, crash cushions, bridge rails, transitions, end terminals, sign posts, and other roadside features.


CIVL 7620/7626 STRUCTURAL DYNAMICS II (3) LEC. 3. Pr. CIVL 7610 or CIVL 7616. Analysis of MDOF systems by direct numerical integration, continuous systems, nonlinear dynamics response, earthquake response of structures.

CIVL 7630/7636 ADVANCED STRESS ANALYSIS (3) LEC. 3. Pr. CIVL 3610. Hooke's 1-D, 2-D, 3-D stress-strain relations and applications, stress and strain transformations and Mohr's circle, material properties and failure theories, biaxial bending, unsymmetrical bending, composite material members, shear center, torsional stress, stress concentrations, beams on elastic foundations.

CIVL 7640/7646 STABILITY OF STRUCTURES (3) LEC. 3. Coreq. CIVL 6670. Introduction to stability and failure of compression members, rigid bar buckling, elastic and inelastic buckling of columns, approximate methods of buckling analysis, beam-columns, buckling of frames, torsional buckling, lateral torsional buckling of beams.

CIVL 7650/7656 ADVANCED ANALYSIS OF FRAMED STRUCTURES (3) LEC. 3. Pr. CIVL 6670 or CIVL 6676. Matrix analysis of framed structures, elastic supports, specified displacements, member end releases, principle of minimum potential energy, geometric non-linearity, frame stability, substructures.

CIVL 7660/7666 FINITE ELEMENT METHODS IN STRUCTURAL MECHANICS (3) LEC. 3. Pr. CIVL 6670 or CIVL 6676. Departmental approval. Introduction to finite element analysis; variational principles. 1D, 2D and 3D element formulation; nonlinear (geometric and constitutive) formulations and solutions; eigenvalue problems.

CIVL 7670/7676 NUMERICAL TECHNIQUES IN STRUCTURAL ANALYSIS (3) LEC. 3. Basic concepts of non-linear analyses, formulation of the continuum mechanics incremental equations, total and updated Lagrangian formulations, finite elements for non-linear analyses, non-linear solution strategies.

CIVL 7680/7686 FATIGUE AND FRACTURE MECHANICS (3) LEC. 3. Pr. CIVL 4650. Departmental approval. Linear-elastic and elastic-plastic fracture mechanics, fatigue, yield criteria, applications to highway structures.

CIVL 7690/7696 ANALYSIS OF PLATE AND SHELL SYSTEMS (3) LEC. 3. Pr. CIVL 6670 or CIVL 6676. Departmental approval. Analysis of isotropic and anisotropic plates with various shapes and boundary conditions due to lateral and in-plane loads; large deflection considerations; numerical techniques; bending and membrane behavior of isotropic shells.

CIVL 7710/7716 APPLIED ELASTICITY (3) LEC. 3. Pr. CIVL 6670 or CIVL 6676. Departmental approval. Analysis of stress-strain; generalized stress-strain relationships; solution of elasticity problem by potentials; thick cylinders, disks and spheres; energy principles and introduction of variational methods.

CIVL 7720/7726 EARTHQUAKE ENGINEERING (3) LEC. 3. Pr. (CIVL 7610 or CIVL 7616) and (CIVL 5670 or CIVL 6670 or CIVL 6676). Principles of earthquakes and earthquake engineering; Analysis and design of steel and reinforced concrete buildings for earthquakes. May count either CIVL 7720 or CIVL 7726.

CIVL 7770/7776 VARIATIONAL METHODS IN STRUCTURAL MECHANICS (3) LEC. 3. Pr. CIVL 6670 or CIVL 6676. Departmental approval. Calculus of variations; derivation of Euler's equations and boundary conditions; applications of energy principles to structures; variational approaches to finite element methods.

CIVL 7810/7816 ADVANCED CONSTRUCTION MATERIALS (4) LEC. 3. LAB. 3. Pr. CIVL 6810 or CIVL 6816. Departmental approval. Evaluate soils, unbound and stabilized materials, hot mix asphalt, and cement concrete products; stress-strain relationships; thermal expansion; design and testing of non-traditional construction products.
CIVL 7820/7826 ADVANCED PAVEMENT DESIGN AND REHABILITATION (3) LEC. 3. Pr. CIVL 7810 or CIVL 7816. Pavement management concepts, life cycle costs analysis, design and rehabilitation alternatives, serviceability concepts, empirical thickness selection models, reliability.

CIVL 7830 ASPHALT CONCRETE MIX DESIGN (3) LEC. 2. LAB. 3. Marshall and Superpave mix design methods and QC/QA for asphalt concrete are covered. Topics include aggregate, asphalt and mix properties, laboratory testing and proportion optimization.

CIVL 7840/7846 PAVEMENT MANAGEMENT AND REHABILITATION (3) LEC. 3. Pr. CIVL 3820. Departmental approval. Topics include: network and project level management, pavement distress surveys, non-destructive testing for condition measurements, flexible and rigid pavement maintenance and rehabilitation practices.

CIVL 7860/7866 PAVEMENT CONSTRUCTION (3) LEC. 3. Pr. CIVL 3820. Operation, quality control and specifications of component construction processes for asphalt and concrete paving; and overview of major rehabilitation strategies.

CIVL 7870 ADVANCED CHARACTERIZATION OF PAVEMENT MATERIALS (3) LEC. 2. LAB. 3. Pr. CIVL 3820. This course introduces theories and procedures for determining fundamental properties of asphalt materials for advanced material evaluation and pavement design.

CIVL 7950 GRADUATE SEMINAR (1) SEM. 1. SU. Course may be repeated for a maximum of 6 credit hours.

CIVL 7970/7976 SPECIAL TOPICS IN CIVIL ENGINEERING (1-3) LEC. Individual student or group endeavor under direct faculty supervision involving special topics of an advanced nature in civil engineering. Course may be repeated for a maximum of 9 credit hours.

CIVL 7980/7986 ENGINEERING PROJECT (1-10) LEC. Departmental approval. Directed study on an engineering project or research supervised by an individual graduate faculty member. Course may be repeated for a maximum of 10 credit hours.

CIVL 7990/7996 RESEARCH AND THESIS (1-10) MST. Departmental approval. Credit to be arranged. Course may be repeated for a maximum of 10 credit hours.

CIVL 8990/8996 RESEARCH AND DISSERTATION (1-10) DSR. Departmental approval. Credit to be arranged. Course may be repeated with change in topics.

Computer Sci Software En Courses

COMP 1000/1003 PERSONAL COMPUTER APPLICATIONS (2) LEC. 2. Introduction to personal computers and software applications, including word processing, spreadsheets, databases, and presentation graphics; generation and retrieval of information with the Internet; integration of data among applications.

COMP 1200 INTRODUCTION TO COMPUTING FOR ENGINEERS AND SCIENTISTS (2) LEC. 2. Computer programming in a high-level language, with emphasis on use of the computer as a tool for engineering or science.

COMP 1201 INTRODUCTION TO COMPUTING LABORATORY (1) LAB. 1. SU. Coreq. COMP 1200. Laboratory activities focused on computer programming in a high-level language.

COMP 1210/1213 FUNDAMENTALS OF COMPUTING I (3) LEC. 2. LAB. 3. Introduction to the fundamental concepts of programming from an object-oriented perspective. Emphasis on good software engineering principles and development of the fundamental programming skills in the context of a language that supports the object-oriented paradigm.

COMP 1A00 COMPUTER COMPETENCY TEST (0) TST. SU. A comprehensive test of all material covered in COMP 1000 and COMP 1003. Course may be repeated with change in topics.

COMP 2000 NETWORK PROGRAMMING WITH HTML AND JAVA (3) LEC. 3. Pr. COMP 1000 or COMP 1003 or ENGR 1110 or ENGR 1113. Introduction to network programming using HTML and Java to build web pages and web-based applications; presentation graphics; retrieval of information from the Internet; integration of data among applications. Pr., COMP 1000 or higher, or ENGR 1110.

COMP 2210/2213 FUNDAMENTALS OF COMPUTING II (4) LEC. 3. LAB. 3. Pr. COMP 1210 or COMP 1213. Software development in the context of collections (e.g., lists, trees, graphs, hashtables). Communication, teamwork, and a design experience are integral course experience.
COMP 2710/2713 SOFTWARE CONSTRUCTION (3) LEC. 3. Pr. COMP 2210. Intensive experience in software construction, to include topics such as testing, debugging, and associated tools; configuration management; low-level file and device I/O; systems and event-driven programming.

COMP 3000 OBJECT-ORIENTED PROGRAMMING FOR ENGINEERS AND SCIENTISTS (3) LEC. 3. Pr., Departmental approval. Fundamentals of object-oriented design and programming principles; data abstraction, identifying objects, problem decomposition, design and implementation of classes. Credit for the major will not be given to CSCI and SWEN, and WIRS majors.

COMP 3010/3013 SPREADSHEET-BASED APPLICATIONS WITH VISUAL BASIC (3) LEC. 2. LAB. 3. Pr. A grade of D or higher in COMP 1200-3000. COMP 1200 or higher. Design and implementation of applications such as simulations, spreadsheet front-ends for modeling, interfaces to databases, and multimedia applications.

COMP 3220 PRINCIPLES OF PROGRAMMING LANGUAGES (3) LEC. 3. Pr. COMP 2210. Study of programming language principles supporting procedural abstraction, data abstraction, storage allocation, and parallel execution; language types and examples; language translations.

COMP 3240/3243 DISCRETE STRUCTURES (3) LEC. 3. Pr. COMP 1210 or COMP 1217. Characterization of computer science data structures and algorithms in terms of sets and relations, functions, recurrence relations. Use of propositional and predicate calculus to describe algorithms. Proving correctness and running time bounds for algorithms by induction and structural induction.

COMP 3270 INTRODUCTION TO ALGORITHMS (3) LEC. 3. Pr. (COMP 3240 or COMP 3243) and COMP 2210. Algorithms for standard computational problems and techniques for analyzing their efficiency; designing efficient algorithms and experimentally evaluating their performance.

COMP 3350/3353 COMPUTER ORGANIZATION AND ASSEMBLY LANGUAGE PROGRAMMING (3) LEC. 3. Pr. ELEC 2200 or ELEC 2210. Stored Program Computers, hardware and software components; data representation, instruction sets, addressing modes; assembly language programming; linkers, loader, and operating systems.

COMP 3500 INTRODUCTION TO OPERATING SYSTEMS (3) LEC. 3. Pr. COMP 2710 and (COMP 3350 or ELEC 2220). Structure and functions of operating systems; processes and process scheduling; synchronization and mutual exclusion; memory management; auxiliary storage management; resource allocation and deadlock; security, privacy, and ethical concerns; design tradeoffs.

COMP 3510 EMBEDDED SYSTEMS DEVELOPMENT (3) LEC. 3. Pr. COMP 2710 and (COMP 3350 or ELEC 2220). Operating system design and analysis for embedded systems: Real-time issues, resource management, scheduling, exception handling, device driver development, kernel development, synchronization, network support.

COMP 3700 SOFTWARE MODELING AND DESIGN (3) LEC. 3. Pr. COMP 2710. Current processes, methods, and tools related to modeling and designing software systems. Communication, teamwork, and a design experience are integral course experiences.

COMP 3710 WIRELESS SOFTWARE ENGINEERING (3) LEC. 3. Pr. COMP 2710. Software engineering for wireless applications: specification, process, testing, and performance evaluation. Design and development of wireless application layer software, including current protocols.

COMP 4200 FORMAL LANGUAGES (3) LEC. 3. Pr. COMP 3240. Fundamentals of formal languages including mathematical models of regular sets, context-free languages and Turing machines; deterministic and non-deterministic models.

COMP 4300 COMPUTER ARCHITECTURE (3) LEC. 3. Pr. COMP 3350. Comparison of computer architectures, emphasizing the relationships between system software and hardware. Includes processor control and datapath organization, memory subsystem design, instruction set design, processor simulation, and quantitative analysis of computer performance.

COMP 4320 INTRODUCTION TO COMPUTER NETWORKS (3) LEC. 3. Pr. COMP 3500 or COMP 3510 or Departmental approval. Fundamentals of computer networks, OSI model, LAN, WAN, packet transmission, interworking, Internet Protocol, WWW and Java technology.

COMP 4710 SENIOR DESIGN PROJECT (3) LEC. 3. Pr. COMP 3700 or COMP 3710. Development of requirement definitions, architectural design specification, detailed design specification, testing plan and documentation for the software and/or hardware components of a comprehensive project.

COMP 4730 COMPUTER ETHICS (1) LEC. 1. Pr. (PHIL 1020 or PHIL 1023 or PHIL 1027) or PHIL 1040. Application of ethical principles to computing-related topics, including privacy, property rights, autonomy, access, and diversity. Communication and teamwork are integral course experiences.
COMP 4960 SPECIAL PROBLEMS (1-4) IND. Course may be repeated for a maximum of 6 credit hours.

COMP 4970 SPECIAL TOPICS (1-3) LEC. 1-3. Investigation of current topics in computer science and software engineering. Departmental approval Course may be repeated for a maximum of 12 credit hours.

COMP 4997 HONORS THESIS (3-6) IND. Pr. Honors College. Departmental approval. Individual student endeavor consisting of directed research and writing of honors thesis. Course may be repeated for a maximum of 6 credit hours.

COMP 5000 WEB APPLICATION DEVELOPMENT (3) LEC. 3. Departmental approval. Design and implementation of web sites and associated applications. Emphasis on user interface design and information organization and presentation. Fall, Spring.

COMP 5020 ADVANCED WEB APPLICATION DEVELOPMENT (3) LEC. 3. Pr. COMP 5000. Departmental approval. Design and implementation of interactive web applications in Java as applets and servlets. Use of concepts like security, internationalization, multi-threading and server/client architectures.

COMP 5120/5123 DATABASE SYSTEMS I (3) LEC. 3. Pr. COMP 3270. Theoretical and applied issues related to the analysis, design, and implementation of relational database systems.

COMP 5130 DATA MINING (3) LEC. 3. Pr. COMP 3270. Advanced concepts, techniques, and applications of data mining with an algorithmic and computational focus, including data visualization, data warehousing, data cube computation, pattern and rule mining, classification, belief networks, clustering, outlier detection, graph matching, and parallel and distributed computation.

COMP 5200 THEORETICAL COMPUTER SCIENCE (3) LEC. 3. Pr. COMP 4200. Departmental approval. The nature of the recursive sets and recursively enumerable sets. Decidability. Context-sensitive grammars and linear-bounded automata, including closure properties; oracles; reduction; the arithmetic hierarchy; the analytic hierarchy.

COMP 5210 COMPILER CONSTRUCTION (3) LEC. 3. Pr. COMP 4200 and COMP 3220. Compiler organization; lexical analysis; parsing; syntax- direction translation; symbol tables; basic dependence analysis; intermediate forms; interpreters vs. compilers; run-time storage management; code generation; error detection and recovery.


COMP 5330 PARALLEL AND DISTRIBUTED COMPUTING (3) LEC. 3. Pr. COMP 3500 or COMP 3510. Overview of hardware and software issues in parallel systems: fundamental parallel architectures, programming languages, tools and algorithms, parallel applications.

COMP 5340 NETWORK QUALITY ASSURANCE AND SIMULATION (3) LEC. 3. Pr. COMP 4320 or ELEC 5220. Theoretical and practical aspects of network simulation and quality assurance.

COMP 5350 DIGITAL FORENSICS (3) LEC. 3. Pr. COMP 2710 or ISMN 3080 or (MNGT 3080 or MNGT 3087). Departmental approval. Computer compromise and forensics, with focus on computer crime and ways to uncover, protect, and exploit digital evidence.

COMP 5360 WIRELESS AND MOBILE NETWORKS (3) LEC. 3. Pr. COMP 4320. Departmental approval. Mobile IP, wireless routing, location management, ad-hoc wireless networks, wireless TCP personal communication systems, and GSM.


COMP 5400 FUNDAMENTALS OF COMPUTER GRAPHICS (3) LEC. 3. Pr. COMP 2710 and MATH 2660. Graphics hardware and software components, coordinate systems, 2-D and 3-D transformations, 3-D viewing and projection, clipping and windowing, scan conversion and algorithms, visibility determination and shadowing, and software projects using a graphics software package.

COMP 5500 DISTRIBUTED OPERATING SYSTEMS (3) LEC. 3. Pr. COMP 4320. Basic concepts of distributed systems. Concurrent process communication and synchronization mechanisms, distributed process scheduling, distributed file systems, distributed shared memory, distributed system security and case studies.
COMP 5520 NETWORK AND OPERATING SYSTEM ADMINISTRATION (3) LEC. 3. Pr. COMP 4320. Studies of the installation, configuration and management of traditional, distributed and networked system software. Network integration of different systems. Performance monitoring, safety and security issues together with policies, politics and the laws regarding system software management.

COMP 5530/5533 CLOUD COMPUTING: PRINCIPLES, PRACTICE, AND APPLICATIONS (3) LEC. 3. Pr. COMP 3220 and COMP 3500. Cloud concepts and issues including architecture, service models, security, and implementation. Hands-on experience in both using, managing, and deploying clouds.


COMP 5630 MACHINE LEARNING (3) LEC. 3. Pr. COMP 3270. An exploration of current concepts, techniques, and applications in machine learning including abductive learning, case-based learning, deep learning, and reinforcement learning.

COMP 5650/5653 DEEP LEARNING (3) LEC. 3. Pr. COMP 5630. Convolutional neural networks (CNNs); visualizing CNNs; segmentation CNNs; recurrent neural networks; machine translation; unsupervised learning; and generative adversarial networks.

COMP 5660/5663 EVOLUTIONARY COMPUTING (3) LEC. 3. Pr. COMP 3270 and STAT 3600 or STAT 3603. This course covers in depth the fundamentals of evolutionary computing and surveys the most popular types of evolutionary algorithms (e.g., genetic programming), a class of stochastic, population-based algorithms inspired by natural evolution theory, genetics, and population dynamics, capable of solving complex optimization and modeling problems. It applies them to solve a series of challenging assignments involving intensive programming, experimentation, statistical analysis, and technical writing.

COMP 5700/5703 SOFTWARE PROCESS (3) LEC. 3. Pr. COMP 3700 or COMP 3710. Departmental approval. Process models of the software life cycle as well as methods and tools for software development.

COMP 5710/5713 SOFTWARE QUALITY ASSURANCE (3) LEC. 3. Pr. COMP 3700 or COMP 3710. Departmental approval. Processes, methods, and tools associated with the production of robust, high-quality software.

COMP 5720 REAL TIME AND EMBEDDED SYSTEMS (3) LEC. 3. Pr. COMP 3500 or COMP 3510. Concepts of real-time and embedded computer systems. Studies of real-time algorithm issues such as timeliness, time-constrained scheduling and communication. Embedded system issues such as limited memory, low power, and high latency communication. Fall, Spring.

COMP 5970 SPECIAL TOPICS (1-3) LEC. Departmental approval. Investigation of current topics in computer science and software engineering. Course may be repeated for a maximum of 9 credit hours.

COMP 6000/6006 WEB APPLICATION DEVELOPMENT (3) LEC. 3. Departmental approval. Design and implementation of web sites and associated applications. Emphasis on user interface design and information organization and presentation. Fall, Spring.

COMP 6020/6026 ADVANCED WEB APPLICATION DEVELOPMENT (3) LEC. 3. Pr. COMP 6000 or COMP 6006. Departmental approval. Design and implementation of interactive web applications in Java as applets and servlets. Use of concepts like security, internationalization, multi-threading and server/client architectures. Fall, Spring.

COMP 6120/6126 DATABASE SYSTEMS I (3) LEC. 3. Departmental approval. Theoretical and applied issues related to the analysis, design, and implementation of relational database systems.

COMP 6130/6136 DATA MINING (3) LEC. 3. Advanced concepts, techniques, and applications of data mining with an algorithmic and computational focus, including data visualization, data warehousing, data cube computation, pattern and rule mining, classification, belief networks, clustering, outlier detection, graph matching, and parallel and distributed computation.

COMP 6200/6206 THEORETICAL COMPUTER SCIENCE (3) LEC. 3. Departmental approval. The nature of the recursive sets and recursively enumerable sets. Decidability. Context-sensitive grammars, and linear-bounded automata, including closure properties; oracles; reduction; the arithmetic hierarchy; the analytic hierarchy.
COMP 6210/6216 Compiler Construction (3) LEC. 3. Departmental approval. Compiler organization; lexical analysis; parsing; syntax-direction translation; symbol tables; basic dependence analysis; intermediate forms; interpreters vs. compilers; run-time storage management; code generation; error detection and recovery.

COMP 6320/6326 Design and Analysis of Computer Networks (3) LEC. 3. Departmental approval. Computer networks design, including multiplexing, switching, routing, internetworking, transport protocols, congestion control, and performance evaluation.

COMP 6330/6336 Parallel and Distributed Computing (3) LEC. 3. Departmental approval. Overview of hardware and software issues in parallel systems: fundamental parallel architectures, programming languages, tools and algorithms, parallel applications.


COMP 6350/6356 Digital Forensics (3) LEC. 3. Pr. COMP 2710 or ISMN 3080 or (MNGT 3080 or MNGT 3087). Departmental approval. Computer compromise and forensics, with focus on computer crime and ways to uncover, protect, and exploit digital evidence.

COMP 6360/6366 Wireless and Mobile Networks (3) LEC. 3. Departmental approval. Mobile IP, wireless routing, location management, ad-hoc wireless networks, wireless TCP personal communication systems, and GSM.


COMP 6400/6406 Fundamentals of Computer Graphics (3) LEC. 3. Departmental approval. Graphics hardware and software components, coordinate systems, 2-D and 3-D transformations, 3-D viewing and projection, clipping and windowing, scan conversion and algorithms, visibility determination and shadowing, and software projects using a graphics software package.

COMP 6500/6506 Distributed Operating Systems (3) LEC. 3. Departmental approval. Basic concepts of distributed systems. Concurrent process communication and synchronization mechanisms, distributed process scheduling, distributed file systems, distributed shared memory, distributed system security and case studies.

COMP 6520/6526 Network and Operating System Administration (3) LEC. 3. Departmental approval. Studies of the installation, configuration and management of traditional, distributed and networked system software. Network integration of different systems. Performance monitoring, safety and security issues together with policies, politics and the laws regarding system software management.


COMP 6600/6606 Artificial Intelligence (3) LEC. 3. Departmental approval. Introduction to intelligent agents, search knowledge representation and reasoning, machine learning.

COMP 6610/6616 Artificial Intelligence Programming (3) LEC. 3. Pr. COMP 6600 or COMP 6606. Departmental approval. Design and implementation of advanced artificial intelligence techniques including expert systems, planning, logic and constraint programming, knowledge representation and heuristic search methods.


COMP 6630/6636 Machine Learning (3) LEC. 3. An exploration of current concepts, techniques, and applications in machine learning including abductive learning, case-based learning, deep learning, and reinforcement learning.

COMP 6650/6656 Deep Learning (3) LEC. 3. Pr. COMP 6630. Convolutional neural networks (CNNs); visualizing CNNs; detection CNNs; segmentation CNNs; recurrent neural networks; machine translation; unsupervised learning; and generative adversarial networks.
COMP 6660/6666 EVOLUTIONARY COMPUTING (3) LEC. 3. Departmental approval. This course covers in depth the fundamentals of evolutionary computing and surveys the most popular types of evolutionary algorithms (e.g., genetic programming), a class of stochastic, population-based algorithms inspired by natural evolution theory, genetics, and population dynamics, capable of solving complex optimization and modeling problems. It applies them to solve a series of challenging assignments involving intensive programming, experimentation, statistical analysis, and technical writing.

COMP 6700/6706 SOFTWARE PROCESS (3) LEC. 3. Departmental approval. Process models of the software life cycle as well as methods and tools for software development.

COMP 6710/6716 SOFTWARE QUALITY ASSURANCE (3) LEC. 3. Departmental approval. Processes, methods, and tools associated with the production of robust, high-quality software.

COMP 6720/6726 REAL TIME AND EMBEDDED SYSTEMS (3) LEC. 3. Departmental approval. Concepts of real-time and embedded computer systems. Studies of real-time algorithm issues such as timeliness, time-constrained scheduling and communication. Embedded system issues such as limited memory, low power, and high latency communication. Fall, Spring.

COMP 6970/6976 SPECIAL TOPICS (1-3) LEC. Investigation of current topics in computer science and software engineering. Course may be repeated for a maximum of 9 credit hours.

COMP 7120/7126 DATABASE SYSTEMS II (3) LEC. 3. Pr. COMP 6120 or COMP 6126. Departmental approval. Theoretical and applied issues related to the analysis, design, and implementation of object-oriented database systems.


COMP 7270/7276 ADVANCED TOPICS IN ALGORITHMS (3) LEC. 3. Departmental approval. In-depth study of advanced topics in algorithms.

COMP 7300/7306 ADVANCED COMPUTER ARCHITECTURE (3) LEC. 3. Departmental approval. Modern instruction level parallel computer design, including superscalar and very-long instruction word processor design.

COMP 7320/7326 ADVANCED COMPUTER NETWORKS (3) LEC. 3. Pr. COMP 6320 or COMP 6326. Departmental approval. Advanced network topics, including ISDN, ATM, active networks, security, Internet, wireless and mobile networks, and network management.

COMP 7330/7336 TOPICS IN PARALLEL AND DISTRIBUTED COMPUTING (3) LEC. 3. Pr. COMP 6330 or COMP 6336. Departmental approval. Parallel programming languages, environments and tools, parallel algorithms performance issues, distributed memory systems, group communication, fault tolerance.

COMP 7360/7366 WIRELESS AND MOBILE NETWORKS (3) LEC. 3. Pr. COMP 6320 or COMP 6326. Departmental approval. Mobile IP, wireless routing, location management, ad-hoc wireless networks, wireless TCP, personal communication systems, and GSM.

COMP 7370/7376 ADVANCED COMPUTER AND NETWORK SECURITY (3) LEC. 3. Pr. COMP 6370 or COMP 6376. Departmental approval. Advanced, research-based examination of computer network attack and defense techniques, viruses and other malware; operating system vulnerabilities and safeguards.

COMP 7400/7406 ADVANCED COMPUTER GRAPHICS (3) LEC. 3. Pr. COMP 6400 or COMP 6406. Departmental approval. Advanced 3-D topics including visual realism issues, visible surface determination algorithms, illumination and shading models, surface and solid modeling, advanced modeling techniques, special purpose graphics architectures, and animation. Software projects will be assigned.

COMP 7440 SIMULATION OF COMPUTER NETWORKS (3) LEC. 3. Departmental approval. Research-based examination of network simulation, including TCP/IP networks, wireless networks and verification and validation of a network simulation.
COMP 7500/7506 ADVANCED TOPICS IN OPERATING SYSTEMS (3) LEC. 3. Departmental approval. Advanced topics in operating system concepts, design and implementation.

COMP 7600/7606 COMPUTATIONAL INTELLIGENCE (3) LEC. 3. Pr. COMP 6600 or COMP 6606. Departmental approval. A study of computational intelligence with emphasis on the design and implementation of neural, genetic and fuzzy computing techniques.

COMP 7610/7616 COMPUTATIONAL COGNITION (3) LEC. 3. Pr. COMP 6600 or COMP 6606. Departmental approval. Computational models of cognition, including knowledge representations and process mechanisms like means-ends analysis, semantic networks, frames.

COMP 7620/7626 HUMAN-COMPUTER INTERACTION (3) LEC. 3. Departmental approval. Coreq. COMP 6620. Theoretical principles and practical aspects of interaction between humans and computers, design and evaluation of interactive systems.

COMP 7700/7706 SOFTWARE ARCHITECTURE (3) LEC. 3. Pr. (COMP 6700 or COMP 6706) and (COMP 6710 or COMP 6716). Departmental approval. Methods and tools related to the analysis, specification and design of software architecture.

COMP 7710/7716 SOFTWARE ENVIRONMENTS (3) LEC. 3. Pr. (COMP 6700 or COMP 6706) and (COMP 6710 or COMP 6716). Departmental approval. Issues associated with the design, implementation, and use of software engineering environments.

COMP 7720/7726 SOFTWARE RE-ENGINEERING (3) LEC. 3. Pr. (COMP 6700 or COMP 6706) and (COMP 6710 or COMP 6716). Departmental approval. Process, methods and tools associated with re-engineering software systems.

COMP 7730/7736 FORMAL METHODS FOR SOFTWARE (3) LEC. 3. Pr. (COMP 6700 or COMP 6706) and (COMP 6710 or COMP 6716). Departmental approval. Precise, abstract models for characterizing and reasoning about properties of software systems.

COMP 7740 AGENT-DIRECTED SIMULATION (3) LEC. 3. Pr. COMP 6700 or COMP 6706. Departmental approval. Covers entire simulation software development life cycle including problem formulation, system and objectives definition, conceptual modeling, model design, implementation, analysis of simulation data, and credibility assessment including verification and validation. Special emphasis is given to modeling aspects using agent-directed simulation methodology.

COMP 7930/7936 DIRECTED STUDY (1-3) IND. Course may be repeated with change in topics.

COMP 7950/7956 INTRODUCTION TO GRADUATE STUDY IN COMPUTER SCIENCE AND SOFTWARE ENGINEERING (1) LEC. 1. SU. Introduction to graduate research and study topics in computer science and software engineering.

COMP 7970/7976 SPECIAL TOPICS (1-3) LEC. Course may be repeated with change in topics.

COMP 7980/7986 CAPSTONE ENGINEERING PROJECT (3) LEC. 3. Planning, implementation, and completion of a design project. Project culminates in both a written report and an oral presentation.

COMP 7990/7996 RESEARCH AND THESIS (1-15) MST. May count either COMP 7990 or COMP 7996. Course may be repeated with change in topics.

COMP 8120 CURRENT TOPICS IN DATABASE SYSTEMS (3) LEC. 3. Pr. COMP 6120 or COMP 6126. Departmental approval. Theoretical and applied research issues related to database systems. Topics will reflect current research in the field.

COMP 8220 RESEARCH TOPICS IN PROGRAMMING LANGUAGES (3) LEC. 3. Pr. COMP 7220 or COMP 7226. Departmental approval. Topics of current research in the area of programming languages, their design, and implementation.


COMP 8330 ADVANCED TOPICS IN PARALLEL AND DISTRIBUTED COMPUTING (3) LEC. 3. Pr. COMP 6330 or COMP 6336. Parallelizing compiler, theory of concurrency, advanced parallel algorithms, load balancing, migration, performance evaluation, distributed architectures. Departmental approval.

COMP 8400 CURRENT TOPICS IN COMPUTER GRAPHICS (3) LEC. 3. Pr. COMP 7400 or COMP 7406. Departmental approval. In-depth study of current research topics in computer graphics. Topics may include theoretical, performance implementation, and system integration issues. Extensive literature survey, issue identification, performance comparison, and future research trends will be discussed.
COMP 8500 RESEARCH TOPICS IN OPERATING SYSTEMS (3) LEC. 3. Pr. COMP 7500 or COMP 7506. Departmental approval. Topics of current research in the area of operating systems, their design, and implementation.

COMP 8600 ADVANCED TOPICS IN ARTIFICIAL INTELLIGENCE (3) LEC. 3. Pr. COMP 6610 or COMP 6616 or COMP 7600 or COMP 7606 or COMP 7610 or COMP 7616. Departmental approval. In-depth study of current research topics in Artificial Intelligence, e.g., reasoning mechanisms, heuristic search methods, cognitive modeling.

COMP 8620 ADVANCED TOPICS IN HUMAN-COMPUTER INTERACTION (3) LEC. 3. Pr. COMP 7620 or COMP 7626. Departmental approval. Current theoretical and applied research issues in Human-Computer Interaction, e.g., evaluation and assessment methods, multimodal interfaces, educational technology.

COMP 8700/8706 CURRENT TOPICS IN SOFTWARE ENGINEERING (3) LEC. 3. Pr. (COMP 6700 or COMP 6706) and (COMP 6710 or COMP 6716). Departmental approval. Current theoretical and applied research issues in software engineering.

COMP 8930/8936 DIRECTED STUDY (1-3) IND. Course may be repeated for a maximum of 6 credit hours.

COMP 8970 SPECIAL TOPICS (1-3) IND. Course may be repeated with change in topics.

COMP 8990/8996 RESEARCH AND DISSERTATION (1-20) DSR. Course may be repeated with change in topics.

CPSC Courses

CPSC 1213 INTRODUCTION TO COMPUTER SCIENCE I (3) DSL. 45. Admission into Bachelor of Computer Science Program. Introduces the fundamental concepts of object-oriented programming.

CPSC 1223 INTRODUCTION TO COMPUTER SCIENCE II (3) DSL. 45. Pr. CPSC 1213. Admission into Bachelor of Computer Science Program. Continues the development of programming from an object-oriented perspective. Emphasizes sound software engineering principles and best practices.

CPSC 1233 DATA STRUCTURES (3) DSL. 45. Pr. CPSC 1223. Admission into Bachelor of Computer Science Program. Developing programs that use data structures and collections to efficiently store data. Emphasis will be placed on the interplay between effective data structures and efficient algorithms.

CPSC 2713 SOFTWARE CONSTRUCTION FUNDAMENTALS (3) DSL. 45. Pr. CPSC 1233. Admission into Bachelor of Computer Science Program. Development of graphical user interface-based, event-driven desktop/laptop computer application using a modern object-oriented language. Systematic testing, debugging, documentation, and maintenance programming.

CPSC 3223 PROGRAMMING LANGUAGES AND TRANSLATION (3) DSL. 45. Pr. CPSC 1233 and CPSC 3303. Admission into Bachelor of Computer Science Program. Fundamental concepts of programming language design, interpretation, and compilation.

CPSC 3243 DISCRETE STRUCTURES (3) DSL. 45. Pr. (MATH 1610 or MATH 1613 or MATH 1617) and MATH 1710. Admission into Bachelor of Computer Science Program. Basics of set theory, propositional and predicate logic as used to describe algorithms, recurrence relations. Proving correctness and estimating running time for algorithms. Mathematical and structural induction.

CPSC 3273 ALGORITHMS I (3) DSL. 45. Pr. CPSC 1233. Admission into Bachelor of Computer Science Program. Introduction to algorithms as tools for computational problem solving, language of algorithms, understanding algorithms, approximately analyzing correctness and efficiency of algorithms, algorithms that solve fundamental computational problems, basic algorithm design techniques, steps of computational problem solving.

CPSC 3283 ALGORITHMS II (3) DSL. 45. Pr. CPSC 3273. Admission into Bachelor of Computer Science Program. Advanced complexity analysis techniques, notions of computational complexity, polynomial time hierarchy, computability, algorithms that solve advanced computational problems, advanced algorithm design techniques, computational problem solving.

CPSC 3303 COMPUTER ORGANIZATION AND ASSEMBLY LANGUAGE PROGRAMMING (3) DSL. 45. Pr. CPSC 3243 and CPSC 1213. Admission into Bachelor of Computer Science Program. Stored program computers, hardware and software components, data representations, instruction sets, addressing modes, assembly language programming, loaders, linkers and operating systems.

CPSC 3323 COMPUTER ARCHITECTURE (3) DSL. 45. Pr. CPSC 3333. Admission into Bachelor of Computer Science Program. Design of Computer Systems, emphasizing the relationship between computer hardware and software. Includes processor control and data path organization, memory subsystem design, instruction set design, processor simulation, and quantitative analysis of computer performance.
CPSC 3333 OPERATING SYSTEMS (3) DSL. 45. Pr. CPSC 1233 and CPSC 3303. Admission into Bachelor of Computer Science Program. Structure and functions of operating systems; processes and process scheduling; synchronization and mutual exclusion; memory management; auxiliary storage management; resource allocation and deadlock; security, privacy, and ethical concerns; design tradeoffs.

CPSC 3343 PARALLEL SYSTEMS (3) DSL. 45. Pr. CPSC 3333. Admission into Bachelor of Computer Science Program. Overview of hardware and software issues in parallel systems: fundamental parallel architectures, programming languages, tools and algorithms, and parallel applications.

CPSC 3353 COMPUTER NETWORKS I (3) DSL. 45. Pr. CPSC 3333. Admission into Bachelor of Computer Science Program. Fundamentals of computer networks, TCP/IP layered model: application layer, transport layer, network layer, link layer, with examples of each layer, and explanation of design issues. IPv6.

CPSC 3363 COMPUTER NETWORKS II (3) DSL. 45. Pr. CPSC 3353. Admission into Bachelor of Computer Science Program. Computer network design, including multiplexing, switching, routing, internetworking, transport protocols, congestion control, and performance evaluation.

CPSC 3373 WIRELESS AND MOBILE NETWORKS (3) DSL. 45. Pr. CPSC 3353. Admission into Bachelor of Computer Science Program. Mobile IP, wireless routing, location management, ad-hoc wireless networks, wireless, wireless TCP personal communication systems, and current mobile phone OTA protocols.

CPSC 3703 SOFTWARE ENGINEERING I (3) DSL. 45. Pr. CPSC 2713. Admission into Bachelor of Computer Science Program. Current processes, methods, and tools related to modeling and designing software systems.

CPSC 3713 SOFTWARE ENGINEERING II (3) DSL. 45. Pr. CPSC 3703. Admission into Computer Science Online Program. Current processes, methods, and tools related to modeling and designing software systems.

CPSC 4003 SYSTEM ADMINISTRATION (3) DSL. 45. Pr. CPSC 3333. Admission into Bachelor of Computer Science. Basics of system administration for Windows and Unix machines, including configuration of Performance measurement and enhancement.

CPSC 4203 FORMAL LANGUAGES (3) DSL. 45. Pr. CPSC 3273 and CPSC 3243. Admission into Bachelor of Computer Science Program. Fundamentals of formal languages including mathematical models of regular sets, context-free languages and Turing machines; deterministic and non-deterministic models. Basics of interpretation and compilation.

CPSC 4733 COMPUTER ETHICS (3) DSL. 45. Admission into Bachelor of Computer Science Program. Application of ethical principles to computing-related topics, including privacy, property rights, autonomy, access, and diversity.

CPSC 4973 SPECIAL TOPICS (3) LEC. 3. Investigation of current topics in computer science. Course may be repeated for a maximum of six credit hours. Departmental approval required.

CPSC 5123 DATABASE I (3) DSL. 45. Pr. CPSC 1233. Admission into Bachelor of Computer Science Program. The design and implementation of database applications, with a focus on relational database management systems.

CPSC 5133 DATABASE II (3) DSL. 45. Pr. CPSC 5123. Admission into Bachelor of Computer Science Program. Theory, design, and implementation of database systems.

CPSC 5203 DEVELOPING WEB APPLICATIONS WITH XML (3) DSL. 45. Pr. CPSC 1233. Admission into Bachelor of Computer Science Program. Comprehensive introduction to XML, working with XML and Databases, event-driven programming with XML, implementing Communication and Web Services with XML, working with XML, JQuery, XHTML and HML5.

CPSC 5213 WEB APPLICATION DEVELOPMENT WITH JSP (3) DSL. 40. Pr. CPSC 5203. Admission into Bachelor of Computer Science Program. Advanced course in web development using JSP, includes JCP fundamentals, JAP and web server software development, and applying JSP in the real world.

CPSC 5333 MOBILE APPLICATIONS I (3) DSL. 45. Pr. CPSC 2713. Admission into Computer Science Online Program. Software development for wireless applications: specification, process, testing, and performance evaluation. Design and development of wireless application layer software, including current protocols.
CPSC 5343 MOBILE APPLICATION DEVELOPMENT II (3) DSL. 3. Pr. CPSC 5333. Admission into Bachelor of Computer Science Program. Builds mastery of mobile application development and the skills necessary to stay current in this fast-moving field throughout one's career by introducing a new programming language and application programmer interface and interface and requiring the student to master them.

Electrical and Computer En Courses

ELEC 2110 ELECTRIC CIRCUIT ANALYSIS (4) LEC. 3. LAB. 3. Pr. (PHYS 1610 or PHYS 1617) and (COMP 1200 or COMP 1210 or COMP 1217) and (P/C ENGR 1110 or P/C ENGR 1113) and P/C MATH 2650. Basic laws and concepts; resistive circuits; first-order transient circuits; phasors and frequency response of circuits; RMS values and complex power.

ELEC 2120 SIGNALS AND SYSTEMS (4) LEC. 3. LAB. 1. Pr. ELEC 2110 and MATH 2650. Time-domain and frequency-domain methods for modeling and analyzing continuous and discrete-data signals and systems.

ELEC 2200 DIGITAL LOGIC CIRCUITS (3) LEC. 3. Pr. COMP 1200 or COMP 1210 or COMP 1217. Electronic devices and digital circuits; binary numbers; Boolean algebra and switching functions; gates and flip-flops; combinational and sequential logic circuits; hierarchical design of digital systems; computer-aided design tools for digital design, simulation, and testing.

ELEC 2210 DIGITAL ELECTRONICS (4) LEC. 3. LAB. 3. Pr. ELEC 2110 and ELEC 2200. History of electronics; semiconductors; biasing and operation of PN junction diodes; field-effect transistors and bipolar junction transistors; logic families and logic technologies; flip-flops and memory circuitry.

ELEC 2220 COMPUTER SYSTEMS (3) LEC. 3. Pr. ELEC 2200. Computer hardware/software organization, processor programming models, assembly language programming, design of memory systems, I/O device interfacing, programming and multiprocessing.

ELEC 3030 RF SYSTEMS LAB (1) LAB. 3. Pr. ELEC 2210. Assembly, testing and analysis of a radio. Integration of basic concepts of electronics, electromagnetics, and signals and systems.

ELEC 3040 ELECTRICAL SYSTEM DESIGN LAB (1) LAB. 3. Pr. ELEC 2220 and (P/C ELEC 3030 and ELEC 3500). Exploration and integration of electrical engineering concepts and professional practice issues through the design of a contemporary engineering system.

ELEC 3050 EMBEDDED SYSTEM DESIGN LAB (1) LAB. 3. Pr. ELEC 2210 and ELEC 2220 and P/C ELEC 2120. Integration of hardware and software in the design of an embedded computing system; development of professional skills.

ELEC 3060 WIRELESS DESIGN LAB (1) LAB. 3. Pr. P/C ELEC 3400. Laboratory experiments geared towards understanding the implementation and testing of components used in wireless communication systems.

ELEC 3310 FUNDAMENTALS OF APPLIED ELECTROMAGNETICS (3) LEC. 3. Pr. MATH 2660 and ELEC 2110. Transmission lines are studied as a bridge to understanding electromagnetic theory. Then, electric and magnetic fields are studied using vector algebra, culminating in Maxwell's equations.

ELEC 3320 ELECTROMAGNETICS FOR WIRELESS COMMUNICATION (3) LEC. 3. Pr. ELEC 3310. Maxwell's equations are used in the study of plane waves, guided waves, fiberoptics, electromagnetic compatibility and interference, antennas and radiation, and satellite communication systems.

ELEC 3400 COMMUNICATION SYSTEMS (3) LEC. 3. Pr. ELEC 3800. Pulse code modulation, line coding, information rate, equalization, amplitude modulation, angle modulation, noise in communication systems.

ELEC 3500 CONTROL SYSTEMS (3) LEC. 3. Pr. ELEC 2120. Analog and discrete transfer function models, system response specifications, control system characteristics, root locus analysis and design, frequency response analysis and design.

ELEC 3600 ELECTRIC POWER ENGINEERING (3) LEC. 3. Pr. ELEC 2110. Introduction to the basic concepts in electric power engineering.


ELEC 3800 RANDOM SIGNALS AND SYSTEMS (3) LEC. 3. Pr. ELEC 2120. Introduction to probability, random variables, random processes and basic statistics, analysis of random signals and noise.
ELEC 3810 FUNDAMENTALS OF ELECTRICAL ENGINEERING (3) LEC. 3. Pr. PHYS 1610 and P/C MATH 2650. Electrical circuit analysis; electronic devices, digital systems, amplifier concepts, power devices and systems. Not open to ECE majors.

ELEC 4000 SENIOR DESIGN PROJECTS (3) LEC. 3. Pr. ELEC 3040 or ELEC 3050 or ELEC 3060. A capstone design project which draws on the accumulated curricular experience. Particular project sections may have additional requisites.

ELEC 4010 CAPSTONE DESIGN I (1) LEC. 1. Pr. P/C ELEC 3040 or P/C ELEC 3050 or (P/C ELEC 3030 and P/C ELEC 3060). The engineering design process, project management and teamwork, ethical and social impacts of design projects, project documentation and presentation, business considerations, and intellectual property.

ELEC 4020 CAPSTONE DESIGN II (3) LEC. 3. Pr. ELEC 4010. A capstone design project which draws on the accumulated curricular experience. Particular project sections may have additional prerequisites. Departmental approval needed.

ELEC 4200 DIGITAL SYSTEM DESIGN (3) LEC. 2. LAB. 3. Pr. ELEC 2210 and ELEC 2220. Hierarchical, modular design of digital systems, computer-aided digital system modeling, simulation, analysis, and synthesis; design implementation with programmable logic devices and FPGAs.

ELEC 4800 INSTRUMENTATION ENGINEERING (3) LEC. 2. LAB. 3. Pr. ELEC 3040 or ELEC 3050. Study and application of sensors, instrumentation and computer technology to research and industrial process control.

ELEC 4980 SPECIAL PROJECTS (1-3) IND. Departmental approval. Supervised study of a specialized area of electrical and computer engineering not covered by regularly offered courses. Course may be repeated with change in topics.

ELEC 4997 HONORS THESIS (1-6) IND. Pr. Honors College. Departmental approval. Directed research and writing of honors thesis. Course may be repeated for a maximum of 6 credit hours.

ELEC 5100 WIRELESS COMMUNICATION SYSTEMS (3) LEC. 3. Pr. ELEC 3400. Introduction to mobile cellular radio and wireless personal communications, mobile radio propagation, modulation techniques, multiple access techniques, wireless systems and standards.

ELEC 5110 WIRELESS NETWORKS (3) LEC. 3. Pr. ELEC 3400. Introduction to wireless broadband, satellite communication, wireless local area networks, Bluetooth and Home RF standards and Internet protocol and wireless access.

ELEC 5120 TELECOMMUNICATION NETWORKS (3) LEC. 3. Pr. ELEC 3400. Principles and building blocks of telecommunication systems, including switched telephone networks, voice and data networks, transmission technologies, and switching architectures.

ELEC 5130 RF DEVICES AND CIRCUITS (3) LEC. 3. Pr. ELEC 3700. Introduction to RF semiconductor devices and circuits targeted for wireless applications.

ELEC 5150 INFORMATION SECURITY (3) LEC. 3. Departmental approval. Emerging protocols, standards and technologies of information security; design of information network security using firewalls, virtual private networks and secured applications.

ELEC 5190 INTRODUCTION TO DIGITAL AND ANALOG IC DESIGN (3) LEC. 3. Pr. ELEC 3700. Digital IC design using Verilog, analog and mixed signal IC design using industry standard tools; emphasis on front-end design skills.

ELEC 5200 COMPUTER ARCHITECTURE AND DESIGN (3) LEC. 3. Pr. ELEC 4200. Structural organization and hardware design of digital computers; register transfers; micro-operations, control units and timing; instruction set design; input/output devices, multiprocessors, automated hardware design aids.

ELEC 5210 HARDWARE SECURITY I (3) LEC. 3. Pr. ELEC 2200. Hardware design of symmetric and asymmetric ciphers, digital signature generation and verification, key management, detection and avoidance of counterfeit ICs, cryptographic primitives, and automated hardware design aids.

ELEC 5220 INFORMATION NETWORKS AND TECHNOLOGY (3) LEC. 3. Pr. ELEC 2220 or COMP 3350. Architectures, protocols, standards and technologies of information networks; design and implementation of information networks; applications of information networks for data, audio and video communications.

ELEC 5230 PARALLEL PROCESSING (3) LEC. 3. Pr. ELEC 2220 or COMP 3350. Hardware components of multiprocessor systems including processor, inter-connection, memory and control architectures; software elements of parallel processing.

ELEC 5250 COMPUTER AIDED DESIGN OF DIGITAL LOGIC CIRCUITS (3) LEC. 3. Pr. ELEC 2220 or COMP 3350. Computer-automated design of digital logic circuits using discrete gates, programmable logic devices, and standard cells; hardware description languages, circuit simulation, verification, fault diagnosis and testing, RTL-to-GDSII ASIC flow.

ELEC 5260 EMBEDDED COMPUTING SYSTEMS (3) LEC. 3. Pr. ELEC 2220 or COMP 3350. The design of systems containing embedded computers. Microcontroller technology, assembly language and C programming, input/output interfacing, data acquisition hardware, interrupts, and timing. Real-time operating systems and application programming. Embedded system application examples.

ELEC 5270 LOW-POWER DESIGN OF ELECTRONIC CIRCUITS (3) LEC. 3. Pr. ELEC 2210. Departmental approval. Design of digital circuits and systems for reduced power consumption, power analysis algorithms, low-power MOS technologies, low-power design architectures for FPGAs, memory, and microprocessors, reduction of power in testing of circuits.

ELEC 5280 BUILT-IN-SELF-TEST (3) LEC. 3. Pr. ELEC 2210. Testing during product life-cycle, fault models and detection, design for testability, test pattern generation, output response analysis, concurrent fault detection, manufacturing and system use, built-in self-test approaches and applications.

ELEC 5290 HARDWARE SECURITY II (3) LEC. 3. Pr. ELEC 5210. This course will provide an in-depth analysis of various topics, which includes advanced cryptography, hardware Trojans, PUFs, RFID security, side-channel attacks and solutions, and blockchain.

ELEC 5310 DESIGN OF ANTENNAS AND ANTENNA SYSTEMS (3) LEC. 3. Pr. P/C ELEC 3320. Application of electromagnetic and circuit concepts to the design of practical antennas and antenna systems.

ELEC 5320 ELECTROMAGNETIC COMPATIBILITY (3) LEC. 3. Pr. ELEC 3320 and ELEC 3700. Electromagnetic noise coupling, designing for electromagnetic compatibility (EMC), EMC regulation, noise sources, standard techniques for eliminating noise, circuit layout for reduced electromagnetic interference (EMI).

ELEC 5340 MICROWAVE AND RF ENGINEERING (3) LEC. 3. Pr. ELEC 3320 and ELEC 3700. Application of electromagnetic and electronic concepts to the design of practical microwave devices and circuits typically used in wireless communications.

ELEC 5350 RADAR PRINCIPLES (3) LEC. 3. Pr. ELEC 3320 and ELEC 3800. Study of the fundamentals of RADAR and related systems such as SONAR and LIDAR.

ELEC 5360 BIOMEDICAL APPLICATIONS OF ELECTROMAGNETICS (3) LEC. 3. Pr. ELEC 3310. Development of medical instrumentation using electromagnetic principles; focus on magnetic resonance imaging systems.

ELEC 5410 DIGITAL SIGNAL PROCESSING (3) LEC. 3. Pr. ELEC 3800. Digital processing of signals, sampling difference equations, discrete-time Fourier transforms, discrete and fast Fourier transforms, digital filter design.

ELEC 5470 FUNDAMENTALS OF VLSI TEST (3) LEC. 3. Test economics, automatic test equipment, fault models, automatic test pattern generation, test generation for sequential circuits, fault simulation, testability measures, fault coverage, yield and defect levels, design-for-testability, scan and boundary scan, IDDQ testing.

ELEC 5530 MOBILE ROBOT DESIGN (3) LEC. 3. Pr. ELEC 2210 or ELEC 3810. Fundamentals of mobile robot design, including motor control, sensor integration, path planning, navigation, and localization.


ELEC 5620 POWER SYSTEM ANALYSIS (3) LEC. 3. Pr. ELEC 3600. Departmental approval. Power system modeling, power flow analysis, analysis of faulted power systems.


ELEC 5640 RENEWABLE ENERGY IN ELECTRICAL POWER SYSTEMS (3) LEC. 3. Pr. ELEC 3600 or ELEC 3810. Conventional power plants, global renewables, energy efficiency, marine hydrokinetic (ocean currents and waves), wind power (aerodynamic, generator, plants, grid integration, finance), photovoltaic (device, inverter, plant levels, finance), hydropower (generator, plant level, pumped storage hydro, advances in hydro), power systems grid integration, system impact studies, control and operation of inverter-based resources, ancillary services provisions, and other important aspects of renewables for bulk power (transmission levels) and for distribution power systems.
ELEC 5650 POWER SYSTEM PROTECTION (3) LEC. 3. Pr. ELEC 3600. Fault analysis using symmetrical components. Power switchgear, including switches, disconnects, fuses, relays and circuit breakers. Fundamentals of electric power system protection, including bus, transformer and line protection.

ELEC 5670 ELECTRIC POWER ENGINEERING TOPICS (1-3) LEC. Pr. ELEC 3600. Various topics representing state-of-the-art power technology. Course may be repeated for a maximum of 12 credit hours.

ELEC 5700 SEMICONDUCTOR FUNDAMENTALS (3) LEC. 3. Pr. ELEC 3700. Introduction to semiconductors: crystal structure, energy band theory, equilibrium electron and hole statistics, doping, generation and recombination processes, carrier drift and diffusion, transport equations.

ELEC 5710 SEMICONDUCTOR DEVICES (3) LEC. 3. Pr. ELEC 5700. Introduction to semiconductor devices: pn junctions, junction diode based devices, optoelectronic devices, bipolar transistors, field effect transistors.

ELEC 5730 MICROELECTRONIC FABRICATION (3) LEC. 2. LAB. 3. Pr. ELEC 2210. Departmental approval. Introduction to monolithic integrated circuit technology. Bipolar and MOS processes and structures. Elements of layout, design, fabrication, and applications. Experiments in microelectronic technologies.

ELEC 5740 ELECTRONICS MANUFACTURING (3) LEC. 2. LAB. 3. Pr. ELEC 2210. Departmental approval. Materials and processes used to manufacture electronic products. Particular attention is given to substrate technology and electronics assembly.

ELEC 5750 INTRODUCTION TO PLASMA ENGINEERING (3) LEC. 3. Pr. ELEC 3320. Departmental approval. Electrical breakdown and discharges in gases, basic plasma theories, applications of plasmas, plasma processing for microelectronic fabrication.

ELEC 5760 SOLID STATE SENSORS (3) LEC. 3. Pr. ELEC 3700. Theory, technology and design micro-machined sensors and related sensor technologies; and the application of micro-machined sensors.

ELEC 5770 VLSI DESIGN (3) LEC. 3. Pr. ELEC 2210 and ELEC 2220. Review of MOS transistor fundamentals, CMOS logic circuits; VLSI fabrication and design rules; clocking strategies and sequential design; performance estimation; memories and programmable arrays; standard cell design methodologies; computer aided design (CAD) tools.

ELEC 5780 ANALOG CIRCUIT DESIGN (3) LEC. 3. Pr. ELEC 3700. Departmental approval. Circuit design techniques used for implementing analog integrated circuits in both CMOS and bipolar technologies.

ELEC 5810 COMPUTED IMAGING SYSTEMS (3) LEC. 3. Pr. ELEC 2120. Departmental approval. Introduction to computed imaging systems such as magnetic resonance imaging (MRI) and computed tomography (CT).

ELEC 5820 MEMS TECHNOLOGY (3) LEC. 3. Departmental approval. Introduction to Micro-Electro-Mechanical Systems (MEMS), the study of the materials and microfabrication processes used to fabricate MEMS devices, the principles of operation of MEMS devices, and an introduction to the different application areas of MEMS devices.

ELEC 5970 SPECIAL TOPICS (1-5) LEC. Departmental approval. Study of a specialized area of electrical and computer engineering not covered by regularly offered courses. Course may be repeated with change in topics.

ELEC 6110/6116 WIRELESS NETWORKS (3) LEC. 3. Introduction to wireless broadband, satellite communication, wireless local area networks, Bluetooth and Home RF standards and Internet protocol and wireless access.

ELEC 6120/6126 TELECOMMUNICATION NETWORKS (3) LEC. 3. Principles and building blocks of telecommunication systems, including switched telephone networks, voice and data networks, transmission technologies, and switching architectures.

ELEC 6130/6136 RF DEVICES AND CIRCUITS (3) LEC. 3. Introduction to RF semiconductor devices and circuits targeted for wireless applications.

ELEC 6150 INFORMATION SECURITY (3) LEC. 3. Departmental approval. Emerging protocols, standards and technologies of information security; design of information network security using firewalls, virtual private networks and secured applications.

ELEC 6190/6196 INTRODUCTION TO DIGITAL AND ANALOG IC DESIGN (3) LEC. 3. Digital IC design using Verilog, analog and mixed signal IC design using industry standard tools; emphasis on on front-end design skills.

ELEC 6200/6206 COMPUTER ARCHITECTURE AND DESIGN (3) LEC. 3. Structural organization and hardware design of digital computers; register transfers; micro-operations, control units and timing; instruction set design; input/output devices, multiprocessors, automated hardware design aids.
ELEC 6210 HARDWARE SECURITY I (3) LEC. 3. This course will provide an in-depth analysis of various topics, which include (i) introduction to cryptography - symmetric and asymmetric ciphers, message authentication codes, and digital signatures, (ii) detection & avoidance of counterfeit ICs, and (iii) security primitives - physically unclonable functions (PUFs) and true random number generators (TRNGs).

ELEC 6220/6226 INFORMATION NETWORKS AND TECHNOLOGY (3) LEC. 3. Architectures, protocols, standards and technologies of information networks; design and implementation of information networks; applications of information networks for data, audio and video communications.

ELEC 6230/6236 PARALLEL PROCESSING (3) LEC. 3. Hardware components of multiprocessor systems including processor, interconnection, memory and control architectures; software elements of parallel processing.


ELEC 6250/6256 COMPUTER AIDED DESIGN OF DIGITAL LOGIC CIRCUITS (3) LEC. 3. Computer-automated design of digital logic circuits using discrete gates, programmable logic devices, and standard cells; hardware description languages, circuit simulation, verification, fault diagnosis and testing, RTL-to-GDSII ASIC flow.

ELEC 6260/6266 EMBEDDED COMPUTING SYSTEMS (3) LEC. 3. The design of systems containing embedded computers. Microcontroller technology, assembly language and C programming, input/output interfacing, data acquisition hardware, interrupts, and timing. Real-time operating systems and application programming. Embedded system application examples.

ELEC 6270/6276 LOW-POWER DESIGN OF ELECTRONIC CIRCUITS (3) LEC. 3. Departmental approval. Design of digital circuits and systems for reduced power consumption, power analysis algorithms, low-power MOS technologies, low-power design architectures for FPGAs, memory, and microprocessors, reduction of power in testing of circuits.

ELEC 6280/6286 BUILT-IN-SELF-TEST (3) LEC. 3. Testing during product life-cycle, fault models and detection, design for testability, test pattern generation, output response analysis, concurrent fault detection, manufacturing and system use, built-in self-test approaches and applications.

ELEC 6290 HARDWARE SECURITY II (3) LEC. 3. Pr. ELEC 5210 or ELEC 6210. This course will provide an in-depth analysis of various topics, which includes advanced cryptography, hardware Trojans, PUFs, RFID security, side-channel attacks and solutions, and blockchain.

ELEC 6310/6316 DESIGN OF ANTENNAS AND ANTENNA SYSTEMS (3) LEC. 3. Application of electromagnetic and circuit concepts to the design of practical antennas and antenna systems.

ELEC 6320/6326 ELECTROMAGNETIC COMPATIBILITY (3) LEC. 3. Electromagnetic noise coupling, designing for electromagnetic compatibility (EMC), EMC regulation, noise sources, standard techniques for eliminating noise, circuit layout for reduced electromagnetic interference (EMI).

ELEC 6340/6346 MICROWAVE AND RF ENGINEERING (3) LEC. 3. Application of electromagnetic and electronic concepts to the design of practical microwave devices and circuits typically used in wireless communications.

ELEC 6350/6356 RADAR PRINCIPLES (3) LEC. 3. Study of the fundamentals of RADAR and related systems such as SONAR and LIDAR.

ELEC 6360/6366 BIOMEDICAL APPLICATIONS OF ELECTROMAGNETICS (3) LEC. 3. Development of medical instrumentation using electromagnetic principles; focus on magnetic resonance imaging systems.

ELEC 6410/6416 DIGITAL SIGNAL PROCESSING (3) LEC. 3. Digital processing of signals, sampling difference equations, discrete-time Fourier transforms, discrete and fast Fourier transforms, digital filter design.

ELEC 6470 FUNDAMENTALS OF VLSI TEST (3) LEC. 3. Test economics, automatic test equipment, fault models, automatic test pattern generation, test generation for sequential circuits, fault simulation, testability measures, fault coverage, yield and defect levels, design-for-testability, scan and boundary scan, IDDQ testing

ELEC 6530/6536 MOBILE ROBOT DESIGN (3) LEC. 3. Fundamentals of mobile robot design, including motor control, sensor integration, path planning, navigation, and localization. Departmental Approval.

ELEC 6620/6626 POWER SYSTEM ANALYSIS (3) LEC. 3. Departmental approval. Power system modeling, power flow analysis, analysis of faulted power systems.


ELEC 6640 RENEWABLE ENERGY IN ELECTRICAL POWER SYSTEMS (3) LEC. 3. Conventional power plants, global renewables, energy efficiency, marine hydrokinetic (ocean currents and waves), wind power (aerodynamic, generator, plants, grid integration, finance), photovoltaic (device, inverter, plant levels, finance), hydropower (generator, plant level, pumped storage hydro, advances in hydro), power systems grid integration, system impact studies, control and operation of inverter-based resources, ancillary services provisions, and other important aspects of renewables for bulk power (transmission levels) and for distribution power systems.

ELEC 6650/6656 POWER SYSTEM PROTECTION (3) LEC. 3. Fault analysis using symmetrical components. Power switchgear, including switches, disconnects, fuses, relays and circuit breakers. Fundamentals of electric power system protection, including bus, transformer and line protection.

ELEC 6670/6676 ELECTRIC POWER ENGINEERING TOPICS (1-3) LEC. Various topics representing state-of-the-art power technology. Course may be repeated for a maximum of 12 credit hours.

ELEC 6700/6706 SEMICONDUCTOR FUNDAMENTALS (3) LEC. 3. Introduction to semiconductors: crystal structure, energy band theory, equilibrium electron and hole statistics, doping, generation and recombination processes, carrier drift and diffusion, transport equations.

ELEC 6710/6716 SEMICONDUCTOR DEVICES (3) LEC. 3. Pr. ELEC 5700 or ELEC 6700 or ELEC 6706. Introduction to semiconductor devices: pn junctions, junction diode based devices, optoelectronic devices, bipolar transistors, field effect transistors.

ELEC 6730/6736 MICROELECTRONIC FABRICATION (3) LEC. 2. LAB. 3. Departmental approval. Introduction to monolithic integrated circuit technology. Bipolar and MOS processes and structures. Elements of layout, design, fabrication, and applications. Experiments in microelectronic technologies.

