

Samuel Ginn College of Engineering

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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. Students are provided with academic guidance and support to assist students in determining the curriculum that best fulfills their personal and educational objectives.

Pre-engineering students are eligible to move into a major upon successful completion of the academic requirements specified for each degree program. These minimum academic requirements must be completed within four resident semesters, not including the summer term between the freshman and sophomore years.

Aerospace, Biosystems*, Materials, & Mechanical Engineering

Unadjusted Cumulative Auburn GPA of 2.0

Complete the following pre-engineering courses with a grade of “C” or better:

Calculus I (MATH 1610), Calculus II (MATH 1620), Chemistry (CHEM 1030 or CHEM 1110), Engineering Physics (PHYS 1600), Intro to Engineering (ENGR 1110), Engineering Orientation (ENGR 1100), Introduction to Computing: MATLAB (COMP 1230)

*includes Bioprocess, Ecological, and Forestry Engineering majors

Civil, Industrial & Systems, & Electrical Engineering

Unadjusted Cumulative Auburn GPA of 2.0

Complete the following pre-engineering courses with a grade of “C” or better:

Calculus I (MATH 1610), Calculus II (MATH 1620), Chemistry (CHEM 1030 or CHEM 1110), Engineering Physics (PHYS 1600), Intro to Engineering (ENGR 1110), Engineering Orientation (ENGR 1100), Introduction to Computing: PYTHON (COMP 1220)

Chemical Engineering

Unadjusted Cumulative Auburn GPA of 2.0

Complete the following pre-engineering courses with a grade of “C” or better:

Calculus I (MATH 1610), Calculus II (MATH 1620), Chemistry I (CHEM 1110/CHEM 1111 or CHEM 1030/CHEM 1031) Chemistry II (CHEM 1120/CHEM 1121 or CHEM 1040/CHEM 1041), Intro to Engineering (ENGR 1110), Engineering Orientation (ENGR 1100)

Computer Engineering

Unadjusted Cumulative Auburn GPA of 2.0

Complete the following pre-engineering courses with a grade of “C” or better:

Calculus I (MATH 1610), Calculus II (MATH 1620), Chemistry (CHEM 1030 or CHEM 1110), Engineering Physics (PHYS 1600), Intro to Engineering (ENGR 1110), Engineering Orientation (ENGR 1100), Introduction to Computing: JAVA (COMP 1210)

Computer Science, Software Engineering

Unadjusted Cumulative Auburn GPA of 2.0

Complete the following pre-engineering courses with a grade of “C” or better:

Calculus I (MATH 1610), Discrete Structures (COMP 2240), Approved Degree-Applicable Lab Science* Engineering Orientation (ENGR 1100), Intro to Engineering (ENGR 1110), and Introduction to Computing: JAVA (COMP 1210)

*BIOL 1020/BIOL 1021 or CHEM 1030/CHEM 1031 or PHYS 1600

Professional Programs

The following undergraduate engineering programs are accredited by the Engineering Accreditation Commission of ABET (<https://www.abet.org/>): Aerospace Engineering, Biosystems Engineering, Chemical Engineering, Civil Engineering, Electrical Engineering, Industrial and Systems Engineering, Materials Engineering, Mechanical Engineering, Polymer and Fiber Engineering, and Software Engineering.

The undergraduate Computer Science program is accredited by the Computing Accreditation Commission of ABET (<https://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.

A bioprocess engineering option, 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 College of Forestry, Wildlife and Environment.

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, 1333 Brown Kopel Student Achievement Center, Auburn, AL, 36849. Telephone: (334) 844-2250. Website: [eng.auburn.edu/cdcr/co-op/index](https://www.eng.auburn.edu/cdcr/co-op/index) (<https://www.eng.auburn.edu/cdcr/co-op/index/>).

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 artificial intelligence engineering, 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 science in 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 (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departamentofoaerospaceengineering/aerospaceengineering_major/)
- Biosystems Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departamentofbiosystemsengineering/biosystemsengineering_major/)
- Biosystems Engineering — Bioprocess Engineering Option (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departamentofbiosystemsengineering/biosystemsengineeringbioprocessengr_obtion/)
- Biosystems Engineering — Ecological Engineering Option (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departamentofbiosystemsengineering/ecologicalengineeringoption_major/)
- Biosystems Engineering — Forest Engineering Option (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departamentofbiosystemsengineering/forestengineering_major/)
- Chemical Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departamentofchemicalengineering/chemicalengineering_major/)
- Civil Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departamentofcivilengineering/civilengineering_major/)
- Computer Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departamentofelectricalandcomputerengineering/computerengineering_major/)
- Computer Science (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departamentofcomputerscienceandsoftwareengineering/computerscience_major/)

- Computer Science — Online Degree Completer Program (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofcomputerscienceandsoftwareengineering/bachelorofcomputerscience_major/)
- Electrical Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofelectricalandcomputerengineering/electricalengineering_major/)
- Industrial and Systems Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofindustrialandsystemsengineering/industrialandsystemsengineering_major/)
- Materials Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofmechanicalengineering/materialsengineering_major/)
- Mechanical Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofmechanicalengineering/mechanicalengineering_major/)
- Software Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofcomputerscienceandsoftwareengineering/softwareengineering_major/)

Minors

- Business-Engineering-Technology (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofindustrialandsystemsengineering/buseng_tech_minor/)
- Computer Science (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofcomputerscienceandsoftwareengineering/computerscience_minor/)
- Information Technology (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofcomputerscienceandsoftwareengineering/informationtechnology_minor/)
- Materials Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofmechanicalengineering/materialengineering_minor/)
- Material Science (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofmechanicalengineering/materialsscience_minor/)
- Nuclear Power Generation Systems (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofmechanicalengineering/nuclearpowergensystems_minor/)
- Tribology (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofmechanicalengineering/tribology_minor/)

Undergraduate Certificates

- Applied Safety and Ergonomics
- Artificial Intelligence Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofcomputerscienceandsoftwareengineering/artificialintelligence_engineering_ucrt/)
- Cyber Defense (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofcomputerscienceandsoftwareengineering/cyberdefense_ucrt/)
- Manufacturing Systems (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofindustrialandsystemsengineering/manufacturingsystems_ucrt/)
- Pulp, Paper, and Bio-Resources Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofchemicalengineering/pulp_paper_bio-resources_eng_ucrt/)

Graduate Programs

- Aerospace Engineering — MS, PhD (<http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/aerospaceengineeringmaemspd/>)
- Artificial Intelligence Engineering — MS (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/aiengineering_ms/)
- Artificial Intelligence Engineering — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/aiengineering_gcrt/)
- Automotive Manufacturing Systems — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/industrialandsystemsengineeringmisemisembamsphd_major/automotivemfgsystems_certificate/)
- Bioproducts and Bioprocessing — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/biop_gcrt/)
- Biosystems Engineering — MS, PhD (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/biosystemsengineeringmsphd_major/)

- Chemical Engineering — MS, PhD (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/chemicalengineeringmchemsphd_major/)
- Civil Engineering — MCE, MS, PhD (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/civilengineeringmcmcsphd_major/)
- Computer Science and Software Engineering — Graduate Certificate, MS, PhD (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/computerscienceandsoftwareengineeringmswemsphd_major/)
- Cybersecurity Engineering — Graduate Certificate, MS (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/cybersecurityengineering_ms/)
- Data Engineering — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/dataengineering_gcrt/)
- Data Science — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/datascience_gcrt/)
- Data Science and Engineering — MS (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/computerscienceandsoftwareengineeringmswemsphd_major/datascienceandengineering_major/)
- Earth System Science — Interdisciplinary PhD Program (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/interdisciplinaryprograminearthssystem_phd/)
- Ecosystems Engineering — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/ecosystems_gcrt/)
- Electrical Engineering — MS, PhD (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/electricalandcomputerengineeringmeemsphd_major/)
- Engineering — ME (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/generalengineeringenms_major/)
- Engineering Management — MEM (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/industrialandsystemsengineeringmismisembamsphd_major/mastersofengineeringmanagement/)
- Geotechnical Engineering — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/Geotech_gcrt/)
- Industrial and Systems Engineering — Graduate Certificate, MS/MBA, MS, MEM, PhD (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/industrialandsystemsengineeringmismisembamsphd_major/)
- Manufacturing Systems — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/industrialandsystemsengineeringmismisembamsphd_major/manufacturingsystems_certificate/)
- Materials Engineering — MS, PhD (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/materialsengineeringmmtlemsphd_major/)
- Mechanical Engineering — MS, PhD (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/mechanicalengineeringmismmephd_major/)
- Modeling and Data Analytics for Operations — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/industrialandsystemsengineeringmismisembamsphd_major/modelingdataanalytics_certificate/)
- Occupational Safety & Ergonomics — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/industrialandsystemsengineeringmismisembamsphd_major/occupationsafetyerogon_certificate/)
- Pavement Analysis and Design — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/pavementanalysis_gcrt/)
- Pavement Materials — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/pavementmaterials_gcrt/)
- Polymer and Fiber Engineering — MS, PhD (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/polymerandfiberengineeringmsphd_major/)
- Polymer Engineering — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/polymer_engineering_gcrt/)
- Power Engineering — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/PowerEngineering_gcrt/)
- Pulp and Paper Engineering — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/pulpandpaperengineering_major/)
- Structural Analysis in Structural Engineering — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/structuralanalysis_gcrt/)
- Structural Design in Structural Engineering — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/structuraldesign_gcrt/)

- Tribology — Graduate Certificate (<http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/tribologygraduatecertificate/>)
- Water Environmental Modeling — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/waterenvironment_gcrt/)
- Water Resources Engineering — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/waterresources_gcrt/)
- Wireless Engineering — Graduate Certificate (http://bulletin.auburn.edu/thegraduateschool/graduatedegreesoffered/wirelessengineering_gcrt/)

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. 1. Pr. BATM 1110 or BIOP 2120. 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 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 3110 AG TECHNOLOGY GEOSPATIAL APPLICATIONS (3) LEC. 2. LAB. 3. Pr. PHYS 1500 or PHYS 1600. Geospatial applications for agricultural land resource management. Course introduces equipment and practices used in conventional land surveying and geospatial mapping as they interface with global positioning systems (GPS), geographic information systems (GIS), and computer-aided design (CAD).