ELEC 6740/6746 ELECTRONICS MANUFACTURING (3) LEC. 2. LAB. 3. Departmental approval. Materials and processes used to manufacture electronic products. Particular attention is given to substrate technology and electronics assembly.

ELEC 6750/6756 INTRODUCTION TO PLASMA ENGINEERING (3) LEC. 3. Departmental approval. Electrical breakdown and discharges in gases, basic plasma theories, applications of plasmas, plasma processing for microelectronic fabrication.

ELEC 6760/6766 SOLID STATE SENSORS (3) LEC. 3. Theory, technology and design of micro-machined sensors and related sensor technologies; and the application of micro-machined sensors.

ELEC 6770/6776 VLSI DESIGN (3) LEC. 3. Review of MOS transistor fundamentals, CMOS logic circuits; VLSI fabrication and design rules; clocking strategies and sequential design; performance estimation; memories and programmable arrays; standard cell design methodologies; computer aided design (CAD) tools.

ELEC 6780/6786 ANALOG CIRCUIT DESIGN (3) LEC. 3. Circuit design techniques used for implementing analog integrated circuits in both CMOS and bipolar technologies.

ELEC 6810/6816 COMPUTED IMAGING SYSTEMS (3) LEC. 3. Introduction to computed imaging systems such as magnetic resonance imaging (MRI) and computed tomography (CT).

ELEC 6820/6826 MEMS TECHNOLOGY (3) LEC. 3. Departmental approval. Introduction to Micro-Electro-Mechanical Systems (MEMS), the study of the materials and microfabrication processes used to fabricate MEMS devices, the principles of operation of MEMS devices, and an introduction to the different application areas of MEMS devices.

ELEC 6970/6976 SPECIAL TOPICS (1-5) LEC. Departmental approval. Study of a specialized area of electrical and computer engineering not covered by regularly offered courses. Course may be repeated with change in topics. Course may be repeated for a maximum of 24 credit hours.

ELEC 7190/7196 ADVANCED RFIC DESIGN FOR WIRELESS COMMUNICATIONS (3) LEC. Pr. ELEC 5190 or ELEC 6190 or ELEC 6196. Wireless standards and multi-standard transceiver architectures, SiGe and CMOS RFIC designs for wireless transceiver building blocks, software defined radios, phase array radars, ultra-high speed data converters, and MIMO wireless transceivers.
ELEC 7250/7256 VLSI TESTING (3) LEC. 3. Pr. ELEC 5770 or ELEC 6770 or ELEC 6776. Exponential nature of the test problem, fault models, test generation algorithms, test generation for sequential circuits, fault simulation, testability measures, fault coverage, yield and defect levels, design-for-testability approaches.


ELEC 7320/7326 ADVANCED ELECTRODYNAMICS II (3) LEC. 3. Pr. ELEC 7310 or ELEC 7316. Cylindrical wave functions. Spherical wave functions. Scattering by cylinders and spheres. Perturbational and variational techniques.

ELEC 7340/7346 COMPUTATIONAL ELECTROMAGNETICS I (3) LEC. 3. Pr. ELEC 7310 or ELEC 7316. Solution of electromagnetic scattering, radiation, and coupling problems using method of moments, finite-difference, finite-element, transmission-line matrix and other advanced computational methods.

ELEC 7350/7356 COMPUTATIONAL ELECTROMAGNETICS II (3) LEC. 3. Pr. ELEC 7310 or ELEC 7316. Solutions of electromagnetic scattering, radiation, and coupling problems using a variety of common asymptotic techniques.

ELEC 7410/7416 STOCHASTIC SIGNAL AND SYSTEM ANALYSIS (3) LEC. 3. Departmental approval. Applications of probability, random variables and stochastic processes in electrical engineering.

ELEC 7440 WIRELESS COMMUNICATION THEORY (3) LEC. 3. Pr. ELEC 3400 or ELEC 7410 or ELEC 7416. The basic of design, analysis and performance limits of wireless communication systems.

ELEC 7450/7456 DIGITAL IMAGE PROCESSING (3) LEC. 3. Departmental approval. Digital image processing principles and applications such as enhancement, restoration and compression.

ELEC 7470 ADVANCED VLSI TEST (3) LEC. 3. Pr. ELEC 5470 and ELEC 6470. Memory/PLA/FPGA testing, delay fault testing, test compression, in-field testing, cell-aware test, adaptive test, system-level test.

ELEC 7500/7506 STATE-VARIABLE ANALYSIS OF SYSTEMS (3) LEC. 3. Departmental approval. Matrices and linear spaces; state variable for linear continuous and discrete systems; applications in analysis and design of control systems.


ELEC 7560/7566 NONLINEAR SYSTEMS AND CONTROL (3) LEC. 3. Pr. ELEC 7500 or ELEC 7506. Departmental approval. Principles of nonlinear system modeling and analysis; nonlinear control systems design; nonlinear system state estimation.

ELEC 7610/7616 POWER SYSTEM DYNAMICS AND STABILITY (3) LEC. 3. Pr. (ELEC 5620 or ELEC 6620 or ELEC 6626) and (ELEC 5650 or ELEC 6650 or ELEC 6656). Departmental approval. Dynamic models of power systems and analysis of power system stability.

ELEC 7620/7626 POWER SYSTEM OPERATION (3) LEC. 3. Pr. ELEC 5620 or ELEC 6620 or ELEC 6626. Departmental approval. Unit commitment, power system security, state estimation, power system control centers and real-time applications.

ELEC 7630/7636 ADVANCED ELECTRIC MACHINES (3) LEC. 3. Pr. ELEC 5630 or ELEC 6630 or ELEC 6636. Departmental approval. Advanced machine modeling, including Kron's generalized machine theory, Park's transformation, and generalized coordinate transformations. Derivation of traditional machine models. Machine non-linearities, including finite element analysis.

ELEC 7640/7646 POWER SYSTEM TRANSIENTS (3) LEC. 3. Pr. ELEC 5620 or ELEC 6620 or ELEC 6626. Departmental approval. Transients in electric power systems, including lightning and switching phenomena. Traveling waves on power transmission lines, BIL, BSL, line insulation. System modeling.

ELEC 7710/7716 THE FIELD-EFFECT TRANSISTOR (3) LEC. 3. Pr. ELEC 5710 or ELEC 6710 or ELEC 6716. Advanced treatment of the modern field-effect transistor: the state-of-the art, the MOS capacitor, the 4-terminal MOSFET, short and narrow-channel effects, reliability, scaling theory, modeling, silicon-on-insulator technology, heterostructure devices.

ELEC 7720/7726 THE BIPOLAR TRANSISTOR (3) LEC. 3. Pr. ELEC 5710 or ELEC 6710 or ELEC 6716. Advanced treatment of the modern bipolar junction transistor; the state-of-the-art, terminal currents, solutions for arbitrary doping profiles, the polysilicon emitter contact, high-injector effects, dynamic operation, device models, heterojunction bipolar transistors.
ELEC 7730/7736 ADVANCED PLASMA PROCESSING FOR MICROELECTRONIC FABRICATION (3) LEC. 3. Pr. ELEC 5750 or ELEC 6750 or ELEC 6756. Departmental approval. Plasma reactor design and process optimization, plasma-assisted etching and deposition processes, plasma-assisted oxidation and surface modification processes, plasma polymerization, plasma-induced damages to semiconductor devices.

ELEC 7740/7746 ELECTRONIC PACKAGING (3) LEC. 3. Pr. ELEC 5740 or ELEC 6740 or ELEC 6746. Departmental approval. Design issues in the packaging of electronics. Emphasis is placed on physical design, electrical performance, thermal characteristics and mechanical stress-induced failures.

ELEC 7750/7756 LOW TEMPERATURE ELECTRONICS (3) LEC. 3. Pr. ELEC 5710 or ELEC 6710 or ELEC 6716. Advanced treatment of electronic devices operating at reduced temperatures: the case for cryogenic computers, semiconductor physics at low temperatures, carrier freeze-out, cooled CMOS technology, cooled bipolar technology, superconductors, packaging.

ELEC 7760/7766 SILICON-BASED HETEROSTRUCTURE DEVICES AND CIRCUITS (3) LEC. 3. Pr. ELEC 5700 or ELEC 6700 or ELEC 6706. Departmental approval. Bandgap engineering, strained SiGe and Si, SiGe BiCMOS technology, noise, linearity, circuits applications.

ELEC 7770/7776 ADVANCED VLSI DESIGN (3) LEC. 3. Pr. ELEC 5770 or ELEC 6770 or ELEC 6776. Departmental approval. Review of CMOS logic circuits; impact of fabrication issues on design; high speed switching circuits; high performance memory structures; advanced clocking strategies and clock distribution; performance optimization; deep submicron design issues; ASIC design flow: logic synthesis, placement and routing; design verification; low power design.

ELEC 7780/7786 RF MICROELECTRONICS (3) LEC. 3. Pr. ELEC 5780 or ELEC 6780 or ELEC 6786. Departmental approval. Techniques used in the design of monolithic integrated circuits for RF applications.

ELEC 7830/7836 PHOTOVOLTAICS (3) LEC. 3. Departmental Approval. Theory, technology, design and application of photovoltaic devices and systems.

ELEC 7900 INDEPENDENT STUDY (1-3) IND. Departmental approval. Supervised study in specialized areas of electrical and computer engineering.

ELEC 7950 ELECTRICAL ENGINEERING SEMINAR (1-10) SEM. SU. Course may be repeated for a maximum of 10 credit hours.

ELEC 7970/7976 SPECIAL TOPICS (1-5) LEC. Departmental approval. Study of a specialized area of electrical and computer engineering not covered by regularly offered courses. Course may be repeated with change of topic. Course may be repeated for a maximum of 24 credit hours.

ELEC 7990/7996 RESEARCH AND THESIS (1-6) MST. Course may be repeated for a maximum of 6 credit hours.

ELEC 8120/8126 PRINCIPLES OF NETWORK PERFORMANCE ANALYSIS (3) LEC. 3. Pr. (ELEC 5120 or ELEC 6120 or ELEC 6126) and (ELEC 7410 or ELEC 7416). Data network performance analysis, queueing systems, admission control, network traffic modeling, network calculus, flow and congestion control, wireless network analysis, and network simulation.

ELEC 8420 DETECTION AND ESTIMATION THEORY (3) LEC. 3. Pr. ELEC 7410 or ELEC 7416. Decision theory concepts. Detection of deterministic and random signals in noise; parameter estimation. Bayesian and maximum likelihood approaches, non-random and random parameter estimation; signal estimation.


ELEC 8710 ADVANCED TOPICS IN SEMICONDUCTOR DEVICES (3) LEC. 3. Pr. ELEC 5710 or ELEC 6710 or ELEC 6716. Advanced treatment of selected topics in semiconductor devices. Course may be repeated for a maximum of 6 credit hours.

ELEC 8780 CONTEMPORARY TOPICS IN ELECTRICAL CIRCUIT DESIGN (3) LEC. 3. Pr. ELEC 5780 or ELEC 6780 or ELEC 6786. Departmental approval. Contemporary topics in electronic circuit design such as Delta-Sigma A/D and D/A conversion, switched capacitor circuitry, continuous time and discrete time filter design, communications electronics. Course may be repeated for a maximum of 6 credit hours.

ELEC 8900 ADVANCED INDEPENDENT STUDY (1-3) IND. Departmental approval. Supervised study in specialized areas of electrical and computer engineering.
ELEC 8970 ADVANCED SPECIAL TOPICS (1-5) LEC. Departmental approval. Study of a specialized area of electrical and computer engineering not covered by regularly offered courses. Course may be repeated with change in topics. Course may be repeated for a maximum of 9 credit hours.

ELEC 8990/8996 RESEARCH AND DISSERTATION (1-10) DSR. Course may be repeated for a maximum of 20 credit hours.

Engineering Courses

ENGR 1100 ENGINEERING ORIENTATION (0) LEC. 1. SU. Introduction to the College of Engineering and its resources, exploration of engineering careers, orientation to campus resources and facilities, and assistance with academics and transition to college. Course may be repeated with change in topics.

ENGR 1110/1113 INTRODUCTION TO ENGINEERING (2) LEC. 1. LAB. 3. Introduction to engineering design, engineering teams, graphical presentation, technical writing, oral presentation. May count either ENGR 1110 or ENGR 1113.

ENGR 1200 GRAPHICAL COMMUNICATION AND DESIGN (3) LEC. 2. LAB. 3. Pr. P/C COMP 1200. Graphical concepts and projective geometry relating to special visualization and communication in design, including technical sketching, instrument drawing and computer-aided drafting and design.

ENGR 1410 ENGINEERING SUCCESS STRATEGIES (1) LEC. 1. Topics and engagement with engineering academic support strategies, academic integrity and ethics, professional development skills, engineering learning strategies, inclusive engineering teaming, inclusion and diversity, effective technical communication techniques, career exploration strategies, and exploration of engineering challenges. Explores a variety of academic, personal development, and career exploration activities intended to build a sense of community with underrepresented engineering and computer science students.

ENGR 2010 THERMODYNAMICS (3) LEC. 2. LAB. 3. Pr. (CHEM 1030 or CHEM 1110 or CHEM 1117) and (MATH 1620 or MATH 1623 or MATH 1627 or MATH 1720) and (P/C PHYS 1600 or P/C PHYS 1607). Principles and applications of thermodynamics to engineering problems. Laboratory includes multi-disciplinary team projects on thermodynamics applications and fundamentals of engineering thermodynamics.

ENGR 2050/2053 STATICS (3) LEC. 3. Pr. (PHYS 1600 or PHYS 1607) and (P/C MATH 2630 or P/C MATH 2633 or P/C MATH 2637). Principles of vectors, forces, moments, free body diagrams, force systems, 2-D and 3-D equilibrium, friction, geometric properties of plane areas.

ENGR 2070 MECHANICS OF MATERIALS (3) LEC. 3. Pr. (ENGR 2050 or ENGR 2053) and P/C MATH 2650. Principles of stress and strain; stress-strain relationships; uniaxially loaded members; torsion; bending; beam shear; shear, moment and thrust diagrams; transformed sections; column buckling.

ENGR 2100 FUNDAMENTALS OF ENGINEERING MECHANICS (3) LEC. 3. Pr. P/C PHYS 1600 or P/C PHYS 1607. Basic principles of two-dimensional force systems, free body diagrams, concepts of stress and strain, centroids of composite areas, kinematics and kinetics of particles and rigid bodies.

ENGR 2200 INTRODUCTION TO THERMODYNAMICS, FLUIDS AND HEAT TRANSFER (3) LEC. 3. Pr. CHEM 1030 and (PHYS 1610 or PHYS 1617). Principles and applications of thermodynamics, fluids and heat transfer.

ENGR 2350 DYNAMICS (3) LEC. 3. Pr. ENGR 2050 or ENGR 2053. Fundamental principles of dynamics including kinematics and kinetics of particles, kinematics and kinetics of rigid bodies, mass moments of inertia, three-dimensional dynamics of rigid bodies, and simple harmonic motion.

ENGR 2700 NUCLEAR POWER OPERATIONS, SYSTEM AND CAREERS (1) LEC. 1. SU. Pr. P/C MATH 1610 or P/C MATH 1613 or P/C MATH 1617. Overview of nuclear power generation systems including civilian and government career options.

ENGR 3510 INTRODUCTION TO BUSINESS AND ENGINEERING (3) LEC. 3. Principles of business and engineering issues in new product and business development.

ENGR 3520 INTEGRATING BUSINESS AND ENGINEERING THEORY WITH PRACTICE (3) LEC. 2. LAB. 3. Case study problems from business and engineering practice.

ENGR 3560 LEADERSHIP FOR BUSINESS AND ENGINEERS (1) LEC. 1. Overview of leadership concepts and skills.
ENGR 3710 BASIC NUCLEAR I: NUCLEAR AND MECHANICAL SYSTEMS (4) LEC. 3. LAB. 1. Pr. P/C ENGR 2700 and (P/C PHYS 1500 or P/C PHYS 1600 or P/C PHYS 1607). Multidisciplinary course teaching fundamental nuclear and mechanical principles as they are utilized in the nuclear power generation industry.

ENGR 3720 BASIC NUCLEAR II: MATERIALS, ELECTRIC, ELECTRONICS (4) LEC. 3. LAB. 2.5. Pr. ENGR 2700 and PHYS 1500 or P/C PHYS 1600 or P/C PHYS 1607. Multidisciplinary course teaching fundamental electronic and electrical theory and materials theory as practiced in nuclear power generation industry.

ENGR 3970 SPECIAL TOPICS: ENGINEERING, TECHNOLOGY AND SOCIETY - SPAIN (1-4) AAB/LLB. Special topics of interest within a global engineering context. Course may be repeated for a maximum of 9 credit hours.

ENGR 4710 ADVANCED REACTOR OPERATIONS I: HEALTH AND SAFETY (3) LEC. 3. Pr. P/C ENGR 2700. Advanced safety topics within regulatory and training structure of nuclear power industry.

ENGR 4720 ADVANCED REACTOR OPERATIONS II: SAFE OPERATIONS (4) LEC. 3. LAB. 1. Pr. ENGR 3710 or ENGR 3720. Nuclear power plant operations are discussed in detail, with a strong emphasis on safety compliance and industry's safety culture. Topics include the NRC's regulatory processes, operator licensing, reactor design certifications, reactor licensing, reactor oversight, enforcement, reactor modes of operation, plant refueling, spent fuel storage, and plant decommissioning. There is a heavy emphasis on integrated plant systems and operations. Industry leaders discuss current topics.

ENGR 4721 ADVANCED REACTOR PLANT OPERATIONS II: LAB (1) LAB. 2.5. Pr. P/C ENGR 4710. Nuclear power plant operations are discussed with a strong emphasis on safety compliance and industry's safety culture. Focus is hands-on practical factors.

ENGR 4957 ENGINEERING HONORS SEMINAR (3) SEM. 3. Pr. Honors College. Departmental approval. Topics of interest to honors students and engineering faculty. Interaction with successful engineering alumni.

ENGR 5540 ENTREPRENEURSHIP AND STRATEGIC MANAGEMENT OF TECHNOLOGY AND INNOVATION (4) LEC. 4. Pr. (BUSI 3510 or ENGR 3510) and (BUSI 3520 or ENGR 3520). Acceptance into the BET minor program. Develop student skills for starting a new business and making strategic decisions concerning technology.

ENGR 5550 PRODUCT/PROCESS DESIGN AND DEVELOPMENT I (2) LEC. 2. Must be in BET minor program. Processes to develop and present design proposal for cooperating industry. Credit will not be given for both BUSI 5970 and ENGR 5970.

ENGR 5560 PRODUCT/PROCESS DESIGN AND DEVELOPMENT II (3) LEC. 3. LAB. 6. Pr. (BUSI 5540 or ENGR 5540) and (BUSI 5550 or ENGR 5550). Must be accepted into BET minor. Cross-functional team design projects for sponsoring industry.

ENGR 6000/6006 ADVANCED ENGINEERING ANALYSIS (3) LEC. 3. Pr. MATH 2660. Analytical solutions of linear and nonlinear problems involving transcendental equations, ODEs/PDEs, Taylor/Fourier/asymptotic series, functional expansions, power series, and approximation methods. May count either ENGR 6000 or ENGR 6006.

ENGR 6540/6546 ENTREPRENEURSHIP AND STRATEGIC MANAGEMENT OF TECHNOLOGY AND INNOVATION (4) LEC. 4. Develop student skills for starting a new business and making strategic decisions concerning technology.

ENGR 6550/6556 PRODUCT/PROCESS DESIGN AND DEVELOPMENT I (2) LEC. 2. Develop student skills for starting a new business and making strategic decisions concerning technology.

ENGR 6560/6566 PRODUCT/PROCESS DESIGN AND DEVELOPMENT II (3) LEC. 3. Pr. (BUSI 5540 or ENGR 6540) and (BUSI 5550 or ENGR 6550). Cross-functional team design projects for sponsoring industry.

ENGR 7940/7946 MASTER OF ENGINEERING PROGRAM ASSESSMENT (0) LEC. 0. SU. The course will require that students describe how well the program helped them to attain the outcomes that they articulated in their application to the program. In addition to a reflective description, students will provide examples of work that demonstrate the skills or knowledge that they gained as part of the degree program. These work examples will then be evaluated using a standardized rubric for program assessment purposes, only.

ENGR TECH ENGINEERING TECH ELECTIVE (3) LEC. 3. Transfer Only Equivalency for Engineering Courses. Course may be repeated with change in topics.

Industrial Sys Eng Courses

INSY 3010 PROGRAMMING AND DATABASE APPLICATIONS FOR ISE (3) LEC. 3. Pr. COMP 1200. Programming and database applications for ISE students. Focus is on algorithm development as related to optimization, probability, statistics, and data analysis.
INSY 3020 OCCUPATIONAL SAFETY ERGONOMICS (3) LEC. 3. Basic principles of occupational safety engineering and ergonomics in the evaluation and design of occupation work areas and processes that include human operators.

INSY 3021 METHODS ENGINEERING AND WORK MEASUREMENT (3) LEC. 2. LAB. 3. Develops the student's ability to design workplaces and methods while providing an understanding of the work measurements process. Enables students to generate much of the basic methods data utilized in most industrial engineering projects.

INSY 3030 CAD FOR ENGINEERS WITH INDUSTRIAL APPLICATIONS (1) LAB. 3. Pr. COMP 1200 or COMP 1210 or COMP 1217 or COMP 3000 or ENGR 1110 or ENGR 1113. Use of computer technology to aid engineering design in industrial applications, e.g. represent and modify mechanical parts, diagrams, schematics, tools, equipment, office and plant layouts, etc.

INSY 3400 STOCHASTIC OPERATIONS RESEARCH (3) LEC. 3. Pr. (ENGR 1110 or ENGR 1113) and MATH 2660 and STAT 3600. with a grade of C or better in STAT 3600. Modeling and analysis of decision-making and operations subject to randomness including decision analysis, stochastic dynamic programming, Markov chains, and queuing theory.

INSY 3410 DETERMINISTIC OPERATIONS RESEARCH (3) LEC. 3. Pr. (ENGR 1110 or ENGR 1113) and MATH 2660 and P/C INSY 3010. Formulation, solution, interpretation, and implementation of mathematical models in operations research including linear programming, integer programming and network flows.

INSY 3420 SIMULATION (3) LEC. 2. LAB. 3. Pr. INSY 3400 and (COMP 3010 or COMP 3013 or INSY 3010) and STAT 3610. with a grade of C or better in INSY 3400. Simulation procedures for solving complex systems analysis problems. Emphasis on random processes, model building and construction of computer simulation models.

INSY 3600 ENGINEERING ECONOMY (3) LEC. 3. Pr. ENGR 1110 or ENGR 1113. Principles required in engineering economic studies.

INSY 3700 OPERATIONS PLANNING AND CONTROL (3) LEC. 3. Pr. INSY 3400 and INSY 3410 and STAT 3610. with a grade of C or better in both INSY 3400 and INSY 3410. Analytical methods for operations planning and control, including forecasting systems, production planning, inventory control systems, scheduling systems, and project management.

INSY 3800 MANUFACTURING SYSTEMS I (3) LEC. 2. LAB. 3. Introduction to the design, analysis, and operation of manufacturing systems, the first course in a required two-course sequence including Manufacturing Systems II.

INSY 4330 STATISTICAL QUALITY DESIGN AND CONTROL (3) LEC. 3. Pr. STAT 3610. Statistical process control and methods for quality improvement. Acceptance sampling for attributes and for variables.

INSY 4500/4503 PROFESSIONAL PRACTICE (1) LEC. Pr. P/C INSY 3700. Discussion and activities in current problems, the global context of, professional practice, professional opportunities and lifelong learning in Industrial and Systems Engineering. Senior standing in INSY.

INSY 4610 INTERNATIONAL ENGINEERING PROJECT (3) LEC. 3. This course provides students with a real-life work experience in solving engineering-business problems through teamwork in an international setting. At the course end, students present their project to faculty and industry sponsors. The course is Auburn University Faculty led in which students work in groups mentored by faculty from Auburn and foreign universities and company sponsors. Students will be involved in projects that expose them to theory and practice of problem solving techniques involving data collection, statistical analysis, computational modeling, and experimental design of problems related to the service and manufacturing industries.

INSY 4700 MANUFACTURING SYSTEMS II (3) LEC. 3. Pr. INSY 3420 and INSY 3600 and INSY 3700 and INSY 3800. Continuation of the design, analysis, and operation of manufacturing systems, the second course in a required two-course sequence including Manufacturing Systems I.

INSY 4800 SENIOR DESIGN (3) LEC. 3. Pr. INSY 3021 and INSY 4500 or INSY 4503 and P/C INSY 4700. Coreq. INSY 4700. Capstone course in which undergraduate course-work principles are brought to bear upon a design problem in a cooperating industry or institution.

INSY 4960 SPECIAL PROBLEMS (1-5) IND. Departmental approval. Individual student endeavor under faculty supervision involving special problems in Industrial and Systems Engineering. Interested student must submit written proposal to department head. Course may be repeated for a maximum of 5 credit hours.
INSY 4970 INDUSTRIAL AND SYSTEMS ENGINEERING SPECIAL TOPICS (1-10) AAB. Departmental approval. Special topics in Industrial and Systems Engineering. Specific prerequisites will be determined and announced for each offering. Course may be repeated for a maximum of 10 credit hours.

INSY 4997 HONORS THESIS (1-6) IND. Pr. Honors College. Departmental approval. Individual student endeavor consisting of direct research and writing of honors thesis. Course may be repeated for a maximum of 6 credit hours.

INSY 5010 SAFETY ENGINEERING I (3) LEC. 3. Pr. INSY 3020. Departmental approval. Occupational safety engineering and management with emphasis on control of hazardous materials, fire prevention, safety considerations in production facility design, and maintenance, and operation of effective safety programs. Credit will not be given for both INSY 5010 and INSY 6010/6016.

INSY 5240 PRODUCTION AND INVENTORY CONTROL SYSTEMS (3) LEC. 3. Pr. INSY 3700. Analysis and design of production and inventory control systems with emphasis on quantitative methods, algorithms, and information technology. Credit will not be given for both INSY 5240 and INSY 6240/6246.

INSY 5250 PROJECT MANAGEMENT (3) LEC. 3. Pr. INSY 3700. Introduction to project management for engineering, business and technology including; project management concepts, project life cycle, planning techniques, scheduling and network analysis, cost estimating and budgeting, risk management, execution and control, and evaluation and closeout.

INSY 5330 SIX SIGMA (3) LEC. 3. Pr. INSY 4330. This course covers the six sigma engineering techniques. The content emphasizes the DMAIC (Define, Measure, Analyze, Improve, and Control) methodology combined with Lean management practices through analytical and quantitative tools.

INSY 5500 MODERN TOOLS FOR DATA ANALYTICS AND MODELING (3) LEC. 3. Pr. INSY 3010. Introduction to modern data science tools with applications in manufacturing and service industries and operations. Focus on the manipulation and use of small and large datasets. Tools include Jupyter, Python, R, and MySQL along with the related packages that support data modeling, visualization, and analysis.

INSY 5550 DECISION SUPPORT SYSTEMS FOR OPERATIONS (3) LEC. 3. Pr. COMP 3010 or COMP 3013. Fundamentals for modeling, designing, and implementing decision support systems for the operation of manufacturing and service industries. Credit will not be given for both INSY 5550 and INSY 6550/6556.

INSY 5600 ENGINEERING ECONOMIC SYSTEMS (3) LEC. 3. Pr. INSY 3600. Continuation of INSY 3600. Emphasis on design economics and cost estimating techniques and applications to various manufacturing and service operations. Credit will not be given for both INSY 5600 and INSY 6600/6606.

INSY 5630 REAL OPTIONS AND DECISION ANALYSIS (3) LEC. 3. Pr. INSY 3600 and STAT 3600. Analysis of engineering and business decisions under risk and contemporary risk management methods including statistical decision theory and real options. Credit will not be given for both INSY 5630 and INSY 6630/6636.

INSY 5753 INFORMATION TECHNOLOGY AUDITING (3) DSL. 3. Pr. ISMN 5730. In-depth instruction on the range of skills required of persons engaged in the performance of IT audit. The skills include those required by but not limited to a technology analyst, data scientist, or CIO.

INSY 5800/5803 LEAN SYSTEMS (3) LEC. 3. Manufacturing system design based on a strategy of linked cells providing a continuous flow of materials. Evaluation strategies and analysis tools are studied. Credit will not be given for both INSY 5800 and INSY 6800/6806.

INSY 5830 VEHICLE TECHNOLOGY AND TRENDS (3) LEC. 3. Investigation of the advances in automotive technology and the impact of future technologies on the design and manufacture of the automobile. Credit will not be given for both INSY 5830 and INSY 6830/6836.

INSY 5840 CONTROL OF THE MANUFACTURING FLOOR AND PROCESSES (3) LEC. 2. LAB. 3. Students work within multidisciplinary teams to apply the principles of Computer Aided Manufacturing and the Toyota Production System (TPS) on the modern automated floor. Laboratory features CNC Controls, Robots, Programmable Logic Controllers (PLC) and Kanban system. DELMIA Catia, and MasterCAM. Credit will not be given for both INSY 5840 and INSY 6840/6846.

INSY 5850 ELECTRONICS MANUFACTURING SYSTEMS (3) LEC. 3. Introduction to electronics packaging and electronics manufacturing technologies including current and future trends, design and quality, and manufacturing for high volume. Credit will not be given for both INSY 5850 and INSY 6850/6856.
INSY 5860 AUTOMOTIVE MANUFACTURING SYSTEMS (3) LEC. 3. History of automotive manufacturing and the automotive manufacturing systems for a typical automotive assembly plant. Credit will not be given for both INSY 5860 and INSY 6860/6866.

INSY 6010/6016 SAFETY ENGINEERING I (3) LEC. 3. Occupational safety engineering and management with emphasis on control of hazardous materials, fire prevention, safety considerations in production facility design and maintenance, and operation of effective safety programs. Departmental approval. Credit will not be given for both INSY 5010 and INSY 6010.

INSY 6240/6246 PRODUCTION AND INVENTORY CONTROL SYSTEMS (3) LEC. 3. Analysis and design of production and inventory control systems with emphasis on quantitative methods, algorithms, and information technology. Credit will not be given for both INSY 5240 and INSY 6240.

INSY 6250/6256 PROJECT MANAGEMENT (3) LEC. 3. Introduction to project management for engineering, business and technology including; project management concepts, project life cycle, planning techniques, scheduling and network analysis, cost estimating and budgeting, risk management, execution and control, and evaluation and closeout.

INSY 6330/6336 SIX SIGMA (3) LEC. 3. This course covers the six sigma engineering techniques. The content emphasizes the DMAIC (Define, Measure, Analyze, Improve, and Control) methodology combined with Lean management practices through analytical and quantitative tools.

INSY 6500/6506 MODERN TOOLS FOR DATA ANALYTICS AND MODELING (3) LEC. 3. Introduction to modern data science tools with applications in manufacturing and service industries and operations. Focus on the manipulation and use of small and large datasets. Tools include Jupyter, Python, R, and MySQL along with the related packages that support data modeling, visualization, and analysis.

INSY 6550/6556 DECISION SUPPORT SYSTEMS FOR OPERATIONS (3) LEC. 3. Fundamentals for modeling, designing, and implementing decision support systems for the operation of manufacturing and service industries. Credit will not be given for both INSY 5550 and INSY 6550.

INSY 6600/6606 ENGINEERING ECONOMIC SYSTEMS (3) LEC. 3. Continuation of INSY 3600. Emphasis on design economics and cost estimating techniques and applications to various manufacturing and service operations. Credit will not be given for both INSY 5600 and INSY 6600.

INSY 6630/6636 REAL OPTIONS/DECISION ANALYSIS (3) LEC. 3. Analysis of engineering and business decisions under risk and contemporary risk management methods including statistical decision theory and real options. Credit will not be given for both INSY 5630 and INSY 6630/6636.

INSY 6800/6806 LEAN SYSTEMS (3) LEC. 3. Manufacturing system design based on a strategy of linked cells providing a continuous flow of materials. Evaluation strategies and analysis tools are studied. Credit will not be given for both INSY 5800 and INSY 6800.

INSY 6830/6836 VEHICLE TECHNOLOGY AND TRENDS (3) LEC. 3. Investigation of the advances in automotive technology and the impact of future technologies on the design and manufacture of the automobile. Credit will not be given for both INSY 5830 and INSY 6830.

INSY 6840/6846 CONTROL OF THE MANUFACTURING FLOOR AND PROCESSES (3) LEC. 2. LAB. 3. Students work within multi-disciplinary teams to apply the principles of Computer Aided Manufacturing and the Toyota Production System (TPS) on the modern automated floor. Laboratory features CNC Controls, Robots, Programmable Logic Controllers (PLC) and Kanban system. DELMIA Catia and MasterCAM. Credit will not be given for both INSY 5840 and INSY 6840.

INSY 6850/6856 ELECTRONICS MANUFACTURING SYSTEMS (3) LEC. 3. Introduction to electronics packaging and electronics manufacturing technologies including current and future trends, design and quality, and manufacturing for high volume. Credit will not be given for both INSY 5850 and INSY 6850.

INSY 6860/6866 AUTOMOTIVE MANUFACTURING SYSTEMS (3) LEC. 3. History of automotive manufacturing and the automotive manufacturing systems for a typical automotive assemble plant. Credit will not be given for both INSY 5860 and INSY 6860.

INSY 7020/7026 SAFETY ENGINEERING II (3) LEC. 3. Pr. (INSY 6010 or INSY 6016). Systems safety analysis techniques including human error and reliability, fault trees, and cost benefit analysis.

INSY 7050/7056 INDUSTRIAL HYGIENE AND ENVIRONMENTAL HAZARDS (3) LEC. 3. Introduction to the basic concepts of industrial hygiene with emphasis on the industrial hygiene/safety interface and on the evaluation and control of noise and vibration stress.

INSY 7060/7066 ERGONOMICS I (3) LEC. 3. Overview of the human body systems and evaluation of the physiological response of the human body to occupational activities with emphasis on task design.

INSY 7070/7076 ERGONOMICS II (3) LEC. 3. Pr. INSY 7060 or INSY 7066. Use of biomechanics in the evaluation and design of work activities. Emphasis is placed on biomechanical modeling, manual materials handling, tool design, and repetitive motion trauma.

INSY 7080/7086 HUMAN FACTORS ENGINEERING (3) LEC. 3. Examination of human factors, ergonomics and safety research methodologies. Emphasis is on human information input, output and control processes with the objective of optimizing integration of the human into simple and complex systems.

INSY 7081 HUMAN FACTORS LABORATORY (1) LAB. 3. Coreq. INSY 7080. Laboratory experience in testing human factors principles and concepts covered in INSY 7080. Experience in proper writing of laboratory reports.

INSY 7100/7106 ADAPTIVE OPTIMIZATION (3) LEC. 3. Departmental approval. Adaptive search methods inspired by nature for continuous and combinatorial optimization. Methods include simulated annealing, genetic algorithms, evolutionary strategies, tabu search and ant colony systems.

INSY 7120/7126 DATA ANALYTICS FOR OPERATIONS (3) LEC. 3. Pr. INSY 6500 or equivalent. This course covers the broad topics of predictive analytics, data visualization, and big data in the context of operations analysis. Focus will be on the application of modern computer tools with previously learned statistical and mathematical modeling tools, culminating in a semester project.

INSY 7130/7136 DATA MINING TECHNIQUES AND APPLICATIONS FOR OPERATIONS (3) LEC. 3. or equivalent. This introductory course will cover the most common techniques for extracting useful information and models from numerical or categorical data. Techniques include clustering and classification, regression and spline models, kriging, and artificial neural networks. Also considered are data pre-processing, model building and model validation. Modeling and validation under conditions of sparse data will be addressed as well. Applications include those in finance, manufacturing, health care, and more.

INSY 7190 OCCUPATIONAL SAFETY AND HEALTH FORUM I (1) LEC. 1.

INSY 7200/7206 ENGINEERING APPLICATIONS OF FUZZY SYSTEMS AND NEURAL NETWORKS (3) LEC. 3. Departmental approval. Introduction to fuzzy systems and neural networks with emphasis on their uses in engineering applications in clustering, modeling, optimization, control, forecasting, and classification.

INSY 7230/7236 ADVANCED LAYOUT AND LOCATION (3) LEC. 3. Facility layout algorithms and the facility design process. Facility location models and their relationship to strategic organization goals.

INSY 7240/7246 PRODUCTION AND INVENTORY CONTROL THEORY (3) LEC. 3. Theoretical foundations for the analysis and design of production and inventory control systems with emphasis on quantitative methods and current areas of research.


INSY 7300/7306 ADVANCED ENGINEERING STATISTICS I (3) LEC. 3. Advanced concepts of experimental design including blocked designs, analysis of variance regression approach, and fractional factorials in base-2 designs. Emphasis throughout is on developing and improving industrial products and processes. Credit will not be given for both INSY 7300 and STAT 7300.

INSY 7310/7316 ADVANCED ENGINEERING STATISTICS II (3) LEC. 3. Pr. (STAT 7300 or STAT 7306) or (INSY 7300 or INSY 7306). Fractional factorial experimentation applied for the purpose of process and quality improvement and optimization, introduction to analysis of covariance, multiple regression analysis, and response surface analysis. Credit will not be given for both INSY 7310 and STAT 7310.

INSY 7330/7336 OFF-LINE AND ON-LINE QUALITY CONTROL (3) LEC. 3. Pr. STAT 7010 or (STAT 7300 or STAT 7306) or (INSY 7300 or INSY 7306). Departmental approval. Taguchi's quality loss functions. Taguchi's orthogonal arrays and their relationships to fractional factorial designs. Taguchi's parameter and tolerance designs, on-line process control concepts and methods. Process capability. CUSUM charts and other process control charts.
INSY 7380/7386 RELIABILITY ENGINEERING (3) LEC. 3. Reliability, maintenance, replacement with emphasis on failure-rate estimation and life testing. Hazard functions, parameter estimation and reliability testing including exponential and Weibull distributions. Markov models and repairable systems. Credit is not given for both INSY 7380 and STAT 7780. Departmental permission.

INSY 7390 OCCUPATIONAL SAFETY AND HEALTH FORUM II (1) LEC. 1. Pr. INSY 7190. Continuation of OSH Forum I (contemporary interdisciplinary issues in occupational safety and health). Emphasis is placed on leadership and mentoring of other OSH students (INSY 7190).

INSY 7400/7406 SIMULATION MODELING AND ANALYSIS (3) LEC. 3. Introduction to discrete event modeling and simulation. Fundamental concepts of Monte Carlo and discrete event simulation and the application of those concepts using commercial simulation software.

INSY 7420/7426 LINEAR PROGRAMMING AND NETWORK FLOWS (3) LEC. 3. Linear programming and network flows emphasizing algorithms and theory.

INSY 7430/7436 INTEGER AND NONLINEAR PROGRAMMING (3) LEC. 3. Pr. INSY 7420 or INSY 7426. Departmental approval. Integer and non linear programming, emphasizing algorithms and theory.

INSY 7440/7446 DYNAMIC PROGRAMMING (3) LEC. 3. Departmental approval. Aspects of sequential decision making with emphasis on formulation and solution using the dynamic programming algorithm. Approximation methods for problems involving large state spaces. Solution techniques for problems under uncertainty.

INSY 7470/7476 SEARCH METHODS FOR OPTIMIZATION (3) LEC. 3. Single and multivariate search techniques and strategies that are used in finding the optimum of discrete and continuous functions.

INSY 7490 OCCUPATIONAL SAFETY AND HEALTH PRACTICUM II (1) LEC. 1. Pr. INSY 7290. Investigation of real-world interdisciplinary OSH problems. Analysis and presentation of OSH concerns and solutions. Emphasis is placed on leadership and mentoring of other OSH students (INSY 7290).

INSY 7500/7506 ADVANCED SIMULATION (3) LEC. 3. Pr. INSY 7400 or INSY 7406. Coverage of advanced simulation and simulation language design concepts. Includes advanced input/output analysis, modeling concepts, and language design/implementation concepts.

INSY 7550/7556 STOCHASTIC OPERATIONS RESEARCH (3) LEC. 3. Stochastic operations research models with emphasis on model formation, solution and interpretation of results. Emphasis on stochastic processes, queuing theory and their applications.


INSY 7710/7716 LIFE CYCLE ENGINEERING (3) LEC. 3. The life cycle engineering course focuses on various life cycle methodologies and tools like life cycle design, product life cycle, life cycle assessment (LCA) and inventory (LCI), service, reuse, re-manufacturing, sustainable design, risk assessment and management and other related topics. May count either INSY 7710 or INSY 7716.

INSY 7720/7726 SYSTEMS ENGINEERING I (3) LEC. 3. Processes and tools for engineering large-scale, complex complex systems: architecture, requirements, risk management, evaluation, concept exploration, decision-making, tradeoff studies, life cycle models, decomposition, system coupling, test, verification, validation, system modeling, business process re-engineering, sensitivity analysis, teamwork, process maturity and documentation. May count either INSY 7720 or INSY 7726.

INSY 7730/7736 PRODUCT DESIGN, DEVELOPMENT, AND TEST (3) LEC. 3. This class teaches modern tools and methods for product design, development, and test of highly complex and large systems including technical specification, reliability, maintainability, manufacturability, testability, marketing, costs, etc. May count either INSY 7730 or INSY 7736.

INSY 7740/7746 PRODUCT LAUNCH, MANUFACTURING, AND DELIVERY (3) LEC. 3. This course teaches students the issues, strategies, and approaches related to launching, manufacturing, and delivering new products or services including customer focus, marketing, manufacturing and launch strategies, delivery and related tools and techniques.
INSY 7750/7756 INTELLECTUAL PROPERTY, LEGAL, AND VENTURE CAPITAL (3) LEC. 3. This course teaches students the US law of intellectual property with major emphasis on patents. Students also learn venture capital including stages of funding, funding presentations, various requirements of funding, types of partnership, exit plans, etc. May count either INSY 7750 or INSY 7756.

INSY 7940/7946 INDUSTRIAL AND SYSTEMS ENGINEERING PROBLEMS (1-5) IND. Departmental approval. Individual student endeavor under staff supervision involving special problems of an advanced undergraduate or graduate nature in Industrial and Systems Engineering. Interested student must submit written proposal to department head. Course may be repeated for a maximum of 5 credit hours.

INSY 7950/7956 SEMINAR (1) LEC. 1. SU. Presentation and discussion of ISE research by graduate students, faculty and guests. Must be taken at least one term and cannot be used in the plan of study to apply towards the minimum number of hours for a degree.

INSY 7970/7976 INDUSTRIAL AND SYSTEMS ENGINEERING SPECIAL TOPICS (1-5) LEC. 1. LAB. 1. Departmental approval. Special topics of a graduate nature pertinent to Industrial and Systems Engineering. Specific prerequisites will be determined and announced for each offering. Course may be repeated for a maximum of 5 credit hours.

INSY 7980/7986 MASTER'S IN INDUSTRIAL AND SYSTEMS ENGINEERING PROJECT (1-5) IND. SU. Non-thesis master's project. Course may be repeated for a maximum of 5 credit hours.

INSY 7990/7996 RESEARCH AND DISSERTATION (1-10) DSR. Course may be repeated with change in topics.

INSY 8010/8016 ADVANCED SAFETY ENGINEERING (3) LEC. 3. Pr. INSY 7020 or INSY 7026. Topics of current interest in occupational safety research. Occupational safety research methodology and research priorities.

INSY 8020/8026 RESEARCH METHODS IN OCCUPATIONAL SAFETY, ERGONOMICS, AND INJURY PREVENTION (3) LEC. 3. Pr. INSY 7300 or INSY 7306 or INSY 7060 or INSY 7066 or INSY 6010 or INSY 6016. To introduce students to contemporary and developmental research methods in occupational safety, ergonomics, and injury prevention with emphasis on the public health model as applied to occupational injury prevention and epidemiology. Instructor approval may be required.

INSY 8060/8066 ADVANCED ERGONOMICS (3) LEC. 3. Pr. INSY 7060 or INSY 7066. Topics of current interest in occupational ergonomics and human factors research. Occupational ergonomics and human factors research methodology and research priorities.

INSY 8250 SCHEDULING THEORY (3) LEC. 3. Pr. (INSY 6250 or INSY 6256) and (INSY 7420 or INSY 7426). The theory for various scheduling methods and models is presented. Emphasis is on current research in the scheduling area.

INSY 8420/8426 TOPICS IN OPTIMIZATION (3) LEC. 3. Pr. INSY 7420 or INSY 7426. Basic concepts and theory of optimization, including saddlepoint conditions for differentiable and non-differentiable programs, duality, approximation, decomposition and partitioning, illustrated by application to specific algorithms.

INSY 8970 INDUSTRIAL AND SYSTEMS ENGINEERING SPECIAL TOPICS (1-5) LEC. Departmental approval. Special topics of an advanced graduate nature pertinent to industrial and systems engineering. Specific prerequisites will be determined and announced for each offering. Course may be repeated for a maximum of 5 credit hours.

INSY 8990/8996 RESEARCH AND DISSERTATION (1-10) DSR. Course may be repeated with change in topics.

Materials Engineering Courses

MATL 2100 INTRODUCTION TO MATERIALS SCIENCE (3) LEC. 3. The science of solid materials and the relationship between this science and material properties.

MATL 2210 MATERIALS FOR SUSTAINABLE ENERGY PRODUCTION AND STORAGE (1) LEC. 1. Pr. CHEM 1030. Technologies for sustainable energy production and storage, renewable energy conversion, associated materials challenges.

MATL 2220 MATERIALS AND THE ENVIRONMENT (1) LEC. 1. Pr. CHEM 1030. Environmental impact of the production, use and disposal of materials.

MATL 2230 MINERAL RESOURCES: PROCESSING AND AVAILABILITY (1) LEC. 1. Pr. CHEM 1030. Mineral resources for engineering materials; processing and availability of mineral resources.

MATL 3100 ENGINEERING MATERIALS - METALS (3) LEC. 3. Pr. MATL 2100. The relationship among processing, microstructure, properties and engineering applications of metallic materials.
MATL 3101 METALLOGRAPHY LABORATORY (1) LAB. 3. Coreq. MATL 3100. The use of microstructural characterization to understand the relationship between microstructure and properties of metallic materials.

MATL 3200 ENGINEERING MATERIALS POLYMERS (3) LEC. 3. Pr. CHEM 1040. The synthesis, processing, structure and properties of polymers and polymer matrix composites.

MATL 3201 POLYMER AND COMPOSITES LABORATORY (1) LAB. 3. Coreq. MATL 3200. A hands-on lab course on the synthesis, processing, structure and properties of polymers and polymer matrix composites.

MATL 3300 ENGINEERING MATERIALS - CERAMICS (3) LEC. 3. Pr. MATL 2100. The engineering of ceramic materials. Structural property relationships of crystalline and glassy ceramics will be included.

MATL 4100 THERMODYNAMICS AND KINETICS OF MATERIALS (3) LEC. 3. Pr. CHEM 1040 and ENGR 2200. Laws of thermodynamics to describe phase equilibria and phase transformations in one-component and multi-component systems, mechanisms of diffusion, the interplay of thermodynamic driving forces and kinetics of mass transfer in materials systems.


MATL 4930 DIRECTED STUDIES (1-6) IND. SU. Departmental approval. Areas of interest within Materials Engineering. Course may be repeated for a maximum of 6 credit hours.

MATL 4980 SENIOR DESIGN PROJECT (3) LEC. 1. LAB. 6. Students select, design, schedule, fabricate and perform an engineering design project related to Materials Engineering.

MATL 4997 HONORS THESIS (1-6) IND. Pr. Honors College. Departmental approval. Individual student directed research and writing of honors thesis. Course may be repeated for a maximum of 6 credit hours.

MATL 5100 THERMODYNAMICS OF MATERIALS SYSTEMS (3) LEC. 3. Pr. CHEM 1040 and ENGR 2200. Departmental approval. Application of thermodynamics to describe phase stability, crystal imperfections, solubility, oxidation, surface, and interface energy and transformations.

MATL 5200 MATERIALS CHARACTERIZATION (2) LEC. 2. Pr. PHYS 1610 or PHYS 1617. Principles of materials characterization including x-ray diffraction, optical and electron microscopy, and other advanced analytical methods for materials design.

MATL 5201 MATERIALS CHARACTERIZATION LABORATORY (1) LAB. 3. Coreq. MATL 5200. Laboratory on the use of x-ray diffraction, metallography, and optical/electron microscopy for materials characterization.

MATL 5300 PHASE TRANSFORMATIONS IN MATERIAL PROCESSING (3) LEC. 3. Pr. MATH 2650 and ENGR 2200. Departmental approval. Principles that govern phase transformations in materials systems and control of nucleation and growth, microstructure and morphology.

MATL 5400 PHYSICS OF SOLIDS (3) LEC. 3. Pr. PHYS 1610 or PHYS 1617. Departmental approval. The physics of solid-state materials, including the electronic, optical and magnetic properties of materials.

MATL 5500 NUMERICAL SIMULATION OF MATERIALS PROCESSING (3) LEC. 3. Pr. MATL 5100 and P/C MATL 5300. Departmental approval. Fundamental principles and applications of computer-aided simulation of transport phenomena in materials processing systems.


MATL 5720 BIOMEDICAL APPLICATIONS OF POLYMERIC MATERIALS (3) LEC. 3. LAB. 13. Pr. P/C BIOL 1030 or P/C CHEM 2070. Study of polymers used in the body for the purposes of aiding healing, correcting abnormalities, and restoring lost function.
MATL 5750 MICROSTRUCTURE AND MECHANICS OF SKELETAL TISSUES (3) LEC. 3. Pr. MATL 2100 and (ENGR 2070 or MECH 3130). Molecular and cellular microstructural influence over the viscoelastic deformation of the skeletal tissues of bone muscle, ligament, tendon and cartilage; mechanics of failure and biomechanical injury mechanisms; consideration of the physiological processes of adaptive remodeling and healing of tissues; recent developments in orthopedic implant materials.

MATL 5970 INTERMEDIATE SPECIAL TOPICS (1-3) LEC. 1-3. Departmental approval. Regular course addressing an advanced specialized area of Materials Engineering not covered by regularly offered courses. Course may be repeated with change in topics.

MATL 6100/6106 THERMODYNAMICS OF MATERIALS SYSTEMS (3) LEC. 3. Departmental approval. Application of thermodynamics to describe phase stability, crystal imperfections, solubility, oxidation, surface and interface energy and transformations.

MATL 6200/6206 MATERIALS CHARACTERIZATION (2) LEC. 2. Principles of materials characterization including x-ray diffraction, optical and electron microscopy, and other advanced analytical methods for materials design.

MATL 6201 MATERIALS CHARACTERIZATION LABORATORY (1) LAB. 3. Coreq. MATL 6200. Laboratory on the use of x-ray diffraction, metallography, and optical/electron microscopy for materials characterization.

MATL 6300/6306 PHASE TRANSFORMATIONS IN MATERIAL PROCESSING (3) LEC. 3. Departmental approval. Principles that govern phase transformations in materials systems and control of nucleation and growth, microstructure, and morphology.

MATL 6400/6406 PHYSICS OF SOLIDS (3) LEC. 3. Departmental approval. The physics of solid-state materials, including the electronic, optical, and magnetic properties of materials.

MATL 6500/6506 NUMERICAL SIMULATION OF MATERIALS PROCESSING (3) LEC. 3. Departmental approval. Fundamental principles and applications of computer-aided simulation of transport phenomena in materials processing systems.


MATL 6720/6726 BIOMEDICAL APPLICATIONS OF POLYMERIC MATERIALS (3) LEC. 3. LAB. 13. Study of polymers used in the body for the purposes of aiding healing, correcting abnormalities, and restoring lost function.

MATL 6750/6756 MICROSTRUCTURE AND MECHANICS OF SKELETAL TISSUES (3) LEC. 3. Departmental approval. Molecular and cellular microstructural influence over the viscoelastic deformation of the skeletal tissues of bone muscle, ligament, tendon and cartilage; mechanics of failure and biomechanical injury mechanisms; consideration of the physiological processes of adaptive remodeling and healing of tissues; recent developments in orthopedic implant materials.

MATL 6970/6976 INTERMEDIATE SPECIAL TOPICS IN MATERIALS ENGINEERING (1-3) LEC. 3. Departmental approval. Regular course addressing an advanced specialized area of Materials Engineering not covered by regularly offered courses. Course may be repeated with change in topics.

MATL 7050/7056 DEFORMATION AND FAILURE OF ENGINEERING MATERIALS (3) LEC. 3. Departmental approval. Coreq. MATL 6200. Theoretical presentation of the fundamental principles of deformation and failure in materials systems.

MATL 7110/7116 PHYSICAL METALLURGY AND APPLICATIONS IN METAL FABRICATION (3) LEC. 3. Departmental approval. The physical metallurgy underlying processing-structure- property relationships in metals and alloys, with examples from joining processes.

MATL 7120/7126 ADVANCED CERAMIC MATERIALS (3) LEC. 3. Departmental approval. Processing, structure-property relationships and applications of advanced ceramics. Structural and functional applications of ceramics.

MATL 7130/7136 ADVANCED POLYMER SCIENCE AND TECHNOLOGY (3) LEC. 3. Departmental approval. Recent developments in both functional and structural polymers including approaches to synthesis, processing techniques, high-strength materials, electronic polymers, optic polymers, and medical polymers.
MATL 7140/7146 ADVANCED COMPOSITE MATERIALS (3) LEC. 3. Departmental approval. Processing, mechanics structure and properties of composite materials. Emphasis will be placed on an understanding of processing-structure-property relationships in polymer-, ceramic-, and metal-matrix composites.


MATL 7210/7216 PLASTIC DEFORMATION AND STRENGTHENING OF METALLIC MATERIALS (3) LEC. 3. Departmental approval. Mechanisms of plastic deformation and strengthening in metals and alloys. The role of dislocations in plastic deformation.

MATL 7220/7226 RADIATION EFFECTS ON MATERIALS (3) LEC. 3. Departmental approval. Theoretical and experimental treatment of the radiation effects and damage in materials as related to the nuclear industry.

MATL 7230/7236 HIGH TEMPERATURE MATERIALS PERFORMANCE (3) LEC. 3. Departmental approval. Theoretical and experimental treatment of the behavior of metals at high temperature.

MATL 7310/7316 SOLIDIFICATION PROCESSING (3) LEC. 3. Departmental approval. Theoretical science and engineering principles that apply to semiconductor crystal growth, ingot solidification, metal casting, welding and rapid solidification processes.

MATL 7320/7326 THIN FILM SCIENCE AND TECHNOLOGY (3) LEC. 3. Departmental approval. Structure, properties, characterization, processing and application of thin films.

MATL 7330/7336 MATERIALS FOR ENERGY STORAGE (3) LEC. 3. Introduction of various electrochemical energy storage devices (Batteries, Supercapacitor, etc) and discussion of advancement in development of materials for these devices. Instructor’s consent required for prerequisites.

MATL 7410/7416 CHEMICAL SENSORS (3) LEC. 3. Departmental approval. Fundamentals and application of chemical sensors. Includes electrolyte, semiconductor and acoustic wave-based sensors.

MATL 7420/7426 SMART MATERIALS AND STRUCTURES (3) LEC. 3. Departmental approval. An introduction to the principles and applications of various sensor, actuator and functionality smart material systems and structures.

MATL 7430/7436 DIELECTRIC MATERIALS AND DEVICES (3) LEC. 3. Pr. (MATL 6100 or MATL 6106) and (MATL 6400 or MATL 6406). Departmental approval. Processing, structure, properties, and application of dielectrics, including physics of dielectrics, material/device design/fabrication processes, and application of dielectric materials in high-technological industry.

MATL 7440/7446 MATERIALS PROCESSES MICRO AND NANOSYSTEMS (3) LEC. 3. Departmental approval. Materials, processes, and principles involved in manufacturing of micro and nanoelectromechanical systems. Properties of materials used in micromachined transducers as a related to current and potential micro and nanofabrication processes.

MATL 7450/7456 HIGH TEMPERATURE ELECTROCHEMICAL DEVICES (3) LEC. 3. Departmental approval. Principles of solid-state electrochemistry, application to temperature devices including chemical sensors, fuel cells and batteries.

MATL 7510/7516 ELECTRON MICROSCOPY (3) LEC. 3. Departmental approval. Theory, instrumentation, techniques and applications of scanning and transmission electron microscopy.

MATL 7511 ELECTRON MICROSCOPY LABORATORY (1) LAB. 3. Coreq. MATL 7510. Laboratory on the use of electron microscopy for materials characterization.


MATL 7610/7616 ENGINEERING ASPECTS OF BIOLOGICAL AND CHEMICAL DETECTION (3) LEC. 3. Departmental approval. Biological and chemical scientific concepts related to biological and chemical threat agents. Existing and developing detection technologies, trends and needs for the future detection systems. Physical principles behind the detection technologies. Evaluation of detection device or system performance.

MATL 7620/7626 NANO/MICRO FLUIDIC SYSTEMS (3) LEC. 3. Departmental approval. Basic understanding of nano/microfluidics (typical volumes are nanoliters or picoliters) and practical applications in materials science and engineering, biotechnology, and other interdisciplinary fields of engineering and science.
MATL 7630/7636 NANOMATERIALS FOR BIOTECHNOLOGY (3) LEC. 3. Departmental approval. Basic understanding of nanobiotechnology and practical applications in the interdisciplinary fields of Materials Science and Engineering and biotechnology/medicine including nanostructured biomolecules and bioarrays as well as biomolecular nanoelectronics.

MATL 7950 MATERIALS ENGINEERING SEMINAR (0) SEM. SU. Required during each semester of residency, but cannot be used toward minimum requirements for graduate degree in Materials Engineering. Content changes each semester and consists of off-campus speakers and presentations by graduate students and faculty.

MATL 7960/7966 DIRECTED READINGS IN MATERIALS ENGINEERING (1-6) IND. SU. Departmental approval. May be taken more than one semester. Up to 6 hours may count toward the minimum degree requirements. Course may be repeated with change in topics.

MATL 7970/7976 SPECIAL TOPICS IN MATERIALS ENGINEERING (1-3) LEC. Departmental approval. Regular course addressing an advanced specialized area of Materials Engineering not covered by regularly offered courses. Course may be repeated with change in topics.

MATL 7980/7986 MASTER MATERIALS ENGINEERING PROJECT (3) LEC. 3. SU. Special design project report directed by major faculty. Topics to be determined by the student's graduate committee.

MATL 7990/7996 RESEARCH AND THESIS (1-15) MST. Individual master's thesis research. Course may be repeated with change in topics.

MATL 8990/8996 RESEARCH AND DISSERTATION (1-15) DSR. Individual doctoral dissertation research. Course may be repeated with change in topics.

Mechanical Engineering Courses

MECH 2020 MANUFACTURING TECHNOLOGY LAB (2) LEC. 3. LAB. 1. Manufacturing technology lab for introduction of processes such as cutting, forming, machining, and joining of metals and other materials. Basic and applied machine shop and manufacturing floor safety.

MECH 2110 STATICS AND DYNAMICS (4) LEC. 3. LAB. 3. Pr. (MATH 1620 or MATH 1623 or MATH 1627) and (PHYS 1600 or PHYS 1607). Vectors, forces, moments and free body diagrams. Systems in mechanical equilibrium. Particles in motion.

MECH 2120 KINEMATICS AND DYNAMICS OF MACHINES (4) LEC. 3. LAB. 3. Pr. (MATH 2630 or MATH 2637) and MECH 2110. Kinematics and dynamics of rigid bodies. Kinematics and dynamics of mechanisms, cams and gears.

MECH 2130 MECHANICAL ENGINEERING STATICS (3) LEC. 2.5. Pr. (MATH 1620 or MATH 1627) and (PHYS 1600 or PHYS 1607). Forces, vectors, moments and free body diagrams. Systems in mechanical equilibrium.

MECH 2140 KINEMATICS AND DYNAMICS (3) LEC. 2.5. Pr. (MATH 2630 or MATH 2637) and MECH 2130. Kinematics and kinetics of particles and rigid bodies with an emphasis on mechanical engineering applications such as machines, mechanisms, cams, gears and vibrations.

MECH 2220 COMPUTER-AIDED ENGINEERING (3) LEC. 2. LAB. 3. Pr. (ENGR 1110 or ENGR 1113) and COMP 1200 and P/C MATH 2650. The computer as a tool in mechanical engineering.

MECH 2AA0 MECHANICAL ENGINEERING PROGRESS ASSESSMENT I (0) TST. SU. Progress Assessment Examination in: multivariate calculus, differential equations, chemistry, physics, statics, dynamics. Course may be repeated with change in topics.


MECH 3030 FLUID MECHANICS (3) LEC. 3. Pr. (MECH 2110 or MECH 2130) and ENGR 2010 and MATH 2650 and (P/C MECH 3130 or P/C MECH 3120). Fluid properties; fluid statics; mass conservation; momentum equation; external and internal flows; Euler and Bernoulli equations; dimensional analysis; viscous flows; boundary layers; compressible flow.


MECH 3050 MEASUREMENT AND INSTRUMENTATION (3) LEC. 2. LAB. 3. Pr. MECH 3030 and P/C ELEC 3810 and P/C MECH 3040. Theory and practice of modern sensors and computer-based data acquisition techniques, uncertainty analysis, results reporting, filtering and signal processing.
MECH 3120 MECHANICS OF MATERIALS (3) LEC. 2.5. Pr. (MECH 2130 or MECH 2110) and MECH 2220 and MATL 2100 and MATH 2650 and MATH 2660. Stress and strain concepts, stress-strain relationships, applications, uniaxially loaded members, torsion, normal and shear stresses in beams, beam deflections, buckling, stress concentration, combined loading, failure theories.

MECH 3130 MECHANICS OF MATERIALS (4) LEC. 3. LAB. 1. Pr. MECH 2110 and MATL 2100 and MATH 2650 and MATH 2660 and (MECH 2220 or MECH 3220). Stress and strain concepts, stress-strain relationships, applications, uniaxially loaded members, torsion, normal and shear stresses in beams, beam deflections, buckling, stress concentration, combined loading, failure theories, strain energy, impact loading, cyclic loading.

MECH 3140 SYSTEM DYNAMICS AND CONTROLS (3) LEC. 3. Pr. (MECH 2120 or MECH 2140) and MATH 2650. System dynamics and automatic control theory.

MECH 3150 DYNAMICS LAB (1) LAB. 2.5. Pr. MECH 2140 and MATL 2100. Laboratory experiences designed to enhance student understanding of engineering mechanics, including statics, dynamics, and kinematics.

MECH 3160 MECHANICS LAB (1) LAB. 2.5. Pr. MECH 3120. Laboratory experiences designed to enhance student understanding of engineering mechanics including statics, stresses, & strains.

MECH 3200 CONCEPTS IN MECHANICAL DESIGN (2) LEC. 1. LAB. 3. Pr. MECH 2110 and (P/C MECH 2220 or P/C MECH 3220). Introduction to the mechanical design process including identification of needs and engineering requirements, concept generation and selection, and design development. Students will work in teams to perform a design project, and will also be exposed to project management and communication skills.

MECH 3210 DESIGN AND MANUFACTURING LAB (1) LAB. 1. Manufacturing safety lab for introduction to manufacturing processes associated with cutting, forming, and joining of metals and other materials.

MECH 3230 MACHINE DESIGN (3) LEC. 3. Pr. MECH 3120 and (MECH 2020 or MECH 3210) and MECH 3200. Design of systems containing a variety of mechanical elements.

MECH 3AA0 MECHANICAL ENGINEERING PROGRESS ASSESSMENT II (0) TST. SU. Pr. MECH 2AA0. Progress Assessment Examination in: Statistics, linear algebra, mechanical design, thermo-fluid design, social impact, contemporary issues. Course may be repeated with change in topics.

MECH 4240 COMPREHENSIVE DESIGN I (2) LEC. 1. LAB. 3. Pr. (MECH 3AA0 and MECH 3150 and MECH 3160 and MECH 3230 and P/C MECH 3040 and P/C MECH 3050 and MECH 3140) or (MECH 3AA0 and MECH 3150 and MECH 3160 and MECH 3230 and P/C MECH 3040 and MECH 3050 and P/C MECH 3140) or (MECH 3AA0 and MECH 3150 and MECH 3160 and MECH 3230 and MECH 3040 and P/C MECH 3050 and P/C MECH 3140). Capstone engineering design course based on a design project similar to those encountered by the engineer in industry involving thermal and mechanical design.

MECH 4250 COMPREHENSIVE DESIGN II (2) LEC. 1. LAB. 3. Pr. (MECH 4240 and MECH 3040 and MECH 3050 and P/C MECH 3140 and P/C INSY 3600) or (MECH 4240 and MECH 3050 and MECH 3140 and P/C MECH 3040 and P/C INSY 3600) or (MECH 4240 and MECH 3140 and MECH 3040 and P/C MECH 3050 and P/C INSY 3600). Continuation of MECH 4240. Detailed design, fabrication, communication, and presentation of a prototype machine for an industrial sponsor.

MECH 4300 MECHANICAL EQUIPMENT ENGINEERING (3) LEC. 3. Pr. MECH 3020 and MECH 3030. Operation, performance, maintenance, selection, design and optimization of mechanical equipment commonly found in industrial operations.

MECH 4310 HEATING, VENTILATING, AIR CONDITIONING AND REFRIGERATION (3) LEC. 3. Pr. MECH 3040. Theory and practice of modern heating, ventilation, air conditioning and refrigeration systems; concepts, equipment, and systems design.

MECH 4320 APPLIED CFD AND HEAT TRANSFER (3) LEC. 3. Pr. MECH 3040 and MATH 2660. Introduction to computational fluid dynamics and heat transfer techniques used to analyze thermal performance of devices and systems. Commercial software will be used.

MECH 4420 VEHICLE DYNAMICS (3) LEC. 3. Pr. ENGR 2100 or ENGR 2350 or MECH 2120. Ground vehicle resistance, propulsion, maneuvering, and control tires, suspensions, braking, aerodynamics, case studies.

MECH 4430 GROUND VEHICLE FUNDAMENTALS (3) LEC. 3. Pr. ENGR 2100 or ENGR 2350 or MECH 2120. Engineering fundamentals of ground vehicles and typical subsystems, including: power (engine and electrical); drivetrain; braking; steering; suspension; ergonomics; and structure.
MECH 4440 AUTOMOTIVE DESIGN EXPERIENCE I (2) LEC. 1. LAB. 3. Pr. MECH 3AA0 and MECH 3230 and P/C MECH 3040 and P/C MECH 3050 and P/C MECH 3140. and Departmental Approval. Team-based design of a ground vehicle, both whole-vehicle and subsystem; design evaluation and modification; oral and written communication.

MECH 4450 AUTOMOTIVE DESIGN EXPERIENCE II (2) LEC. 1. LAB. 3. Pr. MECH 4440. Departmental approval. Team-based fabrication, testing, modification and operation of a ground vehicle; oral and written communication; project management.

MECH 4510 INDUSTRIAL AND ENVIRONMENTAL NOISE CONTROL (3) LEC. 3. Pr. MECH 2120 and MECH 3220. Sources of industrial and community noise, criteria for control, noise measuring instrumentation, issues involved in the design of machinery for minimum noise, noise ordinances and regulations.

MECH 4520 MACHINERY NOISE AND VIBRATION DIAGNOSTICS (3) LEC. 3. Pr. MECH 2120 and MECH 3220. An introduction to machinery diagnostics through noise and vibration signatures. Fundamental principles and applications of predictive maintenance of machinery.

MECH 4700 INTEGRATED ENGINEERING THEORY AND PRACTICE (3) LEC. 3. Pr. MECH 3200. Real world engineering management decision making, case studies from industry.

MECH 4930 DIRECTED STUDIES IN MECHANICAL ENGINEERING (1-3) IND/INT. Departmental approval. Individual or small group study of a specialized area of Mechanical Engineering under faculty direction. Course may be repeated for a maximum of 3 credit hours.

MECH 4970 SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) LEC. Departmental approval. Regular course addressing a specialized area of Mechanical Engineering not covered by a regularly offered course. Topics may vary. Course may be repeated for a maximum of 3 credit hours.

MECH 4997 HONORS THESIS (1-6) IND. Pr. Honors College. Departmental approval. Individual student directed research and writing of an honors thesis. Course may be repeated for a maximum of 6 credit hours.

MECH 5010 COMPRESSIBLE FLUID FLOW (3) LEC. 3. Pr. MECH 3020 and MECH 3030. Properties of ideal gases; General one-dimensional wave motion; Isentropic flow with area change; Normal shock waves; Flow with friction (Fanno Flow) and heat transfer (Rayleigh Flow); Method of characteristics.

MECH 5050 RENEWABLE ENERGY RESOURCES AND APPLICATIONS (3) LEC. 3. Pr. ENGR 2010 or ENGR 2200. or permission of instructor. Overview of renewable energy options with an emphasis on available resources, advantages & disadvantages, and design principles.

MECH 5110 INTERMEDIATE HEAT TRANSFER (3) LEC. 3. Pr. MECH 3040. Introduction to the analytical treatment of heat transfer by conduction, convection, and radiation. Suitable for those that require general coverage of advanced theory but whose primary research interest may lie elsewhere.

MECH 5120 COMBUSTION (3) LEC. 3. Pr. MECH 3040. Thermodynamics and chemical kinetics of combustion processes, premixed and diffusion flames, ignition, characterization and combustion of gaseous, liquid, and solid fuels, environmental aspects of combustion.

MECH 5210 ELECTRONICS THERMAL MANAGEMENT (3) LEC. 3. Pr. MECH 3040 and ELEC 3810. Thermal issues in electronics, review of heat transfer thermal resistance networks, design of finned heat sinks, numerical analysis of electronics cooling, advanced thermal management strategies.

MECH 5220 VIRTUAL PROTOTYPING (3) LEC. 3. Departmental approval. Computer simulation of mechanical systems integrating computer-aided design, dynamic simulation and finite element software; application to two-dimensional and three dimensional simple and complex mechanical systems.

MECH 5230 FRICTION, WEAR AND LUBRICATION (3) LEC. 3. Pr. MECH 3030 and MECH 3130. Theory and techniques for considering friction, wear and lubrication, in the design of machine components, and other surface interactions.

MECH 5240 BOUNDARY AND FULL-FILM LUBRICATION (3) LEC. 3. Pr. MECH 3030. Theory and techniques for design and modeling of the different regimes of lubrication between surfaces and machine components in order to control friction and wear.

MECH 5250 MULTISCALE CONTACT MECHANICS (3) LEC. 3. Pr. MECH 3130. Theory and techniques for considering contact between solid bodies and the effect on friction, wear, the design of machine components, and other surface interactions.
MECH 5270 METALWORKING AND MANUFACTURING TRIBOLOGY (3) LEC. 3. Pr. MECH 3210. Theory and optimization techniques for tool life and surface finish considering friction, wear and lubrication in manufacturing processes including both metalworking fluids and hard/dry machining.

MECH 5300 ADVANCED MECHANICS OF MATERIALS (3) LEC. 3. Pr. MECH 3130. Stress and strain analysis, plane stress and plane strain concepts, generalized Hooke's law, stress function approach applications to 2-D problems, axisymmetric problems bending of curved members, torsion of prismatic members, stress concentration problems.

MECH 5310 MECHANICS OF ELECTRONIC PACKAGING (3) LEC. 3. Pr. MECH 3130 and ELEC 3810. Stress and strain analysis of microelectronic packages and electronic assemblies using analytical, experimental and numerical methods.

MECH 5390 FUNDAMENTALS OF THE FINITE ELEMENT METHOD (3) LEC. 2. LAB. 3. Pr. MECH 3040 and MECH 3130 and MATH 2660. Introduction to the fundamentals of the finite element method.

MECH 5410 DYNAMICS OF ROTATING MACHINERY (3) LEC. 3. Pr. MECH 3140. Issues involved in the analysis and design of high-speed rotating machinery. Modeling, resonance, balancing, bearings, condition monitoring.

MECH 5420 DYNAMICS OF MULTIBODY SYSTEMS (3) LEC. 3. Pr. MECH 3140. Concepts in dynamics of multibody systems such as kinematics analysis, Newton Euler, Lagrange and Kane equations of motion, collisions, and vibrations of flexible links.

MECH 5430 BASICS SENSOR APPLICATIONS (3) LEC. 3. Pr. MECH 3130. Basic concepts, fabrication and operation of micromachined semiconductor, piezoelectric, piezoresistive, capacitive and fiber-optic sensors.


MECH 5510 ENGINEERING ACOUSTICS (3) LEC. 3. Pr. MATH 2650. The fundamentals of acoustics. Vibration of strings, bars, plates. Acoustic plane waves, architectural acoustics and noise control will be emphasized.

MECH 5610 MECHANICAL VIBRATION (3) LEC. 3. Pr. MECH 2120 and MATH 2650 and MATH 2660. Modeling of lumped dynamic systems, free and forced vibration of single degree freedom systems, response to arbitrary excitation, analysis of two and multiple degrees of freedom systems.


MECH 5710 KINEMATICS AND DYNAMICS OF ROBOTS (3) LEC. 3. Pr. MECH 3140. Basic concepts in robotics such as kinematic analysis, coordinate transformation, Lagrange and Newton Euler equations of motion.

MECH 5720 CONTROL OF ROBOTIC MOTION (3) LEC. 3. Pr. MECH 3140. Application of various algorithms for robot manipulators.

MECH 5810 MECHATRONICS (3) LEC. 3. Pr. MECH 2120 and ELEC 3810. Introduction to the integration of mechanisms, sensors, controllers and actuators for machines, and design of automatic machinery.

MECH 5820 INTRODUCTION TO OPTIMAL SYSTEMS (3) LEC. 3. Introduction to the mathematical fundamentals of optimization. Application to multiple solution engineering problems in thermo-fluid and mechanical systems.

MECH 5830 ENGINES (3) LEC. 3. Pr. (ENGR 2010 and MECH 3030) or ENGR 2200. or (ENGR 2010 plus any one of (AERO 3110, CHEN 2610, CIVL 3110, MECH 3030)). Analysis, design, and application issues in internal combustion engines. Characteristics, thermodynamics, thermochemistry, unsteady multi-phase fluid dynamics, stresses, vibration, noise, mechanisms.

MECH 5970 INTERMEDIATE SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) LEC. 1-3. Departmental approval. Regular course addressing an advanced specialized area of Mechanical Engineering not covered by a regularly offered course. Topics may vary. Course may be repeated for a maximum of 9 credit hours.

MECH 6010/6016 COMPRESSIBLE FLUID FLOW (3) LEC. 3. Properties of ideal gases; General one-dimensional wave motion; Isentropic flow with area change; Normal shock waves; Flow with friction (Fanno Flow) and heat transfer (Rayleigh Flow); Method of characteristics.
MECH 6050 RENEWABLE ENERGY RESOURCES AND APPLICATIONS (3) LEC. 2.5. An overview of renewable energy options with an emphasis on available resources, advantages & disadvantages, and design principles.

MECH 6110/6116 INTERMEDIATE HEAT TRANSFER (3) LEC. 3. Introduction to the analytical treatment of heat transfer by conduction, convection, and radiation. Suitable for those that require general coverage of advanced theory but whose primary research interest may lie elsewhere.

MECH 6120/6126 COMBUSTION (3) LEC. 3. Thermodynamics and chemical kinetics of combustion processes, premixed and diffusion flames, ignition, characterization and combustion of gaseous, liquid, and solid fuels, environmental aspects of combustion.

MECH 6210/6216 ELECTRONICS THERMAL MANAGEMENT (3) LEC. 3. Thermal issues in electronics, review of heat transfer thermal resistance networks, design of finned heat sinks, numerical analysis of electronics cooling, advanced thermal management strategies.

MECH 6220 VIRTUAL PROTOTYPING (3) LEC. 3. Departmental approval. Computer simulation of mechanical systems integrating computer-aided design, dynamic simulation and finite element software; application to two-dimensional and three dimensional simple and complex mechanical systems.

MECH 6230/6236 FRICTION, WEAR AND LUBRICATION (3) LEC. 3. Friction, wear, and lubrication in design of machine components and other surface interactions, with emphasis on optimizing tribological performance.

MECH 6240/6246 BOUNDARY AND FULL-FILM LUBRICATION (3) LEC. 3. Theory and techniques for design and modeling of the different regimes of lubrication between surfaces and machine comments in order to control friction and wear.

MECH 6250/6256 MULTISCALE CONTACT MECHANICS (3) LEC. 3. Theory and techniques for considering contact between solid bodies and the effect on friction, wear, the design of machine components, and other surface interactions.

MECH 6270/6276 METALWORKING AND MANUFACTURING TRIBOLOGY (3) LEC. 3. Pr. MECH 3210. Theory and optimization techniques for tool life and surface finish considering friction, wear and lubrication in manufacturing processes including both metalworking fluids and hard/dry machining.

MECH 6300/6306 ADVANCED MECHANICS OF MATERIALS (3) LEC. 3. Stress and strain analysis, plane stress and plane strain concepts, generalized Hooke’s law, stress function approach applications to 2-D problem, axisymmetric problems, bending of curved members, torsion of prismatic members, stress concentration problems.


MECH 6390/6396 FUNDAMENTALS OF THE FINITE ELEMENT METHOD (3) LEC. 2. LAB. 3. Introduction to the fundamentals of the finite element method.

MECH 6410/6416 DYNAMICS OF ROTATING MACHINERY (3) LEC. 3. Issues involved in the analysis and design of high-speed rotating machinery. Modeling, resonance, balancing, bearings, condition monitoring.

MECH 6420/6426 DYNAMICS OF MULTIBODY SYSTEMS (3) LEC. 3. Concepts in dynamics of multibody systems such as kinematics analysis, Newton Euler, Lagrange and Kane equations of motion, collisions, and vibrations of flexible links.

MECH 6430/6436 BASICS OF SENSOR APPLICATIONS (3) LEC. 3. Basic concepts, fabrication and operation of micro machined semiconductor, piezoelectric, piezoresistive, capacitive and fiber-optic sensors.


MECH 6510/6516 ENGINEERING ACOUSTICS (3) LEC. 3. The fundamentals of acoustics. Vibration of strings, bars, plates. Acoustic plane waves, architectural acoustics, and, noise control will be emphasized.

MECH 6610/6616 MECHANICAL VIBRATION (3) LEC. 3. Modeling of lumped dynamic systems, free and forced vibration of single degree of freedom systems, response to arbitrary excitation, analysis of two and multiple degrees of freedom systems.

MECH 6620/6626 STABILITY AND VIBRATION OF DISCRETE SYSTEMS (3) LEC. 3. Pr. MECH 6610 or MECH 6616. Principles of advanced dynamics, linear systems with multiple degrees of freedom, stability and boundedness, free and forced response of linear systems, parameter identification.
MECH 6710/6716 KINEMATICS AND DYNAMICS OF ROBOTS (3) LEC. 3. Basic concepts in robotics such as kinematics analysis, coordinate, Lagrange and Newton Euler equations of motion.

MECH 6720/6726 CONTROL OF ROBOTIC MOTION (3) LEC. 3. Application of various algorithms for robot manipulators.

MECH 6810/6816 MECHATRONICS (3) LEC. 3. Introduction to the integration of mechanisms, sensors, controllers and actuators for machines and design of automatic machinery.

MECH 6820/6826 INTRODUCTION TO OPTIMAL SYSTEMS (3) LEC. 3. Introduction to the mathematical fundamentals of optimization. Application to multiple solution engineering problems in thermo-fluid and mechanical systems.

MECH 6830/6836 ENGINES (3) LEC. 3. Analysis, design, and application issues in internal combustion engines. Characteristics, thermodynamics thermochemistry, unsteady multi-phase fluid dynamics, stresses, vibration, noise, mechanisms.

MECH 6930/6936 INTERMEDIATE DIRECTED STUDIES IN MECHANICAL ENGINEERING (1-3) IND. Departmental approval. Individual or small group study of an advanced, specialized area of Mechanical Engineering under faculty direction. Course may be repeated for a maximum of 3 credit hours.

MECH 6970/6976 INTERMEDIATE SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) LEC. Departmental approval. Regular course addressing an advanced specialized area of Mechanical Engineering not covered by a regularly offered course. Topics may vary. Course may be repeated for a maximum of 3 credit hours.

MECH 7010/7016 ADVANCED THERMODYNAMICS (3) LEC. 3. Classical and statistical treatment of the laws and properties of thermodynamic systems; applications.


MECH 7120/7126 ADVANCED FLUID MECHANICS II (3) LEC. 3. Pr. MECH 7110 or MECH 7116. Schwarz-Christoffel Transformation; Hodograph Method; Three-Dimensional Potential Flows; Interface Waves; Low Reynolds Number Solutions; Oseen Approximation; Stability of Laminar Flows.

MECH 7130/7136 BOUNDARY LAYER THEORY (3) LEC. 3. Pr. MECH 7110 or MECH 7116. Mass Conservation; Momentum Equation; Energy Equation; Dimensional Analysis; Fully-Developed Laminar Flows; Similarity Solutions; Boundary layer Approximation; Stability of Laminar Flows.

MECH 7140/7146 TURBULENCE (3) LEC. 3. Pr. MECH 7130 or MECH 7136. Properties of Turbulence; Governing Conservation, Momentum and Energy Equations; Time-averaging, Vorticity Equatiion; Turbulence Models; Shear Flows; Jets, Wakes and Boundary Layers; Experimental Techniques.

MECH 7150/7156 FLUID MECHANICS OF PROCESSING (3) LEC. 3. Pr. MECH 7130 or MECH 7136. Properties of Fluids; Governing Equations; Dimensional analysis; Particle-Laden Flows; Applications to specific processing problems such as liquid metal flows, polymers, surface deposition.

MECH 7210/7216 DIFFUSIVE TRANSPORT (3) LEC. 3. Formulations and analytical solutions of steady, periodic, and unsteady heat and mass diffusion problems in one, two, and three dimensions.

MECH 7220/7226 CONVECTION HEAT TRANSFER (3) LEC. 3. Advanced topics in free and forced convection transport within the laminar, transitional and turbulent regimes; confined and external flows.

MECH 7230/7236 THERMAL RADIATION (3) LEC. 3. Fundamentals of thermal radiation heat transfer including: absorption, emission, and reflection from solids; absorption, emission, and scattering by gases; combined mode and conjugate heat transfer; exact and approximate solution methodologies.

MECH 7240/7246 NUMERICAL METHODS IN HEAT TRANSFER (3) LEC. 3. Advanced topics in finite element and finite difference methods; solution techniques, stability and convergence.

MECH 7300/7306 FRACTURE MECHANICS (3) LEC. 3. Stress and strain analysis of cracked bodies, energy release rate, Griffith problem, modes of fracture, crack tip fields, stress intensity factors, small scale crack tip yielding, the J-integral, HRR equations, experimental and numerical methods for fracture parameter estimation.

MECH 7310/7316 SOLID MECHANICS (3) LEC. 3. Stress and strain analysis in 3-D, constitutive behavior of elastic solids, orthotropy and isotropy, stress compatibility equations, Navier's equation, stress functions, applications.

MECH 7320/7326 CONTINUUM MECHANICS AND TENSOR ANALYSIS (3) LEC. 3. Pr. MECH 6300 or MECH 6306. Cartesian and curvilinear tensor analysis with applications to the mechanics of continuous media. Constitutive equations for solids and fluids.


MECH 7340/7346 INELASTIC STRESS ANALYSIS (3) LEC. 3. Pr. MECH 6300 or MECH 6306. Introduction to modeling material behavior of non-elastic materials. Theories of plasticity, linear and non-linear viscoelasticity, and viscoplasticity. Applications to modern engineering materials and simple structural members.

MECH 7360/7366 MECHANICS OF COMPOSITE MATERIALS (3) LEC. 3. Properties and mechanical behavior of fiber-reinforced composite materials. Anisotropic stress-strain relations, orthotropic elasticity and laminated plate theories, failure criteria, applications.

MECH 7370/7376 ANALYSIS OF PLATES AND SHELLS (3) LEC. 3. Theories for the bending and stretching of plate and shell structures. Transverse loading, buckling, vibration, and thermal stress problems. Introduction to energy methods, numerical techniques, and large deflection theories.


MECH 7410/7416 OPTICAL METHODS IN MECHANICS (3) LEC. 3. Measurement of stresses, strains, and deformations using optical methods; optical interference; Fourier optics; optical spatial filtering, white light methods; coherent optical methods.

MECH 7430/7436 OPTICAL PROPERTIES OF ADVANCED MATERIALS (3) LEC. 3. Pr. MECH 6430 or MECH 6436 or PHYS 7200. Linear and nonlinear optical properties, correlation with material-structure, electro-optic effects, lasers, frequency conversion, fiber-optics, technological applications.

MECH 7510/7516 ADVANCED ENGINEERING ACOUSTICS (3) LEC. 3. Pr. MECH 6510 or MECH 6516. The fundamentals of advanced acoustics theory. Wave equation derivation from Navier-Stokes equations, spherical waves, monopoles, dipoles, quadrupoles. Duct Acoustics, Statistical Energy Analysis.


MECH 7630/7636 MECHANICAL IMPACT (3) LEC. 3. Departmental approval. Investigation of the fundamental concepts used to solve collision problems with friction.


MECH 7650/7656 RANDOM VIBRATION (3) LEC. 3. Pr. MECH 6610 or MECH 6616. Properties of random processes, review of linear systems with single and multiple degrees of freedom. Vibration of single and multiple degrees of freedom systems subjected to random excitations, design of structures subjected to random excitation. Parameter estimation.

MECH 7710/7716 CONTROL SYSTEMS ANALYSIS AND DESIGN (3) LEC. 3. Topics from control theory are introduced in the context of control systems analysis and design, including state variable feedback, modal control, optimal control and adaptive control for both continuous and discrete systems.
MECH 7930 ADVANCED DIRECTED STUDIES IN MECHANICAL ENGINEERING (1-3) IND. Departmental approval. Individual or small group study of an advanced, specialized area of Mechanical Engineering under faculty direction. Course may be repeated for a maximum of 3 credit hours.

MECH 7950 GRADUATE SEMINAR (1) SEM. 1. SU. Topics may vary. Will not fulfill degree requirements. Course may be repeated with change in topics.

MECH 7970/7976 ADVANCED SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) LEC. Departmental approval. Regular course addressing an advanced specialized area of Mechanical Engineering not covered by regularly offered course. Topics may vary. Course may be repeated for a maximum of 3 credit hours.

MECH 7990 RESEARCH & THESIS (1-12) MST. Individual Master’s thesis research. May be repeated for credit. Course may be repeated with change in topics.

MECH 8990 RESEARCH & DISSERTATION (1-12) DSR. Individual Doctoral dissertation research. May be repeated for credit. Course may be repeated with change in topics.

Polymer Fiber Engineering Courses

PFEN 2270 INTRODUCTION TO ENGINEERED FIBROUS MATERIALS (4) LEC. 4. Pr. ENGR 1110 or ENGR 1113. The fundamentals of chemistry and engineering applied to fibrous assemblies illustrated using the properties required by end-use. Topics will include biomedical materials, architectural applications cables, ropes, and tethers, composite materials, filtration fabrics, ballistic protection, and health-care products.

PFEN 3100 FUNDAMENTALS OF POLYMERS (3) LEC. 3. Pr. CHEM 2030 or CHEM 2070 or CHEM 2077. Fundamentals of polymers: terminology, synthesis, structure, molecular weight, transitions of state, structure and uses.


PFEN 3500 STRUCTURE AND PROPERTIES OF POLYMERS AND FIBERS (3) LEC. 3. Pr. PFEN 3100. Exploration of the relationships between the chemical structure, properties and uses of polymers and fibers. Emphasis on the importance of judicious material selection for particular end use applications. Spring.

PFEN 3570 ENGINEERED PROTECTIVE MATERIALS (3) LEC. 3. Pr. (ENGR 1110 or ENGR 1113) and (MATH 1610 or MATH 1613 or MATH 1617) and (MATH 1620 or MATH 1623 or MATH 1627) and CHEM 1030 and CHEM 1040 and (P/C PHYS 1600 or P/C PHYS 1607). An engineering approach to the design of protective materials and structures based on analyses to counter kinetics, chemical and biological threat hazards to people, animals and valuable objects.

PFEN 4100 POLYMER CHARACTERIZATION (4) LEC. 3. LAB. 3. Pr. (PHYS 1610 or PHYS 1617) and (CHEM 2080 or CHEM 2087) and PFEN 3500. Study of the major techniques for the physical characterization of polymers. Topics to be covered include molecular weight determination, spectroscopy (light, vibrational, nuclear magnetic resonance, electron spin resonance), X-ray diffraction, microscopy (light, electron), optical methods, and thermal analysis.

PFEN 4300 ENGINEERED FIBROUS STRUCTURES (4) LEC. 3. LAB. 3. Pr. PFEN 2270. Design and applications of high performance industrial fibrous structures for civil engineering, architecture and construction, filtration, medical, military and defense, pulp and paper industry, safety and protection, sports and recreation, transportation, agriculture and other industries. Fall.

PFEN 4400 MECHANICS OF FLEXIBLE STRUCTURES (3) LEC. 3. Pr. ENGR 2070 and ENGR 2200 and PFEN 2270. Analysis of mechanical behavior and physical properties of flexible structures such as fibers, yarns and fabrics.

PFEN 4500 FIBER REINFORCED MATERIALS (3) LEC. 3. Pr. ENGR 2070 and ENGR 2200 and MATH 2660 and PFEN 2270. Material properties and manufacture of fiber reinforced materials; perform structures such as weaves and braids, analysis, design methodology and applications. Spring.

PFEN 4810 POLYMER AND FIBER ENGINEERING DESIGN I (3) LEC. 3, IND/LEC. 2. Pr. PFEN 3500. Departmental approval. Tools and skills needed to conduct an engineering design project.

PFEN 4820 POLYMER AND FIBER ENGINEERING DESIGN II (3) IND. 3. Undergraduate senior design project, second semester.

PFEN 4970 SPECIAL TOPICS (1-3) AAB. Departmental approval. Reading course with varying emphasis to give opportunity for overview in specific areas of engineering and technology. Course may be repeated for a maximum of 12 credit hours.
PFEN 4997 HONORS THESIS (1-3) IND. Pr. Honors College. Departmental approval. Honors Thesis is a project-based course and may be presented in form of a written report or a conference-style presentation. Course may be repeated for a maximum of 6 credit hours.


PFEN 5200 POLYMER PROCESSING (4) LEC. 3. LAB. 3. Pr. PFEN 2270. Characteristics and flow properties of polymers; film and fiber extrusion, molding technology, polymer material selection and processing. Credit will not be given for both PFEN 5200 and PFEN 6200.

PFEN 5300 RHEOLOGY (3) LEC. 3. Pr. (MATH 2630 or MATH 2637) and ENGR 2200 or MECH 3030. Departmental approval. Covers the most important aspects of elementary modern rheology, including elastic solids, viscoelastic behavior of polymeric systems, composite systems, concentrated solutions and suspension rheology.

PFEN 5510 POLYMER CHEMISTRY (3) LEC. 3. Pr. CHEM 2030 and (ENGR 2050 or ENGR 2053) and (PHYS 1610 or PHYS 1617). Polymer chemistry including polymer synthesis, polymer characterizations, polymer classes, solubility and swelling, and structure/property relationships.


PFEN 6200 POLYMER PROCESSING (4) LEC. 3. LAB. 3. Departmental approval. Characteristics and flow properties of polymers; film and fiber extrusion, molding technology, polymer material selection and processing. Credit will not be given for both PFEN 5200 and FPEN 6200.

PFEN 6250 ADVANCED ENGINEERING FIBROUS STRUCTURES (3) LEC. 3. Pr. PFEN 4300. Departmental approval. Application of advanced technology to the design, development and analysis of high performance industrial textiles.

PFEN 6510 POLYMER CHEMISTRY (3) LEC. 3. Pr. CHEM 2030 and (ENGR 2050 or ENGR 2053) and (PHYS 1610 or PHYS 1617). Polymer chemistry including polymer synthesis, characterizations, classes, solubility and swelling, and structure/property relationships.

PFEN 6706 BIOMEDICAL APPLICATIONS OF POLYMERIC MATERIALS (3) LEC. 3. LAB. 10. Study of polymers used in the body for the purposes of aiding healing, correcting abnormalities, and restoring lost function. Departmental approval. May count either PFEN 5710, PFEN 6700 or PFEN 6706.


PFEN 7310 STRUCTURE AND PROPERTIES OF POLYMERS (4) LEC. 3. LAB. 3. Pr. CHEM 2080 or CHEM 2087. Departmental approval. The inter-relationships between chemical structure of a polymer, polymer properties and uses. Plastics, elastomers and fibers-synthesis and property requirements.

PFEN 7320 POLYMER PHYSICS (3) LEC. 3. Departmental approval. Mechanical, optical, and transport properties of polymers with respect to the underlying physical chemistry of polymers in melt, solution, and solid state.

PFEN 7410 ADVANCED COLORATION AND INTERFACIAL PROCESSES (4) LEC. 3. LAB. 3. Pr. PFEN 3400. Departmental approval. Colorants and coloration principles for both fibrous and nonfibrous polymers; interfacial processes, such as sorption, adhesion, colloidal processes, surface tension.

PFEN 7500 MECHANICS OF TEXTILE REINFORCED MATERIALS (3) LEC. 3. Pr. PFEN 4500. Design methods for textile reinforced materials, including micro and macro-mechanics, finite element analysis. Fall.

PFEN 7610 ADVANCED POLYMERS FROM RENEWABLE RESOURCES (2) LEC. 2. Departmental approval. Aspects of natural, biodegradable polymers, including fibers, adhesives, films, coatings, their synthesis, their structure/properties relationships, and their microbial degradation.

PFEN 7620 ADVANCED MECHANICS OF FLEXIBLE STRUCTURES (3) LEC. 3. Pr. PFEN 4400. Recent advances in modeling and analysis of mechanical behavior of flexible structures. Spring.
PFEN 7700 ADVANCED METHODS IN POLYMER CHARACTERIZATION (4) LEC. 4. LAB. 3. Pr. PFEN 6510. Departmental approval. Important aspects and methods in polymer characterization.

PFEN 7770 INTRODUCTION TO CONDUCTING POLYMERS (3) LEC. 3. Pr. PFEN 6510. This "Introduction of Conducting Polymers" course covers the most up to date research and applications in the areas of conducting polymers. This course provides extensive background on: mechanism of electrical conductivity of conducting polymers, classification of conducting polymers, potential applications of conducting polymers, and recent advance of the researches in the fields of conducting polymers. For example, organic solar cells, and organic light emitting diodes.

PFEN 7910 POLYMER RHEOLOGY (3) LEC. 3. Pr. PFEN 6510. Departmental approval. Important aspects of elementary modern rheology.

PFEN 7950 GRADUATE SEMINAR (1) SEM. 1. SU. Presentation of departmental research; practicing written and oral communication skills. Course may be repeated with change in topic. Fall.

PFEN 7960 SPECIAL PROBLEMS AND FIBER ENGINEERING (1-3) IND. Specialized project research with varying emphasis in particular areas of polymers and fibers. Course may be repeated for a maximum of 12 credit hours.

PFEN 7970 SPECIAL TOPICS (3) LEC. 3. Analysis of current issues in the area of polymers and fibers. Course may be repeated for a maximum of 12 credit hours.

PFEN 7980 GRADUATE PROJECT (1-3) IND. In-depth work in a particular project in polymers and fibers. Course may be repeated for a maximum of 12 credit hours.

PFEN 7990 RESEARCH AND THESIS (1-10) MST. Departmental approval. Required of all students seeking an advanced degree in the department. Course may be repeated with change in topics.

PFEN 8200 ADVANCED TEXTILE STRUCTURE DESIGN AND DEVELOPMENT (3) LEC. 3. Technical fabric design and development of complex woven, knit, braided and tufted structures for high performance applications. Fall.

PFEN 8990 RESEARCH AND DISSERTATION (1-10) DSR. PhD Research and Dissertation. Course may be repeated with change in topics.

Department of Aerospace Engineering

Aerospace engineers are concerned with the application of scientific principles and engineering concepts and practices to design, build, test and operate aerospace systems. The curriculum is intended to provide students with a broad understanding of fundamental scientific and technological principles, and to develop the ability to use these principles in developing solutions to engineering problems.

The objectives of the aerospace engineering program are: (1) to help students develop written and oral communication skills and to acquire a knowledge of history, literature and society; (2) to provide students a solid foundation in and a sound working knowledge of basic engineering principles; (3) to help students obtain an understanding of the engineering principles and skills specifically needed in the aeronautical and astronautical disciplines; and (4) to assist and encourage each student to develop an enhanced ability to learn and think creatively.

Required courses cover aeronautical and astronautical subjects. Students may also choose to emphasize either aeronautical or astronautical systems. Technical electives allow concentration in such areas as aerodynamics, astronautics, flight dynamics and control, propulsion, structures, and structural dynamics. The design of aerospace components and systems is considered to be an integral part of the education of aerospace engineers. Hence, design is included throughout the curriculum, beginning with a sophomore course in aerospace fundamentals and culminating in the senior design course sequence. Students are required to apply their theoretical knowledge of aerodynamics, dynamics, structures and propulsion to solve open-ended problems and to produce portions of preliminary designs.

Major

• Aerospace Engineering (p. 73)
Courses

AERO 2200 AEROSPACE FUNDAMENTALS (2) LEC. 1. LAB. 3. Pr. (ENGR 1110 or ENGR 1113) and (PHYS 1600 or PHYS 1607). C or better in PHYS 16000. Introduction to the fundamental physical concepts required for the successful design of aircraft and spacecraft.

AERO 3040 ELEMENTARY METEOROLOGY (3) LEC. 3. Basic principles, causes, effects and phenomena of weather with fundamental techniques of forecasting.

AERO 3110 AERODYNAMICS I (3) LEC. 3. Pr. MATH 2650 and AERO 2200. C or better in AERO 2200. Properties of fluids, fluid statics, conservation of mass and momentum, atmospheric properties, two dimensional airfoils, three dimensional wings, drag, and flight performance.

AERO 3120 AERODYNAMICS II (3) LEC. 3. Pr. ENGR 2010 and MATH 2650 and AERO 2200. C or better in AERO 2200. Principles of compressible flow including flows with area changes, friction and heat transfer. Fundamental analysis of aerodynamics and potential flow theory. Correlation of potential flow theory with experimental data.

AERO 3130 AERODYNAMICS LABORATORY (2) LEC. 1. LAB. 3. Pr. P/C AERO 2200. C or better in AERO 2200. Application of fundamental aerodynamic principles to subsonic and supersonic wind tunnel experiments.

AERO 3220 AEROSPACE SYSTEMS (3) LEC. 3. Pr. ENGR 2350 and MATH 2650. C or better in ENGR 2350. Modeling of system elements, classical feedback control techniques used in the analysis of linear systems, analysis of systems undergoing various motions connected with flight.

AERO 3230 FLIGHT DYNAMICS (4) LEC. 3. LAB. 3. Pr. AERO 3110 and ENGR 2350 and MATH 2650. C or better in ENGR 2350. Airplane performance and stability and control including analytical prediction of performance characteristics, experimental determination of static stability parameters, and analytical prediction of dynamic stability characteristics.

AERO 3310 ORBITAL MECHANICS (3) LEC. 3. Pr. ENGR 2350 and MATH 2650. C or better in ENGR 2350. Geometry of the solar system and orbital motion, mathematical integrals of motion, detailed analysis of two-body dynamics and introduction to artificial satellite orbits; Hohmann transfer and patched conics for lunar and interplanetary trajectories.

AERO 3610 AEROSPACE STRUCTURES I (2) LEC. 1. LAB. 3. Pr. ENGR 2070. Fundamental concepts employed in the mechanical testing of engineering materials and structures. Load, stress, and strain measurement techniques are utilized to determine material properties and structural response.

AERO 3970 SPECIAL TOPICS (1-3) AAB. SU. Departmental approval. Investigation of various topics in Aerospace Engineering. Course may be repeated for a maximum of 6 credit hours.

AERO 4140 AERODYNAMICS III (3) LEC. 3. Pr. AERO 3110 and AERO 3120. Theoretical background essential to a fundamental understanding of laminar and turbulent boundary layers and their relations to skin friction and heat transfer.

AERO 4510 AEROSPACE PROPULSION (4) LEC. 3. LAB. 3. Pr. AERO 3120. Fundamental analysis of airbreathing jet propulsion. Introduction to chemical rocket propulsion.

AERO 4620 AEROSPACE STRUCTURES II (4) LEC. 3. LAB. 3. Pr. AERO 3610 and MATH 2660. Aircraft and space vehicle structures. An introduction to the finite element method and its application to structural analysis. The laboratory will utilize state-of-the-art software numerical solution of aerospace structural systems.

AERO 4630 AEROSPACE STRUCTURAL DYNAMICS (4) LEC. 3. LAB. 3. Pr. AERO 4620. Free, forced and damped vibration of single and multiple degree-of-freedom systems. The laboratory will utilize state-of-the-art software for the analysis of the vibration and dynamic response of structural systems.

AERO 4710 AEROSPACE DESIGN I (3) LEC. 2. LAB. 3. Pr. AERO 3120. Introduction to the principles required to design aerospace vehicles.

AERO 4720 AEROSPACE DESIGN II (3) LEC. 2. LAB. 3. Pr. AERO 4710. This course is continuation of AERO 4710.

AERO 4730 SPACE MISSION DESIGN I (3) LEC. 2. LAB. 3. Pr. AERO 3120. And permission of the department. Introduction to the design of space systems including the identification of launch requirements, spacecraft system components, satellite tracking and orbital analysis to achieve a stated scientific objective.
AERO 4740 SPACE MISSION DESIGN II (3) LEC. 2. LAB. 3. Pr. AERO 4730. A continuation of AERO 4730, Space Mission Design I.

AERO 4970 SPECIAL TOPICS IN AEROSPACE ENGINEERING (1-3) AAB. Departmental approval. Investigation of current state-of-the-art technologies in aerospace engineering. Course may be repeated for a maximum of 9 credit hours.

AERO 4997 HONORS THESIS (1-3) IND. Pr. Honors College. Departmental approval. Membership in the Honors College and departmental approval required; Directed research and writing of an honors thesis. Course may be repeated for a maximum of 3 credit hours.

AERO 4AA0 PROGRAM ASSESSMENT (0) LAB. SU. Pr. P/C AERO 4710 or P/C AERO 4730. Academic program assessment covering the areas of aerodynamics, aerospace structures, orbital mechanics, propulsion and vehicle design.

AERO 5110 MISSILE AERODYNAMICS (3) LEC. 3. Pr. AERO 3120. Coreq. AERO 4140. Aerodynamics of slender wing-body combinations, interference effects, linear and non-linear effects, applications to missile design and performance.

AERO 5120 ROTARY WING AERODYNAMICS (3) LEC. 3. Pr. AERO 3110. Aerodynamics and flight characteristics of rotary-wing aircraft.


AERO 5320 APPLICATIONS OF THE GLOBAL POSITIONING SYSTEM (3) LEC. 3. Departmental approval. Operating principles of the control, space and user segments of the Global Positioning System. Implementation of post-processing and real-time positioning strategies and applications. Field work demonstrating the use of GPS receivers, data processing and position accuracy.

AERO 5330 APPLIED ORBITAL MECHANICS (3) LEC. 3. Pr. AERO 3310. Introduction to general and special perturbations; N-body and restricted three-body problems; C-W equations, targeting and rendezvous; satellite constellations.

AERO 5340 SATELLITE APPLICATION (3) LEC. 3. Pr. AERO 3310. AERO 3310 or departmental approval; Principles related to the application of satellites to remote sensing, telecommunications, navigation and trajectory determination. Principles of space policy applied to both the unmanned and manned space flight programs.

AERO 5410 AEROACOUSTICS (3) LEC. 3. Pr. AERO 3120 or Departmental approval. Fundamental concepts in acoustics: decibel scales, sound propagation and measurement, plane and spherical waves, room acoustics, transmission and reflection, reverberant fields and noise assessment. May count either AERO 5410 or AERO 6410.

AERO 5460 PERTURBATION METHODS (3) LEC. 3. Pr. MATH 2660 or Departmental approval. Analytical solutions of nonlinear problems, ODEs, PDEs, multiple scales, and transcendental equations in engineering, mathematics, and physics using both regular and singular perturbation methods. May count either AERO/MATH 5460 or AERO/MATH 6460.

AERO 5520 ROCKET PROPULSION (3) LEC. 3. Pr. AERO 4510. Analysis of the thermodynamics, gas dynamics and design of liquid and solid propellant rocket engines.

AERO 5530 SPACE PROPULSION (3) LEC. 3. Pr. AERO 4510. Analysis of space propulsion systems. Dynamics of electromagnetic systems, ion engines, photon drives, laser propulsion.


AERO 5630 AEROSPACE APPLICATIONS OF COMPOSITE MATERIALS (4) LEC. 3. LAB. 3. Pr. AERO 3610. Basic material and manufacturing information for laminated composite structures. Computational structural analysis of typical aerospace composite structures coupled with experimental verification of the structural response.

AERO 5750 LEGAL ASPECTS OF ENGINEERING PRACTICE (3) LEC. 3. Pr. PHIL 1020 or PHIL 1023 or PHIL 1027. The role of the law in the manufacture of a product. Ethical issues that may confront designers and engineers.

AERO 6110/6116 MISSILE AERODYNAMICS (3) LEC. 3. Coreq. AERO 4140. Aerodynamics of slender wing-body combinations, interference effects, linear and non-linear effects, applications to missile design and performance.

AERO 6120/6126 ROTARY WING AERODYNAMICS (3) LEC. 3. Aerodynamics and flight characteristics of rotary-wing aircraft.

AERO 6326 APPLICATIONS OF THE GLOBAL POSITIONING SYSTEM (3) LEC. 3. Departmental approval. Operating principles of the control, space and user segments of the Global Positioning System. Implementation of post-processing and real-time positioning strategies and applications. Field work demonstrating the use of GPS receivers, data processing, and position accuracy.

AERO 6330/6336 APPLIED ORBITAL MECHANICS (3) LEC. 3. Special perturbation techniques: N-body perturbations; general and restricted three-body problems; preliminary orbit determination; C-W equations, targeting and rendezvous; constellation design; mission planning.

AERO 6340/6346 SATELLITE APPLICATION (3) LEC. 3. Pr. AERO 3310. Departmental approval. Principles related to the application of satellites to remote sensing, telecommunications, navigation and trajectory determination. Principles of space policy applied to both the unmanned and manned space flight programs.

AERO 6410/6416 AEROACOUSTICS (3) LEC. 3. Pr. AERO 4140 or Departmental approval. Fundamental concepts in acoustics: decibel scales, sound propagation and measurement, plane and spherical waves, room acoustics, transmission and reflection, reverberant fields and noise assessment. May count either AERO 5410/5413 or AERO 6410/6416.

AERO 6460/6466 PERTURBATION METHODS (3) LEC. 3. Pr. MATH 2660. Departmental approval. Analytical solutions of nonlinear problems, ODES, PDEs, multiple scales, and transcendentual equations in engineering, mathematics, and physics using both regular and singular perturbation methods. May count either AERO/MATH 5460 or AERO/MATH 6460.

AERO 6520/6526 ROCKET PROPULSION (3) LEC. 3. Analysis of the thermodynamics, gas dynamics and design of liquid and solid propellant rocket engines.

AERO 6530/6536 SPACE PROPULSION (3) LEC. 3. Pr. AERO 4510. Analysis of space propulsion systems. Dynamics of electromagnetic systems, ion engines, photon drives, laser propulsion.


AERO 6630/6636 AEROSPACE APPLICATIONS OF COMPOSITE MATERIALS (4) LEC. 3. LAB. 3. Pr. AERO 3610. Basic material and manufacturing information for laminated composite structures. Computational structural analysis of typical aerospace composite structures coupled with experimental verification of the structural response.

AERO 6756 LEGAL ASPECTS OF ENGINEERING PRACTICE (3) LEC. 3. Pr. PHIL 1020 or PHIL 1023 or PHIL 1027. The role of the law in the manufacture of a product. Ethical issues that may confront designers and engineers.

AERO 7100/7106 ADVANCED SUPERSONIC AERODYNAMICS (3) LEC. 3. Pr. AERO 4140. A rigorous development of linearized and nonlinear fluid flow theories and application. Lifting surfaces, lifting bodies, duct flow, boundary layer effects, shock and expansion waves and method of characteristics.

AERO 7116 AIRFOIL AERODYNAMICS (3) LEC. 3. Pr. AERO 3120. Thin airfoil theory, Joukowsk transformation, Karman Trefftz transformations, thick airfoil theory, panel methods and comparison with experimental data.

AERO 7120/7126 DYNAMICS OF VISCOUS FLUIDS I (3) LEC. 3. Pr. AERO 7100 or AERO 7106. Exact solutions to the Navier Stokes equations. Exact and approximate solutions of the laminar boundary layer equations. Incompressible and compressible boundary layers in theory and experiment.

AERO 7130/7136 DYNAMICS OF VISCOUS FLUIDS II (3) LEC. 3. Pr. AERO 7120 or AERO 7126. Turbulent flows, the Reynolds stresses and turbulence modeling. Computation of incompressible and compressible turbulent boundary layers. Stability theory and transition.

AERO 7140/7146 ADVANCED COMPUTATIONAL FLUID DYNAMICS (3) LEC. 3. Pr. AERO 5140 and AERO 6140. Advanced methods for solving problems in computational fluid dynamics. Topics include: discretization approaches, implicit solution techniques, curvilinear coordinate systems, and upwind schemes.

AERO 7160/7166 PHYSICAL FOUNDATIONS OF TURBULENCE (3) LEC. 3. Pr. AERO 7120 or AERO 7126. Departmental approval. An introduction to turbulence using classical descriptions with a focus on the physics of turbulence phenomena. May count either AERO 7160 or AERO 7166.


AERO 7210/7216 FLIGHT DYNAMICS OF HYPERVELOCITY VEHICLES (3) LEC. 3. Pr. AERO 7200 or AERO 7206. Departmental approval. Development of specialized concepts and methods in dynamics applicable to the modeling of hypersonic flight vehicle motion. Stability concepts and analysis of the stability of steady-state motions of very high speed flight vehicles.


AERO 7236 HELICOPTER DYNAMIC CONTROL (3) LEC. 3. Pr. AERO 7200 or AERO 7206. Departmental approval. Development of specialized concepts and methods in dynamics applicable to the modeling of helicopters. Analysis of helicopter stability and controllability.

AERO 7330/7336 ORBIT DETERMINATION (3) LEC. 3. Pr. AERO 6330 or AERO 6336 or AERO 6230 or AERO 6236. Elements of orbit determination; least squares, minimum norm, minimum variance solutions; batch, sequential and extended sequential filters.

AERO 7340/7346 ADVANCED ORBITAL MECHANICS (3) LEC. 3. Pr. AERO 6330 or AERO 6336 or AERO 6230 or AERO 6236. Elements of time measurements, earth orientation/coordinate system; f and g series; Lambert's Problem; linear orbit theory and circumlunar trajectories.

AERO 7350/7356 OPTIMAL CONTROL OF AEROSPACE VEHICLES (3) LEC. 3. Pr. AERO 3220. Principles of optimization; Pontryagin's principle; Linear quadratic regulator; Observers, state estimation, LQG problem. Optimal output feedback; Synthesis of flight control systems. AERO 3220 or equivalent.

AERO 7376 FUNDAMENTALS OF THE GLOBAL POSITIONING SYSTEM (3) LEC. 3. Pr. AERO 7330 or AERO 7336 or AERO 7230 or AERO 7236. Departmental approval. Principles of the Global Positioning System; GPS overview and historical development; modeling of pseudo-range and carrier phase measurements; positioning solution strategies using kinematic, dynamic, and reduced dynamic techniques.

AERO 7396 SATELLITE REMOTE SENSING (3) LEC. 3. Departmental approval. Topics in satellite remote sensing principles and techniques including active and passive instruments, data processing, and geophysical parameter recovery algorithms.

AERO 7410/7416 LIGHT-FIELD IMAGING (3) LEC. 3. Pr. AERO 7160 or AERO 7166. Departmental approval. An introduction to light-field imaging. Topics include light parameterization, light field cameras, computational photography and Fourier slice photography theorem. May count either AERO 7410 or AERO 7416.

AERO 7420/7426 PARTICLE IMAGE VELOCIMETRY (3) LEC. 3. Pr. AERO 7120 or AERO 7126. Departmental approval. An introduction to particle image velocimetry and it variations including conventional planar PIV, stereo PIV, stereo-PIV and torno-PIV. May count either AERO 7420 or AERO 7426.


AERO 7510/7516 THRUST GENERATION (3) LEC. 3. Pr. AERO 4510. Aerothermodynamics of propulsion. Selected topics in gas dynamics, thermodynamics, and heat transfer as applied to airbreathing and space propulsion.


AERO 7616 ADVANCED AEROSTRUCTURES (3) LEC. 3. Pr. AERO 4620. Departmental approval. Development of the fundamental principles of the analysis of non-linear problems in solid mechanics. Structural problems involving non-linear deflections and/or material properties.

AERO 7620/7626 AEROSPACE COMPUTATIONAL STRUCTURAL ANALYSIS: STATIC STRUCTURES (3) LEC. 3. Pr. AERO 4620. Departmental approval. Advanced techniques for the numerical solution of static elastic and plastic problems, including two and three dimensional solutions.

AERO 7630/7636 AEROSPACE COMPUTATIONAL STRUCTURAL ANALYSIS: STRUCTURAL DYNAMICS (3) LEC. 3. Pr. AERO 4630. Departmental approval. Advanced techniques for the numerical solution to problems in structural dynamics, including steady state and transient response of two-and three-dimensional structures.

AERO 7646 ADAPTIVE AEROSTRUCTURES (3) LEC. 3. Departmental approval. Basic material and manufacturing information for materials employed in adaptive structures. Shape-memory, magnetostrictive, magnetorheological-electrorheological and piezoelectric materials are examined.

AERO 7660/7666 AEROLASTICITY (3) LEC. 3. Pr. AERO 4630. Introduction to the field of aeroelasticity and the interaction therein of structural mechanics and fluid mechanics with dynamics as the "interface adhesive" between them. Flutter, divergence, aileron reversal and related phenomena.

AERO 7676 INTRODUCTION TO LARGE SPACE STRUCTURES (3) LEC. 3. Pr. AERO 4630. Large space structures and their unique concepts, novel on-earth testing requirements, variety of damping schemes and analysis techniques. Concepts and analysis related to shape control, active and passive damping, and structural dynamics/controls interaction.

AERO 7950 SEMINAR (0) SEM. 0. SU. Weekly lectures on current developments in aerospace sciences by staff members, graduate students, and visiting scientists and engineers. Course may be repeated for a maximum of 1 credit hours.

AERO 7970/7976 SPECIAL TOPICS IN AEROSPACE ENGINEERING (1-3) LEC. Course may be repeated for a maximum of 9 credit hours.

AERO 7980/7986 AEROSPACE ENGINEERING PROJECT (3) LEC. 3. SU. Departmental approval. Intended for students in the MAE program. On or off-campus project. The nature of the project is to be determined by the student's major professor. Approval of the project and its final written report by the student's advisory committee is required. Course may be repeated with change in topic.

AERO 7990/7996 RESEARCH AND THESIS (1-10) MST. Credit hours to be arranged. Course may be repeated with change in topics.

AERO 8990/8996 RESEARCH AND DISSERTATION (1-10) DSR. Course may be repeated with change in topics.

Curriculum in Aerospace Engineering

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Fall</th>
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<tr>
<td>CHEM 1030 Fundamentals Chemistry I</td>
<td>3</td>
<td>ENGL 1120 English Composition II</td>
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<td>CHEM 1031 Fundamental Chemistry I Laboratory</td>
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<td>PHYS 1600 Engineering Physics I</td>
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<td>MATH 1620 Calculus II</td>
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<td>Core History(^1)</td>
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<td>ENGR 1110 Introduction to Engineering</td>
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<td>ENGR 1100 Engineering Orientation</td>
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<tr>
<td>COMP 1200 Introduction to Computing for Engineers and Scientists</td>
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\(^1\) Core History or 0 credit. Common Core requirements or elective courses for students majoring in another discipline may be substituted for Core History.
### Sophomore

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<tr>
<td>MATH 2630 Calculus III</td>
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<td>MATH 2660 Topics in Linear Algebra</td>
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<td>MATH 2650 Linear Differential Equations</td>
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<td>ENGR 2070 Mechanics of Materials</td>
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<td>PHYS 1610 Engineering Physics II</td>
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<td>ENGR 2050 Statics</td>
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<td>ENGR 2350 Dynamics</td>
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<td>AERO 2200 Aerospace Fundamentals</td>
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<tr>
<td>MATH 5630 Introduction to Numerical Analysis I</td>
<td>3</td>
<td>AERO 3120 Aerodynamics II</td>
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<td>ELEC 3810 Fundamentals of Electrical Engineering</td>
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<td>AERO 3230 Flight Dynamics</td>
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<td>Core Literature ¹</td>
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<td>AERO 3310 Orbital Mechanics</td>
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<td>AERO 3110 Aerodynamics I</td>
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<td>AERO 3610 Aerospace Structures I</td>
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<td>AERO 3130 Aerodynamics Laboratory</td>
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<td>Core Fine Arts</td>
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<td>AERO 3220 Aerospace Systems</td>
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### Senior

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<td>AERO 4140 Aerodynamics III</td>
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<td>AERO 4630 Aerospace Structural Dynamics</td>
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<td>AERO 4720 Aerospace Design II</td>
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<tr>
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<td>AERO 4AA0 Program Assessment</td>
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<td>UNIV 4AA0 Creed to Succeed</td>
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Total Hours: 125

¹ The AU Bulletin lists the University Core Curriculum requirements for students in the College of Engineering. Students must complete a sequence in either Literature or History.

### Department of Biosystems Engineering

Biosystems Engineers ensure that we have the necessities of life: healthy food to eat, clean water to drink, renewable fuel and energy sources, and a healthy environment in which to live. Therefore, the mission of the Department of Biosystems Engineering at Auburn University is to develop and disseminate engineering knowledge to solve problems in biological systems, natural resources and the environment. It meets the resident instruction portion of that mission through the offering of a degree program which leads to a Bachelor of Biosystems Engineering (BSEN), and another degree that leads to Bachelor of Science in Biological and Agricultural Technology Management (BATM). The four pathways to the BSEN degree program (Biosystems Engineering pathway, Bioprocess Engineering Option, Ecological Engineering Option, and Forest Engineering Option), and the BATM degree program are described below.

### Biosystems Engineering

The Department of Biosystems Engineering offers the only accredited degree in Biosystems Engineering in Alabama. It is committed to preparing students for productive professional careers in the biosystems industries and related natural resource and environmental systems sectors. Specific program educational objectives of the Biosystems Engineering degree program can be found at:

http://eng.auburn.edu/bsen/academics/undergraduate/educational-objectives.html
The Biosystems Engineering program curriculum pathway is coordinated by the Samuel Ginn College of Engineering. Students should apply for admission to the Samuel Ginn College of Engineering and complete the Pre-Biosystems Engineering program.

**Bioprocess Engineering Option**

The focus of the Bioprocess Engineering option is to produce engineers that seamlessly combine engineering and natural sciences to designing and developing systems, processes and equipment that convert biological and agricultural materials to value-added products such as food, nutraceuticals, polymers and pharmaceuticals. Bioprocess engineers provide a bridge between the research lab and the economic, large-scale implementation of technologies used to convert these biological materials to value-added products. The bioprocess engineering option is coordinated by the Samuel Ginn College of Engineering. Students should apply for admission to the Samuel Ginn College of Engineering and complete the Bioprocess Engineering option portion of the Pre-Biosystems Engineering program.

**Ecological Engineering Option**

The Department of Biosystems Engineering offers an option in Ecological Engineering as part of the Bachelor of Biosystems Engineering degree. This option prepares students to solve environmental problems by applying engineering knowledge to natural ecological and biological systems. Ecological engineering combines basic and applied science from engineering, ecology, economics, and natural sciences to design, construct, and manage sustainable ecosystems that have value to both humans and the natural environment. The ecological engineering option is coordinated by the Samuel Ginn College of Engineering. Students should apply for admission to the Samuel Ginn College of Engineering and complete the Ecological Engineering option portion of the Pre-Biosystems Engineering program.

**Forest Engineering Option**

The Department of Biosystems Engineering in conjunction with the Samuel Ginn College of Engineering and School of Forestry and Wildlife Sciences offers an option in Forest Engineering as part of the Bachelor of Biosystems Engineering degree.

This forest engineering option involves preparing graduates to be able to apply of engineering principles and techniques for sustainable management and maintenance of trees, soil, water and other natural resources with the forest ecosystem. Forest engineering is therefore a hybrid of engineering, forest and management that is focused on efficient, cost-effective and environmentally-friendly utilization of these resources. Therefore, this option prepares students for productive professional careers in the forest products industry and related natural resource and environmental systems sector.

The Forest Engineering option is coordinated by the Samuel Ginn College of Engineering and the School of Forestry and Wildlife Sciences, and is administered by the Department of Biosystems Engineering. Students can become registered foresters upon completion of a minor in forest resources. Beginning students should apply to the Samuel Ginn College of Engineering and complete the Forest Engineering option portion of the Pre-Biosystems Engineering program. Students pursuing the Forest Engineering option must meet School of Forestry and Wildlife Sciences requirements for admission to the Forestry Summer Field Practicum.

**Biological and Agricultural Technology Management**

Students enrolled in the Biological and Agricultural Technology Management (BATM) major will take a variety of courses in technology, science and management that will enable them to be practical problem solvers, and be able to manage and develop solutions to the technological challenges of the increasingly complex agricultural and biological systems of the 21st century. The curriculum is also designed such that students can simultaneously obtain a minor in Agronomy and Soils, Stewardship-based Agriculture, Agribusiness, information Systems Management, Technical and Professional Communication, Poultry Science or Business Analytics. The BATM curriculum is coordinated by the College of Agriculture.

/samuelginncollegeofengineering/departmentofbiosystemsengineering/biosystemsengineering_major/ (http://bulletin.auburn.edu/samuelginncollegeofengineering/departmentofbiosystemsengineering/biosystemsengineering_major/)

**Majors**

- Biosystems Engineering (p. 84)
- Biosystems Engineering (Bioprocess Engineering option) (p. 81)
- Biosystems Engineering (Ecological Engineering option) (p. 85)
- Biosystems Engineering (Forest Engineering option) (p. 83)
- Biological and Agricultural Technology Management (http://bulletin.auburn.edu/undergraduate/collegeofagriculture/BioTech_major/)
Bio Ag Technology Management Courses

BATM 1110 INTRODUCTION TO TECHNOLOGY DESIGN (3) LEC. 2. LAB. 3. Introduction to the design process, 2D and 3D parametric solid modeling, and both manual and automated fabrication processes.

BATM 2110 DIGITAL ANALYTICS IN AGRICULTURE AND TECHNOLOGY (3) LEC. 2. LAB. 3. Pr. BATM 1110. An introduction to creative and analytical methods to solve technological problems. Define the problem, explore strategies, select and implement solutions, and evaluate results.

BATM 3100/3103 COMPUTER AIDED DESIGN TECHNOLOGY (3) LEC. 2. LAB. 1. Introductory course in computer aided design (CAD) and land mapping. Students gain competence in CAD operations used to fabricate parts and to develop field- and watershed-scale maps. Class and project topics include drawing for mechanical part fabrication and scale mapping for construction site development and agricultural field management. Must be in Junior standing Course may be repeated for a maximum of 6 credit hours.

BATM 3500 NATURAL RESOURCE SYSTEMS CONSERVATION (3) LEC. 2. LAB. 3. Pr. MATH 1130 or MATH 1133. Natural resource conservation technologies including rainfall-runoff relationships, sediment transport capacity, runoff control structures, water supply development, surveying techniques including GPS methods.

BATM 3510 AGRICULTURAL POWER AND MACHINERY FUNDAMENTALS (3) LEC. 2. LAB. 3. Pr. MATH 1130 or MATH 1133. Power unit fundamentals with emphasis on diesel and small gasoline engines; mechanics of operation, safety, use, and adjustment of machines used for horticultural and agronomic crop production; and precision agricultural principles and technology.

BATM 3530 AGRICULTURAL PRODUCTION AND PROCESSING FACILITY TECHNOLOGY (3) LEC. 3. Pr. MATH 1130 or MATH 1133. Fundamental requirements for the design and operation of agricultural production and processing facilities.

BATM 4100 PROFESSIONAL PRACTICE IN TECHNOLOGY MANAGEMENT (2) LEC. 1. LAB. 3. Pr. BATM 5110. First in the two-course capstone experience. This course focuses on professional topics that prepare students for technical careers; teamwork, communication, standards and codes, economics, project and time management. Teams initiate the capstone design project.

BATM 4110 TECHNOLOGY CAPSTONE (3) LEC. 1. LAB. 6. Pr. BATM 4100. Development and evaluation of a team-based capstone project using tools from the technology curriculum; emphasizing communication, critical thinking, and technical and economic analyses.

BATM 5110 AGRI-INDUSTRIAL ELECTRICAL APPLICATIONS (3) LEC. 2. LAB. 3. Pr. BATM 2110. An introduction to the fundamentals of electricity and electrical systems used in agricultural and industrial applications. Electricity basics include safety, AC (single and three phase) and DC power. Selecting and sizing components include wiring conductors, safety devices, motors, other loads.