BATM 3500 NATURAL RESOURCE SYSTEMS CONSERVATION (3) LLB. Pr. (MATH 1130 or MATH 1133 or MATH 1150 or MATH 1610 or MATH 1680) and (PHYS 1500 or PHYS 1600). 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) LLB. Pr. (MATH 1130 or MATH 1133 or MATH 1150 or MATH 1610 or MATH 1680) and (PHYS 1500 or PHYS 1600). 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 agriculturr principles and technology.

BATM 3530 AGRICULTURAL PRODUCTION AND PROCESSING FACILITY TECHNOLOGY (3) LEC. 3. Pr. MATH 1130 or MATH 1133 or MATH 1150 or MATH 1610 or MATH 1680. Fundamental requirements for the design and operation of agricultural production and processing facilities.

BATM 3560 TURF SYSTEMS IRRIGATION DESIGN (3) LEC. 3. Pr. MATH 1120 or MATH 1130 or MATH 1133 or MATH 1150 or MATH 1610 or MATH 1680. 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.

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 and (PHYS 1500 or PHYS 1600). 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 5130 PRECISION AG TECHNOLOGY (3) LEC. 2. LAB. 3. Pr. BATM 3510. An overview of the principles of precision agriculture with focus on prescriptive agriculture and the ability to effectively execute input management plans using today's technologies. Course material and discussions will include how technologies such as GPS, agricultural GIS, sensors for qualitative and quantitative measurement of soil and plant variables, variable-rate technology are being implemented with data informing sub-field level management and subsequent farm business decisions.

BATM 5140 COMMERCIAL POULTRY & LIVESTOCK HOUSING (3) LEC. 2. LAB. 3. Pr. STAT 2510. 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.

BATM 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 1003 or PHYS 1007 or PHYS 1500 or PHYS 1600 or PHYS 1607). Engineering concepts and unit operations used in processing food products. Fall.

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.

BATM 6130 PRECISION AG TECHNOLOGY (3) LEC. 2. LAB. 3. An overview of the principles of precision agriculture with focus on prescriptive agriculture and the ability to effectively execute input management plans using today's technologies. Course material and discussions will include how technologies such as GPS, agricultural GIS, sensors for qualitative and quantitative measurement of soil and plant variables, variable-rate technology are being implemented with data informing sub-field level management and subsequent farm business decisions.

BATM 6140 COMMERCIAL POULTRY AND LIVESTOCK HOUSING (3) LEC. 2. LAB. 1. 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.

BATM 6550 PRINCIPLES OF FOOD ENGINEERING TECHNOLOGY (4) LEC. 3. LAB. 3. Pr. (MATH 1130 or MATH 1133) and (PHYS 1000 or PHYS 1003 or PHYS 1007). Engineering concepts and unit operations used in processing food products. Fall.

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. BSEN 3610 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 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 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 4970 SPECIAL TOPICS IN BIOSYSTEMS ENGINEERING (1-4) DSL. 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 5220 GEOSPATIAL TECHNOLOGIES IN BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. STAT 2510 or STAT 2513 or STAT 2610 or STAT 3010 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 or CHEM 1120) and BIOL 3200 and (BSEN 3230 or 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 5240 BULK BIOLOGICAL SOLIDS BEHAVIOR, HANDLING AND PROCESSING (3) LEC. 3. Pr. BSEN 3310 or CIVL 3310. Understanding of the properties of bulk solids and how these properties influence the behavior, handling and processability of biological solids.

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 CHEM 1120). 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. 1. 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 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 3230. 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 or CHEM 1120) 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 5560 SITE DESIGN FOR BIOSYSTEMS (3) LEC. 2. LAB. 3. Pr. BSEN 3230 or (CIVL 3110 and CIVL 3010). 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 5570 COASTAL ECOLOGICAL ENGINEERING (3) LEC. 1. LAB. 4. Pr. BSEN 3310. Fundamentals of coastal processes and engineering and also provide an introduction to modeling the flow of water in coastal systems

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. 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 6240 BULK BIOLOGICAL SOLIDS BEHAVIOR, HANDLING AND PROCESSING (3) LEC. 3. Understanding of the properties of bulk solids and how these properties influence the behavior, handling and processing ability of biological bulk solids.

BSEN 6250 DETERMINISTIC MODELING FOR BIOSYSTEMS (3) LEC. 2. LAB. 3. 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. 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 6510 ECOLOGICAL ENGINEERING (3) LEC. 3. 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 6560 SITE DESIGN FOR BIOSYSTEMS (3) LEC. 2. LAB. 3. 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 6570 COASTAL ECOLOGICAL ENGINEERING (3) LEC. 1. LAB. 4. Fundamentals of coastal processes and engineering. Introduction to modeling the flow of water in coastal systems.

BSEN 7110 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 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 7510 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 7520 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 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.

Aerospace Engineering 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 1600. Introduction to the fundamental physical concepts required for the successful design of aircraft and spacecraft.

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 or ENGR 2077. 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. 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 or MATH 2667). 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 5140 COMPUTATIONAL FLUID DYNAMICS (3) LEC. 3. Pr. AERO 3110. An introduction to finite-difference and finite-volume methods for solving partial differential equations of interest in fluid dynamics.

AERO 5210 FLIGHT SIMULATION (3) LEC. 3. Pr. AERO 3230. Time domain simulation of nonlinear, six-degree-of-freedom motion of flight vehicles. Development of modular digital simulations including vehicle models for aerodynamics and propulsion, control, guidance subsystems.

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 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 2650. 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 6110 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 ROTARY WING AERODYNAMICS (3) LEC. 3. Aerodynamics and flight characteristics of rotary-wing aircraft.

AERO 6140 COMPUTATIONAL FLUID DYNAMICS (3) LEC. 3. An introduction to finite-difference and finite-volume methods for solving partial differential equations of interest in fluid dynamics.

AERO 6210 FLIGHT SIMULATION (3) LEC. 3. Time domain simulation of nonlinear, six-degree-of-freedom motion of flight vehicles. Development of modular digital simulations including vehicle models for aerodynamics and propulsion, control, guidance subsystems.

AERO 6330 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 6410 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 PERTURBATION METHODS (3) LEC. 3. Pr. MATH 2650. 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 ROCKET PROPULSION (3) LEC. 3. Analysis of the thermodynamics, gas dynamics and design of liquid and solid propellant rocket engines.

AERO 6530 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 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 6640 ADVANCED VISCOELASTICITY (3) DSL/LEC. An introduction to polymers and the theory of viscoelasticity. Topics include (1) a review of stress and strain analysis and measurement; (2) characteristics, applications, and properties of polymers; (3) polymerization and classification; (4) differential constitutive equations; (5) time and temperature behavior of polymers; (6) viscoelastic stress analysis; and (7) rate and time-dependent failure.

AERO 7100 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 7120 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 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 ADVANCED COMPUTATIONAL FLUID DYNAMICS (3) LEC. 3. Pr. AERO 5140 or 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 7150 COMPRESSIBLE FLUID DYNAMICS (3) LEC. 3. Pr. AERO 4140. Departmental approval. An introduction to the fundamental of compressible fluid dynamics. Application of conservation of mass, momentum and energy for compressible flows. May count either AERO 7150 or AERO 7156.

AERO 7160 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 7170 FUNDAMENTALS OF FLUIDS (3) LEC. 3. Introduction to principal concepts and methods of fluid dynamics; similarity and dimensional analysis; conservation of mass, momentum, and energy for flows in continuum; circulation and vorticity theorems; potential flow theory; introduction to some exact solutions based on simplifying assumptions for inviscid, viscous, unsteady, and compressible flow problems.

AERO 7200 DYNAMICS OF FLIGHT (3) LEC. 3. Departmental approval. Development of specialized concepts and methods in dynamics applicable to the modeling of flight vehicle motion. Stability concepts and analysis of the stability of flight vehicle motions. Effects of variable mass and flexibility.