BATM 5120 AGRI-INDUSTRIAL ELECTRONICS AND CONTROLS (3) LEC. 2. LAB. 3. Pr. BATM 5110. An introduction to the fundamentals of electronic control systems used in agricultural and industrial production and processing applications. Electronic control system components include programmable logic controllers (PLCs), switches, relays, sensors, and ladder logic.

BATM 6110 AGRI-INDUSTRIAL ELECTRICAL APPLICATIONS (3) LEC. 2. LAB. 3. Departmental approval. An introduction to the fundamentals of electricity and electrical systems used in agricultural and industrial applications. Electricity basics include safety, AC (single and three phase) and DC power. Selecting and sizing components include wiring conductors, safety devices, motors, other loads.

BATM 6120 AGRI-INDUSTRIAL ELECTRONICS AND CONTROLS (3) LEC. 2. LAB. 3. Pr. BATM 6110. An introduction to the fundamentals of electronic control systems used in agricultural and industrial production and processing applications. Electronic control system components include programmable logic controllers (PLCs), switches, relays, sensors, and ladder logic.

Biosystems Engineering Courses

BSEN 2210 ENGINEERING METHODS FOR BIOLOGICAL SYSTEMS (2) LEC. 1. LAB. 3. Pr. (ENGR 1110 or ENGR 1113) and (PHYS 1600 or PHYS 1607) or Departmental approval. Introduction to experimental design methodology, basic engineering design and problem solving methodology for Biological Engineering. Visualization skills, computer-aided 3-D solid modeling of parts, 3-D assembly of solid part geometries, computation of mass properties, 2-D engineering drawings, engineering design process, safety, tools and fabrication processes and design, and hands-on shop fabrication of semester project.
BSEN 2240 BIOLOGICAL AND BIOENVIRONMENTAL HEAT AND MASS TRANSFER (3) LEC. 3. Pr. (MATH 2630 or MATH 2637) and (PHYS 1600 or PHYS 1607) and P/C ENGR 2010. Basic principles of heat and mass transfer with special applications to biological and environmental systems. Introduction to steady state and transient heat conduction. Convection, radiation, diffusion, simultaneous heat and mass transfer, and generation and depletion of heat and mass in biological systems.

BSEN 3210 MECHANICAL POWER FOR BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. ENGR 2010 and MATH 2650 and P/C ENGR 2350. Basic engineering analysis, synthesis, and design concepts applied to power sources, mobile equipment, and machinery applications for agricultural, forestry, and natural resource systems.

BSEN 3230 NATURAL RESOURCE CONSERVATION ENGINEERING (3) LEC. 2. LAB. 3. Pr. BSEN 3110. Departmental approval. Engineering analysis applied to natural resource systems. Design principles and practices in rainfall-runoff relationships, soil erosion and its prediction and control, hydraulic structures, and open channel hydraulics.

BSEN 3240 PROCESS ENGINEERING IN BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. BSEN 2240. Departmental approval. Theory and application of process operations in biological, food and agricultural systems. Heat transfer, fluid flow, thermal processing, evaporation, psychrometrics, refrigeration, drying freezing.

BSEN 3260 ENGINEERING FOR PRECISION AGRICULTURE AND FORESTRY (3) LEC. 2. LAB. 3. Pr. ELEC 3810 and MATH 2650. Departmental approval. Engineering aspects of spatial technologies applied to agricultural and forest production. Data collection in the field using GPS and use of field data in site specific applications. Fall.

BSEN 3310 HYDRAULIC TRANSPORT IN BIOLOGICAL SYSTEMS (4) LEC. 3. LAB. 3. Pr. (ENGR 2050 or ENGR 2053) and MATH 2650 or Departmental approval. Fluid properties, Non-Newtonian fluids and biological systems, Fluid statics, Energy equation, mass and momentum balance, pipe flow for Newtonian and Non-Newtonian fluids, dimensional analysis, compressible flows.

BSEN 3560 TURF SYSTEMS IRRIGATION DESIGN (3) LEC. 3. Pr. MATH 1120. Irrigation system design for turf-based systems including residential lawns, commercial properties, athletic fields, and golf courses. Irrigation scheduling and water demand are presented to provide management capabilities.

BSEN 3610 INSTRUMENTATION AND CONTROLS FOR BIOLOGICAL SYSTEMS (3) LEC. 2. LAB. 3. Pr. MATH 2650 and BSEN 2240. Departmental approval. Understanding of fundamentals of electrical circuits, sensing and sensors, simple digital electronics, analog measurement circuits, introductory digital signal processing, computer data acquisition.

BSEN 4200 POLYMERS FROM RENEWABLE RESOURCES (2) LEC. 2. Fundamental aspects of natural, biodegradable polymers, including fibers, adhesives, films and coatings, their synthesis, their structure/properties relationships, and the microbiology of their degradation.

BSEN 4210 IRRIGATION SYSTEM DESIGN (3) LEC. 2. LAB. 3. Pr. BSEN 3240. Departmental approval. Theory and design of irrigation systems for the application of water and wastewater including surveying techniques for system design. Systems include solid-set, traveler, center-pivot, and trickle. Fall.

BSEN 4240 BULK BIOLOGICAL SOLIDS BEHAVIOR AND PROCESSING (3) LEC. 2. LAB. 3. Pr. BIOL 1020 and (STAT 2510 or STAT 3010 or BSEN 3310). The course is designed to enable students to develop fundamental understanding of the properties of bulk biological solids and how these properties influence the behavior and processability of bulk solids.

BSEN 4250 HYDRAULIC CONTROL SYSTEMS DESIGN (3) LEC. 2. LAB. 3. Pr. BSEN 3310 or Departmental approval. Principles of energy transfer by means of fluid power. Design of hydraulic control systems using prime movers, valves, actuators, and accessories. Spring.

BSEN 4300 PROFESSIONAL PRACTICE IN BIOSYSTEMS ENGINEERING (2) LEC. 1. LAB. 3. Pr. ENGR 2070 and (BSEN 4240 or BSEN 3240). This course focuses on issues related to the professional practice of biological engineering including preparing students for transition to careers as professional engineers.

BSEN 4310 ENGINEERING DESIGN FOR BIOSYSTEMS (3) LEC. 1. LAB. 6. Pr. BSEN 4300. Departmental approval. Capstone design course in biosystems engineering emphasizing teamwork, communication, safety engineering, and economic analysis to complete an engineering design project. Spring.

BSEN 4960 SPECIAL PROBLEMS IN BIOSYSTEMS ENGINEERING (1-4) AAB/IND. Departmental approval. Faculty supervision of individual student investigations of specialized problems in biosystems engineering. May be repeated with change in problem. Course may be repeated with change in topics.
BSEN 4967 HONORS SPECIAL PROBLEMS (1-3) IND. Pr. Honors College. Course may be repeated for a maximum of 3 credit hours.

BSEN 4970 SPECIAL TOPICS IN BIOSYSTEMS ENGINEERING (1-4) LEC. Departmental approval. Individual or small group study of a specialized area in biosystems engineering. Course may be repeated for a maximum of 12 credit hours.

BSEN 4980 UNDERGRADUATE RESEARCH (2-4) IND. Departmental approval. Directed research in the area of specialty within the department. Course may be repeated for a maximum of 4 credit hours.

BSEN 4997 HONORS THESIS (1-3) IND. Pr. Honors College. Course may be repeated for a maximum of 3 credit hours.

BSEN 5220 GEOSPATIAL TECHNOLOGIES IN BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. STAT 2510 or STAT 2513 or STAT 2610 or STAT 3010 or CSES 2040 or CSES 2043 or AGRN 2040 or AGRN 2043 or Departmental approval. Geospatial technologies including GPS, GIS, and remote sensing systems applied to biosystems. Collecting, managing, and analyzing spatial data for agricultural and forest systems. Spring.

BSEN 5230 WASTE MANAGEMENT AND UTILIZATION FOR BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. (CHEM 1040 and BIOL 3200) and (P/C BSEN 3230 or P/C BSEN 4240). Introduction to animal waste management problems of confined production systems, and characterization of animal waste types. Design of biological treatment and processing systems. Departmental approval. May count either BSEN 5230 or BSEN 6230.

BSEN 5250 DETERMINISTIC MODELING FOR BIOSYSTEMS (3) LEC. 3. LAB. 2. Pr. MATH 2650. Modeling of biosystems, methods to deal with complexity, and validation tools.

BSEN 5260 RENEWABLE ENERGY IN BIOSYSTEMS PROCESS OPERATIONS (3) LEC. 2. LAB. 3. Pr. BSEN 3310. Application and use of renewable energy in biological, food, forest and agricultural systems including bioenergy, solar energy, wind power and geothermal. Departmental approval. May count either BSEN 5260 or BSEN 6260.

BSEN 5270 METABOLIC ENGINEERING FOR BIOPROCESS (3) LEC. 3. Pr. BIOL 3200 and CHEM 1040. Or with the consent of the instructor. Introduction of basic principles of bioprocess engineering and metabolic engineering, to prepare engineers and scientists for biotechnology and bioeconomy industries.

BSEN 5280 LIFE-CYCLE ASSESSMENT FOR BIOLOGICAL SYSTEMS (3) LEC. 2. LAB. 3. Pr. BSEN 2240 and BSEN 3310. Introduces the concept of life cycle assessment (LCA) in in the context of biological engineering. Examples will include LCA applications to engineered biological systems and other engineering processes and products.

BSEN 5450 COMMERCIAL POULTRY & LIVESTOCK HOUSING (3) LEC. 2. LAB. 3. An introduction to the basic design, operation, and maintenance of modern commercial animal housing systems. Emphasis will be placed on poultry and swine systems with elements of dairy and beef when applicable.

BSEN 5510 ECOLOGICAL ENGINEERING (3) LEC. 3. Pr. BSEN 3230. Ecological engineering non-point source transport of nutrients, sediment, pesticides, pathogens, and chemicals from agricultural, forestry, and urban activities. Departmental approval. May count either BSEN 5510 or BSEN 6510.

BSEN 5520 WATERSHED MODELING (3) LEC. 3. Pr. BSEN 5510. Modeling of non-point source pollution at watershed scale using Soil and Water Assessment Tool model including underlying processes that control movement of pollutants. Departmental approval. May count either BSEN 5520 or BSEN 6520.

BSEN 5540 BIOMASS AND BIOFUELS ENGINEERING (3) LEC. 2. LAB. 3. Pr. CHEM 1040 and MATH 2650 and BSEN 3310. This course introduces the various processes and engineering principles in converting biomass into biofuels and chemicals. The focus will be on thermochemical and biochemical conversion platforms. May count either BSEN 5540 or BSEN 6540.

BSEN 5550 PRINCIPLES OF FOOD ENGINEERING TECHNOLOGY (4) LEC. 3. LAB. 3. Pr. (MATH 1130 or MATH 1133 or MATH 1150 or MATH 1153 or MATH 1610 or MATH 1613 or MATH 1617) and (PHYS 1000 or PHYS 1007) or PHYS 1500 or (PHYS 1600 or PHYS 1607). Engineering concepts and unit operations used in processing food products. Fall.

BSEN 5560 SITE DESIGN FOR BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. BSEN 3230. Development of student skills in computer-aided site design and restoration by using rural and urban best management practices to reduce environmental impacts. Departmental approval. May count either BSEN 5560 or BSEN 6560.
BSEN 6220 GEOSPATIAL TECHNOLOGIES IN BIOSYSTEMS (3) LEC. 2. LAB. 3. Departmental approval. Geospatial technologies including GPS, GIS, and remote sensing systems applied to biosystems. Collecting, managing, and analyzing spatial data for agricultural and forest systems. Spring.

BSEN 6230 WASTE MANAGEMENT AND UTILIZATION FOR BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. CHEM 1040 or CHEM 1041. Departmental approval. Coreq. BSEN 3230. Introduction to the animal waste management problems of confined production systems and characterization of animal waste types. Design of biological treatment and processing systems.

BSEN 6250 DETERMINISTIC MODELING FOR BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. MATH 2650. Modeling of biosystems, methods to deal with complexity, and validation tools.

BSEN 6260 RENEWABLE ENERGY IN BIOSYSTEMS PROCESS OPERATIONS (3) LEC. 2. LAB. 3. Pr. BSEN 3310. Departmental approval. Application and use of renewable energy in biological, food forest and agricultural systems including biomass and bioenergy, solar energy, wind power and geothermal.

BSEN 6270 METABOLIC ENGINEERING FOR BIOPROCESS (3) LEC. 3. Department/instructor approval. An introduction of basic principles of bioprocess engineering and metabolic engineering, to prepare engineers and scientists for biotechnology and bioeconomy industries. May count either BSEN 5270 or BSE 6270.

BSEN 6280 LIFE-CYCLE ASSESSMENT FOR BIOLOGICAL SYSTEMS (3) LEC. 2. LAB. 3. Pr. BSEN 2240. Departmental approval. This course introduces the concept of life cycle assessment (LCA) in the context of biological engineering. Examples will include LCA applications to engineered biological systems and other engineering processes and products.

BSEN 6450 COMMERCIAL POULTRY AND LIVESTOCK HOUSING (3) LEC. 2. LAB. 3. An introduction to the basic design, operation, and maintenance of modern commercial animal housing systems. Emphasis will be placed on poultry and swine systems with elements of dairy and beef when applicable.

BSEN 6510 ECOLOGICAL ENGINEERING (3) LEC. 3. Pr. BSEN 3230. Departmental approval. The course introduces students to ecological engineering non-point source transport of nutrients, sediment, pesticides, pathogens, and chemicals from agricultural, forestry, and urban activities.

BSEN 6520 WATERSHED MODELING (3) LEC. 3. Departmental approval. The course covers modeling of non-point source pollution at the watershed scale using Soil and Water Assessment Tool model including underlying processes that control movement of pollutants.

BSEN 6540 BIOMASS AND BIOFUELS ENGINEERING (3) LEC. 2. LAB. 3. This course introduces the various processes and engineering principles in converting biomass into biofuels and chemicals. The focus will be on thermochemical and biochemical conversion platforms. May count either BSEN 5540 or BSEN 6540.

BSEN 6550 PRINCIPLES OF FOOD ENGINEERING TECHNOLOGY (4) LEC. 3. LAB. 3. Pr. (MATH 1130 or MATH 1133) and (PHYS 1000 or PHYS 1007). Engineering concepts and unit operations used in processing food products. Fall.

BSEN 6560 SITE DESIGN FOR BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. BSEN 3230. Departmental approval. The course is designed to develop student skills in computer-aided site design and restoration by using rural and urban best management practices to reduce environmental impacts.

BSEN 7016 QUANTITATIVE AGRICULTURAL REMOTE SENSING (3) LEC. 3. Departmental approval. Theory and application of remote sensing to quantifying soil and vegetation characteristics, with emphasis on agriculture but also relevant to natural biosystems.

BSEN 7020/7026 SITE-SPECIFIC TECHNOLOGIES FOR AGRICULTURE AND FORESTRY SYSTEMS (3) LEC. 2. LAB. 3. Departmental approval. Introduction to advanced concepts of off-highway vehicle equipment for use in agricultural and forestry production with emphasis on site-specific management (Precision Agriculture/Forestry). The course will overview new concepts and technologies for equipment usage and technologies applied for site-specific crop management.

BSEN 7050 SOIL DYNAMICS OF TILLAGE AND TRACTION (3) LEC. 3. Pr. CIVL 4300 and CSES 7590. Departmental approval. Analyses and measurements of soil reactions as affected by physical properties of soil when subjected to forces imposed by tillage implements and traction devices.
BSEN 7110/7116 FUNDAMENTALS OF INSTRUMENTATION FOR BIOLOGICAL SYSTEMS (3) LEC. 2. LAB. 3. Departmental approval. Students will gain an understanding of the fundamentals of sensing and sensors, simple digital electronics and measurement circuits, introductory digital signal processing, and computer data acquisition. They will be required to build and test instrumentation to collect data on biological systems that might include fluid flow, pressure, force, or other transducers.

BSEN 7120 STOCHASTIC MODELING FOR BIOSYSTEMS (3) LEC. 3. Pr. CIVL 3020. Departmental approval. Solving problems in biosystems engineering and related fields by modeling data with probability distributions, spatial statistics, autoregressive models, Monte-Carlo simulation, and reliability methods.

BSEN 7136 GIS APPLICATIONS IN PRECISION AGRICULTURE (1) LEC. 1. Departmental approval. Exploration of geographic information systems (GIS) and its applications in precision agriculture. Topics include file structure and formatting, interfacing with precision agriculture equipment, georeferencing maps, merging and clipping farm data, data field calculations, designing management zones, variable rate prescriptions, and basic data analysis.

BSEN 7140 ALGAE SYSTEMS ENGINEERING (3) LEC. 2. LAB. 1. This course is a study of engineered systems for cultivating algae for various uses in society. To develop an understanding of engineering principles applied to growing, cultivating, and producing algal biomass for a number of applications, study into the biology, physiology, and ecology of algae and similar species will be a major part of the course. Departmental Approval.

BSEN 7216 BIOMASS TO RENEWABLE ENERGY PROCESSES (3) LEC. 3. Pr. (CHEM 2070 or CHEM 2077) and (CHEM 2080 or CHEM 2087) or CHEM 5180 and BIOL 3200. Departmental approval. This will introduce fundamental principles and practical applications of biomass-to-renewable energy processes.

BSEN 7220 RENEWABLE ENERGY SYSTEMS DESIGN, ANALYSIS AND APPLICATIONS (3) LEC. 3. Understanding of the basic principles, applications, modeling, energetic and economic analysis of renewable energy resources namely solar, biomass, wind, hydropower and geothermal. Design of renewable energy systems.

BSEN 7240 BULK SOLIDS STORAGE, HANDLING AND TRANSPORTATION (3) LEC. 3. Sampling of particulate materials, bulk solids characterization, flow properties, particle and bulk solid flow, dynamics of fluid/solids systems, hydraulic and pneumatic conveyor design, storage bin and hopper design and geometry, safety issues.

BSEN 7260 ADVANCED UNIT OPERATIONS IN BIOSYSTEMS ENGINEERING (3) LEC. 2. LAB. 3. The course is an advance analysis of the unit operations used to process and enhance the value of biological materials.

BSEN 7280 FOOD THERMAL PROCESSING (3) LEC. 2. LAB. 3. Departmental approval. Insight of technologies and approaches used in food thermal processing for commercial purposes. Application of fundamentals of heat transfer, thermo-bacteriology, physical and chemical kinetics of food, and plant layout.

BSEN 7310 NONPOINT SOURCE POLLUTION (3) LEC. 3. Departmental approval. Non-point source (NPS) transport of nutrients, sediment, pesticides, and pathogens from agricultural, forestry, and urban activities. Basic concepts of pollutant transport through soils and with overland flow. Evaluation, management, and prevention of non-point pollution of surface and groundwater.

BSEN 7320 NON-POINT SOURCE POLLUTION MODELING (3) LEC. 3. Pr. BSEN 7310 or Departmental approval. Non-point source (NPS) modeling of nutrients, sediment, pesticides, and pathogens from agricultural, forestry, and urban activities. Underlying processes (climate, hydrology, nutrients and pesticides, erosion, channel), land cover/plants best management practices. Sensitivity and uncertainty analyses.

BSEN 7330 SOIL-PLANT-ENVIRONMENTAL SYSTEM DESIGN SOIL-PLANT-ENVIRONMENTAL SYSTEM DESIGN (3) LEC. 3. Study of systems that incorporate plant uptake of nutrients and/or heavy metals for remediation of soil-based contaminants. Design applications of environmental remediation include constructed wetlands, drip irrigation of wastewater effluent, disposal of municipal sludge, and phytoremediation of contaminants in shallow groundwater.

BSEN 7350 ENGINEERING ANALYSIS OF LAKES AND RESERVOIRS (3) LEC. 3. Departmental approval. Knowledge and understanding of the causes, impacts, and methods of restoring water quality impairments, with emphasis placed on impounded water bodies and perennial streams.

BSEN 7366 INTEGRATING AUTOCAD CIVIL3D & GIS (3) LEC. 3. Departmental approval. Accessing and importing GIS data into C3D. Exporting C3D objects to GIS for subsequent manipulation and display. Emphasis on applications in environmental engineering projects such as stream restoration and wetland design.

BSEN 7516 INTRODUCTION TO LAND AND WATER ENGINEERING (3) LEC. 3. This course aims at equipping students with the engineering tools and knowledge needed for advanced courses in land and water engineering.

BSEN 7526 INTRODUCTION TO FLUVIAL GEOMORPHOLOGY (3) LEC. 3. Pr. BSEN 3230. This course provides an overview of stream geomorphology as it relates to natural stream physical processes.

BSEN 7536 DRAINMOD (3) LEC. 3. Pr. BSEN 3230. This course presents the principles of water movement and fate in shallow water table systems and application of the drainage water management model DRAINMOD to a wide variety of problems.

BSEN 7616 AGRICULTURAL WASTE MANAGEMENT (3) LEC. 3. This course covers principles of managing, handling, treating and applying animal and poultry manures and organic byproducts from an engineering perspective. Departmental approval

BSEN 7626 STORMWATER BMP DESIGN (3) LEC. 3. Pr. BSEN 3230. Departmental approval. This course is designed to introduce students to several innovative stormwater practices including stormwater wetlands, bioretention, green roofs, permeable pavement, cisterns, and others.

BSEN 7636 STREAM RESTORATION STRUCTURE RISK AND FAILURE ASSESS (1) LEC. 1. Pr. BSEN 3230. Departmental approval. Critical thinking about the use of various stream restoration structures an providing the tools needed to investigate further into failure analysis and risk assessment.

BSEN 7646 OPEN CHANNEL HYDRAULICS (3) LEC. 3. Pr. BSEN 3310. Departmental approval. Theory and application of hydraulics in open channels with an emphasis on natural systems (natural streams and rivers).

BSEN 7666 WETLANDS DESIGN AND RESTORATION (3) LEC. 3. Departmental approval. Fundamental understanding of hydrology, soils and ecology of natural wetland systems to serve as the basis of designing wetland systems for water treatment and restoring degraded natural wetlands.

BSEN 7900 SPECIAL PROBLEMS IN BIOSYSTEMS ENGINEERING (1-4) IND. Departmental approval. Faculty supervision of individual student investigations of advanced specialized problems in biosystems engineering at the graduate level. Pr., Course may be repeated with change in topics.

BSEN 7950 SEMINAR (1) SEM. SU. Reviews and discussions of research techniques, current scientific literature, and recent developments in biosystems engineering. Course may be repeated for a maximum of 12 credit hours.

BSEN 7970 SPECIAL TOPICS IN BIOSYSTEMS ENGINEERING (1-4) IND. Departmental approval. Individual or small group study of an advanced specialized area in biosystems engineering at the graduate level. Course may be repeated with change in topics.

BSEN 7990 RESEARCH AND THESIS (1-10) MST. Course may be repeated with change in topic.

BSEN 8990 RESEARCH AND DISSERTATION (1-12) DSR.

Biosystems Engineering (Bioprocess Engineering Option) - BBSE

Freshman

Fall

CHEM 1030 Fundamentals Chemistry I 3
CHEM 1031 Fundamental Chemistry I Laboratory 1
COMP 1200 Introduction to Computing for Engineers and Scientists 2
MATH 1610 Calculus I 4
HIST 1210 Technology and Civilization I or 1010 World History I 3
ENGL 1100 English Composition I 3

Spring

ENGL 1120 English Composition II 3
PHYS 1600 Engineering Physics I 4
ENGR 1110 Introduction to Engineering 2
MATH 1620 Calculus II 4
HIST 1220 Technology And Civilization II or 1020 World History II 3
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<td>BSEN 2210 Engineering Methods for Biological Systems</td>
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<td>ENGR 2010 Thermodynamics</td>
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<td>BIOL 1030 Organismal Biology</td>
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<td>BSEN 5540 Biomass and Biofuels Engineering</td>
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<td>BSEN 4300 Professional Practice in Biosystems Engineering</td>
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<td>PHIL 1020 Introduction to Ethics or 1040 Business Ethics</td>
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<td>BSEN 5220 Geospatial Technologies in Biosystems</td>
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1. The AU Bulletin lists the University Core Curriculum requirements for students in the College of Engineering. Students must complete a sequence in either Literature or History. Biosystems Engineering should complete the World History or Technology and Civilization Course sequence to ensure that all SLOs are met by students by the time of graduation.
2. ECON 2020 preferred.
Approved list of Bioprocess Engineering electives.
- BSEN 4970: Metabolic Engineering for Bioprocess
- BSEN 5260: Renewable Energy Engineering in Biosystems
- BSEN 5220: Geospatial Tech for Biosystems
- BSEN 5450 Commercial Poultry and Livestock Housing
- CHEN 3660: Chemical Engineering Separations
- CHEN 3380: Phase and Reaction Equilibria
- MATL 5700 Biomaterials
- MATL 5720 Biomedical Applications of Polymers
- MATL 5750 Microstructure and Mechanics of Skeletal Tissues
- PFEN 3100 Fundamentals of Polymers
- PFEN 4200 Polymers from Renewable Resources
- INSY 3600: Engineering Economy

Curriculum in Biosystem Engineering (Forest Engineering option)

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<td>COMP 1200 Introduction to</td>
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### Junior

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<th>Course</th>
<th>Hours</th>
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<tbody>
<tr>
<td>BSEN 3210 <strong>Mechanical Power for Biosystems</strong></td>
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<td>BSEN 3230 <strong>Natural Resource Conservation Engineering</strong></td>
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<td>FORY 3180 Forest Resource Sampling</td>
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<td>CIVL 3310 <strong>Geotechnical Engineering I</strong></td>
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<td>FORY 3100 Dendrology</td>
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<tr>
<td>BSEN 3310 <strong>Hydraulic Transport in Biological Systems</strong></td>
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**Total Hours:** 13

### Senior

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<td>BSEN 4310 <strong>Engineering Design for Biosystems</strong></td>
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<tr>
<td>FOEN 5710 <strong>Operations Analysis in Biosystems and Forestry</strong></td>
<td>3</td>
<td>PHIL 1040 Business Ethics or 1020 Introduction to Ethics</td>
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<td>FORY 5230 <strong>Silviculture</strong></td>
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**Total Hours:** 15

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1. The AU Bulletin lists the University Core Curriculum requirements for students in the College of Engineering. Students must complete a sequence in either Literature or History. Biosystems Engineering should complete the World History or Technology and Civilization Course sequence to ensure that all SLOs are met by students by the time of graduation.

2. ECON 2020 preferred.

**Forest Engineering Elective:** see adviser for approved course listing.

### Curriculum in Biosystems Engineering

### Freshman

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<thead>
<tr>
<th>Course</th>
<th>Hours</th>
<th>Course</th>
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<td>ENGR 1100 <strong>Engineering Orientation</strong></td>
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<tr>
<td>MATH 1610 Calculus I</td>
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<td>HIST 1220 Technology And Civilization II or 1020 World History II</td>
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<tr>
<td>HIST 1210 Technology and Civilization I or 1010 World History I</td>
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<td>MATH 1620 Calculus II</td>
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<td>COMP 1200 Introduction to Computing for Engineers and Scientists</td>
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**Total Hours:** 16
### Sophomore

**Fall**

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<td>ENGR 2050 Statics</td>
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<td>ENGR 2350 Dynamics</td>
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<td>BSEN 2210 Engineering Methods for Biological Systems</td>
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16

**Spring**

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### Junior

**Fall**

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<td>BIOL 3200 General Microbiology</td>
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<td>BSEN 3240 Process Engineering in Biosystems</td>
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<td>BIOL 3201 General Microbiology Laboratory</td>
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15

**Spring**

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<tr>
<td>BSEN 3210 Mechanical Power for Biosystems</td>
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<td>BSEN 4210 Irrigation System Design</td>
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<td>BSEN 4300 Professional Practice in Biosystems Engineering</td>
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<tr>
<td>PHIL 1040 Business Ethics or 1020 Introduction to Ethics</td>
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<td>BSEN 5220 Geospatial Technologies in Biosystems</td>
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17

### Senior

**Fall**

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<th>Course/Title</th>
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<tbody>
<tr>
<td>BSEN 3210 Mechanical Power for Biosystems</td>
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<td>BSEN 4210 Irrigation System Design</td>
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<td>BSEN 5220 Geospatial Technologies in Biosystems</td>
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17

Total Hours: 126

1 The AU Bulletin lists the University Core Curriculum requirements for students in the College of Engineering. Students must complete a sequence in either Literature or History. Biosystems Engineering should complete the World History or Technology and Civilization Course sequence to ensure that all SLOs are met by students by the time of graduation.

2 ECON 2020 preferred.

Biosystems Electives: see adviser for approved course listing.

### Curriculum in Biosystems Engineering (Ecological Engineering option)
### Freshman

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<thead>
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<th>Fall</th>
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<tbody>
<tr>
<td>CHEM 1030 Fundamentals Chemistry I</td>
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<td>ENGR 1110 Introduction to Engineering</td>
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<td>HIST 1220 Technology And Civilization II or 1020 World History II</td>
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### Sophomore

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<td>BIOL 1020 Principles of Biology</td>
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### Junior

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### Senior

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<td>BSEN 5520 Watershed Modeling</td>
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Chemical Engineering

Chemical engineers contribute to society through the useful application of knowledge and understanding of chemistry, physics, biology, and mathematics. Chemical engineers traditionally have participated in many decisions crucial to the preservation and improvement of society, including energy, fuel, commodity chemical and food production, resource management, and the design of necessary pollution control measures. Emerging new areas such as biotechnology, space technology, nanofabrication technology, semiconductor devices and modern construction materials also utilize the unique capabilities of the chemical engineer. Many technologies to improve public health depend significantly on chemical engineering such as biomaterials, biomedical devices, medical diagnostics, the chemical design and synthesis of drugs, the genetic engineering of therapeutic materials, drug delivery systems and medical imaging technology. Finally, chemical engineering plays an essential role in important environmental technologies such as atmospheric chemistry, product life cycle analysis, bioremediation, environmental risk and impact analysis, environmental friendly manufacturing technology and products, separation and conversion technologies for waste reduction and the cleanup of contaminated sites.

The instructional mission of the department is to provide its chemical engineering graduates with the tools, skills and competencies necessary to understand and apply today's technologies and, through life-long learning, successfully develop and employ tomorrow's technologies.

The Program Educational Objectives and Student Outcomes can be found at the following URL:

http://www.eng.auburn.edu/chen/academics/undergraduate/educational-objectives-outcomes.html

Because of their broad training and education, chemical engineers contribute to society in many functions, such as pure research, development, environmental protection, process design, plant operation and manufacturing, marketing, sales, and corporate or government administration.

The program is specially designed to assure all students have demonstrated capabilities in the core chemical engineering topics including material and energy balances, thermodynamics, chemical equilibria, heat, mass and momentum transfer, chemical reaction engineering, continuous and stagewise separation operations, process dynamics, statistics and control. The design experience is interwoven throughout the curriculum from elementary design principles in material and energy balances to the capstone senior process design and process control sequence employing advanced computer process and control simulators and experimental control systems.

The curriculum is specifically designed to enable graduates to model and design chemical and physical processes, design and conduct experiments, analyze and interpret chemical engineering data, and to determine capital and operating costs for chemical and physical processes. The curriculum prepares graduates to understand the need for professional integrity and ethical decision making in the practice of chemical engineering as well as providing an understanding of contemporary issues including business practices, environmental, health, and safety and other public interests. Students are also prepared for graduate study in chemical engineering, medicine, business and law.

Because of the breadth of chemical engineering opportunities, the department offers a number of specially designed program specializations that provide unique training and course selection to those students who wish to concentrate in a particular area or technology. The current program specializations are biochemical engineering, biomedical engineering, computer-aided chemical engineering, environmental chemical engineering, pre-medicine specialization and pulp, paper and bio-resource engineering.

Biochemical Engineering Specialization

Chemical engineers trained in biochemical engineering and biotechnology are the key to successful commercialization of new biologically based processes ranging from high value pharmaceuticals to new food processes. This program specialization provides a
strong biology and chemistry fundamental background for graduate work in biochemical engineering and a plan of study to meet these objectives.

Students in this specialization take CHEN 5800 and Biochemical Engineering Technical Electives (9 hours). These courses replace Technical Electives I-IV.

**Biomedical Engineering Specialization**

This specialization provides the necessary preparation for students wanting to do graduate work in biomedical engineering or work in a career with an emphasis of medical applications of chemical engineering.

Students in this specialization take:

<table>
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<td>PHIL 1030</td>
<td>Ethics and the Health Sciences</td>
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<td>CHEN 5810</td>
<td>Biomedical Engineering</td>
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<td>or CHEN 5970</td>
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Students in this specialization are required to take either CHEN 5810 Biomedical Engineering or CHEN 5970 with the specific title Cell & Tissue Engineering. These courses replace Technical Electives I-IV and PHIL 1040.

**Computer-Aided Chemical Engineering Specialization**

Chemical engineers with expertise in the application of advanced computer-aided tools in areas like process systems engineering, process control, and advanced process technology are highly sought after by all process industries. The program specialization provides appropriate courses for an individual with interests in advanced use of computers for solving chemical and biological engineering problems.

Students in this specialization take Computer-Aided Chemical Engineering Technical Electives (12 hours). These courses replace Technical Electives I-IV.

**Environmental Chemical Engineering Specialization**

The environmental specialization in chemical engineering prepares students for careers in the expanding environmental arena. Students specializing in this area learn about the chemical processes and reactions that affect the environment, pollution prevention, the latest standards for air, water and land quality, as well as, hazardous materials management. This specialization prepares students for environmental positions in a broad range of manufacturing and service industries all of which must comply with increasingly complex environmental standards, and in various state and federal agencies.

Students in this specialization take Environmental Chemical Engineering Technical Electives (12 hours). These courses replace Technical Electives I-IV.

**Pre-Medicine Specialization**

This specialization provides the necessary preparation for students wanting to go to medical school. A Pre-Med series of courses, when completed, provides a chemical engineering degree while simultaneously meeting medical school requirements.

Students in this specialization take:

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<td>or CHEN 5970</td>
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In the table above CHEN 5970 is listed as Advanced Special Topics in Chemical Engineering, which is the generic title for CHEN 5970. Students in this specialization are required to take either CHEN 5810 Biomedical Engineering or CHEN 5970 with the specific title Cell.
& Tissue Engineering. These courses replace Technical Electives I-IV and PHIL 1040. Students in this program specialization who are interested in medical school must also work with the director for Pre-Health Professions in the College of Science and Mathematics.

**Pulp, Paper and Bio-Resource Engineering Specialization**

This specialization prepares students for challenging and rewarding careers in the pulp, paper and bio-resource industries. These industries are unique in being capable of sustainable development with a renewable raw material base, recyclable products, and processing technology able to achieve energy self-sufficiency and environmental compatibility. This specialization prepares students for a broad range of career paths in process engineering, product development, bio-technology and sustainable engineering.

Students in this specialization take:

<table>
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<td>CHEN 4100</td>
<td>Pulp and Paper Processing Laboratory</td>
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<td>Biochemical Engineering</td>
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These courses replace Technical Electives I-IV.

**Major**

- Chemical Engineering (p. 95)

**Courses**

**CHEN 2100 PRINCIPLES OF CHEMICAL ENGINEERING** (4) LEC. 3. LAB. 3. Pr. (CHEM 1110 or CHEM 1117 or CHEM 1030 or CHEM 1033) and (MATH 1610 or MATH 1613 or MATH 1617) and (P/C CHEM 1120 or P/C CHEM 1127 or P/C CHEM 1040 or P/C CHEM 1043) and (P/C MATH 1620 or MATH 1623 or P/C MATH 1627) and (P/C PHYS 1600 or P/C PHYS 1607). Application of multicomponent material and energy balances to chemical processes involving phase changes and chemical reactions.

**CHEN 2110 CHEMICAL ENGINEERING THERMODYNAMICS** (3) LEC. 3. Pr. (CHEM 1030 or CHEM 1033 or CHEM 1110 or CHEM 1117) and (MATH 1620 or MATH 1623 or MATH 1627) and (CHEN 2100) and (P/C PHYS 1600 or P/C PHYS 1607) and (P/C CHEN 2650). This course is intended to comprehensively introduce the thermodynamics of single- and multi-phase, pure systems, including the first and second laws of thermodynamics, equations of state, simple processes and cycles, and their applications in chemical engineering.

**CHEN 2610 TRANSPORT I** (3) LEC. 3. Pr. (PHYS 1600 or PHYS 1607) and CHEN 2100 and (P/C MATH 2630 or P/C MATH 2637) and (P/C ENGR 2010 or P/C CHEN 2110). CHEN 2100 requires a grade of C or better. Introduction to fluid statics and dynamics; dimensional analysis; compressible and incompressible flows; design of flow systems, introduction to fluid solids transport including fluidization, flow through process media and multiphase flows.

**CHEN 2650 CHEMICAL ENGINEERING APPLICATIONS OF MATHEMATICAL TECHNIQUES** (3) LEC. 3. Pr. CHEN 2100 and P/C CHEN 2610 and (P/C MATH 2630 or P/C MATH 2637) and P/C MATH 2650 and COMP 1200. CHEN 2100 requires a grade of C or better. CHEN 2610 and MATH 2650 are Prerequisites with Concurrency. COMP 1200 should be the Matlab section, if it is possible to specify this. Otherwise just COMP 1200. Application of a broad range of mathematical techniques to chemical engineering problems. Emphasis on engineering significance and interpretation of mathematical operations.

**CHEN 2AA0 CHEMICAL ENGINEERING PROGRESS ASSESSMENT I** (0) LAB. SU. Pr. CHEN 2100. Progress assessment examination in basic science, general chemistry, physics, basic math principles (geometry, algebra), multivariable calculus, chemical engineering process principles (mass and energy balances). Course may be repeated with change in topics.

**CHEN 3090 PULP AND PAPER TECHNOLOGY** (3) LEC. 3. Pr. (CHEM 1030 or CHEM 1110 or CHEM 1117) and ENGR 2010. An introductory course on the technology of pulp and paper manufacturing with emphasis on raw materials, pulping, bleaching, paper making, coating and environmental control. For students with no previous formal pulp and paper background.

**CHEN 3370 PHASE AND REACTION EQUILIBRIA** (3) LEC. 3. Pr. (MATH 2630 or MATH 2637) and (ENGR 2010 or CHEN 2110) and CHEN 2100 and P/C CHEN 3600 and P/C CHEN 2650. Molecular thermodynamics of phase and chemical reaction equilibria including non-ideal thermodynamics and multicomponent applications. (ENGR 2010 and CHEN 2100 require a grade of C or better).
CHEN 3410 CREATIVITY AND CRITICAL THINKING IN ENGINEERING (3) LEC. 3. Application of creativity and critical thinking principles to effectively approach solving engineering problems. Convincing presentation of information to technical audiences.

CHEN 3600 COMPUTER-AIDED CHEMICAL ENGINEERING (3) LEC. 2. LAB. 3. Pr. COMP 1200 and MATH 2650 and CHEN 2610 and P/C CHEN 2650 and (MATH 2630 or MATH 2637) and CHEN 2110 and CHEN 2100. CHEN 2650 is prerequisite with concurrency. General and structured programming concepts, numerical methods, and introductory probability and statistics concepts. Application to chemical engineering problems involving material and energy balances and transport process, data validation, and analysis. (CHEN 2610 requires a grade of C or better).

CHEN 3620 TRANSPORT II (3) LEC. 3. Pr. (MATH 2630 or MATH 2637) and (ENGR 2010 or CHEN 2110) and CHEN 2610 and P/C CHEN 3600 and MATH 2650 and P/C CHEN 2650. Fundamentals and applications of heat and mass transfer in chemical processes including conduction, convection, and radiation, heat exchange, evaporation, chemical reaction gas absorption, drying and humidification. (ENGR 2010 and CHEN 2610 require a grade of C or better).

CHEN 3650 CHEMICAL ENGINEERING ANALYSIS (3) LEC. 2. LAB. 3. Pr. CHEN 2650 and CHEN 3600 and CHEN 3620 and CHEN 2AA0 and MATH 2650 and P/C CHEN 3700. CHEN 2650, CHEN 3600 and CHEN 3620 all require a grade of C or better. Mathematical modeling, analytical, numerical and statistical analysis of chemical processes.

CHEN 3660 CHEMICAL ENGINEERING SEPARATIONS (3) LEC. 3. Pr. CHEN 3370 and CHEN 3620 and CHEN 3600. Separations processes including distillation, extraction, membrane separation, and other separation operations. (CHEN 3370 and CHEN 3620 require a grade of C or better).

CHEN 3700 CHEMICAL REACTION ENGINEERING (3) LEC. 3. Pr. MATH 2650 and CHEN 2610 and (ENGR 2010 or CHEN 2110) and P/C CHEN 3620 and P/C CHEN 3600. Design of chemical reactors with homogeneous reaction systems. (CHEN 2610 and ENGR 2010 require a grade of C or better).

CHEN 3820 CHEMICAL ENGINEERING LABORATORY I (2) LEC. 1. LAB. 3. Pr. CHEN 3600 and CHEN 3620 and MATH 2650. Experimental study of chemical thermodynamics, heat and momentum transfer with analytical, numerical, and statistical analysis.

CHEN 3AA0 CHEMICAL ENGINEERING PROGRESS ASSESSMENT II (0) LAB. SU. Pr. CHEN 2AA0 and P/C CHEN 3370 and P/C CHEN 3650 and CHEN 3700 and CHEN 3600 and CHEN 3660 and CHEN 3700 and CHEN 3600. Fundamentals of computer-aided simulation and synthesis. Process integration and optimization principles including their applications in design, retrofitting and operation of chemical processes. (CHEN 3370, CHEN 3650, CHEN 3660 and CHEN 3700 require a grade of C or better).
CHEN 4470 PROCESS DESIGN PRACTICE (3) LEC. 2. LAB. 3. Pr. CHEN 3AA0 and CHEN 4450 and CHEN 4460 and CHEN 3650 and CHEN 3660 and CHEN 3700 and PHYS 1610. Flow sheet simulation and techno-economic analysis applied to complex, open-ended chemical processes. Screening of alternatives and economic optimizations. Capstone design course.

CHEN 4560 PULP AND PAPER PROCESS SIMULATION (2) LEC. 1. LAB. 3. Pr. (CHEM 2080 or CHEM 2087) and CHEN 3090 and CHEN 3370 and (CHEN 3650 or CHEN 3653) and CHEN 3660 and CHEN 3700 and P/C CHEN 4100 and P/C CHEN 5110. Fundamentals of microcomputer process simulation with applications to the pulp and paper industry. Design of pulp and paper unit operations and small scale processes using commercial simulation software. (CHEN 3090, CHEN 3370, CHEN 3650, CHEN 3660 and CHEN 3700 require a grade of C or better).

CHEN 4570 PULP AND PAPER PROCESS DESIGN (3) LEC. 2. LAB. 3. Pr. CHEN 3AA0 and CHEN 4450 and CHEN 4560. Application of process simulation and process economics to complex, open-ended design, retrofitting and operation problems in pulp and paper. Design of pulp and paper unit operations and processes. Screening of alternatives and economic optimization.

CHEN 4630 INTRODUCTION TO TRANSPORT PHENOMENA (3) LEC. 3. Pr. CHEN 3620 and (CHEN 3650 or CHEN 3653). Application of chemical engineering analysis to momentum, heat and mass transport problems for advanced undergraduate students preparing for graduate school. (CHEN 3620 and CHEN 3650 require a grade of C or better).

CHEN 4860 CHEMICAL ENGINEERING LABORATORY II (2) LEC. 1. LAB. 3. Pr. CHEN 3660 and CHEN 3820 and P/C CHEN 3700 and CHEN 3650 and P/C CHEN 4170. Experimental study of mass transfer, separations and reaction engineering. Emphasis is on open-ended laboratory projects with electronic instrumentation; experimental design with numerical and statistical analysis of data.

CHEN 4880 PULP AND PAPER ENGINEERING LABORATORY (3) LAB. 9. Pr. CHEN 4100 and CHEN 5110. Comprehensive open-ended projects on pulp and paper topics.

CHEN 4930 DIRECTED STUDIES (1) LEC. 1. Supervised study in specialized areas of chemical engineering. Topic must be arranged with instructor during preregistration. Project report.

CHEN 4970 SPECIAL TOPICS IN CHEMICAL ENGINEERING (1-10) AAB. Departmental approval. Topical courses in special areas. Topic must be arranged with instructor during pre-registration. Course may be repeated for a maximum of 10 credit hours.

CHEN 4980 UNDERGRADUATE RESEARCH (1-3) IND. Pr. 3.00 GPA. Departmental approval. GPA of 3.0 or higher. Individual and small group projects. Topic must be arranged with instructor during preregistration. Research Report. Course may be repeated for a maximum of 3 credit hours.

CHEN 4997 HONORS THESIS (1-6) IND. Pr. Honors College. Departmental approval. Course may be repeated for a maximum of 6 credit hours.

CHEN 5090 PULP AND PAPER TECHNOLOGY (3) LEC. 3. Pr. (ENGR 2010 or CHEN 2110) and (CHEM 1030 or CHEM 1033) and (CHEM 1110 or CHEM 1117) and MATH 2650. An introductory course on the technology of pulp and paper manufacturing with emphasis on raw materials, pulping, bleaching, paper making, coating and environmental control. For students with no previous formal pulp and paper background.

CHEN 5110 PULP AND PAPER ENGINEERING (3) LEC. 3. Pr. CHEN 3620 and CHEN 3700 and P/C CHEN 4450. Chemical and engineering principles in the manufacturing of pulp and paper. (CHEN 3090, CHEN 3620, and CHEN 3700 require a grade of C or better).

CHEN 5120 SURFACE AND COLLOID SCIENCE (3) LEC. 3. Pr. CHEN 3620 and CHEN 4100. Fundamentals of surface and colloid science with applications in pulping and papermaking, including sizing, retention and drainage, charge measurements, dry/wet strength additives, fillers, colorants, foams, pitch and deposits. (CHEN 3620 and CHEN 4100 require a grade of C or better).

CHEN 5400 MOLECULAR ENGINEERING (3) LEC. 3. Pr. (CHEM 2080 or CHEM 2087) and CHEN 3370 and P/C CHEN 3700. Introduction to how molecular structure and long range microstructure affect the properties of chemical engineering products and how this knowledge can be used to design chemical engineering products for specific applications. (CHEN 3370 requires a grade of C or better).

CHEN 5410 MACROMOLECULAR SCIENCE AND ENGINEERING (3) LEC. 3. Pr. (CHEM 2080 or CHEM 2087) and CHEN 3370. Statistical mechanics of chain molecules; thermodynamics of polymer solutions; dilute, semi-dilute, and concentrated solutions and gels; polymer physics; scaling concepts in polymer physics; reputation theory (deGennes, Doi, Edwards) and molecular dynamics; phase separations; crystallization of polymers; rubber elasticity theory; mechanical analysis; viscoelasticity; diffusion theory of polymers; surface properties of polymers. (CHEN 3370 requires a grade of C or better).
CHEN 5420 POLYMER CHEMICAL ENGINEERING (3) LEC. 2. LAB. 3. Pr. (CHEM 2070 or CHEM 2077) and CHEN 3620 and CHEN 5410. Polymer rheology, transport phenomena, thermodynamics, membranes, conducting polymers, surfaces, interfaces and processing. (CHEN 3620 and CHEN 5410 require a grade of C or better).

CHEN 5430 BUSINESS ASPECTS OF CHEMICAL ENGINEERING (3) LEC. 3. Pr., Departmental Approval. The procession of activities required to successfully commercialize and market new chemical-engineering-based technologies to the consumer and process industries.

CHEN 5440 ELECTROCHEMICAL ENGINEERING (3) LEC. 3. Pr. CHEN 3370 and CHEN 3620 and CHEN 3700. Thermodynamics, electrode kinetics and transport phenomena of electrochemical systems, current and potential distributions, double layer theory, electrochemical processes, power sources, synthesis, corrosion. (CHEN 3370, CHEN 3620, and CHEN 3700 require a grade of C or better).

CHEN 5650 HAZARDOUS MATERIALS MANAGEMENT AND ENGINEERING (3) LEC. 3. Pr. (CHEM 2030 or CHEM 2080 or CHEM 2087) and (CHEN 3820 or CIVL 5210). Fundamental principles and regulatory information related to hazardous material and process safety management and engineering, dispersion of chemicals, hazard and operability analysis, chemical engineering principles for risk education.

CHEN 5660 MACROSCALE ASSEMBLY AND APPLICATIONS OF NANOMATERIALS (3) LEC. 3. Departmental approval. Production of macroscopic assemblies and structures from nanomaterials. Processing and applications of inorganic, organic, biological and hybrid nanomaterials.

CHEN 5670 POLLUTION PREVENTION ENGINEERING (3) LEC. 3. Pr. (CHEM 2080 or CHEM 2087) and CHEN 3370 and CHEN 3620 and CHEN 3660 and CHEN 3700. Chemical and engineering principles applied to pollution prevention. Theory and practice of basic separation methods, reaction engineering, process controls, and other fundamental chemical engineering disciplines as well as regulatory requirements to prevent unnecessary waste generation. Case studies. (CHEN 3370, CHEN 3620, CHEN 3660, and CHEN 3700 require a grade of C or better).

CHEN 5700 ADVANCED SEPARATION PROCESSES (3) LEC. 3. Pr. CHEN 3370 and CHEN 3660. Advanced treatment of modern chemical engineering separation processes. Theory and practice of staged multi-component mass transfer operations, non-ideal multi-phase separations and continuous rate processes. (CHEN 3370 and CHEN 3660 require a grade of C or better).

CHEN 5970 ADVANCED SPECIAL TOPICS IN CHEMICAL ENGINEERING (1-6) LEC. Departmental approval. Topical courses in areas for advanced undergraduate and graduate students. Topics must be arranged with instructor during preregistration. Course may be repeated for a maximum of 24 credit hours.

CHEN 6090/6096 PULP AND PAPER TECHNOLOGY (3) LEC. An introductory graduate level course on the technology of pulp and paper manufacturing with emphasis on raw materials, pulping, bleaching, paper making, coating and environmental control. For students with no previous formal pulp and paper background.CHEN Department Approval and Alabama Center for Paper and Bioresource Engineering Director approval.

CHEN 6110/6116 PULP AND PAPER ENGINEERING (3) LEC. 3. Chemical and engineering principles in the manufacturing of pulp and paper.

CHEN 6120/6126 SURFACE AND COLLOID SCIENCE (3) LEC. 3. Fundamentals of surface and colloid science with applications in pulping and papermaking, including sizing, retention and drainage, charge measurements, dry/wet strength additives, fillers, colorants, foams, pitch and deposits.
CHEN 6400/6406 MOLECULAR ENGINEERING (3) LEC. 3. Introduction to how molecular structure and long range microstructure affect the properties of chemical engineering products and how this knowledge can be used to design chemical engineering products for specific applications.

CHEN 6410/6416 MACROMOLECULAR SCIENCE AND ENGINEERING (3) LEC. 3. Statistical mechanics of chain molecules; thermodynamics of polymer solutions; dilute, semi-dilute, and concentrated solutions and gels; polymer physics; scaling concepts in polymer physics; reptation theory (deGennes, Doi, Edwards) and molecular dynamics; phase separations; crystallization of polymers; rubber elasticity theory; mechanical analysis; viscoelasticity; diffusion theory of polymers; surface properties of polymers.

CHEN 6420/6426 POLYMER CHEMICAL ENGINEERING (3) LEC. 3. Polymer rheology, transport phenomena, thermodynamics, membranes, conducting polymers, surfaces, interfaces and processing.

CHEN 6430/6436 BUSINESS ASPECTS OF CHEMICAL ENGINEERING (3) LEC. 3. Departmental approval. The procession of activities required to successfully commercialize and market new chemical-engineering-based technologies to the consumer and process industries.

CHEN 6440/6446 ELECTROCHEMICAL ENGINEERING (3) LEC. 3. Thermodynamics, electrode kinetics and transport phenomena of electrochemical systems, current and potential distributions, double layer theory, electrochemical processes, power sources, synthesis, corrosion.

CHEN 6650/6656 HAZARDOUS MATERIALS MANAGEMENT AND ENGINEERING (3) LEC. 3. Fundamental principles and regulatory information related to hazardous material and process safety management and engineering, dispersion of chemicals, hazard and operability analysis, chemical engineering, principles for risk education.

CHEN 6660/6666 MACROSCELE ASSEMBLY AND APPLICATIONS OF NANOMATERIALS (3) LEC. 3. Production of macroscopic assemblies and structures from nanomaterials. Processing and applications of inorganic, organic, biological and hybrid nanomaterials. Or departmental approval. May count either CHEN 6660 or CHEN 6666.


CHEN 6810/6816 BIOMEDICAL ENGINEERING (3) LEC. 3. Application of chemical engineering principles to the study of medical physiology. Human biochemistry, anatomy, and physiology, rheological properties of blood and synovial fluid, rheology of cell membranes. Biomedical fluid mechanics and heat and mass transfer.

CHEN 6820/6826 ADVANCED TOPICS IN ENVIRONMENTAL BIOTECHNOLOGY (3) LEC. 3. Departmental approval. Application of biotechnology to environmental process treatment, bioremediation and bioreactor development.

CHEN 6970/6976 ADVANCED SPECIAL TOPICS IN CHEMICAL ENGINEERING (1-6) LEC. Departmental approval. Topical courses in areas for advanced undergraduate and graduate students. Topics must be arranged with instructor during preregistration. Course may be repeated for a maximum of 24 credit hours.

CHEN 7020/7026 INTERFACIAL PHENOMENA (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Fundamental analyses of interfacial phenomena at liquid/gas, liquid/liquid and solid/liquid interfaces.


CHEN 7110/7116 CHEMICAL ENGINEERING ANALYSIS AND ADVANCED TRANSPORT PHENOMENA (3) LEC. 3. Pr. CHEN 7100 or CHEN 7106. Analytical solutions of ordinary and partial differential equations pertaining to transport phenomena and other areas of chemical engineering.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEN 7120/7126</td>
<td>ADVANCED TOPICS IN PAPER PROCESSING OPERATIONS (3)</td>
<td>LEC. 3</td>
<td>Pr. CHEN 6120 or CHEN 6126</td>
<td>Surface and colloidal interactions in the wet end of paper manufacturing. Colloidal stability theory, absorption of macromolecules, flocculation and retention of particles. Wet-end chemistry process control.</td>
</tr>
<tr>
<td>CHEN 7130/7136</td>
<td>ADVANCED PULP AND PAPER ENGINEERING (3)</td>
<td>LEC. 3</td>
<td>Topics in pulping, chemical recovery and papermaking.</td>
<td></td>
</tr>
<tr>
<td>CHEN 7200/7206</td>
<td>CHEMICAL ENGINEERING THERMODYNAMICS (3)</td>
<td>LEC. 3</td>
<td>Pr. CHEN 7100 or CHEN 7106</td>
<td>Chemical reaction and phase equilibrium applied to chemical engineering problems. Properties of multicomponent real gases, liquids, and solids and property relationships. Criteria for thermodynamic equilibrium and stability, molecular thermodynamics.</td>
</tr>
<tr>
<td>CHEN 7250/7256</td>
<td>CHEMICAL REACTION ENGINEERING (3)</td>
<td>LEC. 3</td>
<td>Pr. P/C CHEN 7100 or P/C CHEN 7106</td>
<td>Analysis and design of homogeneous and heterogeneous chemical reactors. Physicochemical factors and analysis of non-ideal chemical reactor behavior.</td>
</tr>
<tr>
<td>CHEN 7600/7606</td>
<td>ENVIRONMENTAL TRANSPORT (3)</td>
<td>LEC. 3</td>
<td>Pr. (CHEN 7100 or CHEN 7106) and (CHEN 7200 or CHEN 7206) and (P/C CHEN 7110 or P/C CHEN 7116)</td>
<td>Environmental chemodynamics, interphase equilibrium, reactions, boundary layers, transport mechanisms and models or movement of substances across natural interfaces (air-water-sediment-soil).</td>
</tr>
<tr>
<td>CHEN 7710</td>
<td>INTRODUCTION TO RESEARCH SEMINAR (1)</td>
<td>LEC. 1</td>
<td>Pr. P/C CHEN 7100 or P/C CHEN 7106</td>
<td>Introductory graduate research seminars for entering graduate students.</td>
</tr>
<tr>
<td>CHEN 7720</td>
<td>ADVANCED PROCESS DESIGN SEMINAR (1)</td>
<td>LEC. 1</td>
<td>Pr. (P/C CHEN 7100 or P/C CHEN 7106) and (P/C CHEN 7200 or P/C CHEN 7206)</td>
<td>Fundamentals of advanced process design including process synthesis, simulation, analysis, optimization and integration. Systematic process synthesis tools for screening potential flow sheets.</td>
</tr>
<tr>
<td>CHEN 7900/7906</td>
<td>INDEPENDENT STUDY (1-10)</td>
<td>IND.</td>
<td>Departmental approval. Supervised study in specialized areas of chemical engineering. Topic must be arranged with instructor during pre-registration. Course may be repeated for a maximum of 20 credit hours.</td>
<td></td>
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<tr>
<td>CHEN 7950</td>
<td>GRADUATE SEMINAR (1)</td>
<td>SEM.</td>
<td>SU. Seminar. Course may be repeated for a maximum of 12 credit hours.</td>
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<tr>
<td>CHEN 8100</td>
<td>ADVANCED TOPICS IN CHEMICAL ENGINEERING PROCESSES (3)</td>
<td>LEC. 3</td>
<td>Pr. CHEN 7110 or CHEN 7116</td>
<td>Advanced concepts in fluid dynamics with special emphasis on applications to chemical engineering, creeping flow, multiphase instabilities, computational fluid mechanics and turbulence.</td>
</tr>
<tr>
<td>CHEN 8110</td>
<td>ADVANCED TOPICS IN HEAT AND MASS TRANSFER (3)</td>
<td>LEC. 3</td>
<td>Pr. CHEN 7110 or CHEN 7116</td>
<td>Application of transport operations to chemical engineering problems containing physical and chemical rate processes. Chemically reacting boundary layers, heat and mass transfer, eddy diffusion, phase change and separation processes.</td>
</tr>
<tr>
<td>CHEN 8210</td>
<td>ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS (3)</td>
<td>LEC. 3</td>
<td>Pr. CHEN 7200 or CHEN 7206</td>
<td>Application of advanced thermodynamics to complex chemical engineering problems including advanced models for electrolyte solutions, critical and supercritical phenomena, high pressure equilibrium, non-equilibrium and surface thermodynamics and molecular modeling.</td>
</tr>
</tbody>
</table>
CHEN 8230 CHEMICAL ENGINEERING STATISTICAL THERMODYNAMICS (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Applications of molecular theory and models to the properties of non-ideal gases and liquids using advanced statistical mechanics and chemical thermodynamics.

CHEN 8270 HETEROGENEOUS CATALYSIS (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Advanced concepts, techniques, applications and principles for the use of heterogeneous catalysts in chemical and environmental processes. Departmental approval.

CHEN 8280 SURFACE CHARACTERIZATION/SOLIDS (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Advanced concepts and techniques in the physical and chemical characterization of solid surfaces by microscopic, spectroscopic and chemical methods including various photon and/or electron spectroscopies, thermal desorption.

CHEN 8300 PROCESS DYNAMICS AND CONTROL (3) LEC. 3. Pr. CHEN 7100 or CHEN 7106 and (P/C CHEN 7110 or P/C CHEN 7116). Advanced linear and nonlinear chemical process dynamics and control systems.

CHEN 8310 PROCESS DYNAMICS AND CONTROL II (2) LEC. 2. Advanced chemical process dynamics and control.

CHEN 8320 ADVANCED TOPICS IN CHEMICAL PROCESS COMPUTER CONTROL SYSTEMS (3) LEC. 2. LAB. 3. Pr. CHEN 7100 or CHEN 7106. Analysis and design of advanced digital control systems for chemical processes. Introduction to computer communications through dynamic data exchange and peripheral linkage. Experimental application of advanced digital control algorithms to chemical processes.

CHEN 8340/8346 PROCESS MODELING AND SIMULATION (3) LEC. 2. LAB. 3. Advances in computer-aided process synthesis, simulation, analysis and optimization including systematic process integration tools for developing and screening potential flow sheets using advanced process simulators.

CHEN 8990 RESEARCH AND DISSERTATION (1-20) DSR. Credit hours to be arranged. Course may be repeated with change in topics.

Curriculum in Chemical Engineering

Freshman

Fall

CHEN 1110 General Chemistry I

CHEM 1111 General Chemistry I Laboratory

ENGL 1100 English Composition I

ENGR 1110 Introduction to Engineering

MATH 1610 Calculus I

Core History ¹

16

Hours

3

1

3

2

4

3

Spring

CHEM 1120 General Chemistry for Scientists and Engineers II

CHEM 1121 General Chemistry II Laboratory

COMP 1200 Introduction to Computing for Engineers and Scientists

ENGL 1120 English Composition II

MATH 1620 Calculus II

PHYS 1600 Engineering Physics I

3

1

2

3

4

4

17

Sophomore

Fall

BIOL 1020 Principles of Biology & BIOL 1021 Principles of Biology Laboratory

CHEN 2100 Principles of Chemical Engineering

MATH 2630 Calculus III

PHYS 1610 Engineering Physics II

Hours

4

4

4

4

Spring

CHEM 2070 Organic Chemistry I

CHEM 2071 Organic Chemistry I Laboratory

CHEN 2AA0 Chemical Engineering Progress Assessment I

CHEN 2610 Transport I

CHEM 2650 Chemical Engineering Applications of Mathematical Techniques

3

1

0

3

3
MATH 2650 Linear Differential Equations 3
CHEN 2110 Chemical Engineering Thermodynamics 3

Junior

Fall

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
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<tbody>
<tr>
<td>CHEM 2080 Organic Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 3370 Phase and Reaction Equilibria</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 3600 Computer-Aided Chemical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 3620 Transport II</td>
<td>3</td>
</tr>
<tr>
<td>Core Social Science</td>
<td>1</td>
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Spring

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<tr>
<th>Course</th>
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<tbody>
<tr>
<td>CHEN 33700 Chemical Reaction Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 3820 Chemical Engineering Laboratory I</td>
<td>2</td>
</tr>
<tr>
<td>CHEN Technical Elective I</td>
<td>3</td>
</tr>
<tr>
<td>PHIL 1040 Business Ethics</td>
<td>3</td>
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Senior

Fall

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<th>Course</th>
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<tbody>
<tr>
<td>CHEN 4170 Digital Process Control</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 4450 Process Economics and Safety</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 4460 Process Simulation Synthesis and Optimization</td>
<td>2</td>
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<tr>
<td>CHEN 4860 Chemical Engineering Laboratory II</td>
<td>2</td>
</tr>
<tr>
<td>CHEN Technical Elective II</td>
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<tr>
<td>Core Literature</td>
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Spring

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<tr>
<th>Course</th>
<th>Hours</th>
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<tbody>
<tr>
<td>CHEN 4470 Process Design Practice</td>
<td>3</td>
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<tr>
<td>CHEN Technical Elective 3 or ROTC</td>
<td>3</td>
</tr>
<tr>
<td>CHEN Technical Elective 4 or ROTC</td>
<td>3</td>
</tr>
<tr>
<td>Core Fine Arts</td>
<td>3</td>
</tr>
<tr>
<td>Core Social Science</td>
<td>1</td>
</tr>
<tr>
<td>UNIV 4AA0 Creed to Succeed</td>
<td>0</td>
</tr>
</tbody>
</table>

Total Hours: 128

1 The AU Bulletin lists the University Core Curriculum requirements for students in the College of Engineering. Students must complete a sequence in either Literature or History. Because of the discipline specific requirements for the Humanities courses, it is recommended that a History sequence be completed in the Social Sciences courses.