AERO 7210 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 7220 SPACECRAFT ATTITUDE DYNAMICS AND CONTROL (3) LEC. 3. Pr. AERO 7200 or AERO 7206. Development of specialized concepts and methods in dynamics applicable to the modeling of spacecraft rotational motion. Methods for controlling spacecraft attitude. Analysis of the attitude stability and controllability of spacecraft attitude motion. Department approval.

AERO 7330 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 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 OPTIMAL CONTROL OF AEROSPACE VEHICLES (3) LEC. 3. 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 7360 ADVANCED TRAJECTORY OPTIMIZATION (3) LEC. 3. Departmental approval. This course reviews single- and multi-variable optimization techniques of deterministic continuous systems. A review of the necessary (KKT) and sufficient conditions for optimality is given. We will review principles of dynamic programming and the Hamilton-Jacobi-Bellman (HJB) equation. We will also review Linear Programming (LP) problems and Quadratic Programming (QP) problems. Application of the QP problems for minimum-snap trajectory optimization for path planning of quad-rotors is demonstrated. We will also introduce basic concepts of convex optimization, which uses many of the concepts introduced in the LP and QP problems. The final project is to solve a trajectory optimization problem using successive linearization, which is a widely used technique for converting non-convex problems to convex ones.

AERO 7410 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 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 tomo-PIV. May count either AERO 7420 or AERO 7426.

AERO 7450 AEROSPACE ENGINEERING ANALYSIS (3) LEC. 3. Analysis and techniques for solving ordinary and partial differential equations common in Aerospace applications.

AERO 7460 ADVANCED PERTURBATION METHODS (3) LEC. 3. Departmental approval. Solutions of nonlinear problems and integrals using WKB, Rayleigh-Janzen, Generalized Scales, Latta, van der Pol, Watson, Laplace, Adomian, homotopy, Pade, Liouville-Green and Burmann transformations. May count either AERO 7460/7466 or MATH 7460/7466.

AERO 7510 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 7520 ADVANCED AIR-BREATHING PROPULSION (3) LEC. 3. Topics emphasizing interaction between external aerodynamics and performance of airbreathing jet engines. Performance optimization of ramjet, turbojet, and turbofan engines. Component matching.

AERO 7530 AEROTHERMOCHEM OF PROPULSION (3) LEC. 3. Aerothermodynamics of compressible flow, chemical propellant characteristics, heat transfer in fluid flow, statistical gas dynamics, kinetic theory of gases.

AERO 7600 AEROSPACE SOLID MECHANICS (3) LEC. 3. An introduction to solid mechanics concepts with aerospace engineering applications. The course develops equations of motions from conservation laws and introduces constitutive equations from linearized continuum mechanics perspective for aerospace related applications. Topics include elastostatic solutions, elastodynamic solutions and plasticity.

AERO 7620 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 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 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 SPECIAL TOPICS IN AEROSPACE ENGINEERING (1-3) DSL. Course may be repeated for a maximum of 9 credit hours.

AERO 7980 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 RESEARCH AND THESIS (1-10) DSL/MST. Credit hours to be arranged. Course may be repeated with change in topics.

AERO 8990 RESEARCH AND DISSERTATION (1-10) DSL/DSR. Individual doctoral dissertation research. May be repeated for credit. Course may be repeated with change in topics.

Chemical Engineering Courses

CHEN 1000 CONCEPTS OF CHEMICAL ENGINEERING: THE DESIGN OF COFFEE (3) LEC. 2. LAB. 2. This course is an introduction to chemical engineering concepts and approaches to innovation and problem solving. Qualitative overviews are presented for principles and practices of engineering analysis and design, with corresponding hands-on laboratories applying the concepts to processes for roasting and brewing coffee. The course is intended as a free elective for all majors.

CHEN 1007 HONORS CONCEPTS OF CHEMICAL ENGINEERING: THE DESIGN OF COFFEE (3) LEC. 2. LAB. 2. This course is an introduction to chemical engineering concepts and approaches to innovation and problem solving. Qualitative overviews are presented for principles and practices of engineering analysis and design, with corresponding hands-on laboratories applying the concepts to processes for roasting and brewing coffee. The course is intended as a free elective for all majors.

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 2100 requires a grade of C or better.

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 or COMP 1220 or COMP 1230). CHEN 2100 requires a grade of C or better. CHEN 2610 and MATH 2650 are Prerequisites with Concurrency. 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). CHEN 2100 requires a grade of C or better. Course may be repeated with change in topics.

CHEN 3370 PHASE AND REACTION EQUILIBRIA (3) LEC. 3. Pr. (MATH 2630 or MATH 2633 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 or CHEN 2110) and CHEN 2100 require a grade of C or better.)

CHEN 3600 COMPUTER-AIDED CHEMICAL ENGINEERING (3) LEC. 2. LAB. 3. Pr. (COMP 1200 or COMP 1220 or COMP 1230) and MATH 2650 and CHEN 2610 and P/C CHEN 2650 and (MATH 2630 or MATH 2637) and (ENGR 2010 or 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 2100 and (CHEN 2110 or ENGR 2010) and CHEN 2610 all require a grade of C or better.)

CHEN 3620 TRANSPORT II (3) LEC. 3. Pr. (MATH 2630 or MATH 2633 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 or CHEN 2110) 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, CHEN 3600, and CHEN 3620 all 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 or CHEN 2110) 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 3600 and CHEN 3620 require a grade of C or better.

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. CHEN 2650 requires a grade of C or better. 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.

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 3600, CHEN 3650, and CHEN 3660 all require 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 3600, 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 3600, 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 3650, CHEN 3660, and CHEN 3700 all 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 and PHYS 1610. 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 3650 requires a grade of C or better.

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 and junior standing. 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 or 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 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 5130 INTEGRATED BIOREFINERIES (3) LEC. 3. Pr. CHEN 5090 or CHEN 6090. Departmental approval. Chemical and engineering principles in biomass conversion processes with emphasis on producing value-added materials and chemicals. By the end of the semester students should understand the principles and reasoning behind emerging biorefinery processes integrated to the pulp and paper manufacturing.

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; 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 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 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 5800 BIOCHEMICAL ENGINEERING (3) LEC. 3. Pr. P/C CHEN 3700. Bioreactor design. Analysis of enzyme and microbial processes. (CHEN 3700 requires a grade of C or better).

CHEN 5810 BIOMEDICAL ENGINEERING (3) LEC. 3. Pr. (CHEM 2080 or 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 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 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 PULP AND PAPER ENGINEERING (3) LEC. 3. Chemical and engineering principles in the manufacturing of pulp and paper.

CHEN 6130 INTEGRATED BIOREFINERIES (3) LEC. 3. Pr. CHEN 5090 or CHEN 6090. Departmental approval. Chemical and engineering principles in biomass conversion processes with emphasis on producing value-added materials and chemicals. By the end of the semester students should understand the principles and reasoning behind emerging biorefinery processes integrated to the pulp and paper manufacturing.

CHEN 6410 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 6660 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 6800 BIOCHEMICAL ENGINEERING (3) LEC. 3. Bioreactor design. Analysis of enzyme and microbial processes.

CHEN 6810 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 6970 ADVANCED SPECIAL TOPICS IN CHEMICAL ENGINEERING (1-6) DSL. 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 7100 TRANSPORT PHENOMENA (3) LEC. 3. Principles of heat, mass and momentum transport in application of intermediate complexity. Mathematical analysis of transport problems.

CHEN 7110 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 7200 CHEMICAL ENGINEERING THERMODYNAMICS (3) LEC. 3. 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.

CHEN 7250 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 7900 INDEPENDENT STUDY (1-10) DSL/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 ADVANCED SPECIAL TOPICS IN CHEMICAL ENGINEERING (1-6) DSL. 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 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 or COMP 1220 or COMP 1230). 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 or COMP 1220 or COMP 1230) 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. BSEN 3310 or CIVL 3010 or ENGR 2200 and CHEM 1040 or CHEM 1043. 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 3610 STRUCTURAL ANALYSIS (4)** LEC. 3. LAB. 3. Pr. ENGR 2070 and P/C CIVL 3010. Basic structural analysis of determinate and indeterminate structures, deflections by moment-area and virtual work, influence lines, force method and moment-distribution methods of analysis.
- CIVL 3820 CIVIL ENGINEERING MATERIALS (3)** LEC. 2. LAB. 3. Pr. P/C 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 4650 STRUCTURAL STEEL DESIGN (3)** LEC. 3. Pr. CIVL 3610. Steel properties. Design and analysis of structural steel members in tension, compression, shear, flexure and combined compression and flexure. Bolted and welded connections.
- 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 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 5420 CONSTRUCTION PROJECT SCHEDULING AND CONTROL (3) LEC. 3. Pr. CIVL 3410 and CIVL 4420. Principles related to planning, scheduling and control of civil engineering projects. Deterministic and probabilistic methods of scheduling, resource usage optimization. May count either CIVL 5420 or CIVL 6420.

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. 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 AND SEDIMENT CONTROL TECHNOLOGIES IN CONSTRUCTION (3) LEC. 3. Pr. 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. 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 5670 ADVANCED STRUCTURAL ANALYSIS (3) LEC. 3. Pr. CIVL 3610. Analysis of continuous beams and frames by slope-deflection method. Analysis of beams, trusses, grids, and frames by direct stiffness method. Buckling of planar frames. Use of structural analysis software. May count either CIVL 5670 or CIVL 6670/CIVL 6676.

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 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 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 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 6150 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. May count either CIVL 5150 or CIVL 6150/CIVL 6156.

CIVL 6160 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 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 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 6230 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 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 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 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 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 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 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 6420 CONSTRUCTION PROJECT SCHEDULING AND CONTROL (3) LEC. 3. Pr. CIVL 3410 and CIVL 4420. Principles related to planning, scheduling and control of civil engineering projects. Deterministic and probabilistic methods of scheduling, resource usage optimization. May count either CIVL 5420 or CIVL 6420.

CIVL 6430 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 CONSTRUCTION EQUIPMENT AND METHODS (3) LEC. 3. Pr. CIVL 3410. 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 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 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 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 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 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 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 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 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 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 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 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 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 6670 ADVANCED STRUCTURAL ANALYSIS (3) LEC. 3. Pr. CIVL 3610. Analysis of continuous beams and frames by slope-deflection method. Analysis of beams, trusses, grids, and frames by direct stiffness method. Buckling of planar frames. Use of structural analysis software. May count either CIVL 5650 or CIVL 6650/CIVL 6656.

CIVL 6690 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 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 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 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 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 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 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 7120 HYDROLOGIC MODELING (3) LEC. 3. Pr. (CIVL 6110 or CIVL 6116). Principles and practice of hydrologic modeling, introduction to hydrologic information systems, computer modeling of storm run-off, floodplain hydraulics and bridge hydraulics. Computer applications.

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 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 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 7220 WATER AND WASTEWATER OPERATIONS AND PROCESSES I (3) LEC. 3. Pr. CIVL 3230. Departmental approval. Coreq. CIVL 6210. Physical and chemical principles applied to water and wastewater treatment. Advanced mathematical and modeling concepts.

CIVL 7230 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 7250 BIOLOGICAL WASTEWATER TREATMENT (3) LEC. 3. Pr. CIVL 6250 or CIVL 6256. Departmental approval. Development and application of the theories of biological waste treatment.

CIVL 7270 ADVANCED NUMERICAL METHODS FOR SOLVING ENVIRONMENTAL ENGINEERING PROBLEMS (3) LEC. 3. Pr. CIVL 3010. Departmental approval. Basic concepts of finite element (FE) analysis. Development of FE computer codes for solving environmental engineering problems. FE grid generation and visualization methods.

- CIVL 7280 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 FOUNDATION ENGINEERING (3)** LEC. 3. Pr. CIVL 3310 and CIVL 4600. Analysis, design and construction of shallow and deep foundation systems.
- CIVL 7330 SOIL PROPERTIES (3)** LEC. 3. Pr. CIVL 3310. Soil behavior, shear strength, compressibility, hydraulic conductivity, and measurement of soil properties.
- CIVL 7340 SOIL DYNAMICS (3)** LEC. 3. Pr. CIVL 3310. Soil behavior during dynamic loads, wave propagation, dynamically loaded foundations, geotechnical earthquake engineering.
- CIVL 7360 EARTH SLOPES AND DAMS (3)** LEC. 3. Pr. CIVL 3310. Departmental approval. Engineering design of earth slopes, slope stability, cut slopes, embankments, settlement. Dam siting, stability, flownets, seepage analysis.
- CIVL 7390 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 7420 CONSTRUCTION ENGINEERING PROJECT PLANNING AND CONTROL (3)** LEC. 3. Pr. CIVL 4420. Departmental approval. This course covers the processes needed to develop and use project plans and budgets for construction projects. These tools will be used to create different schedules needed for construction planning and monitoring and be able to adjust a project's projection to maximize performance throughout the project lifecycle. This will include the scheduling methods to predict desired outcomes and performance measures to actively gauge project performance.
- CIVL 7440 CONSTRUCTION EQUIPMENT PRODUCTIVITY AND ENGINEERING ECONOMICS (3)** LEC. 3. Pr. CIVL 4420. Departmental approval. This course will encompass the methods needed to select, use, and manage the proper construction equipment to accomplish different project tasks. This will include using engineering fundamentals to understand the production and efficiency capabilities of equipment and the economic and scheduling impact this will have on the construction project.
- CIVL 7460 PRECONSTRUCTION ENGINEERING PROJECT PLANNING (3)** LEC. 3. Pr. CIVL 4420. Departmental approval. Construction success starts with the planning process known commonly as Preconstruction. During this phase potential construction projects are considered, studied, planned, designed, scheduled, and budgeted. Project owners often rely on consultants such as construction managers to help evaluate a project idea, the factors associated with the idea becoming a reality, and overseeing the steps from project idea to project construction. The proposed course provides students with the tools needed to be able to oversee project planning and owner assistance to usher the project to completion.
- CIVL 7470 ADVANCED ENGINEERING PROJECT MANAGEMENT (3)** LEC. 3. Pr. CIVL 4420. Departmental approval. Construction management requires cutting edge methods to coordinate project activities from project inception through project closeout to meet project needs and maintain competitive balance. Project oversight from pre-construction planning, scheduling, and estimating management require constant management and control while sound decision methods are used for best management methods. The proposed course provides students with the tools needed to be able to meet project requirements and result in successful project completion.
- CIVL 7540 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 7610 STRUCTURAL DYNAMICS I (3)** LEC. 3. Pr. CIVL 6670 or CIVL 6676. Single-degree-of-freedom systems, numerical solution techniques, response spectrum, multi-degree-of-freedom systems, eigenproblem solution, mode superposition analysis.
- CIVL 7630 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 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 7660 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 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 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 7720 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 7820 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 7840 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 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 SPECIAL TOPICS IN CIVIL ENGINEERING (1-3) DSL. 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 ENGINEERING PROJECT (1-10) LEC. 1-10. 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 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 RESEARCH AND DISSERTATION (1-10) DSL/DSR. Departmental approval. Credit to be arranged. Course may be repeated with change in topics.

Computer Sci Software En Courses

COMP 1000 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 1100 THE POWER OF AI: FUNDAMENTALS TO APPLICATIONS (3) LEC. 3. A comprehensive introduction to artificial intelligence accessible to students across all disciplines. Addresses fundamental principles of AI, key concepts like knowledge representation, reasoning, machine learning, natural language processing, and neural networks. Topics such as AI's impact across various fields, critical analyses of the benefits and limitations of the state of the art, ethical considerations, and hands-on experience in leveraging AI technologies will be covered.

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 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 1220 INTRODUCTION TO COMPUTING WITH PYTHON (2) LEC. 1. LAB. 3. Computational problem-solving using Python, with emphasis on developing programs from specifications, verification and testing, and engineering applications.

COMP 1230 INTRODUCTION TO COMPUTING WITH MATLAB (2) LEC. 1. LAB. 3. Computational problem-solving using MATLAB, with emphasis on developing programs from specifications, verification and testing, and engineering applications.

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 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 2240 DISCRETE STRUCTURES (3) LEC. 3. Pr. (COMP 1210 or COMP 1213 or COMP 1217) and (MATH 1610 or MATH 1617). 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 2710 SOFTWARE CONSTRUCTION (3) LEC. 3. Pr. COMP 2210 or COMP 2213. 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 2800 PROFESSIONAL DEVELOPMENT I (1) LEC. Introduction to career opportunities and student development options for majors in computer science and software engineering. Students will explore course, research, and extracurricular options within the department; create resumes and digital professional profiles; investigate post-graduation opportunities; and explore other professional development opportunities.

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 3220 PRINCIPLES OF PROGRAMMING LANGUAGES (3) LEC. 3. Pr. COMP 2210 or COMP 2213. Study of programming language principles supporting procedural abstraction, data abstraction, storage allocation, and parallel execution; language types and examples; language translations.

COMP 3270 INTRODUCTION TO ALGORITHMS (3) LEC. 3. Pr. COMP 2240 and (COMP 2210 or COMP 2213). Algorithms for standard computational problems and techniques for analyzing their efficiency; designing efficient algorithms and experimentally evaluating their performance.

COMP 3350 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 or COMP 2713) and (COMP 3350 or COMP 3353 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 or COMP 3353. 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 2710 and (COMP 3350 or ELEC 2220) 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 or COMP 3703. 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 (2) LEC. 2. Pr. PHIL 1020 or PHIL 1023 or PHIL 1027 or PHIL 1110 or PHIL 1113. Application of ethical principles to computing-related topics, including privacy, property rights, autonomy, access, and diversity. Communication and teamwork are integral course experiences.

COMP 4800 PROFESSIONAL DEVELOPMENT II (1) LEC. 1. Pr. COMP 2800. Discussion and activities in effective communication, ethical solutions, and career development in preparation for students to transition into professional practice and lifelong learning in Computer Science and Software Engineering.

COMP 4810 PROGRAM ASSESSMENT (0) LEC. SU. Pr. COMP 4800. Coreq. UNIV 4AA0. Academic program assessment to include curriculum, course offerings and content, student services, and career exploration and first destination outcomes. Course may be repeated for a maximum of 10 credit hours.