Electives, Technical Electives: See adviser for approved course listing. At least three (3) hours of Technical Electives must be coursework considered as Engineering Topics.

CHEM 1110, 1111, 1120 and 1121 are preferred, but CHEM 1030, 1031, 1040 and 1041 are acceptable substitutes. Honors sections of all courses will be accepted for this curriculum.

Civil Engineering

- Functioned as efficient, reliable team members in the evaluation, planning and design, construction, or operation and maintenance of civil infrastructure systems,
- Demonstrated their belief in lifelong education by expanding their body of knowledge, maturing professionally, and progressing toward licensure as professional engineers,
- Assumed leadership roles in their workplace by exercising initiative and responsible stewardship, and
- Employed the human touch in engaged involvement in their professions and communities.
Civil Engineering Specializations

Civil engineering is a broad field of study. All students that pursue the Bachelor of Civil Engineering degree are required to take introductory courses in surveying, construction engineering, geotechnical engineering, environmental engineering, hydraulics, structural analysis, transportation engineering, and civil engineering materials. Beyond these courses, students satisfy curriculum requirements by selecting elective courses to broaden their civil engineering knowledge while strengthening their understanding in specific areas. Students may choose to focus on one of the following specializations:

- Construction Engineering
- Environmental Engineering
- Geotechnical Engineering
- Pavements and Materials Engineering
- Site Engineering and Land Development
- Structural Engineering
- Transportation Engineering
- Water Resources Engineering

Construction Engineering Specialization

Construction engineers plan, oversee, and manage the construction efforts associated with building new or rehabilitating existing buildings, bridges, roads, and other facilities. The Construction Engineering specialization provides future construction engineers and managers with the ability to manage construction projects. It also develops the ability to collaborate with other civil engineering professionals to solve problems associated with projects and understand the engineering science to effectively implement the solutions. This specialization provides a strong fundamental background for graduate study in construction engineering and project management.

Students in this specialization take

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVL 4420</td>
<td>Project Management</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4600</td>
<td>Reinforced Concrete Design</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5810</td>
<td>Pavement Design and Construction</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4490</td>
<td>Design-Build Project</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5460</td>
<td>Project Estimating</td>
<td>3</td>
</tr>
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<td></td>
<td>Construction Engineering Elective (see list below)</td>
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</table>

These six courses serve as Breadth Electives I–III, the Senior Design Project, and Technical Electives I–II in the Bachelor of Civil Engineering curriculum requirements.

Construction Engineering Electives (select one)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>CIVL 5420</td>
<td>Construction Project Scheduling and Control</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5430</td>
<td>Construction Safety and Health Management</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5440</td>
<td>Construction Equipment and Methods</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5450</td>
<td>Erosion &amp; Sediment Control</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5690</td>
<td>Timber Design</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5480</td>
<td>Legal Aspects of Civil Engineering Practice</td>
<td>3</td>
</tr>
</tbody>
</table>
Environmental Engineering Specialization

Environmental engineers apply scientific and engineering principles to assess, manage, and design sustainable environmental systems for the protection of human and ecological health. The Environmental Engineering specialization prepares students for entry-level positions in this area, including water and wastewater treatment, and provides a fundamental background for graduate study.

Students in this specialization take

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVL 4210</td>
<td>Water and Wastewater Treatment and Design</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5120</td>
<td>Hydrologic Analysis and Modeling</td>
<td>3</td>
</tr>
<tr>
<td>CIVL Breadth Elective (see list below)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CIVL 4220</td>
<td>Environmental Engineering Design</td>
<td>3</td>
</tr>
<tr>
<td>Environmental Engineering Elective I (see list below)</td>
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<tr>
<td>Environmental Engineering Elective II</td>
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</table>

These six courses serve as Breadth Electives I–III, the Senior Design Project, and Technical Electives I–II in the Bachelor of Civil Engineering curriculum requirements.

**CIVL Breadth Electives for Environmental Engineering (select one)**

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<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>CIVL 4310</td>
<td>Geotechnical Engineering II</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4420</td>
<td>Project Management</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5810</td>
<td>Pavement Design and Construction</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4600</td>
<td>Reinforced Concrete Design</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4650</td>
<td>Structural Steel Design</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4530</td>
<td>Geometric Design</td>
<td>3</td>
</tr>
</tbody>
</table>

**Environmental Engineering Electives (select two)**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
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<tbody>
<tr>
<td>CIVL 4230</td>
<td>Urban Hydraulic System Design</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5110</td>
<td>Open Channel Hydraulics</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5130</td>
<td>Hydraulic Design of Pressurized Systems</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5150</td>
<td>Groundwater Hydraulics</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5160</td>
<td>Stormwater Management and Modeling</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5170</td>
<td>Numerical Solutions for Hydro-Environmental Applications</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5210</td>
<td>Chemical Principles of Environmental Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5230</td>
<td>Environmental Health Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5240</td>
<td>Air Pollution</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5250</td>
<td>Biological Principles of Environmental Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5260</td>
<td>Surface Water Quality Modeling</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5330</td>
<td>Landfills</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5410</td>
<td>Geographic Information Systems in Civil Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>
Geotechnical Engineering Specialization

Geotechnical engineers deal with the analysis, design, and construction of earth and earth-supported structures. Geotechnical engineers work on foundations, dams, levees, landfills, landslides, and roadways. The Geotechnical Engineering specialization provides a strong fundamental background for graduate study in geotechnical engineering while preparing students for entry-level positions in this area. Geotechnical engineers may also work in the area of geoenvironmental engineering, which focuses on application of geotechnical and geological principles to problems related to the protection of human health and the environment. Students interested in geoenvironmental engineering should consult with a geotechnical faculty member to identify appropriate courses.

Students in this specialization take

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVL 4310</td>
<td>Geotechnical Engineering II</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5810</td>
<td>Pavement Design and Construction</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4600</td>
<td>Reinforced Concrete Design</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4690</td>
<td>Structural Design Project</td>
<td>3</td>
</tr>
<tr>
<td>Geotechnical Engineering Elective I (see list below)</td>
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<tr>
<td>Geotechnical Engineering Elective II</td>
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</table>

These six courses serve as Breadth Electives I–III, the Senior Design Project, and Technical Electives I–II in the Bachelor of Civil Engineering curriculum requirements.

Geotechnical Engineering Electives (select two)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
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<tbody>
<tr>
<td>CIVL 5150</td>
<td>Groundwater Hydraulics</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5330</td>
<td>Landfills</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5340</td>
<td>Geosynthetics and Soil Improvement</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5350</td>
<td>Earth Retaining Structures</td>
<td>3</td>
</tr>
</tbody>
</table>

Pavements & Materials Engineering Specialization

Pavements and materials engineers design, build, and maintain pavement infrastructure for highways, airports, parking lots, and port facilities. This includes design and characterization of the constituent materials, pavement construction, integration and application of materials in engineered pavement structures, and management of pavement infrastructure. The Pavements & Materials specialization prepares students for entry-level positions in this area and provides a strong fundamental background for graduate study in pavements and materials.

Students in this specialization take

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVL 4310</td>
<td>Geotechnical Engineering II</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4530</td>
<td>Geometric Design</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5810</td>
<td>Pavement Design and Construction</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4590</td>
<td>Transportation Design Project</td>
<td>3</td>
</tr>
<tr>
<td>Pavements &amp; Materials Elective I (see list below)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Pavements &amp; Materials Elective II</td>
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<td></td>
</tr>
</tbody>
</table>

These six courses serve as Breadth Electives I–III, the Senior Design Project, and Technical Electives I–II in the Bachelor of Civil Engineering curriculum requirements.

Pavements & Materials Engineering Electives (select two)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVL 4420</td>
<td>Project Management</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5340</td>
<td>Geosynthetics and Soil Improvement</td>
<td>3</td>
</tr>
</tbody>
</table>
Site Engineering and Land Development Specialization

This specialization addresses site planning and land development for a variety of settings: commercial, industrial, municipal, recreational, and residential. Site design engineers apply geometric, hydraulic, hydrologic, materials, and transportation principles to address roadways, parking, stormwater management, sanitary sewage, grading/earthwork, utilities, and erosion and sediment control when developing land for client/public use. The Site Engineering and Land Development specialization prepares students for entry-level positions in this area while providing a foundation for graduate study.

Students in this specialization take

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
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</tr>
</thead>
<tbody>
<tr>
<td>CIVL 4230</td>
<td>Urban Hydraulic System Design</td>
<td>3</td>
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<tr>
<td>CIVL 4530</td>
<td>Geometric Design</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4420</td>
<td>Project Management</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4590</td>
<td>Transportation Design Project</td>
<td>3</td>
</tr>
<tr>
<td>BSEN 5560</td>
<td>Site Design for Biosystems</td>
<td>3</td>
</tr>
<tr>
<td>Site Engineering and Land Development Elective (see list below)</td>
<td>3</td>
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</tbody>
</table>

These six courses serve as Breadth Electives I–III, the Senior Design Project, and Technical Electives I–II in the Bachelor of Civil Engineering curriculum requirements.

Site Engineering and Land Development Electives

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVL 5120</td>
<td>Hydrologic Analysis and Modeling</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5130</td>
<td>Hydraulic Design of Pressurized Systems</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5150</td>
<td>Groundwater Hydraulics</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5160</td>
<td>Stormwater Management and Modeling</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5410</td>
<td>Geographic Information Systems in Civil Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5450</td>
<td>Erosion &amp; Sediment Control</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5460</td>
<td>Project Estimating</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5480</td>
<td>Legal Aspects of Civil Engineering Practice</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5810</td>
<td>Pavement Design and Construction</td>
<td>3</td>
</tr>
</tbody>
</table>

These six courses serve as Breadth Electives I–III, the Senior Design Project, and Technical Electives I–II in the Bachelor of Civil Engineering curriculum requirements.

Structural Engineering Specialization

Structural engineers design new structures—such as buildings, bridges, and stadiums—to withstand loads and natural hazards. They also evaluate and improve the capabilities of existing structures. The Structural Engineering specialization provides a strong fundamental background for graduate study in structural engineering while preparing students for entry-level positions in this area.

Students in this specialization take

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVL 4600</td>
<td>Reinforced Concrete Design</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4310</td>
<td>Geotechnical Engineering II</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4420</td>
<td>Project Management</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4690</td>
<td>Structural Design Project</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4650</td>
<td>Structural Steel Design</td>
<td>3</td>
</tr>
<tr>
<td>Structural Engineering Elective</td>
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</table>

These six courses serve as Breadth Electives I–III, the Senior Design Project, and Technical Electives I–II in the Bachelor of Civil Engineering curriculum requirements.
Structural Engineering Electives

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>CIVL 5600</td>
<td>Advanced Reinforced Concrete Design</td>
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<td>CIVL 5620</td>
<td>Prestressed Concrete Design</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5630</td>
<td>Advanced Concrete Materials</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5640</td>
<td>Structural Masonry Design</td>
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</tr>
<tr>
<td>CIVL 5650</td>
<td>Advanced Steel Design</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5660</td>
<td>Bridge Engineering</td>
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</tr>
<tr>
<td>CIVL 5670</td>
<td>Advanced Structural Analysis</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5690</td>
<td>Timber Design</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5700</td>
<td>Design for Lateral Loads</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5710</td>
<td>Structural Repair</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5720</td>
<td>Reliability of Structures</td>
<td>3</td>
</tr>
</tbody>
</table>

Transportation Engineering Specialization

Transportation engineers forecast, design, analyze, and manage transportation systems to support the safe, efficient, and environmentally-friendly movement of people and materials. The *Transportation Engineering* specialization incorporates mathematical and scientific principles that allow graduates to pursue careers in general transportation network design and planning, facilities planning, site evaluation, transportation management systems, needs projections and analysis, and analysis of costs. This specialization provides a strong fundamental background for graduate study in transportation engineering.

Students in this specialization take

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVL 4530</td>
<td>Geometric Design</td>
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<tr>
<td>CIVL 4420</td>
<td>Project Management</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5810</td>
<td>Pavement Design and Construction</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4590</td>
<td>Transportation Design Project</td>
<td>3</td>
</tr>
<tr>
<td>Transportation Engineering Elective I (see list below)</td>
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<tr>
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</table>

These six courses serve as Breadth Electives I–III, the Senior Design Project, and Technical Electives I–II in the *Bachelor of Civil Engineering* curriculum requirements.

Transportation Engineering Electives (select two)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
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<tbody>
<tr>
<td>CIVL 4500</td>
<td>Traffic Engineering Fundamentals</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 4520</td>
<td>Airport Design</td>
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</tr>
<tr>
<td>CIVL 5410</td>
<td>Geographic Information Systems in Civil Engineering</td>
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</tr>
<tr>
<td>CIVL 5500</td>
<td>Traffic Engineering Analysis</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5560</td>
<td>Planning for Multimodal Transportation Systems</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5580</td>
<td>Intelligent Transportation Systems</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5420</td>
<td>Construction Project Scheduling and Control</td>
<td>3</td>
</tr>
</tbody>
</table>
Water Resources Engineering Specialization

Water resources engineers design, evaluate, maintain, and operate the water systems in natural and built environments. Applying mathematical and scientific principles, water resources engineers conceive and design new water infrastructure for collecting, storing, moving, conserving, and controlling surface water, pressurized water, and groundwater. This includes water quality control, water cycle management, management of human and industrial water requirements, water delivery, and flood control. The Water Resources Engineering specialization provides a strong fundamental background for graduate study in water resources engineering while preparing students for entry-level positions in this area.

Students in this specialization take

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
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<tr>
<td>CIVL 5110</td>
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<td>CIVL 4230</td>
<td>Urban Hydraulic System Design</td>
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<tr>
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<tr>
<td>CIVL 4220</td>
<td>Environmental Engineering Design</td>
<td>3</td>
</tr>
<tr>
<td>Water Resources Engineering Elective I (see list below)</td>
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<tr>
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These six courses serve as Breadth Electives I–III, the Senior Design Project, and Technical Electives I–II in the Bachelor of Civil Engineering curriculum requirements.

CIVL Breadth Electives for Water Resources Engineering (select one)

<table>
<thead>
<tr>
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<tr>
<td>CIVL 4310</td>
<td>Geotechnical Engineering II</td>
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<td>Project Management</td>
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<tr>
<td>CIVL 5810</td>
<td>Pavement Design and Construction</td>
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<td>CIVL 4650</td>
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<td>CIVL 4530</td>
<td>Geometric Design</td>
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Water Resources Engineering Electives (select two)

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<th>Title</th>
<th>Hours</th>
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<tbody>
<tr>
<td>CIVL 5120</td>
<td>Hydrologic Analysis and Modeling (preferred)</td>
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<tr>
<td>CIVL 5150</td>
<td>Groundwater Hydraulics (preferred)</td>
<td>3</td>
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<tr>
<td>or GEOL 5100</td>
<td>Hydrogeology</td>
<td></td>
</tr>
<tr>
<td>CIVL 5130</td>
<td>Hydraulic Design of Pressurized Systems</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5160</td>
<td>Stormwater Management and Modeling</td>
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<tr>
<td>CIVL 5170</td>
<td>Numerical Solutions for Hydro-Environmental Applications</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 5260</td>
<td>Surface Water Quality Modeling</td>
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<td>Geographic Information Systems in Civil Engineering</td>
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</tr>
<tr>
<td>CIVL 5450</td>
<td>Erosion &amp; Sediment Control</td>
<td>3</td>
</tr>
</tbody>
</table>

Major

- Civil Engineering (p. 112)

Courses

CIVL 2010 SURVEYING (3) LEC. 2. LAB. 3. Pr. (ENGR 1110 or ENGR 1113) and (MATH 1610 or MATH 1613 or MATH 1617) and COMP 1200. Civil engineering surveying theory and practice including history of land surveys and U.S. datums; field measurements, office calculations and graphical/digital presentation of spatial data.
CIVL 3010 CIVIL ENGINEERING ANALYSIS (4) LEC. 3. LAB. 3. Pr. MATH 2650 and COMP 1200 and (ENGR 2050 or ENGR 2053) and STAT 3010. Applications of calculus and ordinary differential equations, numerical methods, vector algebra, and linear algebraic expressions to practical civil engineering problems. Heavy emphasis on computerized techniques and civil engineering software.

CIVL 3110 HYDRAULICS (4) LEC. 3. LAB. 3. Pr. (ENGR 2010 or ENGR 2200) and MATH 2650 and P/C ENGR 2350 and P/C CIVL 3010. Pr. ENGR 2010 is only allowed for students who transfer into Civil Engineering. Students already enrolled in Civil Engineering should take ENGR 2200. Introduction to fluid mechanics, fluid properties, hydrostatics, kinematics, dynamics, energy equation, ideal flow and energy losses. Applications of fluid mechanics, pipe flow, fluid measurements, pumps, open channel flow, dimensional analysis and theory of modeling.

CIVL 3220 WATER AND WASTE TREATMENT (4) LEC. 3. LAB. 3. Pr. CHEM 1040 and BIOL 3200. Fundamentals of potable water treatment and wastewater treatment and disposal. Treatment systems; operation/ process physics, chemistry, and biology; operation and maintenance issues; regulatory requirements. Credit will not be given to students majoring in Civil Engineering.

CIVL 3230 ENVIRONMENTAL ENGINEERING (4) LEC. 3. LAB. 3. Pr. (CHEM 1040 or CHEM 1043) and (ENGR 2200 and P/C CIVL 3010) or P/C BSEN 3310. Fundamental principles of environmental engineering, including basic environmental chemistry and microbiology; materials and energy balances; diffusion; chemical equilibrium; kinetics; and chemical reaction engineering.

CIVL 3310 GEOTECHNICAL ENGINEERING I (4) LEC. 3. LAB. 3. Pr. (CHEM 1040 or CHEM 1043) and ENGR 2070. Soil-forming processes, physical properties of soils, subsurface investigations, clay mineralogy, soil classification, permeability, effective stress, consolidation theory, time-settlement analysis, compaction, shear strength, geosynthetics.

CIVL 3410 CONSTRUCTION ENGINEERING (3) LEC. 3. Pr. CIVL 2010 and P/C CIVL 3010. Basic concepts of the construction industry, contractual methods, estimating and scheduling.

CIVL 3510 TRANSPORTATION ENGINEERING (4) LEC. 4. Pr. CIVL 2010 and STAT 3010. Introduction to transportation engineering practice with emphasis on highway facility design, traffic operations, and life-cycle costing.


CIVL 3820 CIVIL ENGINEERING MATERIALS (3) LEC. 2. LAB. 3. Pr. CIVL 3310. Introduction to common materials used in construction of civil facilities including highways; aggregate, concrete, asphalt, and steel.

CIVL 4210 WATER AND WASTEWATER TREATMENT AND DESIGN (3) LEC. 3. Pr. CIVL 3230. Departmental approval. The fundamentals of theory, design, and operation of water and wastewater treatment systems are covered.

CIVL 4211 WATER AND WASTEWATER LABORATORY (1) LAB. 3. Pr. CHEM 1040 and BIOL 3200. Coreq. CIVL 4210. Introduction to analytical techniques used to assess water quality. Credit will not be given to students majoring in Civil Engineering.

CIVL 4220 ENVIRONMENTAL ENGINEERING DESIGN (3) LEC. 3. Pr. CIVL 4210 or CIVL 4230. Process design of environmental engineering systems.

CIVL 4230 URBAN HYDRAULIC SYSTEM DESIGN (3) LEC. 3. Pr. CIVL 3230 and CIVL 3110. Engineering approaches to designing and managing urban water supply, sanitary sewer, storm water collection systems and flood control works.

CIVL 4310 GEOTECHNICAL ENGINEERING II (3) LEC. 3. Pr. CIVL 3310. Analysis and design in geotechnical engineering based on principles of soil mechanics and soil behavior. Problems of slope stability, earth pressure and design of earth retaining structures, foundation bearing capacity and settlement.

CIVL 4420 PROJECT MANAGEMENT (3) LEC. 3. Pr. CIVL 3410. Planning and management of construction/engineering projects and organizations, project management techniques, skills, and applications.

CIVL 4490 DESIGN-BUILD PROJECT (3) LEC. 3. Pr. CIVL 4420. Develop a design-build proposal for a civil engineering improvement including engineering study, consideration of alternative designs, and formal written and oral presentation.

CIVL 4500 TRAFFIC ENGINEERING FUNDAMENTALS (3) LEC. 3. Pr. CIVL 3510. The fundamental elements of traffic engineering including traffic operations and traffic control devices.
CIVL 4520 AIRPORT DESIGN (3) LEC. 3. Pr. CIVL 3510. Departmental approval. An analysis of the elements affecting the design of airports including forecasting, runway configuration, capacity analyses, geometric design of runways and taxiways, pavement design and airfield drainage.

CIVL 4530 GEOMETRIC DESIGN (3) LEC. 3. Pr. CIVL 3510. An analysis of the elements affecting the location and design of rural highways, urban highways and arterial streets including design controls and criteria.

CIVL 4590 TRANSPORTATION DESIGN PROJECT (3) LEC. 3. Pr. CIVL 4530. Individual senior design project requiring the development of plans for a roadway over a large land segment: horizontal and vertical curves in accord with State and AASHTO standards; topographic terrain features; historical preservation area; minimum elevation; intersection design; earthwork balance.

CIVL 4600 REINFORCED CONCRETE DESIGN (3) LEC. 3. Pr. CIVL 3610. Concrete and reinforcing steel properties; analysis and design of reinforced concrete beams, one-way slabs, columns and footings; anchorage of reinforcement.


CIVL 4690 STRUCTURAL DESIGN PROJECT (3) LEC. 3. Pr. CIVL 4600. Execution of a comprehensive design of a major structure. Emphasis on the design process, creative thinking, analysis, synthesis, teamwork and communications.

CIVL 4960 SPECIAL PROBLEMS (1-3) LEC. Departmental approval. Individual student endeavor under staff supervision involving advanced special problems in civil engineering. Course may be repeated for a maximum of 6 credit hours.

CIVL 4997 HONORS THESIS (1-3) IND. Pr. Honors College. Departmental approval. Course may be repeated for a maximum of 6 credit hours.

CIVL 5110 OPEN CHANNEL HYDRAULICS (3) LEC. 3. Pr. CIVL 3110. Application of continuity, energy, and momentum analyses to problems of open channel flow. Topics include rapidly and gradually varied flow, unsteady flow, flood routing, computational methods, design concepts and applications. Credit will not be given for both CIVL 5110 and CIVL 6110/ CIVL 6116.

CIVL 5120 HYDROLOGIC ANALYSIS AND MODELING (3) LEC. 3. Pr. CIVL 3110 and STAT 3010. Hydrologic cycle, hydrologic frequency analysis, precipitation, infiltration, runoff hydrograph, flood routing, urban hydrology, watershed hydrologic modeling, and computer modeling applications. Departmental approval. May count either CIVL 5120 or CIVL 6120.

CIVL 5130 HYDRAULIC DESIGN OF PRESSURIZED SYSTEMS (3) LEC. 3. Pr. CIVL 3110. Pressurized flow applications; pump-pipeline design optimization; multiple reservoir operation; flow measurement/control systems; distribution manifolds; fundamentals of unsteady flows. Departmental approval. May count either CIVL 5130 or CIVL 6130.

CIVL 5150 GROUNDWATER HYDRAULICS (3) LEC. 3. Pr. CIVL 3110. Mechanics of groundwater flow, definitions, conservation of mass, Darcy's law, confined and unconfined flow, steady and transient flow, groundwater transport. Credit will not be given for both CIVL 5150 and CIVL 6150/CIVL 6156.

CIVL 5160 STORMWATER MANAGEMENT AND MODELING (3) LEC. 3. Pr. CIVL 3110. Introduction of current stormwater management practices (e.g., lower impact development and green infrastructures) and polices, rainfall analysis with different inter-event dry period, flood analysis, stormwater runoff hydrograph modeling (rainfall loss, overland flow hydrograph, unit hydrograph theory, and hydrograph routing), stormwater quality modeling (pollutant buildup, washoff, and transport), peak discharge control using detention ponds, and various best management practices for stormwater volume and quality control. May count either CIVL 5160, CIVL 6160, or CIVL 6166.

CIVL 5170 NUMERICAL SOLUTIONS FOR HYDRO-ENVIRONMENTAL APPLICATIONS (3) LEC. 3. Pr. CIVL 3110 and CIVL 3230. Theoretical and numerical solutions of various problems in water resources and environmental engineering using computational tools. Development of simple codes and spreadsheet-based tools for the description and prediction of flows, contaminant spreading, and other relevant processes in natural and built systems. May count either CIVL 5170 or CIVL 6170/6176.

CIVL 5210 CHEMICAL PRINCIPLES OF ENVIRONMENTAL ENGINEERING (3) LEC. 3. Pr. CIVL 3230. Fundamentals of aquatic chemistry as applied to environmental engineering: chemical thermodynamics, acid/base equilibrium, solution/dissolution chemistry, redox equilibrium, and chemical kinetics. Departmental approval. Credit will not be given for both CIVL 5210 and CIVL 6210/CIVL 6216.

CIVL 5220 ENVIRONMENTAL ENGINEERING PROCESSES LABORATORY (1) LAB. 3. Pr. CIVL 3230. Laboratory exploration of the fundamentals and applications of aquatic chemistry, physical-chemical processes and biological processes, as employed in water and wastewater treatment. Departmental approval. Credit will not be given for both CIVL 5220 and CIVL 6220.
CIVL 5230 ENVIRONMENTAL HEALTH ENGINEERING (3) LEC. 3. Application of engineering methodology in environmental health; communicable disease control, insect and rodent control, solid and hazardous wastes, noise, radiological health, legal and administrative considerations, etc. Departmental approval. Credit will not be given for both CIVL 5230 and CIVL 6230/CIVL 6236.

CIVL 5240 AIR POLLUTION (3) LEC. 3. Nature, sources and effects of air pollutants; effects of atmospheric conditions on dispersion; dispersion modeling, theory and design of control devices; legal/administrative control. Departmental approval. Credit will not be given for both CIVL 5240 and CIVL 6240/CIVL 6246.

CIVL 5250 BIOLOGICAL PRINCIPLES OF ENVIRONMENTAL ENGINEERING (3) LEC. 3. Pr. CIVL 3230. Fundamentals of aquatic biology and microbiology as applied to environmental engineering: microbial growth, microbial metabolism, microbial population dynamics, wastewater treatment microbiology, environmental impacts, toxicity testing, and biomonitoring. Departmental approval. Credit will not be given for both CIVL 5250 and CIVL 6250/CIVL 6256.

CIVL 5260 SURFACE WATER QUALITY MODELING (3) LEC. 3. Pr. CIVL 3230. Water uses and water quality goals, objectives, and criteria of natural aquatic systems. Principles of surface water quality modeling and waste load allocation. Physical, chemical, biological, and hydrological considerations relating to the fate and transport of pollutants in water environment.

CIVL 5330 LANDFILLS (3) LEC. 3. Pr. CIVL 3310. Landfill siting design, construction and operational practices; regulations, terminology, closure regulations and procedures. Credit will not be given for both CIVL 5330 and CIVL 6330/CIVL 6336.

CIVL 5340 GEOSYNTHETICS AND SOIL IMPROVEMENT (3) LEC. 3. Pr. CIVL 3310. Use of geosynthetics in civil engineering design: reinforcement, retaining walls, filtration, slopes, roads and erosion control. Evaluation and testing of geosynthetics. Improvement of soil properties for civil engineering design: principles and practice of densification, grouting, reinforcement, stone columns, soil nailing. Credit will not be given for both CIVL 5340 and CIVL 6340/CIVL 6346.

CIVL 5350 EARTH RETAINING STRUCTURES (3) LEC. 3. Pr. CIVL 3310. Analysis and design of earth retaining structures. Shear strength; earth pressure theory; gravity, mechanically stabilized, flexible sheet, and anchored structures. May count either CIVL 5350 or CIVL 6350/CIVL 6356.

CIVL 5410 GEOGRAPHIC INFORMATION SYSTEMS IN CIVIL ENGINEERING (3) LEC. 3. Pr. CIVL 2010. Departmental approval. Basic principles and the development of geographic information systems and practical experiences in the field of civil engineering. Credit will not be given for both CIVL 5410 and CIVL 6410.


CIVL 5430 CONSTRUCTION SAFETY AND HEALTH MANAGEMENT (3) LEC. 3. Pr. CIVL 3410. Departmental approval. Various causes of construction accidents and adopted strategies for preventing worksite injuries and illness are investigated. Emphasis on OSHA standards, insurance, and health and safety hazards. Credit will not be given for both CIVL 5430 and CIVL 6430/CIVL 6436.

CIVL 5440 CONSTRUCTION EQUIPMENT AND METHODS (3) LEC. 3. Pr. CIVL 3410 and CIVL 3310 and CIVL 3510. Selection of equipment for heavy construction operations, production rates, owning and operating costs, fleet management. May count either CIVL 5440 or CIVL 6440/CIVL 6446.

CIVL 5450 EROSION & SEDIMENT CONTROL (3) LEC. 3. Pr. CIVL 3310 and CIVL 3410. Process of erosion, sediment transport, and sedimentation along with strategies adopted to prevent and manage erosion on construction sites. May count either CIVL 5450 or CIVL 6450.

CIVL 5460 PROJECT ESTIMATING (3) LEC. 3. Pr. CIVL 3410. Conceptual and definitive estimates, overhead and profit determination; claim change order pricing. May count either CIVL 5460 or CIVL 6460.

CIVL 5480 LEGAL ASPECTS OF CIVIL ENGINEERING PRACTICE (3) LEC. 3. Pr. CIVL 3410. Covered is the law of contracts, agency, association, property, and labor law, studied generally and in the context that the practicing civil engineer encounters them. Departmental approval. May count either CIVL 5480 or CIVL 6480/CIVL 6486.

CIVL 5500 TRAFFIC ENGINEERING ANALYSIS (3) LEC. 3. Pr. CIVL 3510. Capacity analysis of rural and suburban highways, 2-lane highways, freeways, weaving sections, ramps and intersections. May count either CIVL 5500 or CIVL 6500/CIVL 6506.
CIVL 5510 TRAFFIC CONTROL SYSTEMS DESIGN (3) LEC. 3. Pr. CIVL 3510 and STAT 3010. Fundamental design concepts for highway traffic control systems. Control requirements and warrants; hardware operation and equipment selection; development and implementation of timing plans for isolated intersections and intersection networks. May count either CIVL 5510 or CIVL 6510/CIVL 6516.

CIVL 5560 PLANNING FOR MULTIMODAL TRANSPORTATION SYSTEMS (3) LEC. 3. Pr. CIVL 3510 and STAT 3010. Departmental approval. The planning process for urban and regional transportation development. Topics include planning objectives and data requirements; planning inventories: modeling of trip-making behavior, development and evaluation of alternate plans; multimodal applications, including railway operations.

CIVL 5580 INTELLIGENT TRANSPORTATION SYSTEMS (3) LEC. 3. Pr. CIVL 3510. Departmental approval. Introduction to intelligent transportation systems, covering applications of information and communication technologies to transportation, with emphasis on operations of traffic management and traveler information systems. Credit will not be given for both CIVL 5580 and CIVL 6580/CIVL 6586.

CIVL 5560 ADVANCED REINFORCED CONCRETE DESIGN (3) LEC. 3. Pr. CIVL 4600. Analysis and design of continuous beams and one-way slabs, bond and development length, torsion, slenderness effects in columns, two-way slabs, footings, and retaining walls. May count either CIVL 5600 or CIVL 6600/CIVL 6606.

CIVL 5620 PRESTRESSED CONCRETE DESIGN (3) LEC. 3. Pr. CIVL 4600. Properties and behavior of pre-stressed concrete, pre-stressing systems and end anchorages, analysis and design of beams for flexure and shear, camber and deflection, cable lay-out, pre-stressed concrete slabs. May count either CIVL 5620 or CIVL 6620/CIVL 6626.

CIVL 5630 ADVANCED CONCRETE MATERIALS (3) LEC. 3. Pr. CIVL 3820. Comprehensive coverage of concrete materials. Topics include cement and aggregate properties; concrete microstructure; mechanical properties; supplementary cementing materials; chemical admixtures; durability issues; special concretes. May count either CIVL 5630 or CIVL 6630/CIVL 6636.

CIVL 5640 STRUCTURAL MASONRY DESIGN (3) LEC. 3. Pr. CIVL 4600. Properties of masonry component materials; behavior and design of unreinforced and reinforced masonry assemblages and structures. May count either CIVL 5640 or CIVL 6640/CIVL 6646.

CIVL 5650 ADVANCED STEEL DESIGN (3) LEC. 3. Pr. CIVL 4650. Composite construction, open web joists, torsion, plate girders, plastic analysis and design, highway bridges, computer applications. May count either CIVL 5650 or CIVL 6650/CIVL 6656.

CIVL 5660 BRIDGE ENGINEERING (3) LEC. 3. Pr. CIVL 4600 and CIVL 4650. The modern approach to design, evaluation, and rehabilitation of bridges, including design of abutments, piers, concrete deck slabs, non-composite and composite steel girders, and prestressed concrete girders.


CIVL 5690 TIMBER DESIGN (3) LEC. 3. Pr. CIVL 3610. Properties and behavior of timber and plywood; design of timber beams, columns, floor and wall assemblies and wood formwork; timber trusses and laminated arches. May count either CIVL 5690 or CIVL 6690/CIVL 6696.

CIVL 5700 DESIGN FOR LATERAL LOADS (3) LEC. 3. Pr. CIVL 3610 and (CIVL 4600 or CIVL 4650). Wind meteorology and loadings, effects of wind loadings, building code wind pressures and load provisions, fundamentals of structural vibrations, earthquake characteristics and loadings, building code earthquake provisions, building lateral load resisting systems. May count either CIVL 5700 or CIVL 6700/CIVL 6706.

CIVL 5710 STRUCTURAL REPAIR (3) LEC. 3. Pr. CIVL 4600. Evaluation of causes of distress; condition; repair materials; methods of repair; protection methods; and structural strengthening in structural concrete applications. May count either CIVL 5710 or CIVL 6710/ CIVL 6716.

CIVL 5720 RELIABILITY OF STRUCTURES (3) LEC. 3. Pr. CIVL 4600 or CIVL 4650. Reliability-based methods of structural analysis including review of probability and statistics, reliability analysis methods, development of design codes, load and resistance models, system reliability, and practical applications. May count either CIVL 5720 or CIVL 6720/6726.

CIVL 5810 PAVEMENT DESIGN AND CONSTRUCTION (3) LEC. 3. Pr. CIVL 3820 and CIVL 3310 and CIVL 3510. General concepts, traffic factors, material characterization, layer thickness selection, earthwork, base and sub-base construction, surface course construction, quality control/assurance. May count either CIVL 5810 or CIVL 6810/CIVL 6816.
CIVL 5820 DESIGN AND PRODUCTION OF ASPHALT PAVING MIXTURES (3) LEC. 2. LAB. 3. Pr. CIVL 3820. Selection and optimization of component materials based on physical properties, specification criteria, performance expectations, and costs. Production and quality assurance. May count either CIVL 5820 or CIVL 6820.

CIVL 5970 CIVIL ENGINEERING SPECIAL TOPICS (3) LEC. 3. Special topics of an advanced undergraduate nature pertinent to civil engineering. Specific prerequisites will be announced for each course offering. Credit will not be given for both CIVL 5970 and CIVL 6970. Course may be repeated for a maximum of 6 credit hours.

CIVL 6110/6116 OPEN CHANNEL HYDRAULICS (3) LEC. 3. Pr. CIVL 3110. Application of continuity, energy, and momentum analyses to problems of open channel flow. Topics include rapidly and gradually varied flow, unsteady flow, flood routing, computational methods, design concepts and applications. Credit will not be given for both CIVL 5110 and CIVL 6110/CIVL 6116.

CIVL 6120/6126 HYDROLOGIC ANALYSIS AND MODELING (3) LEC. 3. Pr. CIVL 3110 and STAT 3110. Departmental approval. Hydrologic cycle, hydrologic frequency analysis, precipitation, infiltration, runoff hydrograph, flood routing, urban hydrology, watershed hydrologic modeling, and computer modeling applications.

CIVL 6130/6136 HYDRAULIC DESIGN OF PRESSURIZED SYSTEMS (3) LEC. 3. Pr. CIVL 3110. Pressurized flow applications; pump-pipeline design optimization; multiple reservoir operation; flow measurement/control systems; distribution manifolds; fundamentals of unsteady flows. Departmental approval. May count either CIVL 5130 or CIVL 6130.


CIVL 6160/6166 STORMWATER MANAGEMENT AND MODELING (3) LEC. 3. Introduction of current stormwater management practices (e.g., lower impact development and green infrastructures) and polices, rainfall analysis with different inter-event dry period, flood analysis, stormwater runoff hydrograph modeling (rainfall loss, overland flow hydrograph, unit hydrograph theory, and hydrograph routing), stormwater quality modeling (pollutant buildup, washoff, and transport), peak discharge control using detention ponds, and various best management practices for stormwater volume and quality control. Approval by the instructor (e.g., undergraduate hydraulics).

CIVL 6170/6176 NUMERICAL SOLUTIONS FOR HYDRO-ENVIRONMENTAL APPLICATIONS (3) LEC. 3. Pr. CIVL 3110 and CIVL 3230. Theoretical and numerical solutions of various problems in water resources and environmental engineering using computational tools. Development of simple codes and spreadsheet-based tools for the description and prediction of flows, contaminant spreading, and other relevant processes in natural and built systems. May count either CIVL 5170 or CIVL 6170/6176.

CIVL 6210/6216 CHEMICAL PRINCIPLES OF ENVIRONMENTAL ENGINEERING (3) LEC. 3. Pr. CIVL 3230. Fundamentals of aquatic chemistry as applied to environmental engineering: chemical thermodynamics, acid/base equilibrium, solution/dissolution chemistry, redox equilibrium, and chemical kinetics. Departmental approval. Credit will not be given for both CIVL 5210 and CIVL 6210/CIVL 6216.

CIVL 6220 ENVIRONMENTAL ENGINEERING PROCESSES LABORATORY (1) LAB. 3. Pr. CIVL 3230. Laboratory exploration of the fundamentals and applications of aquatic chemistry, physical-chemical processes and biological processes, as employed in water and wastewater treatment. Departmental approval. May count either CIVL 5220 or CIVL 6220.

CIVL 6230/6236 ENVIRONMENTAL HEALTH ENGINEERING (3) LEC. 3. Application of engineering methodology in environmental health; communicable disease control, insect and rodent control, solid and hazardous wastes, noise, radiological health, legal and administrative considerations, etc. Departmental approval. Credit will not be given for both CIVL 5230 and CIVL 6230/CIVL 6236.

CIVL 6240/6246 AIR POLLUTION (3) LEC. 3. Nature, sources and effects of air pollutants; effects of atmospheric conditions on dispersion; dispersion modeling theory and design of control devices; legal/administrative control. Departmental approval. Credit will not be given for both CIVL 5240 and CIVL 6240/6246.

CIVL 6250/6256 BIOLOGICAL PRINCIPLES OF ENVIRONMENTAL ENGINEERING (3) LEC. 3. Pr. CIVL 3230. Fundamentals of aquatic biology and microbiology as applied to environmental engineering: microbial growth, microbial metabolism, microbial population dynamics, wastewater treatment microbiology, environmental impacts, toxicity testing, and biomonitoring. Departmental approval. Credit will not be given for both CIVL 5250 and CIVL 6250/6256.
CIVL 6260/6266 SURFACE WATER QUALITY MODELING (3) LEC. 3. Water uses and water quality goals, objectives, and criteria of natural aquatic systems. Principles of surface water quality modeling and waste load allocation. Physical, chemical, biological, and hydrological considerations relating to the fate and transport of pollutants in water environment.

CIVL 6330/6336 LANDFILLS (3) LEC. 3. Pr. CIVL 3310. Landfill siting design, construction and operational practices; regulations, terminology, closure regulations and procedures. Credit will not be given for both CIVL 5330 and CIVL 6330/CIVL 6336.

CIVL 6340/6346 GEOSYNTHETICS AND SOIL IMPROVEMENT (3) LEC. 3. Pr. CIVL 3310. Use of geosynthetics in civil engineering design: reinforcement, retaining walls, filtration, slopes, roads and erosion control. Evaluation and testing of geosynthetics. Improvement of soil properties for civil engineering design: principles and practice of densification, grouting, reinforcement, stone columns, soil nailing. Credit will not be given for both CIVL 5340 and CIVL 6340/CIVL 6346.

CIVL 6350/6356 EARTH RETAINING STRUCTURES (3) LEC. 3. Pr. CIVL 3310. Analysis and design of earth retaining structures. Shear strength; earth pressure theory; gravity, mechanically stabilized, flexible sheet, and anchored structures. May count either CIVL 5350 or CIVL 6350/CIVL 6356.

CIVL 6410 GEOGRAPHIC INFORMATION SYSTEMS IN CIVIL ENGINEERING (3) LEC. 3. Pr. CIVL 2010. Departmental approval. Basic principles and the development of geographic information systems and practical experiences in the field of civil engineering. Credit will not be given for both CIVL 5410 and CIVL 6410.


CIVL 6430/6436 CONSTRUCTION SAFETY (3) LEC. 3. Pr. CIVL 3410. Departmental approval. Various causes of construction accidents and adopted strategies preventing worksite injuries and illnesses are investigated. Emphasis on OSHA standards, insurance, and health and safety hazards. Credit will not be given for both CIVL 5430 and CIVL 6430/CIVL 6436.

CIVL 6440/6446 CONSTRUCTION EQUIPMENT AND METHODS (3) LEC. 3. Pr. CIVL 3410 and CIVL 3310 and CIVL 3510. Selection of equipment for heavy construction operations, production rates, owning and operating costs, fleet management. May count either CIVL 5440 or CIVL 6440/CIVL 6446.

CIVL 6450 EROSION AND SEDIMENT CONTROL TECHNOLOGIES IN CONSTRUCTION (3) LEC. 3. Pr. CIVL 3310 and CIVL 3410. Process of erosion, sediment transport, and sedimentation along with strategies adopted to prevent and manage erosion on construction sites. May count either CIVL 5450 or CIVL 6450.

CIVL 6460 PROJECT ESTIMATING (3) LEC. 3. Pr. CIVL 3410. Conceptual and definitive estimates, overhead and profit determination; claim change order pricing. May count either CIVL 5460 or CIVL 6460.

CIVL 6480/6486 LEGAL ASPECTS OF CIVIL ENGINEERING PRACTICE (3) LEC. 3. Pr. CIVL 3410. Covered is the law of contracts, agency, association, property, and labor law, studied generally and in the context that the practicing civil engineer encounters them. Departmental approval. May count either CIVL 5480 or CIVL 6480/CIVL 6486.

CIVL 6500/6506 TRAFFIC ENGINEERING ANALYSIS (3) LEC. 3. Pr. CIVL 3510. Capacity analysis of rural and suburban highways, 2-lane highways, freeways, weaving sections, ramps and intersections. May count either CIVL 5500 or CIVL 6500/CIVL 6506.

CIVL 6510/6516 TRAFFIC CONTROL SYSTEMS DESIGN (3) LEC. 3. Pr. CIVL 3510 and STAT 3010. Fundamental design concepts for highway traffic control systems. Control requirements and warrants: hardware operation and equipment selection; development and implementation of timing plans for isolated intersections and intersection networks. May count either CIVL 5510 or CIVL 6510/CIVL 6516.

CIVL 6560/6566 PLANNING FOR MULTIMODAL TRANSPORTATION SYSTEMS (3) LEC. 3. Pr. CIVL 3510 and STAT 3010. The planning process for urban and regional transportation development. Topics include planning objectives and data requirements; planning inventories; modeling of trip-making behavior, development and evaluation of alternate plans; multimodal applications, including railway operations. Departmental approval. May count either CIVL 5560.

CIVL 6580/6586 INTELLIGENT TRANSPORTATION SYSTEMS (3) LEC. 3. Pr. CIVL 3510. Introduction to intelligent transportation systems, covering applications of information and communications technologies to transportation, with emphasis on operations of traffic management and traveler information systems. Departmental approval. May count either CIVL 5580 or CIVL 6580/CIVL 6586.
CIVL 6600/6606 ADVANCED REINFORCED CONCRETE DESIGN (3) LEC. 3. Pr. CIVL 4600. Analysis and design of continuous beams and one-way slabs, bond and development length, torsion, slenderness effects in columns, two-way slabs, footings, and retaining walls. May count either CIVL 5600 or CIVL 6600/CIVL 6606.

CIVL 6620/6626 PRESTRESSED CONCRETE DESIGN (3) LEC. 3. Pr. CIVL 4600. Properties and behavior of pre-stressed concrete, pre-stressing systems and end anchorages, analysis and design of beams for flexure and shear, camber and deflection, cable layout, pre-stressed concrete slabs. May count either CIVL 5620 or CIVL 6620/CIVL 6626.

CIVL 6630/6636 ADVANCED CONCRETE MATERIALS (3) LEC. 3. Pr. CIVL 3820. Comprehensive coverage of concrete materials. Topics include cement and aggregate properties; concrete microstructure; mechanical properties; supplementary cementing materials, chemical admixtures; durability issues; special concretes. May count either CIVL 5630 or CIVL 6630/CIVL 6636.

CIVL 6640/6646 STRUCTURAL MASONRY DESIGN (3) LEC. 3. Pr. CIVL 4600. Properties of masonry component materials; behavior and design of unreinforced and reinforced masonry assemblages and structures. May count either CIVL 5640 or CIVL 6640/CIVL 6646.

CIVL 6650/6656 ADVANCED STEEL DESIGN (3) LEC. 3. Pr. CIVL 4650. Composite construction, open web joists, torsion, plate girders, plastic analysis and design, highway bridges, computer applications. May count either CIVL 5650 or CIVL 6650/CIVL 6656.

CIVL 6660/6666 BRIDGE ENGINEERING (3) LEC. 3. Pr. CIVL 4600 and CIVL 4650. The modern approach to design, evaluation, and rehabilitation of bridges, including design of abutments, piers, concrete deck slabs, non-composite and composite steel girders, and prestressed concrete girders. May count either CIVL 5660 or CIVL 6660/6666.


CIVL 6690/6696 TIMBER DESIGN (3) LEC. 3. Pr. CIVL 3610. Properties and behavior of timber and plywood; design of timber beams, columns, floor and wall assemblages and wood formwork; timber trusses and laminated arches. May count either CIVL 5690 or CIVL 6690/CIVL 6696.

CIVL 6700/6706 DESIGN FOR LATERAL LOADS (3) LEC. 3. Pr. CIVL 3610 and (CIVL 4600 or CIVL 4650). Wind meteorology and loadings, effects of wind loadings, building code wind pressures and load provisions, fundamentals of structural vibrations, earthquake characteristics and loadings, building code earthquake provisions, building lateral load resisting systems. May count either CIVL 5700 or CIVL 6700/CIVL 6706.

CIVL 6710/6716 STRUCTURAL REPAIR (3) LEC. 3. Pr. CIVL 4600. Evaluation of causes of distress; condition; repair materials; methods of repair; protection methods; and structural strengthening in structural concrete applications. May count either CIVL 5710 or CIVL 6710/CIVL 6716.

CIVL 6720/6726 RELIABILITY OF STRUCTURES (3) LEC. 3. Pr. CIVL 4600 or CIVL 4650. Reliability-based methods of structural analysis including review of probability and statistics, reliability analysis methods, development of design codes, load and resistance models, system reliability, and practical applications. May count either CIVL 5720 or CIVL 6720/6726.

CIVL 6810/6816 PAVEMENT DESIGN AND CONSTRUCTION (3) LEC. 3. Pr. CIVL 3820 and CIVL 3310 and CIVL 3510. General concepts, traffic factors, material characterization, layer thickness selection, earthwork, base and sub-base construction, surface course construction quality control/assurance. May count either CIVL 5810 or CIVL 6810/CIVL 6816.

CIVL 6820/6826 DESIGN AND PRODUCTION OF ASPHALT PAVING MIXTURES (3) LEC. 2. LAB. 3. Pr. CIVL 3820. Selection and optimization of component materials based on physical properties, specification criteria, performance expectations, and costs. Production and quality assurance. May count either CIVL 5820, CIVL 6820 or CIVL 6826.

CIVL 6970/6976 CIVIL ENGINEERING SPECIAL TOPICS (3) LEC. 3. Departmental approval. Special topics of an advanced undergraduate nature pertinent to civil engineering. Specific prerequisites will be announced for each course offering. Credit will not be given for both CIVL 5970 and CIVL 6970. Course may be repeated for a maximum of 6 credit hours.

CIVL 7130 SOCIAL-ECOLOGICAL-ENGINEERED SYSTEMS (3) LEC. 3. This course explores foundational scholarship on the Social-Ecological Systems (SES) approach to understanding complex environmental problems with emphasis on the role of engineering in human interactions with natural systems. Students are expected to apply SES concepts and theories to analyses in their own areas of research. Note: This class is intended to be cross-listed with ESSI 7300.

CIVL 7140/7146 ECOHYDROLOGY (3) LEC. 3. Pr. P/C CIVL 6120 or P/C CIVL 6126 or P/C GEOL 6100 or P/C FORY 7550. This course covers current theory, methods, and issues in ecohydrology. Topics include the soil-plant-atmosphere continuum; stochastic modeling of soil moisture; vadose zone hydrology; theory, measurement, and modeling of evapotranspiration; ecological competition in water-limited systems; and current issues and research topics.

CIVL 7170/7176 NUMERICAL METHODS IN HYDRAULICS AND HYDROLOGY (3) LEC. 3. Pr. CIVL 3230. Numerical approximations of ordinary and partial differential equations representing problems common to civil engineering including groundwater flow, soil consolidation, and mass transport. The formulation and computational solution of diffusion and equilibrium problems are emphasized. Computer programming is required.

CIVL 7210/7216 METHODS OF POLLUTANT ANALYSIS IN ENVIRONMENTAL ENGINEERING (3) LEC. 2. LAB. 3. Pr. CIVL 6210 or CIVL 6216. Fundamentals of identifying and quantifying environmental pollutants: review of pollutant chemistry, quality and quantity of pollutants, statistical basis of sampling, environmental sampling techniques, analytical techniques, and data analysis.


CIVL 7230/7236 WATER AND WASTEWATER OPERATIONS AND PROCESSES II (3) LEC. 3. Pr. CIVL 7220 or CIVL 7226. Departmental approval. Rigorous analysis of unit operations and processes used in modern water and wastewater treatment systems. Mixing, coagulation, sedimentation, filtration, and chemical precipitation.

CIVL 7240/7246 WATER AND WASTEWATER OPERATIONS AND PROCESSES III (3) LEC. 3. Pr. CIVL 7220 or CIVL 7226. Departmental approval. Design and analysis of unit operations and processes used in modern water and wastewater treatment systems are rigorously examined: adsorption, ion exchange, membrane filtration, reverse osmosis, gas transfer, corrosion, and treatment residuals processing.


CIVL 7260/7266 ENVIRONMENTAL NUTRIENT CONTROL PROCESSES (3) LEC. 3. Pr. CIVL 7250 or CIVL 7256. The nature, sources, and impacts of aquatic nutrients in the environment: microbial nutrient cycles, biological nutrient removal processes, chemical nutrient control processes, natural systems for nutrient removal.


CIVL 7280/7286 SURFACE WATER QUALITY MODELING (3) LEC. 3. Pr. CIVL 3230. Departmental approval. Physical, chemical, biological and hydrological considerations relating to the degradation and self-purification of streams, lakes, and estuaries. Water uses and water quality goals, objectives and criteria. Principles of water quality modeling and waste load allocation.

CIVL 7310/7316 FOUNDATION ENGINEERING (3) LEC. 3. Pr. CIVL 3310 and CIVL 4600. Analysis, design and construction of shallow and deep foundation systems.

CIVL 7330/7336 SOIL PROPERTIES (3) LEC. 3. Pr. CIVL 3310. Soil behavior, shear strength, compressibility, hydraulic conductivity, and measurement of soil properties.

CIVL 7340/7346 SOIL DYNAMICS (3) LEC. 3. Pr. CIVL 3310. Soil behavior during dynamic loads, wave propagation, dynamically loaded foundations, geotechnical earthquake engineering.


CIVL 7390/7396 IN SITU TESTING OF SOILS (3) LEC. 3. Pr. CIVL 4310. In situ tests used in geotechnical engineering: test procedures, interpretation of results, and designing from in situ geotechnical data.
CIVL 7410/7416 TEMPORARY STRUCTURES AND FACILITIES (3) LEC. 3. Pr. STAT 3010 and CIVL 3310 and CIVL 3610. Construction loads, applicable codes and standards, and design principles for temporary structures; planning and implementation of construction facilities; economic analysis of alternatives.

CIVL 7500/7506 TRAFFIC FLOW THEORY (3) LEC. 3. Pr. CIVL 6500 or CIVL 6506. Departmental approval. Basic phenomena underlying traffic stream movement and individual vehicle behavior. Topics include flow parameters and relationships; microscopic and macroscopic flow models; equations of motion and state; single and multi-regime flow models.

CIVL 7520/7526 PUBLIC TRANSPORTATION (3) LEC. 3. Pr. CIVL 3510. Departmental approval. Technology and characteristics of public transportation; transportation demand analysis; transit users; innovative technologies.

CIVL 7540/7546 TRANSPORTATION SAFETY (3) LEC. 3. Pr. CIVL 6500 or CIVL 6506. Departmental approval. Transportation safety problems and the engineer’s role in developing and administering safety programs. Topics include hazardous location identification; analysis of accident data; development and evaluation of accident countermeasures and safety programs.

CIVL 7550/7556 ROADSIDE DESIGN (3) LEC. 3. Pr. CIVL 6500 or CIVL 6506. Departmental approval. Concepts of roadside design that can prevent or reduce crash severity. Topics include design, selection, placement and construction of longitudinal barriers, crash cushions, bridge rails, transitions, end terminals, sign posts, and other roadside features.


CIVL 7620/7626 STRUCTURAL DYNAMICS II (3) LEC. 3. Pr. CIVL 7610 or CIVL 7616. Analysis of MDOF systems by direct numerical integration, continuous systems, nonlinear dynamics response, earthquake response of structures.

CIVL 7630/7636 ADVANCED STRESS ANALYSIS (3) LEC. 3. Pr. CIVL 3610. Hooke’s 1-D, 2-D, 3-D stress-strain relations and applications, stress and strain transformations and Mohr’s circle, material properties and failure theories, biaxial bending, unsymmetrical bending, composite material members, shear center, torsional stress, stress concentrations, beams on elastic foundations.

CIVL 7640/7646 STABILITY OF STRUCTURES (3) LEC. 3. Coreq. CIVL 6670. Introduction to stability and failure of compression members, rigid bar buckling, elastic and inelastic buckling of columns, approximate methods of buckling analysis, beam-columns, buckling of frames, torsional buckling, lateral torsional buckling of beams.

CIVL 7650/7656 ADVANCED ANALYSIS OF FRAMED STRUCTURES (3) LEC. 3. Pr. CIVL 6670 or CIVL 6676. Matrix analysis of framed structures, elastic supports, specified displacements, member end releases, principle of minimum potential energy, geometric non-linearity, frame stability, substructures.

CIVL 7660/7666 FINITE ELEMENT METHODS IN STRUCTURAL MECHANICS (3) LEC. 3. Pr. CIVL 6670 or CIVL 6676. Departmental approval. Introduction to finite element analysis; variational principles. 1D, 2D and 3D element formulation; nonlinear (geometric and constitutive) formulations and solutions; eigenvalue problems.

CIVL 7670/7676 NUMERICAL TECHNIQUES IN STRUCTURAL ANALYSIS (3) LEC. 3. Basic concepts of non-linear analyses, formulation of the continuum mechanics incremental equations, total and updated Lagrangian formulations, finite elements for non-linear analyses, non-linear solution strategies.

CIVL 7680/7686 FATIGUE AND FRACTURE MECHANICS (3) LEC. 3. Pr. CIVL 4650. Departmental approval. Linear-elastic and elastic-plastic fracture mechanics, fatigue, yield criteria, applications to highway structures.

CIVL 7690/7696 ANALYSIS OF PLATE AND SHELL SYSTEMS (3) LEC. 3. Pr. CIVL 6670 or CIVL 6676. Departmental approval. Analysis of isotropic and anisotropic plates with various shapes and boundary conditions due to lateral and in-plane loads; large deflection considerations; numerical techniques; bending and membrane behavior of isotropic shells.

CIVL 7710/7716 APPLIED ELASTICITY (3) LEC. 3. Pr. CIVL 6670 or CIVL 6676. Departmental approval. Analysis of stress-strain; generalized stress-strain relationships; solution of elasticity problem by potentials; thick cylinders, disks and spheres; energy principles and introduction of variational methods.

CIVL 7720/7726 EARTHQUAKE ENGINEERING (3) LEC. 3. Pr. (CIVL 7610 or CIVL 7616) and (CIVL 5670 or CIVL 6670 or CIVL 6676). Principles of earthquakes and earthquake engineering; Analysis and design of steel and reinforced concrete buildings for earthquakes. May count either CIVL 7720 or CIVL 7726.
CIVL 7770/7776 VARIATIONAL METHODS IN STRUCTURAL MECHANICS (3) LEC. 3. Pr. CIVL 6670 or CIVL 6676. Departmental approval. Calculus of variations; derivation of Euler’s equations and boundary conditions; applications of energy principles to structures; variational approaches to finite element methods.

CIVL 7810/7816 ADVANCED CONSTRUCTION MATERIALS (4) LEC. 3. LAB. 3. Pr. CIVL 6810 or CIVL 6816. Departmental approval. Evaluate soils, unbound and stabilized materials, hot mix asphalt, and cement concrete products; stress-strain relationships; thermal expansion; design and testing of non-traditional construction products.

CIVL 7820/7826 ADVANCED PAVEMENT DESIGN AND REHABILITATION (3) LEC. 3. Pr. CIVL 7810 or CIVL 7816. Pavement management concepts, life cycle costs analysis, design and rehabilitation alternatives, serviceability concepts, empirical thickness selection models, reliability.

CIVL 7830 ASPHALT CONCRETE MIX DESIGN (3) LEC. 2. LAB. 3. Marshall and Superpave mix design methods and QC/QA for asphalt concrete are covered. Topics include aggregate, asphalt and mix properties, laboratory testing and proportion optimization.

CIVL 7840/7846 PAVEMENT MANAGEMENT AND REHABILITATION (3) LEC. 3. Pr. CIVL 3820. Departmental approval. Topics include: network and project level management, pavement distress surveys, non-destructive testing for condition measurements, flexible and rigid pavement maintenance and rehabilitation practices.

CIVL 7860/7866 PAVEMENT CONSTRUCTION (3) LEC. 3. Pr. CIVL 3820. Operation, quality control and specifications of component construction processes for asphalt and concrete paving; and overview of major rehabilitation strategies.

CIVL 7870 ADVANCED CHARACTERIZATION OF PAVEMENT MATERIALS (3) LEC. 2. LAB. 3. Pr. CIVL 3820. This course introduces theories and procedures for determining fundamental properties of asphalt materials for advanced material evaluation and pavement design.

CIVL 7950 GRADUATE SEMINAR (1) SEM. 1. SU. Course may be repeated for a maximum of 6 credit hours.

CIVL 7970/7976 SPECIAL TOPICS IN CIVIL ENGINEERING (1-3) LEC. Individual student or group endeavor under direct faculty supervision involving special topics of an advanced nature in civil engineering. Course may be repeated for a maximum of 9 credit hours.

CIVL 7980/7986 ENGINEERING PROJECT (1-10) LEC. Departmental approval. Directed study on an engineering project or research supervised by an individual graduate faculty member. Course may be repeated for a maximum of 10 credit hours.

CIVL 7990/7996 RESEARCH AND THESIS (1-10) MST. Departmental approval. Credit to be arranged. Course may be repeated for a maximum of 10 credit hours.

CIVL 8990/8996 RESEARCH AND DISSERTATION (1-10) DSR. Departmental approval. Credit to be arranged. Course may be repeated with change in topics.

Curriculum in Civil Engineering

**Freshman**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
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<tbody>
<tr>
<td>MATH 1610 Calculus I</td>
<td>4</td>
<td>MATH 1620 Calculus II</td>
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<tr>
<td>CHEM 1030 Fundamentals Chemistry I</td>
<td>3</td>
<td>PHYS 1600 Engineering Physics I</td>
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<tr>
<td>CHEM 1031 Fundamental Chemistry I Laboratory</td>
<td>1</td>
<td>COMP 1200 Introduction to Computing for Engineers and Scientists</td>
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<td>ENGR 1100 Engineering Orientation</td>
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<td>ENGL 1120 English Composition II</td>
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<tr>
<td>ENGR 1110 Introduction to Engineering</td>
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<td>POLI 1090 American Government in Multicultural World</td>
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<td>ENGL 1100 English Composition I</td>
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<tr>
<td>Core History¹</td>
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**Spring**

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<th>Hours</th>
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¹ Core History: Includes American Government in Multicultural World
### Sophomore

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<tr>
<th>Fall</th>
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<th>Hours</th>
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<tr>
<td>MATH 2630 Calculus III</td>
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<td>MATH 2650 Linear Differential Equations</td>
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<td>PHYS 1610 Engineering Physics II</td>
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<td>CHEM 1040 Fundamental Chemistry II</td>
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<tr>
<td>ENGR 2050 Statics</td>
<td>3</td>
<td>ENGR 2070 Mechanics of Materials</td>
<td>3</td>
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<tr>
<td>CIVL 2010 Surveying</td>
<td>3</td>
<td>ENGR 2200 Introduction To Thermodynamics, Fluids And Heat Transfer</td>
<td>3</td>
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<tr>
<td>STAT 3010 Statistics for Engineers and Scientists</td>
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<td>Core Literature₁</td>
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17 | 18

### Junior

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<th>Fall</th>
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<th>Spring</th>
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<tbody>
<tr>
<td>CIVL 3010 Civil Engineering Analysis</td>
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<td>CIVL 3110 Hydraulics</td>
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<tr>
<td>CIVL 3310 Geotechnical Engineering I</td>
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<td>CIVL 3230 Environmental Engineering</td>
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<tr>
<td>CIVL 3410 Construction Engineering</td>
<td>3</td>
<td>CIVL 3510 Transportation Engineering</td>
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<tr>
<td>CIVL 3610 Structural Analysis</td>
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<td>CIVL 3820 Civil Engineering Materials</td>
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15 | 15

### Senior

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<th>Fall</th>
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<th>Spring</th>
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<tr>
<td>PHIL 1040 Business Ethics</td>
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<td>Core Fine Arts</td>
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<tr>
<td>Science Elective²</td>
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<td>Core History/Social Science¹</td>
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<td>Breadth Elective I²</td>
<td>3</td>
<td>Breadth Elective III²</td>
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<tr>
<td>Breadth Elective II²</td>
<td>3</td>
<td>Technical Elective II²</td>
<td>3</td>
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<tr>
<td>Technical Elective I²</td>
<td>3</td>
<td>Senior Design Project²</td>
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<td>UNIV 4AA0 Creed to Succeed</td>
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</tr>
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16 | 15

Total Hours: 128

₁ The AU Bulletin lists the University Core Curriculum requirements for students in the College of Engineering. Students must complete a sequence in either Literature or History. Because of the discipline-specific requirements for the Humanities courses, it is recommended that a History sequence be completed in the Social Sciences courses.