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. Departmental approval. Investigation of current topics in computer science and software engineering. Course may be repeated for a maximum of 12 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 DATABASE SYSTEMS I (3) LEC. 3. Pr. COMP 3270 or COMP 3273. 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 or COMP 3273. 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 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 5320 DESIGN AND ANALYSIS OF COMPUTER NETWORKS (3) LEC. 3. Pr. COMP 4320 or COMP 4323. Departmental approval. Computer networks design, including multiplexing, switching, routing, internetworking, transport protocols, congestion control, and performance evaluation.

COMP 5350 DIGITAL FORENSICS (3) LEC. 3. Pr. COMP 2710 or ISMN 3080 or MNGT 3080 or MNGT 3087 or COMP 2713. 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 5370 COMPUTER AND NETWORK SECURITY (3) LEC. 3. Pr. COMP 4320. Fundamentals of computer security. Access Control. Authentication. Digital signatures and watermarks. Modeling and performance assessment. Viruses and worms. Identification of avenues for compromising systems.

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 SECURE 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 5600 ARTIFICIAL INTELLIGENCE (3) LEC. 3. Pr. COMP 3270 or COMP 3273. Departmental approval. Introduction to intelligent agents, search knowledge representation and reasoning, machine learning.

COMP 5610 ARTIFICIAL INTELLIGENCE PROGRAMMING (3) LEC. 3. Pr. COMP 5600. Design and implementation of advanced artificial intelligence techniques including expert systems, planning, logic, and constraint programming, knowledge representation and heuristic search methods.

COMP 5620 USER INTERFACE DESIGN AND EVALUATION (3) LEC. 3. Pr. COMP 3270 or COMP 3273. Departmental approval. Theory and practice of designing interfaces for interactive systems, usability engineering techniques; implementing and evaluating interfaces.

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 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 EVOLUTIONARY COMPUTING (3) LEC. 3. Pr. COMP 3270 and (STAT 3010 or STAT 3600). 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 SECURE SOFTWARE PROCESS (3) LEC. 3. Pr. COMP 3700 or COMP 3710. Process models of the software life cycle as well as methods and tools for software development with a special emphasis on secure software engineering.

COMP 5710 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 5830 CYBERSECURITY THREATS AND COUNTERMEASURES (3) LEC. 3. LAB. 0, DSL/LEC. 0. Pr. COMP 4320. Analysis of methods used by ethical hackers to identify security threats against networks, systems, and personnel. Examination of tactics, techniques, and procedures employed by threat actors and defensive countermeasures.

COMP 5870 SECURITY INTEGRATION AND APPLICATION (1) LEC/LST. Coreq. COMP 4710. Departmental approval. Exploration of the integration and application of state-of-the-practice cybersecurity topics.

COMP 5970 SPECIAL TOPICS (1-3) LEC. 1-3. 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 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 6120 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 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 6210 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 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 6350 DIGITAL FORENSICS (3) LEC. 3. Departmental approval. Computer compromise and forensics, with focus on computer crime and ways to uncover, protect, and exploit digital evidence.

COMP 6360 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 6370 COMPUTER AND NETWORK SECURITY (3) LEC. 3. Departmental approval. Fundamentals of computer security. Access Control. Authentication. Digital signatures and watermarks. Modeling and performance assessment. Viruses and worms. Identification of avenues for compromising systems.

COMP 6520 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 6530 SECURE CLOUD COMPUTING: PRINCIPLES, PRACTICE, AND APPLICATIONS (3) LEC. 3. Cloud concepts and issues including architecture, service models, security, and implementation. Hands-on experience in both using, managing, and deploying clouds.

COMP 6600 ARTIFICIAL INTELLIGENCE (3) LEC. 3. Departmental approval. Introduction to intelligent agents, search knowledge representation and reasoning, machine learning.

COMP 6610 ARTIFICIAL INTELLIGENCE PROGRAMMING (3) LEC. 3. Pr. COMP 6600 or COMP 6606. Design and implementation of advanced artificial intelligence techniques including expert systems, planning, logic and constraint programming, knowledge representation and heuristic search methods.

COMP 6620 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 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 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 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 SECURE SOFTWARE PROCESS (3) LEC. 3. Pr. COMP 3700. Process models of the software life cycle as well as methods and tools for software development with a special emphasis on secure software engineering.

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

COMP 6720 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 6830 CYBERSECURITY THREATS AND COUNTERMEASURES (3) LEC. 3. Pr. COMP 4320. Analysis of methods used by ethical hackers to identify security threats against networks, systems, and personnel. Examination of tactics, techniques, and procedures employed by threat actors and defensive countermeasures.

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

COMP 7120 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 ADVANCED TOPICS IN ALGORITHMS (3) LEC. 3. Departmental approval. In-depth study of advanced topics in algorithms.

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

COMP 7370 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 7500 ADVANCED TOPICS IN OPERATING SYSTEMS (3) LEC. 3. Departmental approval. Advanced topics in operating system concepts, design and implementation.

COMP 7620 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 7660 RESEARCH METHODS IN EVOLUTIONARY COMPUTING (3) LEC. 3. Pr. COMP 6660 or COMP 5660. This course prepares students to perform independent research in general, and in the field of evolutionary computing (EC) in specific. This course covers in the context of EC: ideation, literature review, proposal writing and evaluation, research software design and implementation, experiment design and analysis, scientific writing and evaluation, and scientific oral presentation.

COMP 7700 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 7720 SOFTWARE REVERSE ENGINEERING (3) LEC. 3. Pr. P/C COMP 6370 or COMP 6376. Process, methods and tools associated with software reverse engineering. Course covers static and dynamic analysis techniques applied to analyze malware (i.e., malicious software).

COMP 7800 ARTIFICIAL INTELLIGENCE FOR SECURITY (3) LEC. 3. Exposes students in mixed-discipline teams to applying concepts and techniques in the AI domain to real-world problems of the security domain. In addition to practical experience with both domains, it will also provide students the opportunity to apply a multidisciplinary perspective conveying the "conventional wisdom" and mindsets of both AI and security through project-based learning. This course mimics R&D environments where teams extract requirements from customers, identify the state-of-the-art, design and propose solutions, implement and evaluate those solutions, and culminates in both customer and technical communication of project artifacts.

COMP 7810 PROGRAM ASSESSMENT (0) LEC. SU. Coreq. UNIV 4AA0. Academic program assessment to include curriculum, course offerings and content, student services, and career exploration and first destination outcomes. Course may be repeated for a maximum of 10 credit hours.

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

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

COMP 7980 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 RESEARCH AND THESIS (1-15) DSL. May count either COMP 7990 or COMP 7996. Course may be repeated with change in topics.

COMP 8930 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 RESEARCH AND DISSERTATION (1-20) DSL/DSR. Course may be repeated with change in topics.

Computer Science Courses

CPSC 1210 INTRODUCTION TO COMPUTER SCIENCE I (3) LEC. 45. Admission into Bachelor of Computer Science Program. Introduces the fundamental concepts of object-oriented programming.

CPSC 1220 INTRODUCTION TO COMPUTER SCIENCE II (3) LEC. 45. Pr. CPSC 1213 or CPSC 1210. 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 1230 DATA STRUCTURES (3) LEC. 45. Pr. CPSC 1223 or CPSC 1220. 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 2010 INTRODUCTION TO COMPUTER SCIENCE I (3) DSL. 45. Admission into Bachelor of Computer Science Program. Introduces the fundamental concepts of object-oriented programming.

CPSC 2710 SOFTWARE CONSTRUCTION FUNDAMENTALS (3) LEC. 45. Pr. CPSC 1233 or CPSC 1230. 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 3220 PROGRAMMING LANGUAGES AND TRANSLATION (3) DSL. Pr. (CPSC 1230 or CPSC 1233) and (CPSC 3300 or CPSC 3303). Admission into Bachelor of Computer Science Program. Fundamental concepts of programming language design, interpretation, and compilation.

CPSC 3240 DISCRETE STRUCTURES (3) LEC. 45. 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 3270 ALGORITHMS I (3) LEC. 45. Pr. CPSC 1233 or CPSC 1230. Admission into Bachelor of Computer Science Program. Introduction to algorithms as tools for computational I 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 3280 ALGORITHMS II (3) LEC. 45. Pr. CPSC 3270 or 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 3300 COMPUTER ORGANIZATION AND ASSEMBLY LANGUAGE PROGRAMMING (3) LEC. 45. Pr. (CPSC 3243 or CPSC 3240) and (CPSC 1213 or CPSC 1210). 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 3320 COMPUTER ARCHITECTURE (3) LEC. 45. Pr. CPSC 3333 or CPSC 3330. 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 3330 OPERATING SYSTEMS (3) LEC. 45. Pr. (CPSC 1230 or CPSC 1233) and (CPSC 3300 or 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 3340 PARALLEL SYSTEMS (3) LEC. 45. Pr. CPSC 3333 or CPSC 3330. 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 3350 COMPUTER NETWORKS I (3) LEC. 45. Pr. CPSC 3330 or 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 3360 COMPUTER NETWORKS II (3) LEC. 45. Pr. CPSC 3353 or CPSC 3350. Admission into Bachelor of Computer Science Program. Computer network design, including multiplexing, switching, routing, internetworking, transport protocols, congestion control, and performance evaluation.

CPSC 3370 WIRELESS AND MOBILE NETWORKS (3) DSL. Pr. CPSC 3353 or CPSC 3350. 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 3700 SOFTWARE ENGINEERING I (3) LEC. 45. Pr. CPSC 2713 or CPSC 2710. Admission into Bachelor of Computer Science Program. Current processes, methods, and tools related to modeling and designing software systems.

CPSC 3710 SOFTWARE ENGINEERING II (3) DSL. Pr. CPSC 3703 or CPSC 3700. Admission into Computer Science Online Program. Current processes, methods, and tools related to modeling and designing software systems.

CPSC 4000 SYSTEM ADMINISTRATION (3) LEC. 45. Pr. CPSC 3330 or 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 4200 FORMAL LANGUAGES (3) DSL/LEC. 45. Pr. (CPSC 3273 or CPSC 3270) and (CPSC 3243 or CPSC 3240). 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 4730 COMPUTER ETHICS (3) LEC. 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 4800 PROFESSIONAL DEVELOPMENT I (1) DSL. Discussion and activities in effective communication, ethical solutions, and career development in preparation for students to transition into professional practice and lifelong learning in Computer Science.

CPSC 4810 PROFESSIONAL DEVELOPMENT II (1) DSL. Pr. CPSC 4800. Discussion and activities in effective communication, ethical solutions, and career development in preparation for students to transition into professional practice and lifelong learning in Computer Science.

CPSC 4820 PROGRAM ASSESSMENT (0) DSL. SU. Coreq. UNIV 4AA0. Academic program assessment to include curriculum, course offerings and content, student services, and career exploration and first destination outcomes. Course may be repeated for a maximum of 10 credit hours.

CPSC 4970 SPECIAL TOPICS (3) LEC. 3. Investigation of current topics in computer science. Course may be repeated for a maximum of fifteen credit hours.

CPSC 5120 DATABASE I (3) LEC. 45. Pr. CPSC 1230 or 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 5130 DATABASE II (3) LEC. 45. Pr. CPSC 5123 or CPSC 5120. Admission into Bachelor of Computer Science Program. Theory, design, and implementation of database systems.

CPSC 5200 DEVELOPING WEB APPLICATIONS WITH XML (3) LEC. 45. Pr. CPSC 1230 or 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 5210 WEB APPLICATION DEVELOPMENT WITH JSP (3) LEC. 40. Pr. CPSC 5203 or CPSC 5200. 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 5330 MOBILE APPLICATIONS I (3) LEC. 45. Pr. CPSC 2710 or 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 5340 MOBILE APPLICATION DEVELOPMENT II (3) LEC. 3. Pr. CPSC 5330 or 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 1220 or COMP 1230 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. 3. Pr. ELEC 2110 and MATH 2650 and (MATH 2630 or MATH 2633 or MATH 2637). Time-domain and frequency-domain methods for modeling and analyzing continuous and discrete-data signals and systems. Generating and observing signals in the time and frequency domains. MATLAB instruction and programming for signal analysis.

ELEC 2200 DIGITAL LOGIC CIRCUITS (3) LEC. 3. Pr. COMP 1200 or COMP 1220 or COMP 1230 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 and (MATH 2630 or MATH 2633 or MATH 2637) and MATH 2650. 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 P/C 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 or MATH 2667) and ELEC 2110 and (MATH 2630 or MATH 2633 or MATH 2637) and MATH 2650. 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 and (MATH 2630 or MATH 2633 or MATH 2637) and MATH 2650. Introduction to the basic concepts in electric power engineering.

ELEC 3700 ANALOG ELECTRONICS (3) LEC. 3. Pr. ELEC 2210 and ELEC 2120. Amplifier modeling. Design and analysis of single-stage and multistage transistor amplifiers. Biasing for integrated circuit design. Operational amplifier circuits.

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 or PHYS 1617) and P/C MATH 2650. Electrical circuit analysis; electronic devices, digital systems, amplifier concepts, power devices and systems. Not open to ECE majors.

ELEC 4010 CAPSTONE DESIGN I (1) LEC. 1. Pr. (ELEC 3800 and P/C ELEC 3030 and P/C ELEC 3040) or (P/C ELEC 3800 and P/C ELEC 3050 and P/C ELEC 4200) or (ELEC 3800 and 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 and ELEC 3030 and ELEC 3040 and ELEC 3320 and ELEC 3600 and ELEC 3700 and P/C ELEC 3400) or (ELEC 4010 and ELEC 3050 and ELEC 3800 and ELEC 4200 and COMP 3270 and P/C ELEC 5200 and P/C ELEC 5220) or (ELEC 4010 and ELEC 3030 and ELEC 3060 and P/C ELEC 4100 and P/C ELEC 5130 and P/C ELEC 5410). A capstone design project which draws on the accumulated curricular experience. Particular project sections may have additional prerequisites. Departmental approval needed.

ELEC 4100 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 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 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 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 5240 NEURAL NETWORKS (3) LEC. 3. Pr. ELEC 2120. Principles, architectures, and technologies of neural networks; design and implementation of neural networks using electronics and optics; applications of neural networks.

ELEC 5250 COMPUTER AIDED DESIGN OF DIGITAL INTEGRATED 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 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 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 5600 ELECTRIC VEHICLES (3) LEC. 3. Pr. ELEC 3600 or ELEC 3810. Electric vehicles, technical aspects, mathematical relationships, and basic design guidelines on electric powertrain, traction inverters, electric machines, motor drives, power converter components, Wide Band Gap power electronics, permanent magnets, battery charging infrastructures, grid interactions, the roles in microgrids and smart grids, and computer simulations.

ELEC 5610 POWER ELECTRONICS (3) LEC. 3. Pr. ELEC 3700 and ELEC 3600. Power electronic circuits, components, and devices.

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 5630 ELECTRIC MACHINES (3) LEC. 3. Pr. ELEC 3600. Departmental approval. Fundamentals of the electromagnetic-mechanical energy conversion process. Principles of operation, application, and control of ac and dc motors and generators.

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 5660 SMART GRIDS (3) LEC. 3. Pr. ELEC 3600 or ELEC 3810. Conventional power systems, renewable energy, inverter base resources, smart grid challenges and opportunities, real-time management, grid edge sensors, communications, advanced system protection, restoration, reactive/voltage control, real power/frequency regulation, monitoring and diagnostics, microgrids concept.

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

ELEC 5690 MICROGRIDS (3) LEC. 3. Pr. ELEC 3600 or ELEC 3810. Distribution power system modeling, inverter-based resources, control, protection, resilience, and security technologies within distributed energy resources (generation, distribution, energy storage, reactive compensation, renewable energy resources) covering microgrid design, analysis, and operation.

ELEC 5700 SEMICONDUCTOR FUNDAMENTALS (3) LEC. 3. Pr. ELEC 2210. 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 2210. Introduction to semiconductor devices: pn junctions, junction diode based devices, optoelectronic devices, bipolar transistors, field effect transistors.

ELEC 5720 LASER-MATERIAL INTERACTIONS (3) LEC. 3. Pr. MATH 1620 or Departmental approval. Fundamental principles of lasers, optics, and laser-matter interaction mechanisms in various laser-based manufacturing, materials processing, and diagnostic techniques.

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 5760 SOLID STATE SENSORS (3) LEC. 3. Pr. ELEC 3700. or consent of instructor. 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. 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 6120 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 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 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 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 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 PARALLEL PROCESSING (3) LEC. 3. Hardware components of multiprocessor systems including processor, inter-connection, memory and control architectures; software elements of parallel processing.

ELEC 6240 NEURAL NETWORKS (3) LEC. 3. Principles, architectures, and technologies of neural networks; design and implementation of neural networks using electronics and optics; applications of neural networks.

ELEC 6250 COMPUTER AIDED DESIGN OF DIGITAL INTEGRATED CIRCUITS (3) DSL/LEC. 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 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 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 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 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 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 RADAR PRINCIPLES (3) LEC. 3. Study of the fundamentals of RADAR and related systems such as SONAR and LIDAR.

ELEC 6410 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 MOBILE ROBOT DESIGN (3) LEC. 3. Fundamentals of mobile robot design, including motor control, sensor integration, path planning, navigation, and localization. Departmental Approval.

ELEC 6600 ELECTRIC VEHICLES (3) LEC. 3. Electric vehicles, technical aspects, mathematical relationships, and basic design guidelines on electric powertrain, traction inverters, electric machines, motor drives, power converter components, Wide Band Gap power electronics, permanent magnets, battery charging infrastructures, grid interactions, the roles in microgrids and smart grids, and computer simulations.

ELEC 6610 POWER ELECTRONICS (3) LEC. 3. Power electronic circuits, components, and devices. Departmental Approval.

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

ELEC 6630 ELECTRIC MACHINES (3) LEC. 3. Departmental approval. Fundamentals of the electromagnetic-mechanical energy conversion process. Principles of operation, application, and control of ac and dc motors and generators.