² Breadth electives, technical electives, the science elective, and the senior design project must be selected from lists of approved courses available from the Department of Civil Engineering. Each student must take a breadth elective in at least three of the seven specialty areas: construction, environmental, geotechnical, pavements and materials, structural, transportation, and water resources engineering.

### Computer Science and Software Engineering

**Software Engineering**

The focus of the software engineering curriculum, which leads to the bachelor of software engineering, is on the analysis, design, verification, validation, construction, application, and maintenance of software systems. The degree program prepares students for professional careers and graduate study with a balance of computer science theory and practical application of software engineering methodology using modern software engineering environments and tools. The curriculum is based on a strong core of topics including software modeling and design, construction, process and quality assurance, intelligent and interactive systems, networks, operating systems, and computer architecture. The curriculum also enriches each student’s general education with a range of courses from science, mathematics, the humanities and the social sciences. Through advanced elective courses, the curriculum allows students to specialize in core areas of computer science and software engineering. Engineering design theory and methodology, as they
apply to software systems, form an integral part of the curriculum, beginning with the first course in computing and culminating with a comprehensive senior design project, which gives students the opportunity to work in one or more significant application domains. The curriculum also emphasizes oral and written communication skills, the importance of ethical behavior, and the need for continual, life-long learning. The overall educational objectives of the Software Engineering program are for graduates of the program to attain success in their chosen profession and/or post-undergraduate studies.


Computer Science

The computer science curriculum, which leads to the bachelor of science in computer science degree, provides an excellent preparation for students seeking careers as software professionals and in computing-related fields, as well as those planning to pursue graduate study. The curriculum builds on a strong foundation in science, mathematics, social sciences, humanities and computer science with advanced course work in theoretical computer science, human-computer interaction, and net-centric computing. Course work ensures that students receive hands-on exposure to a variety of computer systems, tools and techniques. Elective courses allow students to specialize in core areas of computer science such as networking, database systems, and artificial intelligence. In addition, students select a concentration of 9 semester credit hours outside computer science (e.g., business, mathematics, physics, etc.). This concentration enriches students’ educational experience and adds breadth of knowledge by providing an opportunity to explore a second field of study to which computer science can be applied. The curriculum also emphasizes oral and written communication skills, the importance of ethical behavior, and the need for continual, lifelong learning. The overall educational objectives of the Computer Science program are for graduates of the program to attain success in their chosen profession and/or post-undergraduate studies.

The undergraduate Computer Science program is accredited by the Computing Accreditation Commission of ABET, http://www.abet.org.

Computer Science (online)

The Bachelor of Computer Science (CPSC) program prepares students for careers as software professionals and in computing-related fields via an entirely online distance-education-based curriculum. The curriculum builds on a foundation of science, mathematics, social science, and humanities. It provides basic coursework in computer software development and theoretical foundations of computer science. This is followed by advanced coursework in computer systems, software engineering, and applications development, including web software design, database, and mobile applications development (such as smartphone and tablet software). The curriculum is rounded out by advanced electives in areas such as wireless and mobile networks, parallel computing, computer architecture, and formal languages.

The program can be completed in two ways: (1) as a second bachelor’s degree, requiring only the 60 hours of CPSC content outlined in the curriculum model, or (2) as a first bachelor’s degree, by completing the other requirements outlined in the curriculum model in addition to the CPSC content. These other requirements can be completed either by transfer credit or by completing the relevant Auburn University courses either online (if available) or on-campus. Courses from the CPSC curriculum cannot be transferred to any other graduate or undergraduate program in the Samuel Ginn College of Engineering. Likewise courses from the on-campus Computer Science and Software Engineering department programs, such as Computer Science (CSCI), Software Engineering (SWEN), and Wireless Engineering, Software Option (WIRS) cannot be given transfer credit in the CPSC program. Students in the CPSC program do not have to take the pre-engineering required courses.

The CPSC content is delivered online in the form of recorded presentations, multimedia content, websites, programming exercises, quizzes and examinations, online discussions, and any other electronic means the instructor finds appropriate. The courses are offered in eight-week terms, with five weeks per term. The start dates of the five terms are roughly: start of fall semester, middle of fall semester, start of spring semester, middle of spring semester, and during summer semester. Each 8-week course is worth 3 semester credit hours. Thus, taking two courses per 8-week term would correspond in workload to taking four courses on-campus during a regular semester. An 8-week online 3-credit-hour CPSC course will have the same academic work load as an on-campus 3-credit-hour course (roughly twice as many hours per week as a fall or spring semester course). Whereas an on-campus student is expected to complete an average of 3-3.5 hours of academic work per week over the length of a 15 week semester, a student in the CPSC degree program will be expected to complete an average of 6-7 hours of academic work per week over the length of an 8 week semester. Students are expected to watch all recorded content in a timely fashion, interact with the instructor and teaching assistants as needed via electronic means, and complete and submit all assignments electronically. A student must have access to a computer on which they can access the internet to view content, complete programming assignments, download and install needed software, and access remote resources such as virtual machines necessary to complete some programming projects and lab assignments.
Taking two courses per term, the CPSC content can be completed in ten 8-week terms, or two years. The coursework consists of eighteen required courses and two electives.

**Majors**

- Software Engineering (p. 126)
- Computer Science (p. 125)
- Computer Science (Online) (p. 123)
- Wireless Engineering (Hardware Option) (p. 139)
- Wireless Engineering (Software Option) (p. 140)

**Minor**

- Computer Science (p. 124)
- Information Technology ([http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/minorininformationtechnology/](http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/minorininformationtechnology/))

**Computer Sci Software En Courses**

**COMP 1000/1003 PERSONAL COMPUTER APPLICATIONS (2)**
LEC. 2. Introduction to personal computers and software applications, including word processing, spreadsheets, databases, and presentation graphics; generation and retrieval of information with the Internet; integration of data among applications.

**COMP 1200 INTRODUCTION TO COMPUTING FOR ENGINEERS AND SCIENTISTS (2)**
LEC. 2. Computer programming in a high-level language, with emphasis on use of the computer as a tool for engineering or science.

**COMP 1201 INTRODUCTION TO COMPUTING LABORATORY (1)**
LAB. 1. SU. Coreq. COMP 1200. Laboratory activities focused on computer programming in a high-level language.

**COMP 1210/1213 FUNDAMENTALS OF COMPUTING I (3)**
LEC. 2. LAB. 3. Introduction to the fundamental concepts of programming from an object-oriented perspective. Emphasis on good software engineering principles and development of the fundamental programming skills in the context of a language that supports the object-oriented paradigm.

**COMP 1AA0 COMPUTER COMPETENCY TEST (0)**
TST. SU. A comprehensive test of all material covered in COMP 1000 and COMP 1003. Course may be repeated with change in topics.

**COMP 2000 NETWORK PROGRAMMING WITH HTML AND JAVA (3)**
LEC. 3. Pr. COMP 1000 or COMP 1003 or ENGR 1110 or ENGR 1113. Introduction to network programming using HTML and Java to build web pages and web-based applications; presentation graphics; retrieval of information from the Internet; integration of data among applications. Pr., COMP 1000 or higher, or ENGR 1110.

**COMP 2210/2213 FUNDAMENTALS OF COMPUTING II (4)**
LEC. 3. LAB. 3. Pr. COMP 1210 or COMP 1213. Software development in the context of collections (e.g., lists, trees, graphs, hashtables). Communication, teamwork, and a design experience are integral course experience.

**COMP 2710/2713 SOFTWARE CONSTRUCTION (3)**
LEC. 3. Pr. COMP 2210. Intensive experience in software construction, to include topics such as testing, debugging, and associated tools; configuration management; low-level file and device I/O; systems and event-driven programming.

**COMP 3000 OBJECT-ORIENTED PROGRAMMING FOR ENGINEERS AND SCIENTISTS (3)**
LEC. 3. Pr., Departmental approval. Fundamentals of object-oriented design and programming principles; data abstraction, identifying objects, problem decomposition, design and implementation of classes. Credit for the major will not be given to CSCI and SWEN, and WIRS majors.

**COMP 3010/3013 SPREADSHEET-BASED APPLICATIONS WITH VISUAL BASIC (3)**
LEC. 2. LAB. 3. Pr. A grade of D or higher in COMP 1200-3000. COMP 1200 or higher. Design and implementation of applications such as simulations, spreadsheet front-ends for modeling, interfaces to databases, and multimedia applications.

**COMP 3220 PRINCIPLES OF PROGRAMMING LANGUAGES (3)**
LEC. 3. Pr. COMP 2210. Study of programming language principles supporting procedural abstraction, data abstraction, storage allocation, and parallel execution; language types and examples; language translations.
COMP 3240/3243 DISCRETE STRUCTURES (3) LEC. 3. Pr. COMP 1210 or COMP 1217. Characterization of computer science data structures and algorithms in terms of sets and relations, functions, recurrence relations. Use of propositional and predicate calculus to describe algorithms. Proving correctness and running time bounds for algorithms by induction and structural induction.

COMP 3270 INTRODUCTION TO ALGORITHMS (3) LEC. 3. Pr. (COMP 3240 or COMP 3243) and COMP 2210. Algorithms for standard computational problems and techniques for analyzing their efficiency; designing efficient algorithms and experimentally evaluating their performance.

COMP 3350/3353 COMPUTER ORGANIZATION AND ASSEMBLY LANGUAGE PROGRAMMING (3) LEC. 3. Pr. ELEC 2200 or ELEC 2210. Stored Program Computers, hardware and software components; data representation, instruction sets, addressing modes; assembly language programming; linkers, loader, and operating systems.

COMP 3500 INTRODUCTION TO OPERATING SYSTEMS (3) LEC. 3. Pr. COMP 2710 and (COMP 3350 or ELEC 2220). Structure and functions of operating systems; processes and process scheduling; synchronization and mutual exclusion; memory management; auxiliary storage management; resource allocation and deadlock; security, privacy, and ethical concerns; design tradeoffs.

COMP 3510 EMBEDDED SYSTEMS DEVELOPMENT (3) LEC. 3. Pr. COMP 2710 and (COMP 3350 or ELEC 2220). Operating system design and analysis for embedded systems: Real-time issues, resource management, scheduling, exception handling, device driver development, kernel development, synchronization, network support.

COMP 3700 SOFTWARE MODELING AND DESIGN (3) LEC. 3. Pr. COMP 2710. Current processes, methods, and tools related to modeling and designing software systems. Communication, teamwork, and a design experience are integral course experiences.

COMP 3710 WIRELESS SOFTWARE ENGINEERING (3) LEC. 3. Pr. COMP 2710. Software engineering for wireless applications: specification, process, testing, and performance evaluation. Design and development of wireless application layer software, including current protocols.

COMP 4200 FORMAL LANGUAGES (3) LEC. 3. Pr. COMP 3240. Fundamentals of formal languages including mathematical models of regular sets, context-free languages and Turing machines; deterministic and non-deterministic models.

COMP 4300 COMPUTER ARCHITECTURE (3) LEC. 3. Pr. COMP 3350. Comparison of computer architectures, emphasizing the relationships between system software and hardware. Includes processor control and datapath organization, memory subsystem design, instruction set design, processor simulation, and quantitative analysis of computer performance.

COMP 4320 INTRODUCTION TO COMPUTER NETWORKS (3) LEC. 3. Pr. COMP 3500 or COMP 3510 or Departmental approval. Fundamentals of computer networks, OSI model, LAN, WAN, packet transmission, interworking, Internet Protocol, WWW and Java technology.

COMP 4710 SENIOR DESIGN PROJECT (3) LEC. 3. Pr. COMP 3700 or COMP 3710. Development of requirement definitions, architectural design specification, detailed design specification, testing plan and documentation for the software and/or hardware components of a comprehensive project.

COMP 4730 COMPUTER ETHICS (1) LEC. 1. Pr. (PHIL 1020 or PHIL 1023 or PHIL 1027) or PHIL 1040. Application of ethical principles to computing-related topics, including privacy, property rights, autonomy, access, and diversity. Communication and teamwork are integral course experiences.

COMP 4960 SPECIAL PROBLEMS (1-4) IND. Course may be repeated for a maximum of 6 credit hours.

COMP 4970 SPECIAL TOPICS (1-3) LEC. 1-3. Investigation of current topics in computer science and software engineering. Departmental approval Course may be repeated for a maximum of 12 credit hours.

COMP 4997 HONORS THESIS (3-6) IND. Pr. Honors College. Departmental approval. Individual student endeavor consisting of directed research and writing of honors thesis. Course may be repeated for a maximum of 6 credit hours.

COMP 5000 WEB APPLICATION DEVELOPMENT (3) LEC. 3. Departmental approval. Design and implementation of web sites and associated applications. Emphasis on user interface design and information organization and presentation. Fall, Spring.

COMP 5020 ADVANCED WEB APPLICATION DEVELOPMENT (3) LEC. 3. Pr. COMP 5000. Departmental approval. Design and implementation of interactive web applications in Java as applets and servlets. Use of concepts like security, internationalization, multithreading and server/client architectures.
COMP 5120/5123 DATABASE SYSTEMS I (3) LEC. 3. Pr. COMP 3270. Theoretical and applied issues related to the analysis, design, and implementation of relational database systems.

COMP 5130 DATA MINING (3) LEC. 3. Pr. COMP 3270. Advanced concepts, techniques, and applications of data mining with an algorithmic and computational focus, including data visualization, data warehousing, data cube computation, pattern and rule mining, classification, belief networks, clustering, outlier detection, graph matching, and parallel and distributed computation.

COMP 5200 THEORETICAL COMPUTER SCIENCE (3) LEC. 3. Pr. COMP 4200. Departmental approval. The nature of the recursive sets and recursively enumerable sets. Decidability. Context-sensitive grammars and linear-bounded automata, including closure properties; oracles; reduction; the arithmetic hierarchy; the analytic hierarchy.

COMP 5210 COMPILER CONSTRUCTION (3) LEC. 3. Pr. COMP 4200 and COMP 3220. Compiler organization; lexical analysis; parsing; syntax- direction translation; symbol tables; basic dependence analysis; intermediate forms; interpreters vs. compilers; run-time storage management; code generation; error detection and recovery.


COMP 5330 PARALLEL AND DISTRIBUTED COMPUTING (3) LEC. 3. Pr. COMP 3500 or COMP 3510. Overview of hardware and software issues in parallel systems: fundamental parallel architectures, programming languages, tools and algorithms, parallel applications.

COMP 5340 NETWORK QUALITY ASSURANCE AND SIMULATION (3) LEC. 3. Pr. COMP 4320 or ELEC 5220. Theoretical and practical aspects of network simulation and quality assurance.

COMP 5350 DIGITAL FORENSICS (3) LEC. 3. Pr. COMP 2710 or ISMN 3080 or (MNGT 3080 or MNGT 3087). Departmental approval. Computer compromise and forensics, with focus on computer crime and ways to uncover, protect, and exploit digital evidence.

COMP 5360 WIRELESS AND MOBILE NETWORKS (3) LEC. 3. Pr. COMP 4320. Departmental approval. Mobile IP, wireless routing, location management, ad-hoc wireless networks, wireless TCP personal communication systems, and GSM. A


COMP 5400 FUNDAMENTALS OF COMPUTER GRAPHICS (3) LEC. 3. Pr. COMP 2710 and MATH 2660. Graphics hardware and software components, coordinate systems, 2-D and 3-D transformations, 3-D viewing and projection, clipping and windowing, scan conversion and algorithms, visibility determination and shadowing, and software projects using a graphics software package.

COMP 5500 DISTRIBUTED OPERATING SYSTEMS (3) LEC. 3. Pr. COMP 4320. Basic concepts of distributed systems. Concurrent process communication and synchronization mechanisms, distributed process scheduling, distributed file systems, distributed shared memory, distributed system security and case studies.

COMP 5520 NETWORK AND OPERATING SYSTEM ADMINISTRATION (3) LEC. 3. Pr. COMP 4320. Studies of the installation, configuration and management of traditional, distributed and networked system software. Network integration of different systems. Performance monitoring, safety and security issues together with policies, politics and the laws regarding system software management.

COMP 5530/5533 CLOUD COMPUTING: PRINCIPLES, PRACTICE, AND APPLICATIONS (3) LEC. 3. Pr. COMP 3220 and COMP 3500. Cloud concepts and issues including architecture, service models, security, and implementation. Hands-on experience in both using, managing, and deploying clouds.


COMP 5630 MACHINE LEARNING (3) LEC. 3. Pr. COMP 3270. An exploration of current concepts, techniques, and applications in machine learning including abductive learning, case-based learning, deep learning, and reinforcement learning.

COMP 5650/5653 DEEP LEARNING (3) LEC. 3. Pr. COMP 5630. Convolutional neural networks (CNNs); visualizing CNNs; detection CNNs; segmentation CNNs; recurrent neural networks; machine translation; unsupervised learning; and generative adversarial networks.

COMP 5660/5663 EVOLUTIONARY COMPUTING (3) LEC. 3. Pr. COMP 3270 and STAT 3600 or STAT 3603. This course covers in depth the fundamentals of evolutionary computing and surveys the most popular types of evolutionary algorithms (e.g., genetic programming), a class of stochastic, population-based algorithms inspired by natural evolution theory, genetics, and population dynamics, capable of solving complex optimization and modeling problems. It applies them to solve a series of challenging assignments involving intensive programming, experimentation, statistical analysis, and technical writing.

COMP 5700/5703 SOFTWARE PROCESS (3) LEC. 3. Pr. COMP 3700 or COMP 3710. Departmental approval. Process models of the software life cycle as well as methods and tools for software development.

COMP 5710/5713 SOFTWARE QUALITY ASSURANCE (3) LEC. 3. Pr. COMP 3700 or COMP 3710. Departmental approval. Processes, methods, and tools associated with the production of robust, high-quality software.

COMP 5720 REAL TIME AND EMBEDDED SYSTEMS (3) LEC. 3. Pr. COMP 3500 or COMP 3510. Concepts of real-time and embedded computer systems. Studies of real-time algorithm issues such as timeliness, time-constrained scheduling and communication. Embedded system issues such as limited memory, low power, and high latency communication. Fall, Spring.

COMP 5970 SPECIAL TOPICS (1-3) LEC. Departmental approval. Investigation of current topics in computer science and software engineering. Course may be repeated for a maximum of 9 credit hours.

COMP 6000/6006 WEB APPLICATION DEVELOPMENT (3) LEC. 3. Departmental approval. Design and implementation of web sites and associated applications. Emphasis on user interface design and information organization and presentation. Fall, Spring.

COMP 6020/6026 ADVANCED WEB APPLICATION DEVELOPMENT (3) LEC. 3. Pr. COMP 6000 or COMP 6006. Departmental approval. Design and implementation of interactive web applications in Java as applets and servlets. Use of concepts like security, internationalization, multi-threading and server/client architectures. Fall, Spring.

COMP 6120/6126 DATABASE SYSTEMS I (3) LEC. 3. Departmental approval. Theoretical and applied issues related to the analysis, design, and implementation of relational database systems.

COMP 6130/6136 DATA MINING (3) LEC. 3. Advanced concepts, techniques, and applications of data mining with an algorithmic and computational focus, including data visualization, data warehousing, data cube computation, pattern and rule mining, classification, belief networks, clustering, outlier detection, graph matching, and parallel and distributed computation.

COMP 6200/6206 THEORETICAL COMPUTER SCIENCE (3) LEC. 3. Departmental approval. The nature of the recursive sets and recursively enumerable sets. Decidability. Context-sensitive grammars, and linear-bounded automata, including closure properties; oracles; reduction; the arithmetic hierarchy; the analytic hierarchy.

COMP 6210/6216 COMPILER CONSTRUCTION (3) LEC. 3. Departmental approval. Compiler organization; lexical analysis; parsing; syntax- direction translation; symbol tables; basic dependence analysis; intermediate forms; interpreters vs. compilers; run-time storage management; code generation; error detection and recovery.

COMP 6320/6326 DESIGN AND ANALYSIS OF COMPUTER NETWORKS (3) LEC. 3. Departmental approval. Computer networks design, including multiplexing, switching, routing, internetworking, transport protocols, congestion control, and performance evaluation.

COMP 6330/6336 PARALLEL AND DISTRIBUTED COMPUTING (3) LEC. 3. Departmental approval. Overview of hardware and software issues in parallel systems: fundamental parallel architectures, programming languages, tools and algorithms, parallel applications.

COMP 6340/6346 NETWORK QUALITY ASSURANCE AND SIMULATION (3) LEC. 3. Departmental approval. Theoretical and practical aspects of network simulation and quality assurance.

COMP 6350/6356 DIGITAL FORENSICS (3) LEC. 3. Pr. COMP 2710 or ISMN 3080 or (MNGT 3080 or MNGT 3087). Departmental approval. Computer compromise and forensics, with focus on computer crime and ways to uncover, protect, and exploit digital evidence.
COMP 6360/6366 WIRELESS AND MOBILE NETWORKS (3) LEC. 3. Departmental approval. Mobile IP, wireless routing, location management, ad-hoc wireless networks, wireless TCP personal communication systems, and GSM.


COMP 6400/6406 FUNDAMENTALS OF COMPUTER GRAPHICS (3) LEC. 3. Departmental approval. Graphics hardware and software components, coordinate systems, 2-D and 3-D transformations, 3-D viewing and projection, clipping and windowing, scan conversion and algorithms, visibility determination and shadowing, and software projects using a graphics software package.

COMP 6500/6506 DISTRIBUTED OPERATING SYSTEMS (3) LEC. 3. Departmental approval. Basic concepts of distributed systems. Concurrent process communication and synchronization mechanisms, distributed process scheduling, distributed file systems, distributed shared memory, distributed system security and case studies.

COMP 6520/6526 NETWORK AND OPERATING SYSTEM ADMINISTRATION (3) LEC. 3. Departmental approval. Studies of the installation, configuration and management of traditional, distributed and networked system software. Network integration of different systems. Performance monitoring, safety and security issues together with policies, politics and the laws regarding system software management.


COMP 6600/6606 ARTIFICIAL INTELLIGENCE (3) LEC. 3. Departmental approval. Introduction to intelligent agents, search knowledge representation and reasoning, machine learning.

COMP 6610/6616 ARTIFICIAL INTELLIGENCE PROGRAMMING (3) LEC. 3. Pr. COMP 6600 or COMP 6606. Departmental approval. Design and implementation of advanced artificial intelligence techniques including expert systems, planning, logic and constraint programming, knowledge representation and heuristic search methods.

COMP 6620/6626 USER INTERFACE DESIGN AND EVALUATION (3) LEC. 3. Departmental approval. Theory and practice of designing interfaces for interactive systems, usability engineering techniques; implementing and evaluating interfaces.

COMP 6630/6636 MACHINE LEARNING (3) LEC. 3. An exploration of current concepts, techniques, and applications in machine learning including abductive learning, case-based learning, deep learning, and reinforcement learning.

COMP 6650/6656 DEEP LEARNING (3) LEC. 3. Pr. COMP 6630. Convolutional neural networks (CNNs); visualizing CNNs; detection CNNs; segmentation CNNs; recurrent neural networks; machine translation; unsupervised learning; and generative adversarial networks.

COMP 6660/6666 EVOLUTIONARY COMPUTING (3) LEC. 3. Departmental approval. This course covers in depth the fundamentals of evolutionary computing and surveys the most popular types of evolutionary algorithms (e.g., genetic programming), a class of stochastic, population-based algorithms inspired by natural evolution theory, genetics, and population dynamics, capable of solving complex optimization and modeling problems. It applies them to solve a series of challenging assignments involving intensive programming, experimentation, statistical analysis, and technical writing.

COMP 6700/6706 SOFTWARE PROCESS (3) LEC. 3. Departmental approval. Process models of the software life cycle as well as methods and tools for software development.

COMP 6710/6716 SOFTWARE QUALITY ASSURANCE (3) LEC. 3. Departmental approval. Processes, methods, and tools associated with the production of robust, high-quality software.

COMP 6720/6726 REAL TIME AND EMBEDDED SYSTEMS (3) LEC. 3. Departmental approval. Concepts of real-time and embedded computer systems. Studies of real-time algorithm issues such as timeliness, time-constrained scheduling and communication. Embedded system issues such as limited memory, low power, and high latency communication. Fall, Spring.

COMP 6970/6976 SPECIAL TOPICS (1-3) LEC. Investigation of current topics in computer science and software engineering. Course may be repeated for a maximum of 9 credit hours.
COMP 7120/7126 DATABASE SYSTEMS II (3) LEC. 3. Pr. COMP 6120 or COMP 6126. Departmental approval. Theoretical and applied issues related to the analysis, design, and implementation of object-oriented database systems.


COMP 7270/7276 ADVANCED TOPICS IN ALGORITHMS (3) LEC. 3. Departmental approval. In-depth study of advanced topics in algorithms.

COMP 7300/7306 ADVANCED COMPUTER ARCHITECTURE (3) LEC. 3. Departmental approval. Modern instruction level parallel computer design, including superscalar and very-long instruction word processor design.

COMP 7320/7326 ADVANCED COMPUTER NETWORKS (3) LEC. 3. Pr. COMP 6320 or COMP 6326. Departmental approval. Advanced network topics, including ISDN, ATM, active networks, security, Internet, wireless and mobile networks, and network management.

COMP 7330/7336 TOPICS IN PARALLEL AND DISTRIBUTED COMPUTING (3) LEC. 3. Pr. COMP 6330 or COMP 6336. Departmental approval. Parallel programming languages, environments and tools, parallel algorithms performance issues, distributed memory systems, group communication, fault tolerance.

COMP 7360/7366 WIRELESS AND MOBILE NETWORKS (3) LEC. 3. Pr. COMP 6320 or COMP 6326. Departmental approval. Mobile IP, wireless routing, location management, ad-hoc wireless networks, wireless TCP, personal communication systems, and GSM.

COMP 7370/7376 ADVANCED COMPUTER AND NETWORK SECURITY (3) LEC. 3. Pr. COMP 6370 or COMP 6376. Departmental approval. Advanced, research-based examination of computer network attack and defense techniques, viruses and other malware; operating system vulnerabilities and safeguards.

COMP 7400/7406 ADVANCED COMPUTER GRAPHICS (3) LEC. 3. Pr. COMP 6400 or COMP 6406. Departmental approval. Advanced 3-D topics including visual realism issues, visible surface determination algorithms, illumination and shading models, surface and solid modeling, advanced modeling techniques, special purpose graphics architectures, and animation. Software projects will be assigned.

COMP 7440 SIMULATION OF COMPUTER NETWORKS (3) LEC. 3. Departmental approval. Research-based examination of network simulation, including TCP/IP networks, wireless networks and verification and validation of a network simulation.

COMP 7500/7506 ADVANCED TOPICS IN OPERATING SYSTEMS (3) LEC. 3. Departmental approval. Advanced topics in operating system concepts, design and implementation.

COMP 7600/7606 COMPUTATIONAL INTELLIGENCE (3) LEC. 3. Pr. COMP 6600 or COMP 6606. Departmental approval. A study of computational intelligence with emphasis on the design and implementation of neural, genetic and fuzzy computing techniques.

COMP 7610/7616 COMPUTATIONAL COGNITION (3) LEC. 3. Pr. COMP 6600 or COMP 6606. Departmental approval. Computational models of cognition, including knowledge representations and process mechanisms like means-ends analysis, semantic networks, frames.

COMP 7620/7626 HUMAN-COMPUTER INTERACTION (3) LEC. 3. Departmental approval. Coreq. COMP 6620. Theoretical principles and practical aspects of interaction between humans and computers, design and evaluation of interactive systems.

COMP 7700/7706 SOFTWARE ARCHITECTURE (3) LEC. 3. Pr. (COMP 6700 or COMP 6706) and (COMP 6710 or COMP 6716). Departmental approval. Methods and tools related to the analysis, specification and design of software architecture.

COMP 7710/7716 SOFTWARE ENVIRONMENTS (3) LEC. 3. Pr. (COMP 6700 or COMP 6706) and (COMP 6710 or COMP 6716). Departmental approval. Issues associated with the design, implementation, and use of software engineering environments.

COMP 7720/7726 SOFTWARE RE-ENGINEERING (3) LEC. 3. Pr. (COMP 6700 or COMP 6706) and (COMP 6710 or COMP 6716). Departmental approval. Process, methods and tools associated with re-engineering software systems.
COMP 7730/7736 FORMAL METHODS FOR SOFTWARE (3) LEC. 3. Pr. (COMP 6700 or COMP 6706) and (COMP 6710 or COMP 6716). Departmental approval. Precise, abstract models for characterizing and reasoning about properties of software systems.

COMP 7740 AGENT-DIRECTED SIMULATION (3) LEC. 3. Pr. COMP 6700 or COMP 6706. Departmental approval. Covers entire simulation software development life cycle including problem formulation, system and objectives definition, conceptual modeling, model design, implementation, analysis of simulation data, and credibility assessment including verification and validation. Special emphasis is given to modeling aspects using agent-directed simulation methodology.

COMP 7930/7936 DIRECTED STUDY (1-3) IND. Course may be repeated with change in topics.

COMP 7950/7956 INTRODUCTION TO GRADUATE STUDY IN COMPUTER SCIENCE AND SOFTWARE ENGINEERING (1) LEC. 1. SU. Introduction to graduate research and study topics in computer science and software engineering.

COMP 7970/7976 SPECIAL TOPICS (1-3) LEC. Course may be repeated with change in topics.

COMP 7980/7986 CAPSTONE ENGINEERING PROJECT (3) LEC. 3. Planning, implementation, and completion of a design project. Project culminates in both a written report and an oral presentation.

COMP 7990/7996 RESEARCH AND THESIS (1-15) MST. May count either COMP 7990 or COMP 7996. Course may be repeated with change in topics.

COMP 8120 CURRENT TOPICS IN DATABASE SYSTEMS (3) LEC. 3. Pr. COMP 6120 or COMP 6126. Departmental approval. Theoretical and applied research issues related to database systems. Topics will reflect current research in the field.

COMP 8220 RESEARCH TOPICS IN PROGRAMMING LANGUAGES (3) LEC. 3. Pr. COMP 7220 or COMP 7226. Departmental approval. Topics of current research in the area of programming languages, their design, and implementation.


COMP 8330 ADVANCED TOPICS IN PARALLEL AND DISTRIBUTED COMPUTING (3) LEC. 3. Pr. COMP 6330 or COMP 6336. Parallelizing compiler, theory of concurrency, advanced parallel algorithms, load balancing, migration, performance evaluation, distributed architectures. Departmental approval.

COMP 8400 CURRENT TOPICS IN COMPUTER GRAPHICS (3) LEC. 3. Pr. COMP 7400 or COMP 7406. Departmental approval. In-depth study of current research topics in computer graphics. Topics may include theoretical, performance implementation, and system integration issues. Extensive literature survey, issue identification, performance comparison, and future research trends will be discussed.

COMP 8500 RESEARCH TOPICS IN OPERATING SYSTEMS (3) LEC. 3. Pr. COMP 7500 or COMP 7506. Departmental approval. Topics of current research in the area of operating systems their design, and implementation.

COMP 8600 ADVANCED TOPICS IN ARTIFICIAL INTELLIGENCE (3) LEC. 3. Pr. COMP 6610 or COMP 6616 or COMP 7600 or COMP 7606 or COMP 7610 or COMP 7616. Departmental approval. In-depth study of current research topics in Artificial Intelligence, e.g., reasoning mechanisms, heuristic search methods, cognitive modeling.

COMP 8620 ADVANCED TOPICS IN HUMAN-COMPUTER INTERACTION (3) LEC. 3. Pr. COMP 7620 or COMP 7626. Departmental approval. In-depth study of current research topics in Human-Computer Interaction, e.g., evaluation and assessment methods, multimodal interfaces, educational technology.

COMP 8700/8706 CURRENT TOPICS IN SOFTWARE ENGINEERING (3) LEC. 3. Pr. (COMP 6700 or COMP 6706) and (COMP 6710 or COMP 6716). Departmental approval. Current theoretical and applied research issues in software engineering.

COMP 8930/8936 DIRECTED STUDY (1-3) IND. Course may be repeated for a maximum of 6 credit hours.

COMP 8970 SPECIAL TOPICS (1-3) IND. Course may be repeated with change in topics.

COMP 8990/8996 RESEARCH AND DISSERTATION (1-20) DSR. Course may be repeated with change in topics.
CPSC Courses

CPSC 1213 INTRODUCTION TO COMPUTER SCIENCE I (3) DSL. 45. Admission into Bachelor of Computer Science Program. Introduces the fundamental concepts of object-oriented programming.

CPSC 1223 INTRODUCTION TO COMPUTER SCIENCE II (3) DSL. 45. Pr. CPSC 1213. Admission into Bachelor of Computer Science Program. Continues the development of programming from an object-oriented perspective. Emphasizes sound software engineering principles and best practices.

CPSC 1233 DATA STRUCTURES (3) DSL. 45. Pr. CPSC 1223. Admission into Bachelor of Computer Science Program. Developing programs that use data structures and collections to efficiently store data. Emphasis will be placed on the interplay between effective data structures and efficient algorithms.

CPSC 2713 SOFTWARE CONSTRUCTION FUNDAMENTALS (3) DSL. 45. Pr. CPSC 1233. Admission into Bachelor of Computer Science Program. Development of graphical user interface-based, event-driven desktop/laptop computer application using a modern object-oriented language. Systematic testing, debugging, documentation, and maintenance programming.

CPSC 3223 PROGRAMMING LANGUAGES AND TRANSLATION (3) DSL. 45. Pr. CPSC 1233 and CPSC 3303. Admission into Bachelor of Computer Science Program. Fundamental concepts of programming language design, interpretation, and compilation.

CPSC 3243 DISCRETE STRUCTURES (3) DSL. 45. Pr. (MATH 1610 or MATH 1613 or MATH 1617) and MATH 1710. Admission into Bachelor of Computer Science Program. Basics of set theory, propositional and predicate logic as used to describe algorithms, recurrence relations. Proving correctness and estimating running time for algorithms. Mathematical and structural induction.

CPSC 3273 ALGORITHMS I (3) DSL. 45. Pr. CPSC 1233. Admission into Bachelor of Computer Science Program. Introduction to algorithms as tools for computational problem solving, language of algorithms, understanding algorithms, approximately analyzing correctness and efficiency of algorithms, algorithms that solve fundamental computational problems, basic algorithm design techniques, steps of computational problem solving.

CPSC 3283 ALGORITHMS II (3) DSL. 45. Pr. CPSC 3273. Admission into Bachelor of Computer Science Program. Advanced complexity analysis techniques, notions of computational complexity, polynomial time hierarchy, computability, algorithms that solve advanced computational problems, advanced algorithm design techniques, computational problem solving.

CPSC 3303 COMPUTER ORGANIZATION AND ASSEMBLY LANGUAGE PROGRAMMING (3) DSL. 45. Pr. CPSC 3243 and CPSC 1213. Admission into Bachelor of Computer Science Program. Stored program computers, hardware and software components, data representations, instruction sets, addressing modes, assembly language programming, loaders, linkers and operating systems.

CPSC 3323 COMPUTER ARCHITECTURE (3) DSL. 45. Pr. CPSC 3333. Admission into Bachelor of Computer Science Program. Design of Computer Systems, emphasizing the relationship between computer hardware and software. Includes processor control and data path organization, memory subsystem design, instruction set design, processor simulation, and quantitative analysis of computer performance.

CPSC 3333 OPERATING SYSTEMS (3) DSL. 45. Pr. CPSC 1233 and CPSC 3303. Admission into Bachelor of Computer Science Program. Structure and functions of operating systems; processes and process scheduling; synchronization and mutual exclusion; memory management; auxiliary storage management; resource allocation and deadlock; security, privacy, and ethical concerns; design tradeoffs.

CPSC 3343 PARALLEL SYSTEMS (3) DSL. 45. Pr. CPSC 3333. Admission into Bachelor of Computer Science Program. Overview of hardware and software issues in parallel systems: fundamental parallel architectures, programming languages, tools and algorithms, and parallel applications.

CPSC 3353 COMPUTER NETWORKS I (3) DSL. 45. Pr. CPSC 3333. Admission into Bachelor of Computer Science Program. Fundamentals of computer networks, TCP/IP layered model: application layer, transport layer, network layer, link layer, with examples of each layer, and explanation of design issues. IPv6.

CPSC 3363 COMPUTER NETWORKS II (3) DSL. 45. Pr. CPSC 3353. Admission into Bachelor of Computer Science Program. Computer network design, including multiplexing, switching, routing, internetworking, transport protocols, congestion control, and performance evaluation.
CPSC 3373 WIRELESS AND MOBILE NETWORKS (3) DSL. 45. Pr. CPSC 3353. Admission into Bachelor of Computer Science Program. Mobile IP, wireless routing, location management, ad-hoc wireless networks, wireless, wireless TCP personal communication systems, and current mobile phone OTA protocols.

CPSC 3703 SOFTWARE ENGINEERING I (3) DSL. 45. Pr. CPSC 2713. Admission into Bachelor of Computer Science Program. Current processes, methods, and tools related to modeling and designing software systems.

CPSC 3713 SOFTWARE ENGINEERING II (3) DSL. 45. Pr. CPSC 3703. Admission into Computer Science Online Program. Current processes, methods, and tools related to modeling and designing software systems.

CPSC 4003 SYSTEM ADMINISTRATION (3) DSL. 45. Pr. CPSC 3333. Admission into Bachelor of Computer Science. Basics of system administration for Windows and Unix machines, including configuration of Performance measurement and enhancement.

CPSC 4203 FORMAL LANGUAGES (3) DSL. 45. Pr. CPSC 3273 and CPSC 3243. Admission into Bachelor of Computer Science Program. Fundamentals of formal languages including mathematical models of regular sets, context-free languages and Turing machines; deterministic and non-deterministic models. Basics of interpretation and compilation.

CPSC 4733 COMPUTER ETHICS (3) DSL. 45. Admission into Bachelor of Computer Science Program. Application of ethical principles to computing-related topics, including privacy, property rights, autonomy, access, and diversity.

CPSC 4973 SPECIAL TOPICS (3) LEC. 3. Investigation of current topics in computer science. Course may be repeated for a maximum of six credit hours. Departmental approval required.

CPSC 5123 DATABASE I (3) DSL. 45. Pr. CPSC 1233. Admission into Bachelor of Computer Science Program. The design and implementation of database applications, with a focus on relational database management systems.

CPSC 5133 DATABASE II (3) DSL. 45. Pr. CPSC 5123. Admission into Bachelor of Computer Science Program. Theory, design, and implementation of database systems.

CPSC 5203 DEVELOPING WEB APPLICATIONS WITH XML (3) DSL. 45. Pr. CPSC 1233. Admission into Bachelor of Computer Science Program. Comprehensive introduction to XML, working with XML and Databases, event-driven programming with XML, implementing Communication and Web Services with XML, working with XML, JQuery, XHTML and HML5.

CPSC 5213 WEB APPLICATION DEVELOPMENT WITH JSP (3) DSL. 40. Pr. CPSC 5203. Admission into Bachelor of Computer Science Program. Advanced course in web development using JSP, includes JCP fundamentals, JAP and web server software development, and applying JSP in the real world.

CPSC 5333 MOBILE APPLICATIONS I (3) DSL. 45. Pr. CPSC 2713. Admission into Computer Science Online Program. Software development for wireless applications: specification, process, testing, and performance evaluation. Design and development of wireless application layer software, including current protocols.

CPSC 5343 MOBILE APPLICATION DEVELOPMENT II (3) DSL. 3. Pr. CPSC 5333. Admission into Bachelor of Computer Science Program. Builds mastery of mobile application development and the skills necessary to stay current in this fast-moving field throughout one’s career by introducing a new programming language and application programmer interface and interface and requiring the student to master them.

Bachelor of Computer Science (On-line)

The Bachelor of Computer Science is designed as a completer degree, in which non-major coursework is satisfied by acceptable transfer credit, which could include credit earned for a first bachelor’s degree at a regionally accredited institution. All students must satisfy the degree requirements as specified in the In-Major Courses and Non-Major Courses below. Students without transfer credit for all the requirements specified in the Non-Major Courses table must consult their academic advisor regarding what courses should be selected to satisfy these requirements. Each In-Major course is offered completely online in 7.5 week terms, with 5 terms per calendar year.

In-Major Courses

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<th>Term</th>
<th>Course 1</th>
<th>Hours</th>
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Non-Major Course

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TOTAL HOURS 120

Computer Science Minor

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<td>COMP 3240</td>
<td>Discrete Structures</td>
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<td>COMP 3270</td>
<td>Introduction to Algorithms</td>
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<tr>
<td>COMP 3700</td>
<td>Software Modeling and Design</td>
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Total Hours 19
# Curriculum in Computer Science

## Freshman

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## Sophomore

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## Junior

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<td>COMP 3220 <strong>Principles of Programming Languages</strong></td>
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<td>PHIL 1020 Introduction to Ethics or 1040 Business Ethics</td>
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<td>COMP 3270 <strong>Introduction to Algorithms</strong></td>
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<td>COMP 3500 <strong>Introduction to Operating Systems</strong></td>
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<td>COMP 3350 <strong>Computer Organization and Assembly Language Programming</strong></td>
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## Senior

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**Total Hours:** 120

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1. Students must complete a sequence in either Literature or History. Because of the discipline specific requirements for the Humanities courses, it is recommended that a History sequence be completed in the Social Sciences courses.

2. Courses for COMP Elective, Math Elective, Core Science Sequence, Science Elective, or Concentration credit must be chosen in accordance with CSSE department policies and approved course listings. Students must consult with the CSSE Academic Advisor when selecting these courses.
The Humanities / Social Science Elective must be chosen from the set of courses designated as Humanities or Social Sciences in the Auburn University Core Curriculum.

The AU Bulletin lists the University Core Curriculum requirements for students in the College of Engineering.

The course in bold-face are those used to calculate in-major GPA.

## Curriculum in Software Engineering

### Freshman

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
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<tr>
<td>ENGL 1100</td>
<td>3</td>
<td>ENGL 1120 English Composition II</td>
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<tr>
<td>World History or Technology &amp; Civilization</td>
<td>3 Core Social Science</td>
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<tr>
<td>Core Fine Arts</td>
<td>3 MATH 1620 Calculus II</td>
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<tr>
<td>MATH 1610 Calculus I</td>
<td>4 PHYS 1600 Engineering Physics I</td>
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### Sophomore

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<th>Fall</th>
<th>Hours</th>
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<tr>
<td>Core Social Science</td>
<td>3 Core Literature</td>
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<td>MATH 2630 Calculus III</td>
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<td>PHYS 1610 Engineering Physics II</td>
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<td>COMP 2210 Fundamentals of Computing II</td>
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<td>COMP 3220 Principles of Programming Languages</td>
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<td>COMP 3270 Introduction to Algorithms</td>
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<td>COMP 3350 Computer Organization and Assembly Language Programming</td>
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### Junior

<table>
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<tr>
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<td>COMP 3270 Introduction to Algorithms</td>
<td>3 COMP 3500 Introduction to Operating Systems</td>
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<td>COMP 3350 Computer Organization and Assembly Language Programming</td>
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### Senior

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<td>6 COMP 5710 Software Quality Assurance</td>
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Courses in bold-face are those used to calculate in-major GPA.

**Electrical and Computer Engineering**

The Electrical and Computer Engineering curricula produce well-educated graduates prepared to practice engineering at a professional level in an era of rapid and challenging technological development. The educational objectives of the Electrical Engineering curriculum include developing within our graduates a basic foundation in seven fundamental areas of electrical engineering (circuits and systems, electromagnetics, electronics, digital systems, communications and signal processing, control systems, and power engineering) to provide the technical proficiency needed for the professional practice of electrical engineering. The educational objectives of the Computer Engineering curriculum include developing within our graduates a basic foundation in both electrical engineering (circuits and systems, electronics, and digital systems) and computer science to provide the technical proficiency needed for the professional practice of computer engineering, including the design and application of computer components and systems. In addition, both curricula have as educational objectives to develop within our graduates the ability to communicate their ideas effectively to technical and non-technical audiences and work effectively in multidisciplinary teams, to prepare them to take their places in society as responsible citizens, and to provide them with the basis for, and instill within them an appreciation of and enthusiasm for, lifelong scientific inquiry, learning and creativity.

The goal of the professional portion of each curriculum is to emphasize basic areas of study while providing the flexibility to accommodate a diversity of interests and talents. To this end, each curriculum emphasizes engineering design, hands-on laboratory experience, knowledgeable use of digital computer systems, oral and written communication skills, the importance of business, economic, social and global forces on engineering, appreciation of the need to maintain the highest ethical standards, and the maintenance of professional competence through continued self-improvement after graduation.

Each curriculum builds upon a solid foundation in mathematics and science. In the Electrical Engineering curriculum, topics in the seven fundamental areas of electrical engineering are introduced early and are carefully coordinated to provide the principles necessary for the practice of electrical engineering. In the Computer Engineering curriculum, fundamental topics in both electrical engineering and computer science are introduced early and are carefully coordinated to provide the principles necessary for the design and application of computer components and systems. In each case, design experience is interwoven throughout the curriculum by introducing basic design concepts early, emphasizing design experiences in the laboratories, and culminating with a capstone design project in the senior year. The senior year elective structure provides students with the flexibility to pursue a range of career options.

**Major**

- Computer Engineering (p. 137)
- Electrical Engineering (p. 138)
- Wireless Engineering (Hardware Option) (p. 139)
- Wireless Engineering (Software Option) (p. 140)

**Courses**

**ELEC 2110 ELECTRIC CIRCUIT ANALYSIS (4)** LEC. 3. LAB. 3. Pr. (PHYS 1610 or PHYS 1617) and (COMP 1200 or COMP 1210 or COMP 1217) and (P/C ENGR 1110 or P/C ENGR 1113) and P/C MATH 2650. Basic laws and concepts; resistive circuits; first-order transient circuits; phasors and frequency response of circuits; RMS values and complex power.
ELEC 2120 SIGNALS AND SYSTEMS (4) LEC. 3. LAB. 1. Pr. ELEC 2110 and MATH 2650. Time-domain and frequency-domain methods for modeling and analyzing continuous and discrete-data signals and systems.

ELEC 2200 DIGITAL LOGIC CIRCUITS (3) LEC. 3. Pr. COMP 1200 or COMP 1210 or COMP 1217. Electronic devices and digital circuits; binary numbers; Boolean algebra and switching functions; gates and flip-flops; combinational and sequential logic circuits; hierarchical design of digital systems; computer-aided design tools for digital design, simulation, and testing.

ELEC 2210 DIGITAL ELECTRONICS (4) LEC. 3. LAB. 3. Pr. ELEC 2110 and ELEC 2200. History of electronics; semiconductors; biasing and operation of PN junction diodes; field-effect transistors and bipolar junction transistors; logic families and logic technologies; flip-flops and memory circuitry.

ELEC 2220 COMPUTER SYSTEMS (3) LEC. 3. Pr. ELEC 2200. Computer hardware/software organization, processor programming models, assembly language programming, design of memory systems, I/O device interfacing, programming and multiprocessing.

ELEC 3030 RF SYSTEMS LAB (1) LAB. 3. Pr. ELEC 2210. Assembly, testing and analysis of a radio. Integration of basic concepts of electronics, electromagnetics, and signals and systems.

ELEC 3040 ELECTRICAL SYSTEM DESIGN LAB (1) LAB. 3. Pr. ELEC 2220 and (P/C ELEC 3030 and ELEC 3500). Exploration and integration of electrical engineering concepts and professional practice issues through the design of a contemporary engineering system.

ELEC 3050 EMBEDDED SYSTEM DESIGN LAB (1) LAB. 3. Pr. ELEC 2210 and ELEC 2220 and P/C ELEC 2120. Integration of hardware and software in the design of an embedded computing system; development of professional skills.

ELEC 3060 WIRELESS DESIGN LAB (1) LAB. 3. Pr. P/C ELEC 3400. Laboratory experiments geared towards understanding the implementation and testing of components used in wireless communication systems.

ELEC 3310 FUNDAMENTALS OF APPLIED ELECTROMAGNETICS (3) LEC. 3. Pr. MATH 2660 and ELEC 2110. Transmission lines are studied as a bridge to understanding electromagnetic theory. Then, electric and magnetic fields are studied using vector algebra, culminating in Maxwell’s equations.

ELEC 3320 ELECTROMAGNETICS FOR WIRELESS COMMUNICATION (3) LEC. 3. Pr. ELEC 3310. Maxwell’s equations are used in the study of plane waves, guided waves, fiberoptics, electromagnetic compatibility and interference, antennas and radiation, and satellite communication systems.

ELEC 3400 COMMUNICATION SYSTEMS (3) LEC. 3. Pr. ELEC 3800. Pulse code modulation, line coding, information rate, equalization, amplitude modulation, angle modulation, noise in communication systems.

ELEC 3500 CONTROL SYSTEMS (3) LEC. 3. Pr. ELEC 2120. Analog and discrete transfer function models, system response specifications, control system characteristics, root locus analysis and design, frequency response analysis and design.

ELEC 3600 ELECTRIC POWER ENGINEERING (3) LEC. 3. Pr. ELEC 2110. Introduction to the basic concepts in electric power engineering.


ELEC 3800 RANDOM SIGNALS AND SYSTEMS (3) LEC. 3. Pr. ELEC 2120. Introduction to probability, random variables, random processes and basic statistics, analysis of random signals and noise.

ELEC 3810 FUNDAMENTALS OF ELECTRICAL ENGINEERING (3) LEC. 3. Pr. PHYS 1610 and P/C MATH 2650. Electrical circuit analysis; electronic devices, digital systems, amplifier concepts, power devices and systems. Not open to ECE majors.

ELEC 4000 SENIOR DESIGN PROJECTS (3) LEC. 3. Pr. ELEC 3040 or ELEC 3050 or ELEC 3060. A capstone design project which draws on the accumulated curricular experience. Particular project sections may have additional requisites.

ELEC 4010 CAPSTONE DESIGN I (1) LEC. 1. Pr./C ELEC 3040 or P/C ELEC 3050 or (P/C ELEC 3030 and P/C ELEC 3060). The engineering design process, project management and teamwork, ethical and social impacts of design projects, project documentation and presentation, business considerations, and intellectual property.

ELEC 4020 CAPSTONE DESIGN II (3) LEC. 3. Pr. ELEC 4010. A capstone design project which draws on the accumulated curricular experience. Particular project sections may have additional prerequisites. Departmental approval needed.
ELEC 4200 DIGITAL SYSTEM DESIGN (3) LEC. 2. LAB. 3. Pr. ELEC 2210 and ELEC 2220. Hierarchical, modular design of digital systems, computer-aided digital system modeling, simulation, analysis, and synthesis; design implementation with programmable logic devices and FPGAs.

ELEC 4800 INSTRUMENTATION ENGINEERING (3) LEC. 2. LAB. 3. Pr. ELEC 3040 or ELEC 3050. Study and application of sensors, instrumentation and computer technology to research and industrial process control.

ELEC 4980 SPECIAL PROJECTS (1-3) IND. Departmental approval. Supervised study of a specialized area of electrical and computer engineering not covered by regularly offered courses. Course may be repeated with change in topics.

ELEC 4997 HONORS THESIS (1-6) IND. Pr. Honors College. Departmental approval. Directed research and writing of honors thesis. Course may be repeated for a maximum of 6 credit hours.

ELEC 5100 WIRELESS COMMUNICATION SYSTEMS (3) LEC. 3. Pr. ELEC 3400. Introduction to mobile cellular radio and wireless personal communications, mobile radio propagation, modulation techniques, multiple access techniques, wireless systems and standards.

ELEC 5110 WIRELESS NETWORKS (3) LEC. 3. Pr. ELEC 3400. Introduction to wireless broadband, satellite communication, wireless local area networks, Bluetooth and Home RF standards and Internet protocol and wireless access.

ELEC 5120 TELECOMMUNICATION NETWORKS (3) LEC. 3. Pr. ELEC 3400. Principles and building blocks of telecommunication systems, including switched telephone networks, voice and data networks, transmission technologies, and switching architectures.

ELEC 5130 RF DEVICES AND CIRCUITS (3) LEC. 3. Pr. ELEC 3700. Introduction to RF semiconductor devices and circuits targeted for wireless applications.

ELEC 5150 INFORMATION SECURITY (3) LEC. 3. Departmental approval. Emerging protocols, standards and technologies of information security; design of information network security using firewalls, virtual private networks and secured applications.

ELEC 5190 INTRODUCTION TO DIGITAL AND ANALOG IC DESIGN (3) LEC. 3. Pr. ELEC 3700. Digital IC design using Verilog, analog and mixed signal IC design using industry standard tools; emphasis on front-end design skills.

ELEC 5200 COMPUTER ARCHITECTURE AND DESIGN (3) LEC. 3. Pr. ELEC 4200. Structural organization and hardware design of digital computers; register transfers; micro-operations, control units and timing; instruction set design; input/output devices, multiprocessors, automated hardware design aids.

ELEC 5210 HARDWARE SECURITY I (3) LEC. 3. Pr. ELEC 2200. Hardware design of symmetric and asymmetric ciphers, digital signature generation and verification, key management, detection and avoidance of counterfeit ICs, cryptographic primitives, and automated hardware design aids.

ELEC 5220 INFORMATION NETWORKS AND TECHNOLOGY (3) LEC. 3. Pr. ELEC 2220 or COMP 3350. Architectures, protocols, standards and technologies of information networks; design and implementation of information networks; applications of information networks for data, audio and video communications.

ELEC 5230 PARALLEL PROCESSING (3) LEC. 3. Pr. ELEC 2220 or COMP 3350. Hardware components of multiprocessor systems including processor, inter-connection, memory and control architectures; software elements of parallel processing.


ELEC 5250 COMPUTER AIDED DESIGN OF DIGITAL LOGIC CIRCUITS (3) LEC. 3. Pr. ELEC 2220 or COMP 3350. Computer-automated design of digital logic circuits using discrete gates, programmable logic devices, and standard cells; hardware description languages, circuit simulation, verification, fault diagnosis and testing, RTL-to-GDSII ASIC flow.

ELEC 5260 EMBEDDED COMPUTING SYSTEMS (3) LEC. 3. Pr. ELEC 2220 or COMP 3350. The design of systems containing embedded computers. Microcontroller technology, assembly language and C programming, input/output interfacing, data acquisition hardware, interrupts, and timing. Real-time operating systems and application programming. Embedded system application examples.

ELEC 5270 LOW-POWER DESIGN OF ELECTRONIC CIRCUITS (3) LEC. 3. Pr. ELEC 2210. Departmental approval. Design of digital circuits and systems for reduced power consumption, power analysis algorithms, low-power MOS technologies, low-power design architectures for FPGAs, memory, and microprocessors, reduction of power in testing of circuits.
ELEC 5280 BUILT-IN-SELF-TEST (3) LEC. 3. Pr. ELEC 2210. Testing during product life-cycle, fault models and detection, design for testability, test pattern generation, output response analysis, concurrent fault detection, manufacturing and system use, built-in self-test approaches and applications.

ELEC 5290 HARDWARE SECURITY II (3) LEC. 3. Pr. ELEC 5210. This course will provide an in-depth analysis of various topics, which includes advanced cryptography, hardware Trojans, PUFs, RFID security, side-channel attacks and solutions, and blockchain.

ELEC 5310 DESIGN OF ANTENNAS AND ANTENNA SYSTEMS (3) LEC. 3. Pr. P/C ELEC 3320. Application of electromagnetic and circuit concepts to the design of practical antennas and antenna systems.

ELEC 5320 ELECTROMAGNETIC COMPATIBILITY (3) LEC. 3. Pr. ELEC 3320 and ELEC 3700. Electromagnetic noise coupling, designing for electromagnetic compatibility (EMC), EMC regulation, noise sources, standard techniques for eliminating noise, circuit layout for reduced electromagnetic interference (EMI).

ELEC 5340 MICROWAVE AND RF ENGINEERING (3) LEC. 3. Pr. ELEC 3320 and ELEC 3700. Application of electromagnetic and electronic concepts to the design of practical microwave devices and circuits typically used in wireless communications.

ELEC 5350 RADAR PRINCIPLES (3) LEC. 3. Pr. ELEC 3320 and ELEC 3800. Study of the fundamentals of RADAR and related systems such as SONAR and LIDAR.

ELEC 5360 BIOMEDICAL APPLICATIONS OF ELECTROMAGNETICS (3) LEC. 3. Pr. ELEC 3310. Development of medical instrumentation using electromagnetic principles; focus on magnetic resonance imaging systems.

ELEC 5410 DIGITAL SIGNAL PROCESSING (3) LEC. 3. Pr. ELEC 3800. Digital processing of signals, sampling difference equations, discrete-time Fourier transforms, discrete and fast Fourier transforms, digital filter design.

ELEC 5470 FUNDAMENTALS OF VLSI TEST (3) LEC. 3. Test economics, automatic test equipment, fault models, automatic test pattern generation, test generation for sequential circuits, fault simulation, testability measures, fault coverage, yield and defect levels, design-for-testability, scan and boundary scan, IDDQ testing.

ELEC 5530 MOBILE ROBOT DESIGN (3) LEC. 3. Pr. ELEC 2210 or ELEC 3810. Fundamentals of mobile robot design, including motor control, sensor integration, path planning, navigation, and localization.


ELEC 5620 POWER SYSTEM ANALYSIS (3) LEC. 3. Pr. ELEC 3600. Departmental approval. Power system modeling, power flow analysis, analysis of faulted power systems.


ELEC 5640 RENEWABLE ENERGY IN ELECTRICAL POWER SYSTEMS (3) LEC. 3. Pr. ELEC 3600 or ELEC 3810. Conventional power plants, global renewables, energy efficiency, marine hydrokinetic (ocean currents and waves), wind power (aerodynamic, generator, plants, grid integration, finance), photovoltaic (device, inverter, plant levels, finance), hydropower (generator, plant level, pumped storage hydro, advances in hydro), power systems grid integration, system impact studies, control and operation of inverter-based resources, ancillary services provisions, and other important aspects of renewables for bulk power (transmission levels) and for distribution power systems.

ELEC 5650 POWER SYSTEM PROTECTION (3) LEC. 3. Pr. ELEC 3600. Fault analysis using symmetrical components. Power switchgear, including switches, disconnects, fuses, relays and circuit breakers. Fundamentals of electric power system protection, including bus, transformer and line protection.

ELEC 5670 ELECTRIC POWER ENGINEERING TOPICS (1-3) LEC. Pr. ELEC 3600. Various topics representing state-of-the-art power technology. Course may be repeated for a maximum of 12 credit hours.

ELEC 5700 SEMICONDUCTOR FUNDAMENTALS (3) LEC. 3. Pr. ELEC 3700. Introduction to semiconductors: crystal structure, energy band theory, equilibrium electron and hole statistics, doping, generation and recombination processes, carrier drift and diffusion, transport equations.

ELEC 5710 SEMICONDUCTOR DEVICES (3) LEC. 3. Pr. ELEC 5700. Introduction to semiconductor devices: pn junctions, junction diode based devices, optoelectronic devices, bipolar transistors, field effect transistors.
ELEC 5730 MICROELECTRONIC FABRICATION (3) LEC. 2. LAB. 3. Pr. ELEC 2210. Departmental approval. Introduction to monolithic integrated circuit technology. Bipolar and MOS processes and structures. Elements of layout, design, fabrication, and applications. Experiments in microelectronic technologies.

ELEC 5740 ELECTRONICS MANUFACTURING (3) LEC. 2. LAB. 3. Pr. ELEC 2210. Departmental approval. Materials and processes used to manufacture electronic products. Particular attention is given to substrate technology and electronics assembly.

ELEC 5750 INTRODUCTION TO PLASMA ENGINEERING (3) LEC. 3. Pr. ELEC 3320. Departmental approval. Electrical breakdown and discharges in gases, basic plasma theories, applications of plasmas, plasma processing for microelectronic fabrication.

ELEC 5760 SOLID STATE SENSORS (3) LEC. 3. Pr. ELEC 3700. Theory, technology and design micro-machined sensors and related sensor technologies; and the application of micro-machined sensors.

ELEC 5770 VLSI DESIGN (3) LEC. 3. Pr. ELEC 2210 and ELEC 2220. Review of MOS transistor fundamentals, CMOS logic circuits; VLSI fabrication and design rules; clocking strategies and sequential design; performance estimation; memories and programmable arrays; standard cell design methodologies; computer aided design (CAD) tools.

ELEC 5780 ANALOG CIRCUIT DESIGN (3) LEC. 3. Pr. ELEC 3700. Departmental approval. Circuit design techniques used for implementing analog integrated circuits in both CMOS and bipolar technologies.

ELEC 5810 COMPUTED IMAGING SYSTEMS (3) LEC. 3. Pr. ELEC 2120. Departmental approval. Introduction to computed imaging systems such as magnetic resonance imaging (MRI) and computed tomography (CT).

ELEC 5820 MEMS TECHNOLOGY (3) LEC. 3. Departmental approval. Introduction to Micro-Electro-Mechanical Systems (MEMS), the study of the materials and microfabrication processes used to fabricate MEMS devices, the principles of operation of MEMS devices, and an introduction to the different application areas of MEMS devices.

ELEC 5970 SPECIAL TOPICS (1-5) LEC. Departmental approval. Study of a specialized area of electrical and computer engineering not covered by regularly offered courses. Course may be repeated with change in topics.