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 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 6660 SMART GRIDS (3) LEC. 3. Conventional power systems, renewable energy, inverter base resources, smart grid challenges and opportunities, real-time management, grid edge sensors, communications, advanced system protection, restoration, reactive/voltage control, real power/frequency regulation, monitoring and diagnostics, microgrids concept.

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

ELEC 6690 MICROGRIDS (3) LEC. 3. Distribution power system modeling, inverter-based resources, control, protection, resilience, and security technologies within distributed energy resources (generation, distribution, energy storage, reactive compensation, renewable energy resources) covering microgrid design, analysis, and operation.

ELEC 6700 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 SEMICONDUCTOR DEVICES (3) LEC. 3. Introduction to semiconductor devices: pn junctions, junction diode based devices, optoelectronic devices, bipolar transistors, field effect transistors.

ELEC 6720 LASER-MATERIAL INTERACTIONS (3) LEC. 3. Departmental approval. Fundamental principles of lasers, optics, and laser-matter interaction mechanisms in various laser-based manufacturing, materials processing, and diagnostic techniques.

ELEC 6730 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 6750 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 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 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 ANALOG CIRCUIT DESIGN (3) LEC. 3. Circuit design techniques used for implementing analog integrated circuits in both CMOS and bipolar technologies.

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

ELEC 6820 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 SPECIAL TOPICS (1-5) DSL. 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 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 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 7310 ADVANCED ELECTRODYNAMICS I (3) LEC. 3. Departmental approval. Review of basic electromagnetics. Electromagnetic wave propagation in infinite and bounded media. Equivalence Principle, Uniqueness Theorem, Reciprocity, Green's functions and Plane wave functions.

ELEC 7320 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 7410 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 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 or ELEC 6470. Memory/PLA/FPGA testing, delay fault testing, test compression, in-field testing, cell-aware test, adaptive test, system-level test.

ELEC 7500 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 7520 ADVANCED DISCRETE CONTROL (3) LEC. 3. Departmental approval. Discrete state modeling. Pole assignment and estimation. Multi-rate sampled systems. Non-synchronous sampled systems. MIMO.

ELEC 7560 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 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 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 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 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 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 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 7750 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 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 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 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 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 SPECIAL TOPICS (1-5) DSL. 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 RESEARCH AND THESIS (1-6) MST. Course may be repeated for a maximum of 6 credit hours.

ELEC 8120 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 8560 ADAPTIVE CONTROL (3) LEC. 3. Pr. ELEC 7500 or ELEC 7506. Departmental approval. Theory and application of adaptive control systems. Real-time parameter estimation, self-tuning regulators, model-reference adaptive systems, stability, auto-tuning and gain scheduling controllers.

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 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 RESEARCH AND DISSERTATION (1-10) DSL/DSR. Individual doctoral dissertation research. Course may be repeated with change in topics.

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 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 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. 3. Pr. (CHEM 1030 or CHEM 1033 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.

ENGR 2030 FUNDAMENTALS OF 3D PRINTING (2) LEC. 1. LAB. 3. Introductory level practical aspects of 3D printing, including: model file generation, computer aided design (CAD), slicing, and hands-on printing. Overview of 3D printing technologies and practical troubleshooting.

ENGR 2050 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. Minimum grade of C or better in ENGR 2050. 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 2077 HONORS MECHANICS OF MATERIALS (3) LEC. 3. Pr. Honors College. MATH 2650 and ENGR 2050 or ENGR 2053. Minimum grade of C or better in ENGR 2050. 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 or CHEM 1033) 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 3920 INTERNSHIP IN ENGINEERING (0) INT. SU. Professional work experience in an engineering position. Students participating in ENGR 3920 are expected to work in a fulltime, 40 hour/week, engineering job. Course may be repeated for a maximum of 10 credit hours.

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 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. 1. 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 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 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 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 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 7920 INTERNSHIP IN ENGINEERING (0) INT. SU. Professional work experience in an engineering position. Course may be repeated for a maximum of 10 credit hours.

ENGR 7940 MASTER OF ENGINEERING PROGRAM ASSESSMENT (0) IND. 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 or COMP 1220 or COMP 1230. 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. 2.5. 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 or MATH 2667) 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. Junior or Senior standing.

INSY 3607 HONORS 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. Departmental approval required for non-INSY majors.

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 PROFESSIONAL PRACTICE (1) LEC. 1. 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 3010 and INSY 3400 and INSY 3410 and INSY 3420 and (INSY 3600 or INSY 3607) 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. 0. LAB. 3. Pr. INSY 3021 and (INSY 4500 or INSY 4503) and P/C 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 5010 OCCUPATIONAL SAFETY ENGINEERING (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 5050 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 chemical exposures, biological hazards, noise and heat stress for undergraduate engineers.

INSY 5080 HUMAN FACTORS ENGINEERING (3) LEC. 3. Human Factors Engineering is the science of designing products and systems for optimal human well-being and system performance. This course will focus on information processing and the cognitive aspects of ergonomics design. Students will gain insight into the effects of various environments (hot, cold, noise, information overload, etc.) on humans and human performance. Physical ergonomics will be addressed somewhat as well. Emphasis is on human information input, output, and control processes with the objective of optimizing the integration of the human into simple and complex systems.

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. 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. 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 5400 MULTI-PARADIGM MODELING AND SIMULATION (3) LEC. 2. LAB. 1. Pr. INSY 3420. Multi-paradigm simulation modeling procedures for analyzing real-world complex systems. Emphasis on model building, and construction of multi-paradigm computer simulation models using Agent Based Modeling, System Dynamics, and Discrete Event Simulation approaches.

INSY 5450 SIMULATION-BASED PLANNING AND SCHEDULING (3) LEC. 3. Pr. INSY 3420. A graduate/undergraduate course in simulation-based planning and scheduling. Topics include intermediate simulation modeling, dispatching and scheduling methods, and implementation of scheduling systems and supply chain planning systems using a commercial simulation software package.

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. INSY 3010. 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 5800 LEAN SYSTEMS (3) LEC. 2. LAB. 2. 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 INNOVATIONS IN MANUFACTURING SYSTEMS (3) LEC. 3. This course reviews the history of manufacturing and discusses the contributions of the automotive manufacturing industry in developing most of the major manufacturing systems improvements over the decades. Issues associated with suppliers are presented related to processes, supply chain, product and process improvement, quality control, and costs. In addition, the issue of globalization and the digitalization of manufacturing is investigated. Finally, a discussion of future manufacturing technologies and impacts will be discussed. Credit will not be given for both INSY 5860 and INSY 6860/6866.

INSY 5870 INTERACTIVE SENSING SYSTEMS (3) LEC. 3. Pr. (INSY 3010). Interactive Sensing Systems is an advanced course designed to provide students with in-depth knowledge and hands-on experience in developing intelligent systems that integrate microcontrollers and sensors. The course emphasizes the practical application of sensor technologies and microcontroller programming to solve real-world problems.

INSY 6010 OCCUPATIONAL SAFETY ENGINEERING (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. Credit will not be given for both INSY 5010 and INSY 6010.

INSY 6050 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 chemical exposures, biological hazards, noise and heat stress for graduate engineers.

INSY 6080 HUMAN FACTORS ENGINEERING (3) LEC. 3. Human Factors Engineering is the science of designing products and systems for optimal human well-being and system performance. This course will focus on information processing and the cognitive aspects of ergonomics design. Students will gain insight into the effects of various environments (hot, cold, noise, information overload, etc.) on humans and human performance. Emphasis is on human information input, output, and control processes with the objective of optimizing the integration of the human into simple and complex systems.

INSY 6100 SYSTEMS ENGINEERING I (3) LEC. 3. Processes and tools for engineering large-scale, 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. Credit will not be given for both INSY 5100 and INSY 6100.

INSY 6240 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 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 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 6400 MULTI-PARADIGM MODELING AND SIMULATION (3) LLB. Pr. INSY 7400. Multi-paradigm simulation modeling procedures for analyzing real-world complex systems. Emphasis on model building, and construction of multi-paradigm computer simulation models using Agent Based Modeling, System Dynamics, and Discrete Event Simulation approaches. Students must have successfully passed a graduate level course in Probability and Statistics or an equivalent course, INSY 7400, or request instructor approval.

INSY 6450 SIMULATION-BASED PLANNING AND SCHEDULING (3) DSL/LEC. A graduate/undergraduate course in simulation-based planning and scheduling. Topics include intermediate simulation modeling, dispatching and scheduling methods, and implementation of scheduling systems and supply chain planning systems using a commercial simulation software package. Knowledge of simulation and basic understanding of Simio is required to enroll in course.

INSY 6500 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 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 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 6700 DIGITAL DRAWINGS, GEOMETRIC TOLERANCES, AND METROLOGY FOR INDUSTRY 4.0 (4) LEC. 3. LAB. 2.33. Departmental approval. Digital manufacturing begins with accurate electronic drawings designed with precision measurement in mind. This course covers the design, dimensioning, tolerancing, and inspection for part and assembly manufacturing from the ASME Y14.5 (2018) Standard. Students will model parts in a CAD program, create manufacturing inspection drawings with applied GD&T concepts, and work with an industry grade Coordinate Measurement Machine (CMM) software to develop inspection plans. Basic Computer Aided Design (CAD) concepts are taught in Fusion 360.