ELEC 6110/6116 WIRELESS NETWORKS (3) LEC. 3. Introduction to wireless broadband, satellite communication, wireless local area networks, Bluetooth and Home RF standards and Internet protocol and wireless access.

ELEC 6120/6126 TELECOMMUNICATION NETWORKS (3) LEC. 3. Principles and building blocks of telecommunication systems, including switched telephone networks, voice and data networks, transmission technologies, and switching architectures.

ELEC 6130/6136 RF DEVICES AND CIRCUITS (3) LEC. 3. Introduction to RF semiconductor devices and circuits targeted for wireless applications.

ELEC 6150 INFORMATION SECURITY (3) LEC. 3. Departmental approval. Emerging protocols, standards and technologies of information security; design of information network security using firewalls, virtual private networks and secured applications.

ELEC 6190/6196 INTRODUCTION TO DIGITAL AND ANALOG IC DESIGN (3) LEC. 3. Digital IC design using Verilog, analog and mixed signal IC design using industry standard tools; emphasis on on front-end design skills.

ELEC 6200/6206 COMPUTER ARCHITECTURE AND DESIGN (3) LEC. 3. Structural organization and hardware design of digital computers; register transfers; micro-operations, control units and timing; instruction set design; input/output devices, multiprocessors, automated hardware design aids.

ELEC 6210 HARDWARE SECURITY I (3) LEC. 3. This course will provide an in-depth analysis of various topics, which include (i) introduction to cryptography - symmetric and asymmetric ciphers, message authentication codes, and digital signatures, (ii) detection & avoidance of counterfeit ICs, and (iii) security primitives - physically unclonable functions (PUFs) and true random number generators (TRNGs).

ELEC 6220/6226 INFORMATION NETWORKS AND TECHNOLOGY (3) LEC. 3. Architectures, protocols, standards and technologies of information networks; design and implementation of information networks; applications of information networks for data, audio and video communications.

ELEC 6230/6236 PARALLEL PROCESSING (3) LEC. 3. Hardware components of multiprocessor systems including processor, interconnection, memory and control architectures; software elements of parallel processing.

ELEC 6250/6256 COMPUTER AIDED DESIGN OF DIGITAL LOGIC CIRCUITS (3) LEC. 3. Computer-automated design of digital logic circuits using discrete gates, programmable logic devices, and standard cells; hardware description languages, circuit simulation, verification, fault diagnosis and testing, RTL-to-GDSII ASIC flow.

ELEC 6260/6266 EMBEDDED COMPUTING SYSTEMS (3) LEC. 3. The design of systems containing embedded computers. Microcontroller technology, assembly language and C programming, input/output interfacing, data acquisition hardware, interrupts, and timing. Real-time operating systems and application programming. Embedded system application examples.

ELEC 6270/6276 LOW-POWER DESIGN OF ELECTRONIC CIRCUITS (3) LEC. 3. Departmental approval. Design of digital circuits and systems for reduced power consumption, power analysis algorithms, low-power MOS technologies, low-power design architectures for FPGAs, memory, and microprocessors, reduction of power in testing of circuits.

ELEC 6280/6286 BUILT-IN-SELF-TEST (3) LEC. 3. Testing during product life-cycle, fault models and detection, design for testability, test pattern generation, output response analysis, concurrent fault detection, manufacturing and system use, built-in self-test approaches and applications.

ELEC 6290 HARDWARE SECURITY II (3) LEC. 3. Pr. ELEC 5210 or ELEC 6210. This course will provide an in-depth analysis of various topics, which includes advanced cryptography, hardware Trojans, PUFs, RFID security, side-channel attacks and solutions, and blockchain.

ELEC 6310/6316 DESIGN OF ANTENNAS AND ANTENNA SYSTEMS (3) LEC. 3. Application of electromagnetic and circuit concepts to the design of practical antennas and antenna systems.

ELEC 6320/6326 ELECTROMAGNETIC COMPATIBILITY (3) LEC. 3. Electromagnetic noise coupling, designing for electromagnetic compatibility (EMC), EMC regulation, noise sources, standard techniques for eliminating noise, circuit layout for reduced electromagnetic interference (EMI).

ELEC 6340/6346 MICROWAVE AND RF ENGINEERING (3) LEC. 3. Application of electromagnetic and electronic concepts to the design of practical microwave devices and circuits typically used in wireless communications.

ELEC 6350/6356 RADAR PRINCIPLES (3) LEC. 3. Study of the fundamentals of RADAR and related systems such as SONAR and LIDAR.

ELEC 6360/6366 BIOMEDICAL APPLICATIONS OF ELECTROMAGNETICS (3) LEC. 3. Development of medical instrumentation using electromagnetic principles; focus on magnetic resonance imaging systems.

ELEC 6410/6416 DIGITAL SIGNAL PROCESSING (3) LEC. 3. Digital processing of signals, sampling difference equations, discrete-time Fourier transforms, discrete and fast Fourier transforms, digital filter design.

ELEC 6470 FUNDAMENTALS OF VLSI TEST (3) LEC. 3. Test economics, automatic test equipment, fault models, automatic test pattern generation, test generation for sequential circuits, fault simulation, testability measures, fault coverage, yield and defect levels, design-for-testability, scan and boundary scan, IDDQ testing

ELEC 6530/6536 MOBILE ROBOT DESIGN (3) LEC. 3. Fundamentals of mobile robot design, including motor control, sensor integration, path planning, navigation, and localization. Departmental Approval.


ELEC 6620/6626 POWER SYSTEM ANALYSIS (3) LEC. 3. Departmental approval. Power system modeling, power flow analysis, analysis of faulted power systems.


ELEC 6640 RENEWABLE ENERGY IN ELECTRICAL POWER SYSTEMS (3) LEC. 3. Conventional power plants, global renewables, energy efficiency, marine hydrokinetic (ocean currents and waves), wind power (aerodynamic, generator, plants, grid integration, finance), photovoltaic (device, inverter, plant levels, finance), hydropower (generator, plant level, pumped storage hydro, advances in hydro), power systems grid integration, system impact studies, control and operation of inverter-based resources, ancillary services provisions, and other important aspects of renewables for bulk power (transmission levels) and for distribution power systems.
ELEC 6650/6656 POWER SYSTEM PROTECTION (3) LEC. 3. Fault analysis using symmetrical components. Power switchgear, including switches, disconnects, fuses, relays and circuit breakers. Fundamentals of electric power system protection, including bus, transformer and line protection.

ELEC 6670/6676 ELECTRIC POWER ENGINEERING TOPICS (1-3) LEC. Various topics representing state-of-the-art power technology. Course may be repeated for a maximum of 12 credit hours.

ELEC 6700/6706 SEMICONDUCTOR FUNDAMENTALS (3) LEC. 3. Introduction to semiconductors: crystal structure, energy band theory, equilibrium electron and hole statistics, doping, generation and recombination processes, carrier drift and diffusion, transport equations.

ELEC 6710/6716 SEMICONDUCTOR DEVICES (3) LEC. 3. Pr. ELEC 5700 or ELEC 6700 or ELEC 6706. Introduction to semiconductor devices: pn junctions, junction diode based devices, optoelectronic devices, bipolar transistors, field effect transistors.

ELEC 6730/6736 MICROELECTRONIC FABRICATION (3) LEC. 2. LAB. 3. Departmental approval. Introduction to monolithic integrated circuit technology. Bipolar and MOS processes and structures. Elements of layout, design, fabrication, and applications. Experiments in microelectronic technologies.

ELEC 6740/6746 ELECTRONICS MANUFACTURING (3) LEC. 2. LAB. 3. Departmental approval. Materials and processes used to manufacture electronic products. Particular attention is given to substrate technology and electronics assembly.

ELEC 6750/6756 INTRODUCTION TO PLASMA ENGINEERING (3) LEC. 3. Departmental approval. Electrical breakdown and discharges in gases, basic plasma theories, applications of plasmas, plasma processing for microelectronic fabrication.

ELEC 6760/6766 SOLID STATE SENSORS (3) LEC. 3. Theory, technology and design of micro-machined sensors and related sensor technologies; and the application of micro-machined sensors.

ELEC 6770/6776 VLSI DESIGN (3) LEC. 3. Review of MOS transistor fundamentals, CMOS logic circuits; VLSI fabrication and design rules; clocking strategies and sequential design; performance estimation; memories and programmable arrays; standard cell design methodologies; computer aided design (CAD) tools.

ELEC 6780/6786 ANALOG CIRCUIT DESIGN (3) LEC. 3. Circuit design techniques used for implementing analog integrated circuits in both CMOS and bipolar technologies.

ELEC 6810/6816 COMPUTED IMAGING SYSTEMS (3) LEC. 3. Introduction to computed imaging systems such as magnetic resonance imaging (MRI) and computed tomography (CT).

ELEC 6820/6826 MEMS TECHNOLOGY (3) LEC. 3. Departmental approval. Introduction to Micro-Electro-Mechanical Systems (MEMS), the study of the materials and microfabrication processes used to fabricate MEMS devices, the principles of operation of MEMS devices, and an introduction to the different application areas of MEMS devices.

ELEC 6970/6976 SPECIAL TOPICS (1-5) LEC. Departmental approval. Study of a specialized area of electrical and computer engineering not covered by regularly offered courses. Course may be repeated with change in topics. Course may be repeated for a maximum of 24 credit hours.

ELEC 7190/7196 ADVANCED RFIC DESIGN FOR WIRELESS COMMUNICATIONS (3) LEC. Pr. ELEC 5190 or ELEC 6190 or ELEC 6196. Wireless standards and multi-standard transceiver architectures, SiGe and CMOS RFIC designs for wireless transceiver building blocks, software defined radios, phase array radars, ultra-high speed data converters, and MIMO wireless transceivers.

ELEC 7250/7256 VLSI TESTING (3) LEC. 3. Pr. ELEC 5770 or ELEC 6770 or ELEC 6776. Exponential nature of the test problem, fault models, test generation algorithms, test generation for sequential circuits, fault simulation, testability measures, fault coverage, yield and defect levels, design-for-testability approaches.


ELEC 7320/7326 ADVANCED ELECTRODYNAMICS II (3) LEC. 3. Pr. ELEC 7310 or ELEC 7316. Cylindrical wave functions. Spherical wave functions. Scattering by cylinders and spheres. Perturbational and variational techniques.
ELEC 7340/7346 COMPUTATIONAL ELECTROMAGNETICS I (3) LEC. 3. Pr. ELEC 7310 or ELEC 7316. Solution of electromagnetic scattering, radiation, and coupling problems using method of moments, finite-difference, finite-element, transmission-line matrix and other advanced computational methods.

ELEC 7350/7356 COMPUTATIONAL ELECTROMAGNETICS II (3) LEC. 3. Pr. ELEC 7310 or ELEC 7316. Solutions of electromagnetic scattering, radiation, and coupling problems using a variety of common asymptotic techniques.

ELEC 7410/7416 STOCHASTIC SIGNAL AND SYSTEM ANALYSIS (3) LEC. 3. Departmental approval. Applications of probability, random variables and stochastic processes in electrical engineering.

ELEC 7440 WIRELESS COMMUNICATION THEORY (3) LEC. 3. Pr. ELEC 3400 or ELEC 7410 or ELEC 7416. The basic of design, analysis and performance limits of wireless communication systems.

ELEC 7450/7456 DIGITAL IMAGE PROCESSING (3) LEC. 3. Departmental approval. Digital image processing principles and applications such as enhancement, restoration and compression.

ELEC 7470 ADVANCED VLSI TEST (3) LEC. 3. Pr. ELEC 5470 and ELEC 6470. Memory/PLA/FPGA testing, delay fault testing, test compression, in-field testing, cell-aware test, adaptive test, system-level test.

ELEC 7500/7506 STATE-VARIABLE ANALYSIS OF SYSTEMS (3) LEC. 3. Departmental approval. Matrices and linear spaces; state variable for linear continuous and discrete systems; applications in analysis and design of control systems.


ELEC 7560/7566 NONLINEAR SYSTEMS AND CONTROL (3) LEC. 3. Pr. ELEC 7500 or ELEC 7506. Departmental approval. Principles of nonlinear system modeling and analysis; nonlinear control systems design; nonlinear system state estimation.

ELEC 7610/7616 POWER SYSTEM DYNAMICS AND STABILITY (3) LEC. 3. Pr. (ELEC 5620 or ELEC 6620 or ELEC 6626) and (ELEC 5650 or ELEC 6650 or ELEC 6656). Departmental approval. Dynamic models of power systems and analysis of power system stability.

ELEC 7620/7626 POWER SYSTEM OPERATION (3) LEC. 3. Pr. ELEC 5620 or ELEC 6620 or ELEC 6626. Departmental approval. Unit commitment, power system security, state estimation, power system control centers and real-time applications.

ELEC 7630/7636 ADVANCED ELECTRIC MACHINES (3) LEC. 3. Pr. ELEC 5630 or ELEC 6630 or ELEC 6636. Departmental approval. Advanced machine modeling, including Kron’s generalized machine theory, Park’s transformation, and generalized coordinate transformations. Derivation of traditional machine models. Machine non-linearities, including finite element analysis.

ELEC 7640/7646 POWER SYSTEM TRANSIENTS (3) LEC. 3. Pr. ELEC 5620 or ELEC 6620 or ELEC 6626. Departmental approval. Transients in electric power systems, including lightning and switching phenomena. Traveling waves on power transmission lines, BIL, BSL, line insulation. System modeling.

ELEC 7710/7716 THE FIELD-EFFECT TRANSISTOR (3) LEC. 3. Pr. ELEC 5710 or ELEC 6710 or ELEC 6716. Advanced treatment of the modern field-effect transistor: the state-of-the art, the MOS capacitor, the 4-terminal MOSFET, short and narrow-channel effects, reliability, scaling theory, modeling, silicon-on-insulator technology, heterostructure devices.

ELEC 7720/7726 THE BIPOLAR TRANSISTOR (3) LEC. 3. Pr. ELEC 5710 or ELEC 6710 or ELEC 6716. Advanced treatment of the modern bipolar junction transistor: the state-of-the art, terminal currents, solutions for arbitrary doping profiles, the polysilicon emitter contact, high-injector effects, dynamic operation, device models, heterojunction bipolar transistors.

ELEC 7730/7736 ADVANCED PLASMA PROCESSING FOR MICROELECTRONIC FABRICATION (3) LEC. 3. Pr. ELEC 5750 or ELEC 6750 or ELEC 6756. Departmental approval. Plasma reactor design and process optimization, plasma-assisted etching and deposition processes, plasma-assisted oxidation and surface modification processes, plasma polymerization, plasma-induced damages to semiconductor devices.

ELEC 7740/7746 ELECTRONIC PACKAGING (3) LEC. 3. Pr. ELEC 5740 or ELEC 6740 or ELEC 6746. Departmental approval. Design issues in the packaging of electronics. Emphasis is placed on physical design, electrical performance, thermal characteristics and mechanical stress-induced failures.
ELEC 7750/7756 LOW TEMPERATURE ELECTRONICS (3) LEC. 3. Pr. ELEC 5710 or ELEC 6710 or ELEC 6716. Advanced treatment of electronic devices operating at reduced temperatures: the case for cryogenic computers, semiconductor physics at low temperatures, carrier freeze-out, cooled CMOS technology, cooled bipolar technology, superconductors, packaging.

ELEC 7760/7766 SILICON-BASED HETEROSTRUCTURE DEVICES AND CIRCUITS (3) LEC. 3. Pr. ELEC 5700 or ELEC 6700 or ELEC 6706. Departmental approval. Bandgap engineering, strained SiGe and Si, SiGe BiCMOS technology, noise, linearity, circuits applications.

ELEC 7770/7776 ADVANCED VLSI DESIGN (3) LEC. 3. Pr. ELEC 5770 or ELEC 6770 or ELEC 6776. Departmental approval. Review of CMOS logic circuits; impact of fabrication issues on design; high speed switching circuits; high performance memory structures; advanced clocking strategies and clock distribution; performance optimization; deep submicron design issues; ASIC design flow: logic synthesis, placement and routing; design verification; low power design.

ELEC 7780/7786 RF MICROELECTRONICS (3) LEC. 3. Pr. ELEC 5780 or ELEC 6780 or ELEC 6786. Departmental approval. Techniques used in the design of monolithic integrated circuits for RF applications.

ELEC 7830/7836 PHOTOVOLTAICS (3) LEC. 3. Departmental Approval. Theory, technology, design and application of photovoltaic devices and systems.

ELEC 7900 INDEPENDENT STUDY (1-3) IND. Departmental approval. Supervised study in specialized areas of electrical and computer engineering.

ELEC 7950 ELECTRICAL ENGINEERING SEMINAR (1-10) SEM. SU. Course may be repeated for a maximum of 10 credit hours.

ELEC 7970/7976 SPECIAL TOPICS (1-5) LEC. Departmental approval. Study of a specialized area of electrical and computer engineering not covered by regularly offered courses. Course may be repeated with change of topic. Course may be repeated for a maximum of 24 credit hours.

ELEC 7990/7996 RESEARCH AND THESIS (1-6) MST. Course may be repeated for a maximum of 6 credit hours.

ELEC 8120/8126 PRINCIPLES OF NETWORK PERFORMANCE ANALYSIS (3) LEC. 3. Pr. (ELEC 5120 or ELEC 6120 or ELEC 6126) and (ELEC 7410 or ELEC 7416). Data network performance analysis, queueing systems, admission control, network traffic modeling, network calculus, flow and congestion control, wireless network analysis, and network simulation.

ELEC 8420 DETECTION AND ESTIMATION THEORY (3) LEC. 3. Pr. ELEC 7410 or ELEC 7416. Decision theory concepts. Detection of deterministic and random signals in noise; parameter estimation. Bayesian and maximum likelihood approaches, non-random and random parameter estimation; signal estimation.


ELEC 8710 ADVANCED TOPICS IN SEMICONDUCTOR DEVICES (3) LEC. 3. Pr. ELEC 5710 or ELEC 6710 or ELEC 6716. Advanced treatment of selected topics in semiconductor devices. Course may be repeated for a maximum of 6 credit hours.

ELEC 8780 CONTEMPORARY TOPICS IN ELECTRICAL CIRCUIT DESIGN (3) LEC. 3. Pr. ELEC 5780 or ELEC 6780 or ELEC 6786. Departmental approval. Contemporary topics in electronic circuit design such as Delta-Sigma A/D and D/A conversion, switched capacitor circuitry, continuous time and discrete time filter design, communications electronics. Course may be repeated for a maximum of 6 credit hours.

ELEC 8900 ADVANCED INDEPENDENT STUDY (1-3) IND. Departmental approval. Supervised study in specialized areas of electrical and computer engineering.

ELEC 8970 ADVANCED SPECIAL TOPICS (1-5) LEC. Departmental approval. Study of a specialized area of electrical and computer engineering not covered by regularly offered courses. Course may be repeated with change in topics. Course may be repeated for a maximum of 9 credit hours.

ELEC 8990/8996 RESEARCH AND DISSERTATION (1-10) DSR. Course may be repeated for a maximum of 20 credit hours.

Curriculum in Computer Engineering
### Freshman

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<th>Fall</th>
<th>Hours</th>
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<tr>
<td>ENGL 1100 English Composition I</td>
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<td>ENGL 1120 English Composition II</td>
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<td>PHYS 1600 Engineering Physics I</td>
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<td>MATH 1610 Calculus I</td>
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<td>PHYS 1610 Engineering Physics II</td>
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<td>Core Fine Arts</td>
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<td>MATH 1620 Calculus II</td>
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<td>ENGR 1110 Introduction to Engineering</td>
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<td>COMP 1210 Fundamentals of Computing I</td>
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### Sophomore

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<tr>
<td>MATH 2650 Linear Differential Equations</td>
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<td>CHEM 1030 Fundamentals Chemistry I</td>
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<td>MATH 2630 Calculus III</td>
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<td>CHEM 1031 Fundamental Chemistry I Laboratory</td>
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<td>COMP 2210 Fundamentals of Computing II</td>
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<td>MATH 2660 Topics in Linear Algebra</td>
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<td>ELEC 2200 Digital Logic Circuits</td>
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<td>ELEC 2220 Computer Systems</td>
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<td>ELEC 2110 Electric Circuit Analysis</td>
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### Junior

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<th>Fall</th>
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<tr>
<td>Core History¹</td>
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<td>Core History or Core Social Science¹</td>
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<tr>
<td>COMP 3240 Discrete Structures</td>
<td>3 COMP 3270 Introduction to Algorithms</td>
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<tr>
<td>COMP 3500 Introduction to Operating Systems</td>
<td>3 ELEC 3050 Embedded System Design Lab</td>
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<td>ELEC 2120 Signals and Systems</td>
<td>3 ELEC 3700 Analog Electronics</td>
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<td>ELEC 2210 Digital Electronics</td>
<td>4 ELEC 3800 Random Signals and Systems</td>
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### Senior

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<tr>
<td>Core Literature¹</td>
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<td>PHIL 1020 Introduction to Ethics or 1040 Business Ethics</td>
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<tr>
<td>Core Social Science¹</td>
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<td>ELEC 4000 Senior Design Projects</td>
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<td>INSY 3600 Engineering Economy²</td>
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<td>ELEC 5200 Computer Architecture and Design</td>
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Total Hours: 122

¹ The AU Bulletin lists the University Core Curriculum requirements for students in the College of Engineering. Students must complete a sequence in either Literature or History. Because of the discipline specific requirements for the Humanities courses, it is recommended that a History sequence be completed in the Social Sciences courses.

² For students completing the ROTC program, the first ROTC course may be used as the 3-hour free elective, and the second ROTC course may be substituted for INSY 3600.
ECE elective - see adviser for approved course listing.

## Curriculum in Computer Engineering

### Freshman

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<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
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<tbody>
<tr>
<td>CHEM 1030 Fundamentals Chemistry I</td>
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<td>COMP 1210 <em>Fundamentals of Computing I</em></td>
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<tr>
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<td>MATH 1610 Calculus I</td>
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<td>PHYS 1600 Engineering Physics I</td>
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### Sophomore

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
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<tr>
<td>COMP 2210 <em>Fundamentals of Computing II</em></td>
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<td>COMP 2710 Software Construction</td>
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<td>ELEC 2110 Electric Circuit Analysis</td>
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<td>PHYS 1610 Engineering Physics II</td>
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<td>MATH 2650 Linear Differential Equations</td>
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### Junior

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<td>COMP 3240 <em>Discrete Structures</em></td>
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<td>COMP 3270 <em>Introduction to Algorithms</em></td>
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<td>COMP 3500 <em>Introduction to Operating Systems</em></td>
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<td>ELEC 3050 Embedded System Design Lab</td>
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<tr>
<td>ELEC 2120 <em>Signals and Systems</em></td>
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<td>ELEC 3800 Random Signals and Systems</td>
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<tr>
<td>ELEC 2210 <em>Digital Electronics</em></td>
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<td>Core History or Core Social Science</td>
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<td></td>
<td></td>
<td>Ethics</td>
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### Senior

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<th>Spring</th>
<th>Hours</th>
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<tbody>
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<td>ELEC 4020 <em>Capstone Design II</em></td>
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<tr>
<td>CMPE Elective</td>
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<td>ELEC 5200 <em>Computer Architecture and Design</em></td>
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<td>Free Elective</td>
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<tr>
<td>ELEC 5220 <em>Information Networks and Technology</em></td>
<td>3</td>
<td>Core Literature</td>
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<tr>
<td>INSY 3600 Engineering Economy</td>
<td>3</td>
<td>UNIV 4AA0 Creed to Succeed</td>
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<tr>
<td>Core Social Science</td>
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<td></td>
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</table>

*Total Hours: 124*

Comments:
The AU Bulletin lists the University Core Curriculum requirements for students in the College of Engineering. Students must complete a sequence in either literature or History. Because of the discipline specific requirements for the Humanities courses, it is recommended that a History sequence be completed in the Social Sciences courses.

Ethics course options: PHIL 1020 Introduction to Ethics, PHIL 1030 Ethics and the Health Sciences, PHIL 1040 Business Ethics, and PHIL 1113 Ethical and Conceptual Foundations of Science.

CMPE elective - see advisor for approved course listing.

Students must take at least 3 of the following 4 courses: COMP 3270, ELEC 3800, ELEC 5200, ELEC 5220 before registering for ELEC 4020.

For students completing the ROTC program, the first ROTC course may be used as the 3-hour free elective, and the second ROTC course may be substituted for INSY 3600.

## Curriculum in Electrical Engineering

### Freshman

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<thead>
<tr>
<th>Course</th>
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<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
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<tbody>
<tr>
<td>CHEM 1030 Fundamentals Chemistry I</td>
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<td>COMP 1200 Introduction to Computing for Engineers and Scientists</td>
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<td>ENGR 1110 Introduction to Engineering</td>
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<td>ENGR 1100 Engineering Orientation</td>
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<tr>
<td>MATH 1610 Calculus I</td>
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<td>PHYS 1600 Engineering Physics I</td>
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<tr>
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<td><strong>Total Hours</strong></td>
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### Sophomore

<table>
<thead>
<tr>
<th>Course</th>
<th>Fall</th>
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<th>Spring</th>
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<tbody>
<tr>
<td>ELEC 2200 Digital Logic Circuits</td>
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<td>ELEC 2110 Electric Circuit Analysis</td>
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<tr>
<td>ENGR 2100 Fundamentals of Engineering Mechanics</td>
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<td>ELEC 2220 Computer Systems</td>
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<td>MATH 2630 Calculus III</td>
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<td>MATH 2650 Linear Differential Equations</td>
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<td>MATH 2660 Topics in Linear Algebra</td>
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<tr>
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<td>Core History or Core Social Science</td>
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### Junior

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<thead>
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<th>Spring</th>
<th>Hours</th>
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<tr>
<td>ELEC 2120 Signals and Systems</td>
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<td>ELEC 3030 RF Systems Lab</td>
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<td>ELEC 2210 Digital Electronics</td>
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<td>ELEC 3040 Electrical System Design Lab</td>
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</tr>
<tr>
<td>ELEC 3310 Fundamentals of Applied Electromagnetics</td>
<td>3</td>
<td>ELEC 3320 Electromagnetics for Wireless Communication</td>
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<tr>
<td>ELEC 3600 Electric Power Engineering</td>
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<td>ELEC 3500 Control Systems</td>
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<td>Ethics</td>
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<td>ELEC 3700 Analog Electronics</td>
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<td></td>
<td></td>
<td>ELEC 3800 Random Signals and Systems</td>
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<td><strong>Total Hours</strong></td>
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<td>14</td>
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### Senior

<table>
<thead>
<tr>
<th>Course</th>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
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<tbody>
<tr>
<td>ELEC 3400 Communication Systems</td>
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<td>ELEC 4020 Capstone Design II</td>
<td>3</td>
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</table>
ELEC 4010 Capstone Design I

INSY 3600 Engineering Economy
Core Social Science
ELEC Elective
Technical Elective

1 ENGR 2200 Introduction To Thermodynamics, Fluids And Heat Transfer
3 Core Literature
3 ELEC Elective
3 Free Elective
3 UNIV 4AA0 Creed to Succeed

Total Hours: 124

1 The AU Bulletin lists the University Core Curriculum requirements for students in the College of Engineering. Students must complete a sequence in either Literature or History. Because of the discipline specific requirements for the Humanities courses, it is recommended that a History sequence be completed in the Social Sciences courses.

2 Students take the C-programming version of COMP 1200, or they may opt for the 3 credit course COMP 1210 Fundamentals of Computing I. Only two credits of COMP 1210 will count in place of COMP 1200, and the third hour may count towards free elective credit.

3 Ethics course options: PHIL 1020 Introduction to Ethics, PHIL 1030 Ethics and the Health Sciences, PHIL 1040 Business Ethics, and PHIL 1113 Ethical and Conceptual Foundations of Science.

4 Technical elective is chosen from an approved list of MATH/SCIENCE, ELEC, and other College of Engineering electives.

5 Students must take at least 3 of the following 4 courses: ELEC 3320, ELEC 3400, ELEC 3600, ELEC 3700 before registering for ELEC 4020.

6 For students completing the ROTC program, the first ROTC course may be used as the 3-hour free elective, and the second ROTC course may be substituted for ENGR 2200.

ELEC and Technical Elective: see adviser for approved course listing.

Joint Wireless Engineering-Hardware Option

Freshman

Fall
CHEM 1030 Fundamentals Chemistry I
CHEM 1031 Fundamental Chemistry I Laboratory
ENGL 1100 English Composition I
ENGR 1100 Engineering Orientation
MATH 1610 Calculus I
Core Fine Arts

Spring
3 COMP 1200 Introduction to Computing for Engineers and Scientists
1 ENGL 1120 English Composition II
3 ENGR 1110 Introduction to Engineering
0 MATH 1620 Calculus II
4 PHYS 1600 Engineering Physics I

Total Hours: 14

Sophomore

Fall
ELEC 2200 Digital Logic Circuits
MATH 2630 Calculus III
PHYS 1610 Engineering Physics II
Core History
Core Social Science

Spring
3 ELEC 2110 Electric Circuit Analysis
4 ELEC 2220 Computer Systems
4 MATH 2650 Linear Differential Equations
3 MATH 2660 Topics in Linear Algebra
3 Core History or Core Social Science

Total Hours: 17
### Junior

<table>
<thead>
<tr>
<th>Fall</th>
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<th>Spring</th>
<th>Hours</th>
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<tr>
<td>COMP 3000 <strong>Object-Oriented</strong></td>
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<td>ELEC 3030 <strong>RF Systems Lab</strong></td>
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<tr>
<td><strong>Programming for Engineers and</strong></td>
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<td><strong>Communication</strong></td>
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<td>Scientists</td>
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<td>ELEC 2120 <strong>Signals and Systems</strong></td>
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<td>ELEC 2120 <strong>Signals and Systems</strong></td>
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<td>ELEC 3320 Electromagnetics for</td>
<td>3</td>
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<tr>
<td>ELEC 2210 <strong>Digital Electronics</strong></td>
<td>4</td>
<td>Wireless Communication**</td>
<td></td>
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<tr>
<td>ELEC 3310 <strong>Fundamentals of</strong></td>
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<td>ELEC 3800 Random Signals and</td>
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<td><strong>Applied Electromagnetics</strong></td>
<td></td>
<td>Systems**</td>
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<td>ELEC 5220 <strong>Information Networks</strong></td>
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<td>INSY 3600 Engineering Economy (or ROTC)**</td>
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<tr>
<td>Technology</td>
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<td><strong>3</strong></td>
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### Senior

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<th>Spring</th>
<th>Hours</th>
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<tr>
<td>ELEC 3060 <strong>Wireless Design Lab</strong></td>
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<td>ELEC 4020 <strong>Capstone Design II</strong></td>
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<td>ELEC 3400 <strong>Communication Systems</strong></td>
<td>3</td>
<td><strong>Wireless Communication Systems</strong></td>
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<tr>
<td>ELEC 4010 <strong>Capstone Design I</strong></td>
<td>1</td>
<td><strong>Wireless Elective</strong></td>
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<td>ELEC 5130 <strong>RF Devices and Circuits</strong></td>
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<td>Free Elective/ROTC**</td>
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<td>ELEC 5410 <strong>Digital Signal</strong></td>
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<td><strong>Processing</strong></td>
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<td>Technology</td>
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Total Hours: 124

1. The AU Bulletin lists the University Core Curriculum requirements for students in the College of Engineering. Students must complete a sequence in either Literature or History. Because of the discipline specific requirements for the Humanities courses, it is recommended that a History sequence be completed in the Social Sciences courses.
2. Students may opt for the 3 credit course COMP 1210 Fundamentals of Computing I. Only two credits of COMP 1210 will count in place of COMP 1200, and the third hour may count towards free elective credit.
3. For students completing the ROTC program, the first ROTC course may be used as the 3-hour free elective, and the second ROTC course may be substituted for INSY 3600.
4. Ethics course options: PHIL 1020 Introduction to Ethics, PHIL 1030 Ethics and the Health Sciences, PHIL 1040 Business Ethics, and PHIL 1113 Ethical and Conceptual Foundations of Science.
5. Before registering for ELEC 4020, students must be taking or have already taken ELEC 5100. They also must have taken at least 1 of the following 2 courses: ELEC 5130, ELEC 5410.
6. See advisor for list of approved Wireless electives.

Wireless Elective - see adviser for approved course listing.

### Joint Wireless Engineering-Software Option

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<thead>
<tr>
<th>Freshman</th>
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<th>Spring</th>
<th>Hours</th>
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<tr>
<td><strong>Fall</strong></td>
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<td><strong>Spring</strong></td>
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<tr>
<td>Core Fine Arts</td>
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<td>ENGR 1110 Introduction to Engineering</td>
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<td>ENGL 1100 English Composition I</td>
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<td>ENGL 1120 English Composition II</td>
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<td>MATH 1620 Calculus II</td>
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<tr>
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<td>COMP 1210 <strong>Fundamentals of Computing I</strong></td>
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**Core Fine Arts**

**ENGL 1100 English Composition I**

**MATH 1610 Calculus I**

**ENGR 1100 Engineering Orientation**
<table>
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<tr>
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<tr>
<td>Fall</td>
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<td>Hours</td>
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<tr>
<td>MATH 2630 Calculus III</td>
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<td>MATH 2650 Linear Differential Equations</td>
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<td>COMP 2210 Fundamentals of Computing II</td>
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<td>ELEC 2110 Electric Circuit Analysis</td>
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<tr>
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<td>Core Social Science¹</td>
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<td>Core History or Social Science¹</td>
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<tr>
<td>COMP 3240 Discrete Structures</td>
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<tr>
<td>COMP 3350 Computer Organization and Assembly Language Programming</td>
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<tr>
<td>ELEC 3800 Random Signals and Systems</td>
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<tr>
<td>Fall</td>
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<tr>
<td>Hours</td>
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<tr>
<td>Core Literature¹</td>
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<td>Select one of the following:</td>
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<td>Math/Science Elective²</td>
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<tr>
<td>INSY 3410 Deterministic Operations Research³</td>
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<tr>
<td>PHIL 1020 Introduction to Ethics or 1040 Business Ethics</td>
</tr>
<tr>
<td>COMP 4320 Introduction to Computer Networks</td>
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<td>ELEC 3060 Wireless Design Lab</td>
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<tr>
<td>Select one of the following:</td>
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<tr>
<td>COMP 5700 Software Process²</td>
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<td>ELEC 5120 Telecommunication Networks³</td>
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¹ The AU Bulletin lists the University Core Curriculum requirements for students in the College of Engineering. Students must complete a sequence in either Literature or History. Because of the disciple specific requirements for the Humanities courses, it is recommended that a History sequence be completed in the Social Sciences courses.

² Software Specialization requires COMP 5700, COMP 5710, and a Math/Science Elective

³ Network Specialization requires INSY 3410, COMP 5340, ELEC 5120

⁴ For students completing the ROTC program, the first ROTC course may be used as the 3-hour free elective, and the second ROTC course may be substituted for INSY 3600.

Wireless Elective, Math/Science Elective: See adviser for approved course listing.
Industrial and Systems Engineering

Industrial and Systems Engineers plan, design, implement, and analyze systems. This engineering discipline is where technology, people, business and information intersect. The degree provides graduates with broad, flexible career opportunities with manufacturing, consulting, service or governmental organizations. The degree can also provide the foundation and background for further studies in engineering and business as well as professions such as law or medicine. The curriculum builds on a solid engineering mathematics and science core and adds courses manufacturing, ergonomics and safety, operations research, statistics, quality control, engineering economics, simulation, and information technologies. The curriculum graduates students who have:

- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- An ability to communicate effectively with a range of audiences
- An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Major

- Industrial and Systems Engineering (p. 149)

Minor

- Automotive Engineering and Manufacturing (p. 148)
- Business-Engineering-Technology (p. 149)
- Nuclear Power Generation Systems (p. 150)

Courses

**INSY 3010 PROGRAMMING AND DATABASE APPLICATIONS FOR ISE (3)** LEC. 3. Pr. COMP 1200. Programming and database applications for ISE students. Focus is on algorithm development as related to optimization, probability, statistics, and data analysis.

**INSY 3020 OCCUPATIONAL SAFETY ERGONOMICS (3)** LEC. 3. Basic principles of occupational safety engineering and ergonomics in the evaluation and design of occupation work areas and processes that include human operators.

**INSY 3021 METHODS ENGINEERING AND WORK MEASUREMENT (3)** LEC. 2. LAB. 3. Develops the student's ability to design workplaces and methods while providing an understanding of the work measurements process. Enables students to generate much of the basic methods data utilized in most industrial engineering projects.

**INSY 3030 CAD FOR ENGINEERS WITH INDUSTRIAL APPLICATIONS (1)** LAB. 3. Pr. COMP 1200 or COMP 1210 or COMP 1217 or COMP 3000 or ENGR 1110 or ENGR 1113. Use of computer technology to aid engineering design in industrial applications, e.g. represent and modify mechanical parts, diagrams, schematics, tools, equipment, office and plant layouts, etc.

**INSY 3400 STOCHASTIC OPERATIONS RESEARCH (3)** LEC. 3. Pr. (ENGR 1110 or ENGR 1113) and MATH 2660 and STAT 3600. with a grade of C or better in STAT 3600. Modeling and analysis of decision-making and operations subject to randomness including decision analysis, stochastic dynamic programming, Markov chains, and queuing theory.

**INSY 3410 DETERMINISTIC OPERATIONS RESEARCH (3)** LEC. 3. Pr. (ENGR 1110 or ENGR 1113) and MATH 2660 and P/C INSY 3010. Formulation, solution, interpretation, and implementation of mathematical models in operations research including linear programming, integer programming and network flows.

**INSY 3420 SIMULATION (3)** LEC. 2. LAB. 3. Pr. INSY 3400 and (COMP 3010 or COMP 3013 or INSY 3010) and STAT 3610. with a grade of C or better in INSY 3400. Simulation procedures for solving complex systems analysis problems. Emphasis on random processes, model building and construction of computer simulation models.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSY 3600</td>
<td>ENGINEERING ECONOMY (3)</td>
<td>LEC. 3.</td>
<td>Pr. ENGR 1110 or ENGR 1113.</td>
<td>Principles required in engineering economic studies.</td>
</tr>
<tr>
<td>INSY 3700</td>
<td>OPERATIONS PLANNING AND CONTROL (3)</td>
<td>LEC. 3.</td>
<td>Pr. INSY 3400 and INSY 3410 and STAT 3610. with a grade of C or better in both</td>
<td>Analytical methods for operations planning and control, including forecasting systems, production planning, inventory control systems, scheduling systems, and project management.</td>
</tr>
<tr>
<td>INSY 3800</td>
<td>MANUFACTURING SYSTEMS I (3)</td>
<td>LEC. 2.</td>
<td></td>
<td>Introduction to the design, analysis, and operation of manufacturing systems, the first course in a required two-course sequence including Manufacturing Systems II.</td>
</tr>
<tr>
<td>INSY 4330</td>
<td>STATISTICAL QUALITY DESIGN AND CONTROL (3)</td>
<td>LEC. 3.</td>
<td>Pr. STAT 3610.</td>
<td>Analytical methods for operations planning and control, including forecasting systems, production planning, inventory control systems, scheduling systems, and project management.</td>
</tr>
<tr>
<td>INSY 4500/4503</td>
<td>PROFESSIONAL PRACTICE (1)</td>
<td>LEC. Pr.</td>
<td>P/C INSY 3700.</td>
<td>Discussion and activities in current problems, the global context of, professional practice, professional opportunities and lifelong learning in Industrial and Systems Engineering. Senior standing in INSY.</td>
</tr>
<tr>
<td>INSY 4610</td>
<td>INTERNATIONAL ENGINEERING PROJECT (3)</td>
<td>LEC. 3.</td>
<td></td>
<td>This course provides students with a real-life work experience in solving engineering-business problems through teamwork in an international setting. At the course end, students present their project to faculty and industry sponsors. The course is Auburn University Faculty led in which students work in groups mentored by faculty from Auburn and foreign universities and company sponsors. Students will be involved in projects that expose them to theory and practice of problem solving techniques involving data collection, statistical analysis, computational modeling, and experimental design of problems related to the service and manufacturing industries.</td>
</tr>
<tr>
<td>INSY 4700</td>
<td>MANUFACTURING SYSTEMS II (3)</td>
<td>LEC. 3.</td>
<td>Pr. INSY 3420 and INSY 3600 and INSY 3700 and INSY 3800.</td>
<td>Continuation of the design, analysis, and operation of manufacturing systems, the second course in a required two-course sequence including Manufacturing Systems I.</td>
</tr>
<tr>
<td>INSY 4800</td>
<td>SENIOR DESIGN (3)</td>
<td>LEC. 3.</td>
<td>Pr. INSY 3021 and INSY 4500 or INSY 4503 and P/C INSY 4700. Coreq. INSY 4700.</td>
<td>Capstone course in which undergraduate course-work principles are brought to bear upon a design problem in a cooperating industry or institution.</td>
</tr>
<tr>
<td>INSY 4960</td>
<td>SPECIAL PROBLEMS (1-5)</td>
<td>IND.</td>
<td>Departmental approval. Individual student endeavor under faculty supervision involving special problems in Industrial and Systems Engineering. Interested student must submit written proposal to department head. Course may be repeated for a maximum of 5 credit hours.</td>
<td>Departmental approval. Individual student endeavor under faculty supervision involving special problems in Industrial and Systems Engineering. Interested student must submit written proposal to department head. Course may be repeated for a maximum of 5 credit hours.</td>
</tr>
<tr>
<td>INSY 4970</td>
<td>INDUSTRIAL AND SYSTEMS ENGINEERING SPECIAL TOPICS (1-10)</td>
<td>AAB.</td>
<td>Departmental approval. Special topics in Industrial and Systems Engineering. Specific prerequisites will be determined and announced for each offering. Course may be repeated for a maximum of 10 credit hours.</td>
<td>Departmental approval. Special topics in Industrial and Systems Engineering. Specific prerequisites will be determined and announced for each offering. Course may be repeated for a maximum of 10 credit hours.</td>
</tr>
<tr>
<td>INSY 4997</td>
<td>HONORS THESIS (1-6)</td>
<td>IND.</td>
<td>Pr. Honors College. Departmental approval. Individual student endeavor consisting of direct research and writing of honors thesis. Course may be repeated for a maximum of 6 credit hours.</td>
<td>Departmental approval. Individual student endeavor consisting of direct research and writing of honors thesis. Course may be repeated for a maximum of 6 credit hours.</td>
</tr>
<tr>
<td>INSY 5010</td>
<td>SAFETY ENGINEERING I (3)</td>
<td>LEC. 3.</td>
<td>Pr. INSY 3020.</td>
<td>Occupational safety engineering and management with emphasis on control of hazardous materials, fire prevention, safety considerations in production facility design, and maintenance, and operation of effective safety programs. Credit will not be given for both INSY 5010 and INSY 6010/6016.</td>
</tr>
<tr>
<td>INSY 5240</td>
<td>PRODUCTION AND INVENTORY CONTROL SYSTEMS (3)</td>
<td>LEC. 3.</td>
<td>Pr. INSY 3700.</td>
<td>Analysis and design of production and inventory control systems with emphasis on quantitative methods, algorithms, and information technology. Credit will not be given for both INSY 5240 and INSY 6240/6246.</td>
</tr>
<tr>
<td>INSY 5250</td>
<td>PROJECT MANAGEMENT (3)</td>
<td>LEC. 3.</td>
<td>Pr. INSY 3700.</td>
<td>Introduction to project management for engineering, business and technology including; project management concepts, project life cycle, planning techniques, scheduling and network analysis, cost estimating and budgeting, risk management, execution and control, and evaluation and closeout.</td>
</tr>
<tr>
<td>INSY 5330</td>
<td>SIX SIGMA (3)</td>
<td>LEC. 3.</td>
<td>Pr. INSY 4330.</td>
<td>This course covers the six sigma engineering techniques. The content emphasizes the DMAIC (Define, Measure, Analyze, Improve, and Control) methodology combined with Lean management practices through analytical and quantitative tools.</td>
</tr>
</tbody>
</table>
INSY 5500 MODERN TOOLS FOR DATA ANALYTICS AND MODELING (3) LEC. 3. Pr. INSY 3010. Introduction to modern data science tools with applications in manufacturing and service industries and operations. Focus on the manipulation and use of small and large datasets. Tools include Jupyter, Python, R, and MySQL along with the related packages that support data modeling, visualization, and analysis.

INSY 5550 DECISION SUPPORT SYSTEMS FOR OPERATIONS (3) LEC. 3. Pr. COMP 3010 or COMP 3013. Fundamentals for modeling, designing, and implementing decision support systems for the operation of manufacturing and service industries. Credit will not be given for both INSY 5550 and INSY 6550/6556.

INSY 5600 ENGINEERING ECONOMIC SYSTEMS (3) LEC. 3. Pr. INSY 3600. Continuation of INSY 3600. Emphasis on design economics and cost estimating techniques and applications to various manufacturing and service operations. Credit will not be given for both INSY 5600 and INSY 6600/6606.

INSY 5630 REAL OPTIONS AND DECISION ANALYSIS (3) LEC. 3. Pr. INSY 3600 and STAT 3600. Analysis of engineering and business decisions under risk and contemporary risk management methods including statistical decision theory and real options. Credit will not be given for both INSY 5630 and INSY 6630/6636.

INSY 5650 INFORMATION TECHNOLOGY AUDITING (3) DSL. 3. Pr. ISMN 5730. In-depth instruction on the range of skills required of persons engaged in the performance of IT audit. The skills include those required by but not limited to a technology analyst, data scientist, or CIO.

INSY 5800/5803 LEAN SYSTEMS (3) LEC. 3. Manufacturing system design based on a strategy of linked cells providing a continuous flow of materials. Evaluation strategies and analysis tools are studied. Credit will not be given for both INSY 5800 and INSY 6800/6806.

INSY 5830 VEHICLE TECHNOLOGY AND TRENDS (3) LEC. 3. Investigation of the advances in automotive technology and the impact of future technologies on the design and manufacture of the automobile. Credit will not be given for both INSY 5830 and INSY 6830/6836.

INSY 5840 CONTROL OF THE MANUFACTURING FLOOR AND PROCESSES (3) LEC. 2. LAB. 3. Students work within multi-disciplinary teams to apply the principles of Computer Aided Manufacturing and the Toyota Production System (TPS) on the modern automated floor. Laboratory features CNC Controls, Robots, Programmable Logic Controllers (PLC) and Kanban system. DELMIA Catia, and MasterCAM. Credit will not be given for both INSY 5840 and INSY 6840/6846.

INSY 5850 ELECTRONICS MANUFACTURING SYSTEMS (3) LEC. 3. Introduction to electronics packaging and electronics manufacturing technologies including current and future trends, design and quality, and manufacturing for high volume. Credit will not be given for both INSY 5850 and INSY 6850/6856.

INSY 5860 AUTOMOTIVE MANUFACTURING SYSTEMS (3) LEC. 3. History of automotive manufacturing and the automotive manufacturing systems for a typical automotive assembly plant. Credit will not be given for both INSY 5860 and INSY 6860/6866.

INSY 6010/6016 SAFETY ENGINEERING I (3) LEC. 3. Occupational safety engineering and management with emphasis on control of hazardous materials, fire prevention, safety considerations in production facility design and maintenance, and operation of effective safety programs. Departmental approval. Credit will not be given for both INSY 5010 and INSY 6010.

INSY 6240/6246 PRODUCTION AND INVENTORY CONTROL SYSTEMS (3) LEC. 3. Analysis and design of production and inventory control systems with emphasis on quantitative methods, algorithms, and information technology. Credit will not be given for both INSY 5240 and INSY 6240.

INSY 6250/6256 PROJECT MANAGEMENT (3) LEC. 3. Introduction to project management for engineering, business and technology including; project management concepts, project life cycle, planning techniques, scheduling and network analysis, cost estimating and budgeting, risk management, execution and control, and evaluation and closeout.

INSY 6330/6336 SIX SIGMA (3) LEC. 3. This course covers the six sigma engineering techniques. The content emphasizes the DMAIC (Define, Measure, Analyze, Improve, and Control) methodology combined with Lean management practices through analytical and quantitative tools.

INSY 6500/6506 MODERN TOOLS FOR DATA ANALYTICS AND MODELING (3) LEC. 3. Introduction to modern data science tools with applications in manufacturing and service industries and operations. Focus on the manipulation and use of small and large datasets. Tools include Jupyter, Python, R, and MySQL along with the related packages that support data modeling, visualization, and analysis.
INSY 6550/6556 DECISION SUPPORT SYSTEMS FOR OPERATIONS (3) LEC. 3. Fundamentals for modeling, designing, and implementing decision support systems for the operation of manufacturing and service industries. Credit will not be given for both INSY 5550 and INSY 6550.

INSY 6600/6606 ENGINEERING ECONOMIC SYSTEMS (3) LEC. 3. Continuation of INSY 3600. Emphasis on design economics and cost estimating techniques and applications to various manufacturing and service operations. Credit will not be given for both INSY 5600 and INSY 6600.

INSY 6630/6636 REAL OPTIONS/DECISION ANALYSIS (3) LEC. 3. Analysis of engineering and business decisions under risk and contemporary risk management methods including statistical decision theory and real options. Credit will not be given for both INSY 5630 and INSY 6630/6636.

INSY 6800/6806 LEAN SYSTEMS (3) LEC. 3. Manufacturing system design based on a strategy of linked cells providing a continuous flow of materials. Evaluation strategies and analysis tools are studied. Credit will not be given for both INSY 5800 and INSY 6800.

INSY 6830/6836 VEHICLE TECHNOLOGY AND TRENDS (3) LEC. 3. Investigation of the advances in automotive technology and the impact of future technologies on the design and manufacture of the automobile. Credit will not be given for both INSY 5830 and INSY 6830.

INSY 6840/6846 CONTROL OF THE MANUFACTURING FLOOR AND PROCESSES (3) LEC. 2. LAB. 3. Students work within multidisciplinary teams to apply the principles of Computer Aided Manufacturing and the Toyota Production System (TPS) on the modern automated floor. Laboratory features CNC Controls, Robots, Programmable Logic Controllers (PLC) and Kanban system. DELMIA Catia and MasterCAM. Credit will not be given for both INSY 5840 and INSY 6840.

INSY 6850/6856 ELECTRONICS MANUFACTURING SYSTEMS (3) LEC. 3. Introduction to electronics packaging and electronics manufacturing technologies including current and future trends, design and quality, and manufacturing for high volume. Credit will not be given for both INSY 5850 and INSY 6850.

INSY 6860/6866 AUTOMOTIVE MANUFACTURING SYSTEMS (3) LEC. 3. History of automotive manufacturing and the automotive manufacturing systems for a typical automotive assemble plant. Credit will not be given for both INSY 5860 and INSY 6860.

INSY 7020/7026 SAFETY ENGINEERING II (3) LEC. 3. Pr. (INSY 6010 or INSY 6016). Systems safety analysis techniques including human error and reliability, fault trees, and cost benefit analysis.


INSY 7050/7056 INDUSTRIAL HYGIENE AND ENVIRONMENTAL HAZARDS (3) LEC. 3. Introduction to the basic concepts of industrial hygiene with emphasis on the industrial hygiene/safety interface and on the evaluation and control of noise and vibration stress.

INSY 7060/7066 ERGONOMICS I (3) LEC. 3. Overview of the human body systems and evaluation of the physiological response of the human body to occupational activities with emphasis on task design.

INSY 7070/7076 ERGONOMICS II (3) LEC. 3. Pr. INSY 7060 or INSY 7066. Use of biomechanics in the evaluation and design of work activities. Emphasis is placed on biomechanical modeling, manual materials handling, tool design, and repetitive motion trauma.

INSY 7080/7086 HUMAN FACTORS ENGINEERING (3) LEC. 3. Examination of human factors, ergonomics and safety research methodologies. Emphasis is on human information input, output and control processes with the objective of optimizing integration of the human into simple and complex systems.

INSY 7081 HUMAN FACTORS LABORATORY (1) LAB. 3. Coreq. INSY 7080. Laboratory experience in testing human factors principles and concepts covered in INSY 7080. Experience in proper writing of laboratory reports.

INSY 7100/7106 ADAPTIVE OPTIMIZATION (3) LEC. 3. Departmental approval. Adaptive search methods inspired by nature for continuous and combinatorial optimization. Methods include simulated annealing, genetic algorithms, evolutionary strategies, tabu search and ant colony systems.
INSY 7120/7126 DATA ANALYTICS FOR OPERATIONS (3) LEC. 3. Pr. INSY 6500. or equivalent. This course covers the broad topics of predictive analytics, data visualization, and big data in the context of operations analysis. Focus will be on the application of modern computer tools with previously learned statistical and mathematical modeling tools, culminating in a semester project.

INSY 7130/7136 DATA MINING TECHNIQUES AND APPLICATIONS FOR OPERATIONS (3) LEC. 3. or equivalent. This introductory course will cover the most common techniques for extracting useful information and models from numerical or categorical data. Techniques include clustering and classification, regression and spline models, kriging, and artificial neural networks. Also considered are data pre-processing, model building and model validation. Modeling and validation under conditions of sparse data will be addressed as well. Applications include those in finance, manufacturing, health care, and more.

INSY 7190 OCCUPATIONAL SAFETY AND HEALTH FORUM I (1) LEC. 1.

INSY 7200/7206 ENGINEERING APPLICATIONS OF FUZZY SYSTEMS AND NEURAL NETWORKS (3) LEC. 3. Departmental approval. Introduction to fuzzy systems and neural networks with emphasis on their uses in engineering applications in clustering, modeling, optimization, control, forecasting, and classification. A

INSY 7230/7236 ADVANCED LAYOUT AND LOCATION (3) LEC. 3. Facility layout algorithms and the facility design process. Facility location models and their relationship to strategic organization goals.

INSY 7240/7246 PRODUCTION AND INVENTORY CONTROL THEORY (3) LEC. 3. Theoretical foundations for the analysis and design of production and inventory control systems with emphasis on quantitative methods and current areas of research.


INSY 7300/7306 ADVANCED ENGINEERING STATISTICS I (3) LEC. 3. Advanced concepts of experimental design including blocked designs, analysis of variance regression approach, and fractional factorials in base-2 designs. Emphasis throughout is on developing and improving industrial products and processes. Credit will not be given for both INSY 7300 and STAT 7300.

INSY 7310/7316 ADVANCED ENGINEERING STATISTICS II (3) LEC. 3. Pr. (STAT 7300 or STAT 7306) or (INSY 7300 or INSY 7306). Fractional factorial experimentation applied for the purpose of process and quality improvement and optimization, introduction to analysis of covariance, multiple regression analysis, and response surface analysis. Credit will not be given for both INSY 7310 and STAT 7310.

INSY 7330/7336 OFF-LINE AND ON-LINE QUALITY CONTROL (3) LEC. 3. Pr. STAT 7010 or (STAT 7300 or STAT 7306) or (INSY 7300 or INSY 7306). Departmental approval. Taguchi's quality loss functions. Taguchi's orthogonal arrays and their relationships to fractional factorial designs. Taguchi's parameter and tolerance designs, on-line process control concepts and methods. Process capability. CUSUM charts and other process control charts.

INSY 7380/7386 RELIABILITY ENGINEERING (3) LEC. 3. Reliability, maintenance, replacement with emphasis on failure-rate estimation and life testing. Hazard functions, parameter estimation and reliability testing including exponential and Weibull distributions. Markov models and repairable systems. Credit is not given for both INSY 7380 and STAT 7780. Departmental permission.

INSY 7390 OCCUPATIONAL SAFETY AND HEALTH FORUM II (1) LEC. 1. Pr. INSY 7190. Continuation of OSH Forum I (contemporary interdisciplinary issues in occupational safety and health). Emphasis is placed on leadership and mentoring of other OSH students (INSY 7190).

INSY 7400/7406 SIMULATION MODELING AND ANALYSIS (3) LEC. 3. Introduction to discrete event modeling and simulation. Fundamental concepts of Monte Carlo and discrete event simulation and the application of those concepts using commercial simulation software.

INSY 7420/7426 LINEAR PROGRAMMING AND NETWORK FLOWS (3) LEC. 3. Linear programming and network flows emphasizing algorithms and theory.

INSY 7430/7436 INTEGER AND NONLINEAR PROGRAMMING (3) LEC. 3. Pr. INSY 7420 or INSY 7426. Departmental approval. Integer and non linear programming, emphasizing algorithms and theory.

INSY 7440/7446 DYNAMIC PROGRAMMING (3) LEC. 3. Departmental approval. Aspects of sequential decision making with emphasis on formulation and solution using the dynamic programming algorithm. Approximation methods for problems involving large state spaces. Solution techniques for problems under uncertainty.
INSY 7470/7476 SEARCH METHODS FOR OPTIMIZATION (3) LEC. 3. Single and multivariate search techniques and strategies that are used in finding the optimum of discrete and continuous functions.

INSY 7490 OCCUPATIONAL SAFETY AND HEALTH PRACTICUM II (1) LEC. 1. Pr. INSY 7290. Investigation of real-world interdisciplinary OSH problems. Analysis and presentation of OSH concerns and solutions. Emphasis is placed on leadership and mentoring of other OSH students (INSY 7290).

INSY 7500/7506 ADVANCED SIMULATION (3) LEC. 3. Pr. INSY 7400 or INSY 7406. Coverage of advanced simulation and simulation language design concepts. Includes advanced input/output analysis, modeling concepts, and language design/implementation concepts.

INSY 7550/7556 STOCHASTIC OPERATIONS RESEARCH (3) LEC. 3. Stochastic operations research models with emphasis on model formation, solution and interpretation of results. Emphasis on stochastic processes, queuing theory and their applications.


INSY 7710/7716 LIFE CYCLE ENGINEERING (3) LEC. 3. The life cycle engineering course focuses on various life cycle methodologies and tools like life cycle design, product life cycle, life cycle assessment (LCA) and inventory (LCI), service, reuse, re-manufacturing, sustainable design, risk assessment and management and other related topics. May count either INSY 7710 or INSY 7716.

INSY 7720/7726 SYSTEMS ENGINEERING I (3) LEC. 3. Processes and tools for engineering large-scale, complex complex systems: architecture, requirements, risk management, evaluation, concept exploration, decision-making, tradeoff studies, life cycle models, decomposition, system coupling, test, verification, validation, system modeling, business process re-engineering, sensitivity analysis, teamwork, process maturity and documentation. May count either INSY 7720 or INSY 7726.

INSY 7730/7736 PRODUCT DESIGN, DEVELOPMENT, AND TEST (3) LEC. 3. This class teaches modern tools and methods for product design, development, and test of highly complex and large systems including technical specification, reliability, maintainability, manufacturability, testability, marketing, costs, etc. May count either INSY 7730 or INSY 7736.

INSY 7740/7746 PRODUCT LAUNCH, MANUFACTURING, AND DELIVERY (3) LEC. 3. This course teaches students the issues, strategies, and approaches related to launching, manufacturing, and delivering new products or services including customer focus, marketing, manufacturing and launch strategies, delivery and related tools and techniques.

INSY 7750/7756 INTELLECTUAL PROPERTY, LEGAL, AND VENTURE CAPITAL (3) LEC. 3. This course teaches students the US law of intellectual property with major emphasis on patents. Students also learn venture capital including stages of funding, funding presentations, various requirements of funding, types of partnership, exit plans, etc. May count either INSY 7750 or INSY 7756.

INSY 7940/7946 INDUSTRIAL AND SYSTEMS ENGINEERING PROBLEMS (1-5) IND. Departmental approval. Individual student endeavor under staff supervision involving special problems of an advanced undergraduate or graduate nature in Industrial and Systems Engineering. Interested student must submit written proposal to department head. Course may be repeated for a maximum of 5 credit hours.

INSY 7950/7956 SEMINAR (1) LEC. 1. SU. Presentation and discussion of ISE research by graduate students, faculty and guests. Must be taken at least one term and cannot be used in the plan of study to apply towards the minimum number of hours for a degree.

INSY 7970/7976 INDUSTRIAL AND SYSTEMS ENGINEERING SPECIAL TOPICS (1-5) LEC. 1. LAB. 1. Departmental approval. Special topics of a graduate nature pertinent to Industrial and Systems Engineering. Specific prerequisites will be determined and announced for each offering. Course may be repeated for a maximum of 5 credit hours.

INSY 7980/7986 MASTER'S IN INDUSTRIAL AND SYSTEMS ENGINEERING PROJECT (1-5) IND. SU. Non-thesis master's project. Course may be repeated for a maximum of 5 credit hours.

INSY 7990/7996 RESEARCH AND THESIS (1-10) MST. Course may be repeated with change in topics.

INSY 8010/8016 ADVANCED SAFETY ENGINEERING (3) LEC. 3. Pr. INSY 7020 or INSY 7026. Topics of current interest in occupational safety research. Occupational safety research methodology and research priorities.
INSY 8020/8026 RESEARCH METHODS IN OCCUPATIONAL SAFETY, ERGONOMICS, AND INJURY PREVENTION (3) LEC. 3. Pr. INSY 7300 or INSY 7306 or INSY 7060 or INSY 7066 or INSY 6010 or INSY 6016. To introduce students to contemporary and developmental research methods in occupational safety, ergonomics, and injury prevention with emphasis on the public health model as applied to occupational injury prevention and epidemiology. Instructor approval may be required.

INSY 8060/8066 ADVANCED ERGONOMICS (3) LEC. 3. Pr. INSY 7060 or INSY 7066. Topics of current interest in occupational ergonomics and human factors research. Occupational ergonomics and human factors research methodology and research priorities.

INSY 8250 SCHEDULING THEORY (3) LEC. 3. Pr. INSY 7300 or INSY 7306 or INSY 7060 or INSY 7066 or INSY 6010 or INSY 6016. To introduce students to contemporary and developmental research methods in occupational safety, ergonomics, and injury prevention with emphasis on the public health model as applied to occupational injury prevention and epidemiology. Instructor approval may be required.

INSY 8420/8426 TOPICS IN OPTIMIZATION (3) LEC. 3. Pr. INSY 7420 or INSY 7426. Basic concepts and theory of optimization, including saddlepoint conditions for differentiable and non-differentiable programs, duality, approximation, decomposition and partitioning, illustrated by application to specific algorithms.

INSY 8970 INDUSTRIAL AND SYSTEMS ENGINEERING SPECIAL TOPICS (1-5) LEC. Departmental approval. Special topics of an advanced graduate nature pertinent to industrial and systems engineering. Specific prerequisites will be determined and announced for each offering. Course may be repeated for a maximum of 5 credit hours.

INSY 8990/8996 RESEARCH AND DISSERTATION (1-10) DSR. Course may be repeated with change in topics.

Automotive Engineering and Manufacturing Minor

Students in any engineering major may choose to minor in automotive engineering and manufacturing. Three curriculum tracks are available: industrial and systems engineering, mechanical engineering, and car team tracks. The courses required for the minor may require prerequisites that will not count toward the student’s major or toward the minor.

The minor requires successful completion of 15-16 semester credit hours as shown below:

### Industrial and Systems Engineering Track

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MECH 4430</td>
<td>Ground Vehicle Fundamentals</td>
<td>3</td>
</tr>
<tr>
<td>INSY 5800</td>
<td>Lean Systems</td>
<td>3</td>
</tr>
<tr>
<td>INSY 5840</td>
<td>Control of the Manufacturing Floor and Processes</td>
<td>3</td>
</tr>
<tr>
<td>INSY 5860</td>
<td>Automotive Manufacturing Systems</td>
<td>3</td>
</tr>
<tr>
<td>INSY 5330</td>
<td>Six Sigma</td>
<td>3</td>
</tr>
<tr>
<td>or INSY 5830</td>
<td>Vehicle Technology and Trends</td>
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Total Hours: 15

### Mechanical Engineering Track

<table>
<thead>
<tr>
<th>Code</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>MECH 4420</td>
<td>Vehicle Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>MECH 4430</td>
<td>Ground Vehicle Fundamentals</td>
<td>3</td>
</tr>
<tr>
<td>MECH 5830</td>
<td>Engines</td>
<td>3</td>
</tr>
<tr>
<td>INSY 5800</td>
<td>Lean Systems</td>
<td>3</td>
</tr>
<tr>
<td>INSY 5860</td>
<td>Automotive Manufacturing Systems</td>
<td>3</td>
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</tbody>
</table>

Total Hours: 15

### SAE Team Track

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>MECH 4430</td>
<td>Ground Vehicle Fundamentals</td>
<td>3</td>
</tr>
<tr>
<td>MECH 4440</td>
<td>Automotive Design Experience I</td>
<td>2</td>
</tr>
<tr>
<td>MECH 4450</td>
<td>Automotive Design Experience II</td>
<td>2</td>
</tr>
<tr>
<td>INSY 5800</td>
<td>Lean Systems</td>
<td>3</td>
</tr>
<tr>
<td>INSY 5840</td>
<td>Control of the Manufacturing Floor and Processes</td>
<td>3</td>
</tr>
</tbody>
</table>
 SignIn 5860 Automotive Manufacturing Systems 3
Total Hours 16

1 Approval of department and car team advisor required.

Business-Engineering-Technology

Students who minor in Business-Engineering-Technology learn, practice, and integrate entrepreneurship, engineering, and business management skills demanded by the technology-driven global economy, solve real-world case study and design problems, and work in cross-functional teams. The minor is a joint offering by the Colleges of Business and Engineering. Admission to the minor is competitive. To remain in the program, the cumulative GPA must be equal to or greater than 3.0.

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<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
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<tbody>
<tr>
<td>BUSI/ENGR 3510</td>
<td>Introduction to Business and Engineering</td>
<td>3</td>
</tr>
<tr>
<td>BUSI/ENGR 3520</td>
<td>Integrating Business and Engineering Theories with Practice</td>
<td>3</td>
</tr>
<tr>
<td>BUSI/ENGR 3560</td>
<td>Leadership for Business and Engineers</td>
<td>1</td>
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<tr>
<td>BUSI/ENGR 5540</td>
<td>Entrepreneurship and Strategic Management of Technology and Innovation</td>
<td>4</td>
</tr>
<tr>
<td>BUSI/ENGR 5550</td>
<td>Product/Process Design and Development I</td>
<td>2</td>
</tr>
<tr>
<td>BUSI/ENGR 5560</td>
<td>Product/Process Design and Development II</td>
<td>3</td>
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<td>Total Hours</td>
<td>16</td>
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Curriculum in Industrial and Systems Engineering

Freshman

Fall                      Hours  Spring                      Hours
ENGL 1100 English Composition I 3 ENGL 1120 English Composition II 3
Core Fine Arts 3 Core History 1 3
MATH 1610 Calculus I 4 MATH 1620 Calculus II 4
CHEM 1030 Fundamentals Chemistry I 3 PHYS 1600 Engineering Physics I 4
CHEM 1031 Fundamental Chemistry I Laboratory 1 COMP 1200 Introduction to Computing for Engineers and Scientists 2
ENGR 1100 Engineering Orientation 0
ENGR 1110 Introduction to Engineering 2

16 16

Sophomore

Fall                      Hours  Spring                      Hours
PHYS 1610 Engineering Physics II 4 MATH 2660 Topics in Linear Algebra 3
MATH 2630 Calculus III 4 ENGR Elective 2, 4 3
MATH 2650 Linear Differential Equations 3 INSY 3020 Occupational Safety Ergonomics 3
STAT 3600 Probability and Statistics I 3 INSY 3021 Methods Engineering and Work Measurement
STAT 3610 Probability and Statistics II 3
The AU Bulletin lists the University Core Curriculum requirements for students in the College of Engineering. Students must complete a sequence in either Literature or History. Because of the discipline specific requirements for the Humanities courses, it is recommended that a History sequence be completed in the Social Sciences courses.

Any 3-hour ISE course not required for major or COMP 5000, ELEC 5150, MATL 3100, MECH 2220, MECH 5510, STAT 4610, STAT 4620, STAT 4630, STAT 5630, STAT 5670, STAT 5690, or a course with ISE department approval.

Six hours of ROTC required courses can be substituted for the ENGR and one TECH Elective. Three hours of minor or major required courses in BET, Nuclear, Supply Chain, Computer Science, or Information Systems Management count as one TECH elective.

General Note: Bold classes represent major classes. Total Hours for degree = 120, (P) Denotes courses required to complete pre-engineering.

Grade of C or better is required in these courses.

Nuclear Power Generation Systems Minor

This 16-hour minor prepares Auburn engineering students for careers specializing in the support and service of America’s nuclear power generation industry. Students who complete this minor will have demonstrated an understanding of the industry’s basic construction techniques, power plant models, integration into the national electrical grid and common reactor plant operations. Coursework for the minor will take place in the classroom as well as on-site at nuclear power generating facilities, and will
be led by faculty and nuclear industry leaders. Areas of emphasis include: regulation, safety, reliability and dependability, radiological health and work control practices, and training requirements for operators and maintenance technicians.

<table>
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<th>Code</th>
<th>Title</th>
<th>Hours</th>
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<tr>
<td>ENGR 2700</td>
<td>Nuclear Power Operations, System and Careers</td>
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<tr>
<td>ENGR 3710</td>
<td>Basic Nuclear I: Nuclear and Mechanical Systems</td>
<td>4</td>
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<tr>
<td>ENGR 3720</td>
<td>Basic Nuclear II: Materials, Electric, Electronics</td>
<td>4</td>
</tr>
<tr>
<td>ENGR 4710</td>
<td>Advanced Reactor Operations I: Health and Safety</td>
<td>3</td>
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<tr>
<td>ENGR 4720</td>
<td>Advanced Reactor Operations II: Safe Operations</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Total Hours</td>
<td>16</td>
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</tbody>
</table>

**Mechanical Engineering**

The curriculum in Mechanical Engineering focuses on the analysis, design, manufacturing, and maintenance of mechanical components and systems. Emphasis is placed on the fundamental concepts of engineering science and design needed in a variety of industries, including automotive, aerospace, biotechnology, material and chemical processing, microsystems and sensors, nanotechnology, machinery and robotics, pharmaceutical, energy production and distribution, heating and refrigeration, food production and processing, entertainment, pulp and paper, weapons systems, and many others. Mechanical engineering students take courses in several areas of engineering including: mechanics of rigid and deformable solids, thermo-fluid sciences, energy systems, dynamic systems and controls, design and manufacturing, materials, and electronics.

In compliance with the Engineering Accreditation Commission (EAC) of ABET, the Department of Mechanical Engineering at Auburn University has developed and maintained a well-defined set of Program Educational Objectives to assure the quality of our program and graduates. These objectives are broad statements that describe the career and professional accomplishments that the mechanical engineering degree program is preparing the graduates to achieve a few years after graduation. The objectives are consistent with the needs and expectations of the program constituencies, and are reviewed and updated regularly using an annual assessment process. The current program educational objectives are:

- Our graduates have rewarding careers where they use their technical proficiency and mechanical engineering education for the professional practice of mechanical engineering or any other career path they choose.
- Our graduates contribute to their chosen field by effectively leveraging a broad array of professional skills such as oral and written communication, leadership, and teamwork.
- Our graduates are life-long learners through a variety of means including self study, continuing education courses, and graduate level education.
- Our graduates maintain awareness of a broad range of contemporary issues and global concerns especially as they relate to the field of mechanical engineering.

Students are able to concentrate on areas of special interest through technical elective courses taken in the senior year. In addition, specialized concentrations are offered in Additive Manufacturing, Automotive Engineering, and Pulp and Paper Engineering. Minors are offered in Tribology, Business Engineering and Technology, and Automotive Engineering and Manufacturing.

**Materials Engineering**

The curriculum in Materials Engineering (MATL) is structured to address problems associated with the design of materials and materials processes to meet specific needs for a variety of industries. Emphasis is on the basic sciences and principles of engineering with applications of these principles to materials behavior. The student must obtain a broad foundation in chemistry, physics and mathematics, which is applied in engineering courses. Within materials engineering courses, students obtain a foundation in the major areas of materials science and to the major classes of engineering materials, which is applied in courses in materials properties and selection, computational methods and in a capstone design course. Students gain in-depth experience in another engineering discipline through coordinated technical elective sequences. Students may design alternative cross-disciplinary sequences, but they must be coordinated and approved by the Materials Engineering Curriculum Committee. The objective of the MATL program is to produce graduates who are engaged in careers through which they apply materials engineering proficiency, effective communication and lifelong learning to provide technical, economic, or other benefits to society.
Major
- Materials Engineering (p. 162)
- Mechanical Engineering (p. 163)

Minor
- Automotive Engineering and Manufacturing (p. 148)
- Tribology (p. 166)
- Materials Engineering Minor (p. 165)
- Materials Science Minor (p. 165)

Materials Engineering Courses
MATL 2100 INTRODUCTION TO MATERIALS SCIENCE (3) LEC. 3. The science of solid materials and the relationship between this science and material properties.

MATL 2210 MATERIALS FOR SUSTAINABLE ENERGY PRODUCTION AND STORAGE (1) LEC. 1. Pr. CHEM 1030. Technologies for sustainable energy production and storage, renewable energy conversion, associated materials challenges.

MATL 2220 MATERIALS AND THE ENVIRONMENT (1) LEC. 1. Pr. CHEM 1030. Environmental impact of the production, use and disposal of materials.

MATL 2230 MINERAL RESOURCES: PROCESSING AND AVAILABILITY (1) LEC. 1. Pr. CHEM 1030. Mineral resources for engineering materials; processing and availability of mineral resources.

MATL 3100 ENGINEERING MATERIALS - METALS (3) LEC. 3. Pr. MATL 2100. The relationship among processing, microstructure, properties and engineering applications of metallic materials.

MATL 3101 METALLOGRAPHY LABORATORY (1) LAB. 3. Coreq. MATL 3100. The use of microstructural characterization to understand the relationship between microstructure and properties of metallic materials.

MATL 3200 ENGINEERING MATERIALS POLYMERS (3) LEC. 3. Pr. CHEM 1040. The synthesis, processing, structure and properties of polymers and polymer matrix composites.

MATL 3201 POLYMER AND COMPOSITES LABORATORY (1) LAB. 3. Coreq. MATL 3200. A hands-on lab course on the synthesis, processing, structure and properties of polymers and polymer matrix composites.

MATL 3300 ENGINEERING MATERIALS - CERAMICS (3) LEC. 3. Pr. MATL 2100. The engineering of ceramic materials. Structural property relationships of crystalline and glassy ceramics will be included.

MATL 4100 THERMODYNAMICS AND KINETICS OF MATERIALS (3) LEC. 3. Pr. CHEM 1040 and ENGR 2200. Laws of thermodynamics to describe phase equilibria and phase transformations in one-component and multi-component systems, mechanisms of diffusion, the interplay of thermodynamic driving forces and kinetics of mass transfer in materials systems.


MATL 4930 DIRECTED STUDIES (1-6) IND. SU. Departmental approval. Areas of interest within Materials Engineering. Course may be repeated for a maximum of 6 credit hours.

MATL 4980 SENIOR DESIGN PROJECT (3) LEC. 1. LAB. 6. Students select, design, schedule, fabricate and perform an engineering design project related to Materials Engineering.

MATL 4997 HONORS THESIS (1-6) IND. Pr. Honors College. Departmental approval. Individual student directed research and writing of honors thesis. Course may be repeated for a maximum of 6 credit hours.

MATL 5100 THERMODYNAMICS OF MATERIALS SYSTEMS (3) LEC. 3. Pr. CHEM 1040 and ENGR 2200. Departmental approval. Application of thermodynamics to describe phase stability, crystal imperfections, solubility, oxidation, surface, and interface energy and transformations.
MATL 5200 MATERIALS CHARACTERIZATION (2) LEC. 2. Pr. PHYS 1610 or PHYS 1617. Principles of materials characterization including x-ray diffraction, optical and electron microscopy, and other advanced analytical methods for materials design.

MATL 5201 MATERIALS CHARACTERIZATION LABORATORY (1) LAB. 3. Coreq. MATL 5200. Laboratory on the use of x-ray diffraction, metallography, and optical/electron microscopy for materials characterization.

MATL 5300 PHASE TRANSFORMATIONS IN MATERIAL PROCESSING (3) LEC. 3. Pr. MATH 2650 and ENGR 2200. Departmental approval. Principles that govern phase transformations in materials systems and control of nucleation and growth, microstructure and morphology.

MATL 5400 PHYSICS OF SOLIDS (3) LEC. 3. Pr. PHYS 1610 or PHYS 1617. Departmental approval. The physics of solid-state materials, including the electronic, optical and magnetic properties of materials.

MATL 5500 NUMERICAL SIMULATION OF MATERIALS PROCESSING (3) LEC. 3. Pr. MATL 5100 and P/C MATL 5300. Departmental approval. Fundamental principles and applications of computer-aided simulation of transport phenomena in materials processing systems.


MATL 5720 BIOMEDICAL APPLICATIONS OF POLYMERIC MATERIALS (3) LEC. 3. LAB. 13. Pr. P/C BIOL 1030 or P/C CHEM 2070. Study of polymers used in the body for the purposes of aiding healing, correcting abnormalities, and restoring lost function.

MATL 5750 MICROSTRUCTURE AND MECHANICS OF SKELETAL TISSUES (3) LEC. 3. Pr. MATL 2100 and (ENGR 2070 or MECH 3130). Molecular and cellular microstructural influence over the viscoelastic deformation of the skeletal tissues of bone muscle, ligament, tendon and cartilage; mechanics of failure and biomechanical injury mechanisms; consideration of the physiological processes of adaptive remodeling and healing of tissues; recent developments in orthopedic implant materials.

MATL 5970 INTERMEDIATE SPECIAL TOPICS (1-3) LEC. 1-3. Departmental approval. Regular course addressing an advanced specialized area of Materials Engineering not covered by regularly offered courses. Course may be repeated with change in topics.

MATL 6100/6106 THERMODYNAMICS OF MATERIALS SYSTEMS (3) LEC. 3. Departmental approval. Application of thermodynamics to describe phase stability, crystal imperfections, solubility, oxidation, surface and interface energy and transformations.

MATL 6200/6206 MATERIALS CHARACTERIZATION (2) LEC. 2. Principles of materials characterization including x-ray diffraction, optical and electron microscopy, and other advanced analytical methods for materials design.

MATL 6201 MATERIALS CHARACTERIZATION LABORATORY (1) LAB. 3. Coreq. MATL 6200. Laboratory on the use of x-ray diffraction, metallography, and optical/electron microscopy for materials characterization.

MATL 6300/6306 PHASE TRANSFORMATIONS IN MATERIAL PROCESSING (3) LEC. 3. Departmental approval. Principles that govern phase transformations in materials systems and control of nucleation and growth, microstructure, and morphology.

MATL 6400/6406 PHYSICS OF SOLIDS (3) LEC. 3. Departmental approval. The physics of solid-state materials, including the electronic, optical, and magnetic properties of materials.

MATL 6500/6506 NUMERICAL SIMULATION OF MATERIALS PROCESSING (3) LEC. 3. Departmental approval. Fundamental principles and applications of computer-aided simulation of transport phenomena in materials processing systems.


MATL 6720/6726 BIOMEDICAL APPLICATIONS OF POLYMERIC MATERIALS (3) LEC. 3. LAB. 13. Study of polymers used in the body for the purposes of aiding healing, correcting abnormalities, and restoring lost function.

MATL 6750/6756 MICROSTRUCTURE AND MECHANICS OF SKELETAL TISSUES (3) LEC. 3. Departmental approval. Molecular and cellular microstructural influence over the viscoelastic deformation of the skeletal tissues of bone muscle, ligament, tendon and cartilage; mechanics of failure and biomechanical injury mechanisms; consideration of the physiological processes of adaptive remodeling and healing of tissues; recent developments in orthopedic implant materials.

MATL 6970/6976 INTERMEDIATE SPECIAL TOPICS IN MATERIALS ENGINEERING (1-3) LEC. 3. Departmental approval. Regular course addressing an advanced specialized area of Materials Engineering not covered by regularly offered courses. Course may be repeated with change in topics.

MATL 7050/7056 DEFORMATION AND FAILURE OF ENGINEERING MATERIALS (3) LEC. 3. Departmental approval. Coreq. MATL 6200. Theoretical presentation of the fundamental principles of deformation and failure in materials systems.

MATL 7110/7116 PHYSICAL METALLURGY AND APPLICATIONS IN METAL FABRICATION (3) LEC. 3. Departmental approval. The physical metallurgy underlying processing-structure-property relationships in metals and alloys, with examples from joining processes.

MATL 7120/7126 ADVANCED CERAMIC MATERIALS (3) LEC. 3. Departmental approval. Processing, structure-property relationships and applications of advanced ceramics. Structural and functional applications of ceramics.

MATL 7130/7136 ADVANCED POLYMER SCIENCE AND TECHNOLOGY (3) LEC. 3. Departmental approval. Recent developments in both functional and structural polymers including approaches to synthesis, processing techniques, high-strength materials, electronic polymers, optic polymers, and medical polymers.

MATL 7140/7146 ADVANCED COMPOSITE MATERIALS (3) LEC. 3. Departmental approval. Processing, mechanics structure and properties of composite materials. Emphasis will be placed on an understanding of processing-structure-property relationships in polymer-, ceramic-, and metal-matrix composites.


MATL 7210/7216 PLASTIC DEFORMATION AND STRENGTHENING OF METALLIC MATERIALS (3) LEC. 3. Departmental approval. Mechanisms of plastic deformation and strengthening in metals and alloys. The role of dislocations in plastic deformation.

MATL 7220/7226 RADIATION EFFECTS ON MATERIALS (3) LEC. 3. Departmental approval. Theoretical and experimental treatment of the radiation effects and damage in materials as related to the nuclear industry.

MATL 7230/7236 HIGH TEMPERATURE MATERIALS PERFORMANCE (3) LEC. 3. Departmental approval. Theoretical and experimental treatment of the behavior of metals at high temperature.

MATL 7310/7316 SOLIDIFICATION PROCESSING (3) LEC. 3. Departmental approval. Theoretical science and engineering principles that apply to semiconductor crystal growth, ingot solidification, metal casting, welding and rapid solidification processes.

MATL 7320/7326 THIN FILM SCIENCE AND TECHNOLOGY (3) LEC. 3. Departmental approval. Structure, properties, characterization, processing and application of thin films.

MATL 7330/7336 MATERIALS FOR ENERGY STORAGE (3) LEC. 3. Introduction of various electrochemical energy storage devices (Batteries, Supercapacitor, etc) and discussion of advancement in development of materials for these devices. Instructor’s consent required for prerequisites.

MATL 7410/7416 CHEMICAL SENSORS (3) LEC. 3. Departmental approval. Fundamentals and application of chemical sensors. Includes electrolyte, semiconductor and acoustic wave-based sensors.

MATL 7420/7426 SMART MATERIALS AND STRUCTURES (3) LEC. 3. Departmental approval. An introduction to the principles and applications of various sensor, actuator and functionally smart material systems and structures.

MATL 7430/7436 DIELECTRIC MATERIALS AND DEVICES (3) LEC. 3. Pr. (MATL 6100 or MATL 6106) and (MATL 6400 or MATL 6406). Departmental approval. Processing, structure, properties, and application of dielectrics, including physics of dielectrics, material/device design/fabrication processes, and application of dielectric materials in high-technological industry.
MATL 7440/7446 MATERIALS PROCESSES MICRO AND NANOSYSTEMS (3) LEC. 3. Departmental approval. Materials, processes, and principles involved in manufacturing of micro and nanoelectromechanical systems. Properties of materials used in micromachined transducers as a related to current and potential micro and nanofabrication processes.

MATL 7450/7456 HIGH TEMPERATURE ELECTROCHEMICAL DEVICES (3) LEC. 3. Departmental approval. Principles of solid-state electrochemistry, application to temperature devices including chemical sensors, fuel cells and batteries.

MATL 7510/7516 ELECTRON MICROSCOPY (3) LEC. 3. Departmental approval. Theory, instrumentation, techniques and applications of scanning and transmission electron microscopy.

MATL 7511 ELECTRON MICROSCOPY LABORATORY (1) LAB. 3. Coreq. MATL 7510. Laboratory on the use of electron microscopy for materials characterization.


MATL 7610/7616 ENGINEERING ASPECTS OF BIOLOGICAL AND CHEMICAL DETECTION (3) LEC. 3. Departmental approval. Biological and chemical scientific concepts related to biological and chemical threat agents. Existing and developing detection technologies, trends and needs for the future detection systems. Physical principles behind the detection technologies. Evaluation of detection device or system performance.

MATL 7620/7626 NANO/MICRO FLUIDIC SYSTEMS (3) LEC. 3. Departmental approval. Basic understanding of nano/microfluidics (typical volumes are nanoliters or picoliters) and practical applications in materials science and engineering, biotechnology, and other interdisciplinary fields of engineering and science.

MATL 7630/7636 NANOMATERIALS FOR BIOTECHNOLOGY (3) LEC. 3. Departmental approval. Basic understanding of nanobiotechnology and practical applications in the interdisciplinary fields of Materials Science and Engineering and biotechnology/medicine including nanostructured biomolecules and bioarrays as well as biomolecular nanoelectronics.

MATL 7950 MATERIALS ENGINEERING SEMINAR (0) SEM. SU. Required during each semester of residency, but cannot be used toward minimum requirements for graduate degree in Materials Engineering. Content changes each semester and consists of off-campus speakers and presentations by graduate students and faculty.

MATL 7960/7966 DIRECTED READINGS IN MATERIALS ENGINEERING (1-6) IND. SU. Departmental approval. May be taken more than one semester. Up to 6 hours may count toward the minimum degree requirements. Course may be repeated with change in topics.

MATL 7970/7976 SPECIAL TOPICS IN MATERIALS ENGINEERING (1-3) LEC. Departmental approval. Regular course addressing an advanced specialized area of Materials Engineering not covered by regularly offered courses. Course may be repeated with change in topics.

MATL 7980/7986 MASTER MATERIALS ENGINEERING PROJECT (3) LEC. 3. SU. Special design project report directed by major faculty. Topics to be determined by the student’s graduate committee.

MATL 7990/7996 RESEARCH AND THESIS (1-15) MST. Individual master’s thesis research. Course may be repeated with change in topics.

MATL 8990/8996 RESEARCH AND DISSERTATION (1-15) DSR. Individual doctoral dissertation research. Course may be repeated with change in topics.

**Mechanical Engineering Courses**

MECH 2020 MANUFACTURING TECHNOLOGY LAB (2) LEC. 3. LAB. 1. Manufacturing technology lab for introduction of processes such as cutting, forming, machining, and joining of metals and other materials. Basic and applied machine shop and manufacturing floor safety.

MECH 2110 STATICS AND DYNAMICS (4) LEC. 3. LAB. 3. Pr. (MATH 1620 or MATH 1623 or MATH 1627) and (PHYS 1600 or PHYS 1607). Vectors, forces, moments and free body diagrams. Systems in mechanical equilibrium. Particles in motion.

MECH 2120 KINEMATICS AND DYNAMICS OF MACHINES (4) LEC. 3. LAB. 3. Pr. (MATH 2630 or MATH 2637) and MECH 2110. Kinematics and kinetics of rigid bodies. Kinematics and dynamics of mechanisms, cams and gears.
MECH 2130 MECHANICAL ENGINEERING STATICS (3) LEC. 2.5. Pr. (MATH 1620 or MATH 1627) and (PHYS 1600 or PHYS 1607). Forces, vectors, moments and free body diagrams. Systems in mechanical equilibrium.

MECH 2140 KINEMATICS AND DYNAMICS (3) LEC. 2.5. Pr. (MATH 2630 or MATH 2637) and MECH 2130. Kinematics and kinetics of particles and rigid bodies with an emphasis on mechanical engineering applications such as machines, mechanisms, cams, gears and vibrations.

MECH 2220 COMPUTER-AIDED ENGINEERING (3) LEC. 2. LAB. 3. Pr. (ENGR 1110 or ENGR 1113) and COMP 1200 and P/C MATH 2650. The computer as a tool in mechanical engineering.

MECH 2AA0 MECHANICAL ENGINEERING PROGRESS ASSESSMENT I (0) TST. SU. Progress Assessment Examination in: multivariate calculus, differential equations, chemistry, physics, statics, dynamics. Course may be repeated with change in topics.


MECH 3030 FLUID MECHANICS (3) LEC. 3. Pr. (MECH 2110 or MECH 2130) and ENGR 2010 and MATH 2650 and (P/C MECH 3130 or P/C MECH 3120). Fluid properties; fluid statics; mass conservation; momentum equation; external and internal flows; Euler and Bernoulli equations; dimensional analysis; viscous flows; boundary layers; compressible flow.


MECH 3050 MEASUREMENT AND INSTRUMENTATION (3) LEC. 2. LAB. 3. Pr. MECH 3030 and P/C ELEC 3810 and P/C MECH 3040. Theory and practice of modern sensors and computer-based data acquisition techniques, uncertainty analysis, results reporting, filtering and signal processing.

MECH 3120 MECHANICS OF MATERIALS (3) LEC. 2.5. Pr. (MECH 2130 or MECH 2110) and MECH 2220 and MATL 2100 and MATH 2650 and MATH 2660. Stress and strain concepts, stress-strain relationships, applications, uniaxially loaded members, torsion, normal and shear stresses in beams, beam deflections, buckling, stress concentration, combined loading, failure theories

MECH 3130 MECHANICS OF MATERIALS (4) LEC. 3. LAB. 1. Pr. MECH 2110 and MATL 2100 and MATH 2650 and MATH 2660 and (MECH 2220 or MECH 3220). Stress and strain concepts, stress-strain relationships, applications, uniaxially loaded members, torsion, normal and shear stresses in beams, beam deflections, buckling, stress concentration, combined loading, failure theories, strain energy, impact loading, cyclic loading.

MECH 3140 SYSTEM DYNAMICS AND CONTROLS (3) LEC. 3. Pr. (MECH 2120 or MECH 2140) and MATH 2650. System dynamics and automatic control theory.

MECH 3150 DYNAMICS LAB (1) LAB. 2.5. Pr. MECH 2140 and MATL 2100. Laboratory experiences designed to enhance student understanding of engineering mechanics, including statics, dynamics, and kinematics.

MECH 3160 MECHANICS LAB (1) LAB. 2.5. Pr. MECH 3120. Laboratory experiences designed to enhance student understanding of engineering mechanics including statics, stresses, & strains.

MECH 3200 CONCEPTS IN MECHANICAL DESIGN (2) LEC. 1. LAB. 3. Pr. MECH 2110 and (P/C MECH 2220 or P/C MECH 3220). Introduction to the mechanical design process including identification of needs and engineering requirements, concept generation and selection, and design development. Students will work in teams to perform a design project, and will also be exposed to project management and communication skills.

MECH 3210 DESIGN AND MANUFACTURING LAB (1) LAB. 1. Manufacturing safety lab for introduction to manufacturing processes associated with cutting, forming, and joining of metals and other materials.

MECH 3230 MACHINE DESIGN (3) LEC. 3. Pr. MECH 3120 and (MECH 2020 or MECH 3210) and MECH 3200. Design of systems containing a variety of mechanical elements.

MECH 3AA0 MECHANICAL ENGINEERING PROGRESS ASSESSMENT II (0) TST. SU. Pr. MECH 2AA0. Progress Assessment Examination in: Statistics, linear algebra, mechanical design, thermo-fluid design, social impact, contemporary issues. Course may be repeated with change in topics.
MECH 4240 COMPREHENSIVE DESIGN I (2) LEC. 1. LAB. 3. Pr. (MECH 3AA0 and MECH 3150 and MECH 3160 and MECH 3230 and P/C MECH 3040 and P/C MECH 3050 and MECH 3140) or (MECH 3AA0 and MECH 3150 and MECH 3160 and MECH 3230 and P/C MECH 3040 and MECH 3050 and P/C MECH 3140) or (MECH 3AA0 and MECH 3150 and MECH 3160 and MECH 3230 and P/C MECH 3040 and P/C MECH 3050 and P/C MECH 3140). Capstone engineering design course based on a design project similar to those encountered by the engineer in industry involving thermal and mechanical design.

MECH 4250 COMPREHENSIVE DESIGN II (2) LEC. 1. LAB. 3. Pr. (MECH 4240 and MECH 3040 and MECH 3050 and P/C MECH 3140 and P/C INSY 3600) or (MECH 4240 and MECH 3050 and MECH 3140 and P/C MECH 3040 and P/C INSY 3600) or (MECH 4240 and MECH 3140 and MECH 3040 and P/C MECH 3050 and P/C INSY 3600). Continuation of MECH 4240. Detailed design, fabrication, communication, and presentation of a prototype machine for an industrial sponsor.

MECH 4300 MECHANICAL EQUIPMENT ENGINEERING (3) LEC. 3. Pr. MECH 3020 and MECH 3030. Operation, performance, maintenance, selection, design and optimization of mechanical equipment commonly found in industrial operations.

MECH 4310 HEATING, VENTILATING, AIR CONDITIONING AND REFRIGERATION (3) LEC. 3. Pr. MECH 3040. Theory and practice of modern heating, ventilation, air conditioning and refrigeration systems; concepts, equipment, and systems design.

MECH 4320 APPLIED CFD AND HEAT TRANSFER (3) LEC. 3. Pr. MECH 3040 and MATH 2660. Introduction to computational fluid dynamics and heat transfer techniques used to analyze thermal performance of devices and systems. Commercial software will be used.

MECH 4420 VEHICLE DYNAMICS (3) LEC. 3. Pr. ENGR 2100 or ENGR 2350 or MECH 2120. Ground vehicle resistance, propulsion, maneuvering, and control tires, suspensions, braking, aerodynamics, case studies.

MECH 4430 GROUND VEHICLE FUNDAMENTALS (3) LEC. 3. Pr. ENGR 2100 or ENGR 2350 or MECH 2120. Engineering fundamentals of ground vehicles and typical subsystems, including: power (engine and electrical); drivetrain; braking; steering; suspension; ergonomics; and structure.

MECH 4440 AUTOMOTIVE DESIGN EXPERIENCE I (2) LEC. 1. LAB. 3. Pr. MECH 3AA0 and MECH 3230 and P/C MECH 3040 and P/C MECH 3050 and P/C MECH 3140. Team-based design of a ground vehicle, both whole-vehicle and subsystem; design evaluation and modification; oral and written communication.

MECH 4450 AUTOMOTIVE DESIGN EXPERIENCE II (2) LEC. 1. LAB. 3. Pr. MECH 4440. Team-based fabrication, testing, modification and operation of a ground vehicle; oral and written communication; project management.

MECH 4510 INDUSTRIAL AND ENVIRONMENTAL NOISE CONTROL (3) LEC. 3. Pr. MECH 2120 and MECH 3220. Sources of industrial and community noise, criteria for control, noise measuring instrumentation, issues involved in the design of machinery for minimum noise, noise ordinances and regulations.

MECH 4520 MACHINERY NOISE AND VIBRATION DIAGNOSTICS (3) LEC. 3. Pr. MECH 2120 and MECH 3220. An introduction to machinery diagnostics through noise and vibration signatures. Fundamental principles and applications of predictive maintenance of machinery.

MECH 4700 INTEGRATED ENGINEERING THEORY AND PRACTICE (3) LEC. 3. Pr. MECH 3200. Real world engineering management decision making, case studies from industry.

MECH 4930 DIRECTED STUDIES IN MECHANICAL ENGINEERING (1-3) IND/INT. Departmental approval. Individual or small group study of a specialized area of Mechanical Engineering under faculty direction. Course may be repeated for a maximum of 3 credit hours.

MECH 4970 SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) LEC. Departmental approval. Regular course addressing a specialized area of Mechanical Engineering not covered by a regularly offered course. Topics may vary. Course may be repeated for a maximum of 3 credit hours.

MECH 4997 HONORS THESIS (1-6) IND. Pr. Honors College. Departmental approval. Individual student directed research and writing of an honors thesis. Course may be repeated for a maximum of 6 credit hours.

MECH 5010 COMPRESSIBLE FLUID FLOW (3) LEC. 3. Pr. MECH 3020 and MECH 3030. Properties of ideal gases; General onedimensional wave motion; Isentropic flow with area change; Normal shock waves; Flow with friction (Fanno Flow) and heat transfer (Rayleigh Flow); Method of characteristics.
MECH 5050 RENEWABLE ENERGY RESOURCES AND APPLICATIONS (3) LEC. 3. Pr. ENGR 2010 or ENGR 2200, or permission of instructor. Overview of renewable energy options with an emphasis on available resources, advantages & disadvantages, and design principles.

MECH 5110 INTERMEDIATE HEAT TRANSFER (3) LEC. 3. Pr. MECH 3040. Introduction to the analytical treatment of heat transfer by conduction, convection, and radiation. Suitable for those that require general coverage of advanced theory but whose primary research interest may lie elsewhere.

MECH 5120 COMBUSTION (3) LEC. 3. Pr. MECH 3040. Thermodynamics and chemical kinetics of combustion processes, premixed and diffusion flames, ignition, characterization and combustion of gaseous, liquid, and solid fuels, environmental aspects of combustion.

MECH 5210 ELECTRONICS THERMAL MANAGEMENT (3) LEC. 3. Pr. MECH 3040 and ELEC 3810. Thermal issues in electronics, review of heat transfer thermal resistance networks, design of finned heat sinks, numerical analysis of electronics cooling, advanced thermal management strategies.

MECH 5220 VIRTUAL PROTOTYPING (3) LEC. 3. Departmental approval. Computer simulation of mechanical systems integrating computer-aided design, dynamic simulation and finite element software; application to two-dimensional and three dimensional simple and complex mechanical systems.

MECH 5230 FRICTION, WEAR AND LUBRICATION (3) LEC. 3. Pr. MECH 3030 and MECH 3130. Theory and techniques for considering friction, wear and lubrication, in the design of machine components, and other surface interactions.

MECH 5240 BOUNDARY AND FULL-FILM LUBRICATION (3) LEC. 3. Pr. MECH 3030. Theory and techniques for design and modeling of the different regimes of lubrication between surfaces and machine components in order to control friction and wear.

MECH 5250 MULTISCALE CONTACT MECHANICS (3) LEC. 3. Pr. MECH 3130. Theory and techniques for considering contact between solid bodies and the effect on friction, wear, the design of machine components, and other surface interactions.

MECH 5270 METALWORKING AND MANUFACTURING TRIBOLOGY (3) LEC. 3. Pr. MECH 3210. Theory and optimization techniques for tool life and surface finish considering friction, wear and lubrication in manufacturing processes including both metalworking fluids and hard/dry machining.

MECH 5300 ADVANCED MECHANICS OF MATERIALS (3) LEC. 3. Pr. MECH 3130. Stress and strain analysis, plane stress and plane strain concepts, generalized Hooke's law, stress function approach applications to 2-D problems, axisymmetric problems bending of curved members, torsion of prismatic members, stress concentration problems.

MECH 5310 MECHANICS OF ELECTRONIC PACKAGING (3) LEC. 3. Pr. MECH 3130 and ELEC 3810. Stress and strain analysis of microelectronic packages and electronic assemblies using analytical, experimental and numerical methods.

MECH 5390 FUNDAMENTALS OF THE FINITE ELEMENT METHOD (3) LEC. 2. LAB. 3. Pr. MECH 3040 and MECH 3130 and MATH 2660. Introduction to the fundamentals of the finite element method.

MECH 5410 DYNAMICS OF ROTATING MACHINERY (3) LEC. 3. Pr. MECH 3140. Issues involved in the analysis and design of high-speed rotating machinery. Modeling, resonance, balancing, bearings, condition monitoring.

MECH 5420 DYNAMICS OF MULTIBODY SYSTEMS (3) LEC. 3. Pr. MECH 3140. Concepts in dynamics of multibody systems such as kinematics analysis, Newton Euler, Lagrange and Kane equations of motion, collisions, and vibrations of flexible links.

MECH 5430 BASICS SENSOR APPLICATIONS (3) LEC. 3. Pr. MECH 3130. Basic concepts, fabrication and operation of micromachined semiconductor, piezoelectric, piezoresistive, capacitive and fiber-optic sensors.


MECH 5510 ENGINEERING ACOUSTICS (3) LEC. 3. Pr. MATH 2650. The fundamentals of acoustics. Vibration of strings, bars, plates. Acoustic plane waves, architectural acoustics and noise control will be emphasized.

MECH 5610 MECHANICAL VIBRATION (3) LEC. 3. Pr. MECH 2120 and MATH 2650 and MATH 2660. Modeling of lumped dynamic systems, free and forced vibration of single degree freedom systems, response to arbitrary excitation, analysis of two and multiple degrees of freedom systems.

MECH 5710 KINEMATICS AND DYNAMICS OF ROBOTS (3) LEC. 3. Pr. MECH 3140. Basic concepts in robotics such as kinematic analysis, coordinate transformation, Lagrange and Newton Euler equations of motion.

MECH 5720 CONTROL OF ROBOTIC MOTION (3) LEC. 3. Pr. MECH 3140. Application of various algorithms for robot manipulators.

MECH 5810 MECHATRONICS (3) LEC. 3. Pr. MECH 2120 and ELEC 3810. Introduction to the integration of mechanisms, sensors, controllers and actuators for machines, and design of automatic machinery.

MECH 5820 INTRODUCTION TO OPTIMAL SYSTEMS (3) LEC. 3. Introduction to the mathematical fundamentals of optimization. Application to multiple solution engineering problems in thermo-fluid and mechanical systems.

MECH 5830 ENGINES (3) LEC. 3. Pr. (ENGR 2010 and MECH 3030) or ENGR 2200. or (ENGR 2010 plus any one of (AERO 3110, CHEN 2610, CIVL 3110, MECH 3030)), Analysis, design, and application issues in internal combustion engines. Characteristics, thermodynamics, thermochemistry, unsteady multi-phase fluid dynamics, stresses, vibration, noise, mechanisms.

MECH 5970 INTERMEDIATE SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) LEC. 1-3. Departmental approval. Regular course addressing an advanced specialized area of Mechanical Engineering not covered by a regularly offered course. Topics may vary. Course may be repeated for a maximum of 9 credit hours.

MECH 6010/6016 COMPRESSIBLE FLUID FLOW (3) LEC. 3. Properties of ideal gases; General one-dimensional wave motion; Isentropic flow with area change; Normal shock waves; Flow with friction (Fanno Flow) and heat transfer (Rayleigh Flow); Method of characteristics.

MECH 6050 RENEWABLE ENERGY RESOURCES AND APPLICATIONS (3) LEC. 2.5. An overview of renewable energy options with an emphasis on available resources, advantages & disadvantages, and design principles.

MECH 6110/6116 INTERMEDIATE HEAT TRANSFER (3) LEC. 3. Introduction to the analytical treatment of heat transfer by conduction, convection, and radiation. Suitable for those that require general coverage of advanced theory but whose primary research interest may lie elsewhere.

MECH 6120/6126 COMBUSTION (3) LEC. 3. Thermodynamics and chemical kinetics of combustion processes, premixed and diffusion flames, ignition, characterization and combustion of gaseous, liquid, and solid fuels, environmental aspects of combustion.

MECH 6210/6216 ELECTRONICS THERMAL MANAGEMENT (3) LEC. 3. Thermal issues in electronics, review of heat transfer thermal resistance networks, design of finned heat sinks, numerical analysis of electronics cooling, advanced thermal management strategies.

MECH 6220 VIRTUAL PROTOTYPING (3) LEC. 3. Departmental approval. Computer simulation of mechanical systems integrating computer-aided design, dynamic simulation and finite element software; application to two-dimensional and three dimensional simple and complex mechanical systems.

MECH 6230/6236 FRICTION, WEAR AND LUBRICATION (3) LEC. 3. Friction, wear, and lubrication in design of machine components and other surface interactions, with emphasis on optimizing tribological performance.

MECH 6240/6246 BOUNDARY AND FULL-FILM LUBRICATION (3) LEC. 3. Theory and techniques for design and modeling of the different regimes of lubrication between surfaces and machine components in order to control friction and wear.

MECH 6250/6256 MULTISCALE CONTACT MECHANICS (3) LEC. 3. Theory and techniques for considering contact between solid bodies and the effect on friction, wear, the design of machine components, and other surface interactions.

MECH 6270/6276 METALWORKING AND MANUFACTURING TRIBOLOGY (3) LEC. 3. Pr. MECH 3210. Theory and optimization techniques for tool life and surface finish considering friction, wear and lubrication in manufacturing processes including both metalworking fluids and hard/dry machining.

MECH 6300/6306 ADVANCED MECHANICS OF MATERIALS (3) LEC. 3. Stress and strain analysis, plane stress and plane strain concepts, generalized Hooke's law, stress function approach applications to 2-D problem, axisymmetric problems, bending of curved members, torsion of prismatic members, stress concentration problems.

MECH 6390/6396 FUNDAMENTALS OF THE FINITE ELEMENT METHOD (3) LEC. 2. LAB. 3. Introduction to the fundamentals of the finite element method.

MECH 6410/6416 DYNAMICS OF ROTATING MACHINERY (3) LEC. 3. Issues involved in the analysis and design of high-speed rotating machinery. Modeling, resonance, balancing, bearings, condition monitoring.

MECH 6420/6426 DYNAMICS OF MULTIBODY SYSTEMS (3) LEC. 3. Concepts in dynamics of multibody systems such as kinematics analysis, Newton Euler, Lagrange and Kane equations of motion, collisions, and vibrations of flexible links.

MECH 6430/6436 BASICS OF SENSOR APPLICATIONS (3) LEC. 3. Basic concepts, fabrication and operation of micro machined semiconductor, piezoelectric, piezoresistive, capacitive and fiber-optic sensors.


MECH 6510/6516 ENGINEERING ACOUSTICS (3) LEC. 3. The fundamentals of acoustics. Vibration of strings, bars, plates. Acoustic plane waves, architectural acoustics, and, noise control will be emphasized.

MECH 6610/6616 MECHANICAL VIBRATION (3) LEC. 3. Modeling of lumped dynamic systems, free and forced vibration of single degree of freedom systems, response to arbitrary excitation, analysis of two and multiple degrees of freedom systems.

MECH 6620/6626 STABILITY AND VIBRATION OF DISCRETE SYSTEMS (3) LEC. 3. Pr. MECH 6610 or MECH 6616. Principles of advanced dynamics, linear systems with multiple degrees of freedom, stability and boundedness, free and forced response of linear systems, parameter identification.

MECH 6710/6716 KINEMATICS AND DYNAMICS OF ROBOTS (3) LEC. 3. Basic concepts in robotics such as kinematics analysis, coordinate, Lagrange and Newton Euler equations of motion.

MECH 6720/6726 CONTROL OF ROBOTIC MOTION (3) LEC. 3. Application of various algorithms for robot manipulators.

MECH 6810/6816 MECHATRONICS (3) LEC. 3. Introduction to the integration of mechanisms, sensors, controllers and actuators for machines and design of automatic machinery.

MECH 6820/6826 INTRODUCTION TO OPTIMAL SYSTEMS (3) LEC. 3. Introduction to the mathematical fundamentals of optimization. Application to multiple solution engineering problems in thermo-fluid and mechanical systems.

MECH 6830/6836 ENGINES (3) LEC. 3. Analysis, design, and application issues in internal combustion engines. Characteristics, thermodynamics thermochemistry, unsteady multi-phase fluid dynamics, stresses, vibration, noise, mechanisms.

MECH 6930/6936 INTERMEDIATE DIRECTED STUDIES IN MECHANICAL ENGINEERING (1-3) IND. Departmental approval. Individual or small group study of an advanced, specialized area of Mechanical Engineering under faculty direction. Course may be repeated for a maximum of 3 credit hours.

MECH 6970/6976 INTERMEDIATE SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) LEC. Departmental approval. Regular course addressing an advanced specialized area of Mechanical Engineering not covered by a regularly offered course. Topics may vary. Course may be repeated for a maximum of 3 credit hours.

MECH 7010/7016 ADVANCED THERMODYNAMICS (3) LEC. 3. Classical and statistical treatment of the laws and properties of thermodynamic systems; applications.


MECH 7120/7126 ADVANCED FLUID MECHANICS II (3) LEC. 3. Pr. MECH 7110 or MECH 7116. Schwarz-Christoffel Transformation; Hodograph Method; Three-Dimensional Potential Flows; Interface Waves; Low Reynolds Number Solutions; Oseen Approximation; Stability of Laminar Flows.
MECH 7130/7136 BOUNDARY LAYER THEORY (3) LEC. 3. Pr. MECH 7110 or MECH 7116. Mass Conservation; Momentum Equation; Energy Equation; Dimensional Analysis; Fully-Developed Laminar Flows; Similarity Solutions; Boundary layer Approximation; Stability of Laminar Flows.

MECH 7140/7146 TURBULENCE (3) LEC. 3. Pr. MECH 7130 or MECH 7136. Properties of Turbulence; Governing Conservation, Momentum and Energy Equations; Time-averaging, Vorticity Equations; Turbulence Models; Shear Flows; Jets, Wakes and Boundary Layers; Experimental Techniques.

MECH 7150/7156 FLUID MECHANICS OF PROCESSING (3) LEC. 3. Pr. MECH 7130 or MECH 7136. Properties of Fluids; Governing Equations; Dimensional analysis; Particle-Laden Flows; Applications to specific processing problems such as liquid metal flows, polymers, surface deposition.

MECH 7210/7216 DIFFUSIVE TRANSPORT (3) LEC. 3. Formulations and analytical solutions of steady, periodic, and unsteady heat and mass diffusion problems in one, two, and three dimensions.

MECH 7220/7226 CONVECTION HEAT TRANSFER (3) LEC. 3. Advanced topics in free and forced convection transport within the laminar, transitional and turbulent regimes; confined and external flows.

MECH 7230/7236 THERMAL RADIATION (3) LEC. 3. Fundamentals of thermal radiation heat transfer including: absorption, emission, and reflection from solids; absorption, emission, and scattering by gases; combined mode and conjugate heat transfer; exact and approximate solution methodologies.

MECH 7240/7246 NUMERICAL METHODS IN HEAT TRANSFER (3) LEC. 3. Advanced topics in finite element and finite difference methods; solution techniques, stability and convergence.


MECH 7300/7306 FRACTURE MECHANICS (3) LEC. 3. Stress and strain analysis of cracked bodies, energy release rate, Griffith problem, modes of fracture, crack tip fields, stress intensity factors, small scale crack tip yielding, the J-integral, HRR equations, experimental and numerical methods for fracture parameter estimation.

MECH 7310/7316 SOLID MECHANICS (3) LEC. 3. Stress and strain analysis in 3-D, constitutive behavior of elastic solids, orthotropy and isotropy, stress compatibility equations, Navier’s equation, stress functions, applications.

MECH 7320/7326 CONTINUUM MECHANICS AND TENSOR ANALYSIS (3) LEC. 3. Pr. MECH 6300 or MECH 6306. Cartesian and curvilinear tensor analysis with applications to the mechanics of continuous media. Constitutive equations for solids and fluids.


MECH 7340/7346 INELASTIC STRESS ANALYSIS (3) LEC. 3. Pr. MECH 6300 or MECH 6306. Introduction to modeling material behavior of non-elastic materials. Theories of plasticity, linear and non-linear viscoelasticity, and viscoplasticity. Applications to modern engineering materials and simple structural members.

MECH 7360/7366 MECHANICS OF COMPOSITE MATERIALS (3) LEC. 3. Properties and mechanical behavior of fiber-reinforced composite materials. Anisotropic stress-strain relations, orthotropic elasticity and laminated plate theories, failure criteria, applications.

MECH 7370/7376 ANALYSIS OF PLATES AND SHELLS (3) LEC. 3. Theories for the bending and stretching of plate and shell structures. Transverse loading, buckling, vibration, and thermal stress problems. Introduction to energy methods, numerical techniques, and large deflection theories.


MECH 7410/7416 OPTICAL METHODS IN MECHANICS (3) LEC. 3. Measurement of stresses, strains, and deformations using optical methods; optical interference; Fourier optics; optical spatial filtering, white light methods; coherent optical methods.
MECH 7430/7436 OPTICAL PROPERTIES OF ADVANCED MATERIALS (3) LEC. 3. Pr. MECH 6430 or MECH 6436 or PHYS 7200. Linear and nonlinear optical properties, correlation with material-structure, electro-optic effects, lasers, frequency conversion, fiber-optics, technological applications.

MECH 7510/7516 ADVANCED ENGINEERING ACOUSTICS (3) LEC. 3. Pr. MECH 6510 or MECH 6516. The fundamentals of advanced acoustics theory. Wave equation derivation from Navier-Stokes equations, spherical waves, monopoles, dipoles, quadrupoles. Duct Acoustics, Statistical Energy Analysis.


MECH 7630/7636 MECHANICAL IMPACT (3) LEC. 3. Departmental approval. Investigation of the fundamental concepts used to solve collision problems with friction.


MECH 7650/7656 RANDOM VIBRATION (3) LEC. 3. Pr. MECH 6610 or MECH 6616. Properties of random processes, review of linear systems with single and multiple degrees of freedom. Vibration of single and multiple degrees of freedom systems subjected to random excitations, design of structures subjected to random excitation. Parameter estimation.

MECH 7710/7716 CONTROL SYSTEMS ANALYSIS AND DESIGN (3) LEC. 3. Topics from control theory are introduced in the context of control systems analysis and design, including state variable feedback, modal control, optimal control and adaptive control for both continuous and discrete systems.

MECH 7930 ADVANCED DIRECTED STUDIES IN MECHANICAL ENGINEERING (1-3) IND. Departmental approval. Individual or small group study of an advanced, specialized area of Mechanical Engineering under faculty direction. Course may be repeated for a maximum of 3 credit hours.

MECH 7950 GRADUATE SEMINAR (1) SEM. 1. SU. Topics may vary. Will not fulfill degree requirements. Course may be repeated with change in topics.

MECH 7970/7976 ADVANCED SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) LEC. Departmental approval. Regular course addressing an advanced specialized area of Mechanical Engineering not covered by regularly offered course. Topics may vary. Course may be repeated for a maximum of 3 credit hours.

MECH 7990 RESEARCH & THESIS (1-12) MST. Individual Master's thesis research. May be repeated for credit. Course may be repeated with change in topics.

MECH 8990 RESEARCH & DISSERTATION (1-12) DSR. Individual Doctoral dissertation research. May be repeated for credit. Course may be repeated with change in topics.

Curriculum in Materials Engineering

**Freshman**

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<th>Fall</th>
<th>Hours</th>
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<tr>
<td>CHEM 1030 Fundamentals Chemistry I</td>
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<td>CHEM 1040 Fundamental Chemistry II</td>
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<td>ENGR 2050 Statics</td>
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<td>ELEC 3810 Fundamentals of Electrical Engineering</td>
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<td>MATH 2660 Topics in Linear Algebra</td>
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<td>ENGR 2200 Introduction To Thermodynamics, Fluids And Heat Transfer</td>
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<td>PHIL 1020 Introduction to Ethics</td>
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<td>MECH 2220 Computer-Aided Engineering</td>
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<td>MATL 5500 Numerical Simulation of Materials Processing</td>
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</table>

^1 The AU Bulletin lists the University Core Curriculum requirements for students in the College of Engineering. Students must complete a sequence in either Literature or History. Because of the discipline specific requirements for the Humanities courses, it is recommended that a History sequence be completed in the Social Sciences courses.

^2 Technical elective are chosen from a list of coordinated cross-disciplinary sequences. Sequences other than those specified must be approved by the material engineering curriculum committee.

**Curriculum in Mechanical Engineering**
### Freshman

#### Fall

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<th>Course</th>
<th>Hours</th>
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<td>MATH 1610 Calculus I</td>
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#### Sophomore

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<td>MATH 2660 Topics in Linear Algebra</td>
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#### Junior

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<td>MECH 3030 Fluid Mechanics</td>
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<td>MECH 3040 Heat Transfer</td>
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<td>MECH 3200 Concepts in Mechanical Design</td>
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<td>MECH 3050 Measurement and Instrumentation</td>
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#### Senior

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<th>Course</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Literature(^2)</td>
<td>3</td>
<td>Core Social Science(^1)</td>
<td>3</td>
</tr>
<tr>
<td>PHIL 1020 Introduction to Ethics or 1040 Business Ethics (Core Ethics)</td>
<td>3</td>
<td>Core Fine Arts</td>
<td>3</td>
</tr>
<tr>
<td>MECH 4240 Comprehensive Design I</td>
<td>2</td>
<td>MECH 4250 Comprehensive Design II</td>
<td>2</td>
</tr>
<tr>
<td>Technical Elective</td>
<td>6</td>
<td>Technical Elective</td>
<td>3</td>
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<tr>
<td></td>
<td></td>
<td>Free Elective</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td></td>
<td>16</td>
</tr>
</tbody>
</table>
The AU Bulletin lists the University Core Curriculum requirements for students in the College of Engineering. Students must complete a sequence in either Literature or History. In order to complete the degree in 122 credits, because of the Mechanical Engineering specific requirements for the Humanities and Fine Arts courses, it is recommended that a two course History sequence (HIST 1010, HIST 1020, HIST 1017, HIST 1027, HIST 1210, HIST 1220 or HIST 1217- HIST 1227) be completed in the Social Sciences.

Core Literature: ENGL 2200, ENGL 2207, ENGL 2210, ENGL 2217, ENGL 2230,ENGL 2240, ENGL 2250 orENGL 2260.

Technical Elective - see adviser for approved course listing.

**Material Engineering Minor**

Students completing this 15-hour minor will have an understanding structure-property relationships of different types of materials and be able to apply this understanding to the processing and selection of materials for engineering applications. The minor includes courses that focus on each of the major classes of materials (metals, polymer and ceramics) and includes an elective to allow students to pursue their particular areas of interest. The minor will provide students in other disciplines with a better understanding of materials related to their particular interests.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATL 2100</td>
<td>Introduction to Materials Science</td>
<td>3</td>
</tr>
<tr>
<td>MATL 3100</td>
<td>Engineering Materials - Metals</td>
<td>3</td>
</tr>
<tr>
<td>MATL 3200</td>
<td>Engineering Materials Polymers</td>
<td>3</td>
</tr>
<tr>
<td>MATL 3300</td>
<td>Engineering Materials - Ceramics</td>
<td>3</td>
</tr>
<tr>
<td>Elective Courses (at least 3 credit hours from the following)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATL 2210</td>
<td>Materials for Sustainable Energy Production and Storage</td>
<td>1</td>
</tr>
<tr>
<td>MATL 2220</td>
<td>Materials and the Environment</td>
<td>1</td>
</tr>
<tr>
<td>MATL 2230</td>
<td>Mineral Resources: Processing and Availability</td>
<td>1</td>
</tr>
<tr>
<td>MATL 3101</td>
<td>Metallography Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>MATL 3201</td>
<td>Polymer and Composites Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>MATL 4500</td>
<td>Materials Properties and Selection</td>
<td>4</td>
</tr>
<tr>
<td>MATL 5600</td>
<td>Corrosion ¹</td>
<td>3</td>
</tr>
<tr>
<td>MATL 5700</td>
<td>Biomaterials ¹</td>
<td>3</td>
</tr>
<tr>
<td>MATL 5750</td>
<td>Microstructure and Mechanics of Skeletal Tissues ¹</td>
<td>3</td>
</tr>
</tbody>
</table>

¹ These courses aren't offered every year.

**Materials Science Minor**

Students completing this 15-hour minor will have an understanding science underlying the structure-property relationships in solid state materials. The minor provides student with understanding of the solid state chemistry and physics that are applied to control materials properties and design fabrication processes. The minor can provide complementary scientific understanding to engineering students or demonstrate application of science to materials properties to students from the sciences.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATL 2100</td>
<td>Introduction to Materials Science</td>
<td>3</td>
</tr>
<tr>
<td>MATL 4100</td>
<td>Thermodynamics and Kinetics of Materials</td>
<td>3</td>
</tr>
<tr>
<td>MATL 5200</td>
<td>Materials Characterization</td>
<td>2</td>
</tr>
<tr>
<td>MATL 5201</td>
<td>Materials Characterization Laboratory</td>
<td>1</td>
</tr>
</tbody>
</table>
MATL 5500 | Numerical Simulation of Materials Processing | 3

**Elective Courses (3 credit hours from the following)**

MATL 5400 | Physics of Solids | 3
PHYS 5610 | Introduction to Solid State Physics | 3

**Tribology Minor**

This 15-hour multidisciplinary minor prepares students from various science and engineering majors for careers that require a background in friction, wear and lubrication (tribology). Students will be prepared for not only the lubricant and bearing manufacturing industry, but for design and maintenance in the power generation, vehicle, and manufacturing industries. Students who complete this minor will acquire the skills necessary to identify critical parameters in a tribological system, design a tribological system for the needs of a specific application, including geometry, lubricant, and surface properties. Students will also understand the chemical formulation and operating mechanisms of lubricants and additives.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MECH 5240</td>
<td>Boundary and Full-Film Lubrication</td>
<td>3</td>
</tr>
<tr>
<td>or PFEN 5300</td>
<td>Rheology</td>
<td></td>
</tr>
<tr>
<td>or CHEN 5410</td>
<td>Macromolecular Science and Engineering</td>
<td></td>
</tr>
<tr>
<td>MECH 5230</td>
<td>Friction, Wear and Lubrication</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 2080</td>
<td>Organic Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>or CHEM 2030</td>
<td>Survey of Organic Chemistry</td>
<td></td>
</tr>
<tr>
<td>or CHEM 4070</td>
<td>Physical Chemistry I</td>
<td></td>
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</tbody>
</table>

**Electives courses**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEN 5430</td>
<td>Business Aspects of Chemical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>MATL 5600</td>
<td>Corrosion</td>
<td>3</td>
</tr>
<tr>
<td>MECH 5830</td>
<td>Engines (This Course is newly added.)</td>
<td>3</td>
</tr>
<tr>
<td>MECH 5270</td>
<td>Metalworking and Manufacturing Tribology</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 5660</td>
<td>Macroscale Assembly and Applications of Nanomaterials</td>
<td>3</td>
</tr>
<tr>
<td>MECH 5970</td>
<td>Intermediate Special Topics in Mechanical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 3520</td>
<td>Integrating Business and Engineering Theory with Practice</td>
<td>3</td>
</tr>
<tr>
<td>MATL 5200</td>
<td>Materials Characterization</td>
<td>2</td>
</tr>
<tr>
<td>BSEN 5540</td>
<td>Biomass and Biofuels Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 5120</td>
<td>Surface and Colloid Science</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 4070</td>
<td>Physical Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td>MECH 5250</td>
<td>Multiscale Contact Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 3510</td>
<td>Introduction to Business and Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 5420</td>
<td>Polymer Chemical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>BSEN 4250</td>
<td>Hydraulic Control Systems Design</td>
<td>3</td>
</tr>
</tbody>
</table>

**Wireless Engineering**

The wireless engineering curriculum is a joint offering of the Department of Electrical and Computer Engineering and the Department of Computer Science and Software Engineering, leading to the bachelor of wireless engineering (BWE). To meet the need for engineers that can improve life and business in these times of a mobile society, the program has the following educational objectives. Within a few years of graduation, alumni of the wireless engineering program are expected to have (1) contributed positively to the development and application of new wireless technologies and systems as an individual contributor, a member of one or more project teams, and/or as a leader of one or more project teams, (2) achieved success in their chosen profession as evidenced by career satisfaction, promotions/raises, and leadership at levels appropriate to their experience, and/or (3) achieved success in post-undergraduate studies as evidenced by satisfaction with the decision to further their education, advanced degrees earned, professional registration, and professional visibility (e.g. publications, presentations, awards, etc.) The program is designed to develop within its graduates a basic foundation in wireless engineering and either electrical engineering, software engineering, or communication networks that will provide the technical proficiency needed for the professional practice of engineering in the wireless industry; the ability to
communicate their ideas effectively within the technical community and to the general public; the basis for, and an appreciation of and enthusiasm for lifelong scientific inquiry, learning and creativity; and preparation to take their places in society as responsible citizens, with an appreciation of and understanding for the need to maintain the highest ethical standards in their personal and professional lives. Graduates of this program will be able to analyze, develop, design, test, administer and support wireless network systems, communication devices, and other components used in wireless computer and telecommunication networks.

The BWE curriculum has two formal options - wireless engineering-hardware (WIRE), emphasizing a hardware design-oriented approach to wireless engineering, and wireless engineering-software (WIRS), emphasizing a software-oriented approach. There is a network specialization within each option. Students interested in designing wireless hardware, such as integrated circuit chips, wireless communication devices, and wireless network switching equipment, should choose the WIRE hardware specialization option. Students interested in application software development, including server-side, client-side, and embedded applications, should choose the WIRS software specialization option. Students interested in pursuing a career with wireless service providers and other companies that develop and maintain wireless networks and sell service, can choose the Network Specialization within either the WIRE option or the WIRS option.

Each curriculum builds upon a solid foundation in mathematics, science, and electrical or software engineering fundamentals to introduce wireless communications theories, devices, circuits, systems, networks, standards, management, and applications. Design experience is interwoven throughout the curriculum by introducing basic design concepts early, emphasizing hands-on design experiences in the laboratories, including effective use of computers and other modern engineering tools, and culminating with a capstone design project in the senior year. In addition to its technical aspects, the curriculum emphasizes oral and written communication skills, the importance of business, economic, social and global forces on engineering, appreciation of the need to maintain the highest ethical standards, and the maintenance of professional competence through continued self-improvement after graduation.

Major

- Wireless Engineering (Hardware Option) (p. 139)
- Wireless Engineering (Software Option) (p. 140)

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