INSY 6710 BASIC CONCEPTS OF 21ST CENTURY MANUFACTURING PROCESSES (3) LEC. 3. Departmental approval. This is the first of a two-semester program detailing all the manufacturing concepts and processes available in the 21st Century. There is a heavy emphasis on the interaction of shapes, materials and process in design and economic decision making. Students will review basic fundamentals of acceptance testing, material properties and characteristics as a foundation for all process decisions. Processes introduced in this course will include metal casting, rolling, and extrusion.

INSY 6720 ADVANCED CONCEPTS OF 21ST CENTURY MANUFACTURING PROCESSES (3) LEC. 3. Departmental approval. This is the second of a two-semester program detailing all the manufacturing concepts and processes available in the 21st Century. There is a heavy emphasis on the interaction of shapes, materials and process in design and economic decision making. This course covers all the classic and modern subtractive methods as well as the joining methods. Automation of manufacturing processes, computer aided and computer integrated manufacturing along with industry 4.0 are covered.

INSY 6730 CONCEPTS OF COMPUTER NUMERICAL CONTROLS (4) LEC. 3. LAB. 2.33. Pr. INSY 5700 or INSY 6700. Departmental approval. This course will introduce key concepts involved in the use of Computer Aided Machining. Concepts include the construction of tools within CAM software, determining feeds and speeds from tool manufacturer specifications, basics of G-Code and M-Code, and various tool pathing operations. The course covers model-based CAM, conversational CAM, and basic 3D printing concepts. The model-based CAM portion will cover 3 axis and 5 axis mill work, lathe operations, and mill turn operations.

INSY 6740 CONCEPTS OF INDUSTRY 4.0 (3) LEC. 2. LAB. 2.33. Pr. INSY 5700 or INSY 6700. Departmental approval. Students develop a firm understanding of the fundamentals of Mechatronics and learn how to utilize these new tools in conjunction with the Industrial Internet of Things (IIOT) via the MTConnect Standard. Topics include circuits, sensors, actuators, controls, communication protocols, Industry 4.0, and the MTConnect Standard. Labs will be held at the Interdisciplinary Center for Advanced Manufacturing Systems (ICAMS).

INSY 6800 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 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 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 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 INNOVATIONS IN MANUFACTURING SYSTEMS (3) LEC. 3. This course reviews the history of manufacturing and discusses the contributions of the automotive manufacturing industry in developing most of the major manufacturing systems improvements over the decades. Issues associated with suppliers are presented related to processes, supply chain, product and process improvement, quality control, and costs. In addition, the issue of globalization and the digitalization of manufacturing is investigated. Finally, a discussion of future manufacturing technologies and impacts will be discussed. Credit will not be given for both INSY 5860 and INSY 6860.

INSY 6870 INTERACTIVE SENSING SYSTEMS (3) LEC/LLB. Interactive Sensing Systems is an advanced course designed to provide students with in-depth knowledge and hands-on experience in developing intelligent systems that integrate microcontrollers and sensors. The course emphasizes the practical application of sensor technologies and microcontroller programming to solve real-world problems.

INSY 7020 SYSTEM SAFETY ENGINEERING (3) LEC. 3. Systems safety analysis techniques including human error and reliability, fault trees, and cost benefit analysis.

INSY 7040 COGNITIVE ENGINEERING AND SYSTEM DESIGN (3) LEC. 3. Cognitive Engineering and System Design is an introduction into human capabilities and limitations in human-machine interaction, with a focus on human cognition, memory, attention, and error. The course emphasis is on cognitive engineering theory and its application to automated system design.

INSY 7060 FUNDAMENTALS OF ERGONOMICS (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 OCCUPATIONAL BIOMECHANICS (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 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 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 DATA ANALYTICS FOR OPERATIONS (3) LEC. 3. Pr. INSY 6500 or INSY 6506. 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 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 7290 OCCUPATIONAL SAFETY AND HEALTH PRACTICUM I (1) LEC. 1. Study of contemporary interdisciplinary issues in occupational safety and health. Investigation of real-world interdisciplinary OSH problems. Analysis and presentation of OSH concerns and solutions.

INSY 7300 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 7380 RELIABILITY ENGINEERING (3) LEC. 3. Departmental approval. Reliability Engineering is a sub-discipline of systems engineering that emphasizes the ability of a system or component to function without failure. This course covers concepts and methods to evaluate the reliability of engineering systems. The primary focus is on statistical reliability distributions, analysis of reliability data, prediction of failure and reliability modeling, accelerated life testing, reliability of complex systems, and design for reliability.

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 APPLIED DISCRETE-EVENT SIMULATION MODELING (3) LEC. 3. Introductory graduate course in discrete event modeling and simulation. Course focus is on the application of modern simulation tools and techniques for solving design and analysis problems in manufacturing, service systems, and general operations.

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

INSY 7430 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 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 7450 STOCHASTIC OPTIMIZATION AND RISK (3) LEC. 3. Pr. INSY 7420. Stochastic Optimization and Risk is a course for graduate students in engineering, operations research, management science, etc. The objective of the course is to familiarize students with the challenges that uncertain or randomized data bring into the decision making/design process and introduce the general methods and approaches for dealing with such challenges. We will discuss various approaches to modeling of uncertainties and risk in optimization problems, properties of the resulting stochastic programming formulations, and several common techniques for solving stochastic programs.

INSY 7470 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 7550 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 SYSTEM LIFECYCLE REQUIREMENTS (3) LEC. 3. The System Lifecycle Requirements course focuses on developing and writing proper requirements for systems across the entire life cycle. Well written requirements are a solid foundation for system design development and this course will identify design considerations at early concept identification, design maturation, implementation, production, operations & sustainment, and disposal phases. Students will exercise stakeholder needs elicitation, requirements writing, requirements decomposition, and applying life cycle considerations during requirements development process during a semester long project.

INSY 7730 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 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 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 7760 ENGINEERING & TECHNOLOGY MANAGEMENT (3) LEC. 3. Engineering Management is the branch of management that focuses on leading technical personnel in the management of engineering driven enterprises. This course emphasizes the application of management principles to the engineering of large-scale systems and research efforts. It focuses on the planning, individual & team motivation, strategic /tactical management, change and risk management and decision-making necessary to manage a company's technical portfolio.

INSY 7940 INDUSTRIAL AND SYSTEMS ENGINEERING PROBLEMS (1-5) DSL/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 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 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 MASTER'S IN INDUSTRIAL AND SYSTEMS ENGINEERING PROJECT (1-5) DSL/IND. SU. Non-thesis master's project. Course may be repeated for a maximum of 5 credit hours.

INSY 7990 RESEARCH AND THESIS (1-10) MST. Departmental approval. Individual masters research. May be repeated for credit. Course may be repeated with change in topics. No more than six hours may be counted toward meeting degree requirements. Must be an INSY major.

INSY 8010 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 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 CONTEMPORARY 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 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 RESEARCH AND DISSERTATION (1-10) DSL/DSR. Departmental approval. Individual doctoral dissertation research. May be repeated for credit. Course may be repeated with change in topics. Must be INSY major.

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. Technologies for sustainable energy production and storage, renewable energy conversion, associated materials challenges.

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

MATL 2230 MINERAL RESOURCES: PROCESSING AND AVAILABILITY (1) LEC. 1. 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 4500 MATERIALS PROPERTIES AND SELECTION (4) LEC. 3. LAB. 3. Pr. ENGR 2070 and MATL 3100 and MATL 3200. Methods for microstructure control. Design of processing sequences, statistical and economical analysis.

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 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 5420 PLASMONICS AND NANOPHOTONICS (3) LEC. 3. Pr. PHYS 1600 or PHYS 1610. This course will cover both fundamental and application aspects, with an emphasis on basic principles in nanophotonics, nanophotonic devices for light manipulation, plasmonic energy transfer, biomedical treatment, plasmonics in emerging materials, etc.

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 5600 CORROSION (3) LEC. 3. Pr. CHEM 1040. Fundamentals of chemical degradation of materials. Types and methods for prevention and minimization of corrosion.

MATL 5700 BIOMATERIALS (3) LEC. 3. Departmental approval. Interactions between materials and proteins, cells, and tissue as related to medicine and biotechnology including tissue culture, cardiovascular, drug delivery, tissue engineering and other applications. Thermodynamics of protein adsorption. Cell biology of adhesion. Analytical methods, sterilization, and regulations.

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

MATL 6420 PLASMONICS AND NANOPHOTONICS (3) LEC. 3. This course will cover both fundamental and application aspects, with an emphasis on basic principles in nanophotonics, nanophotonic devices for light manipulation, plasmonic energy transfer, biomedical treatment, plasmonics in emerging materials, etc.

MATL 6500 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 6600 CORROSION (3) LEC. 3. Pr. CHEM 1040. Fundamentals of chemical degradation of materials. Types and methods for prevention and minimization of corrosion.

MATL 6700 BIOMATERIALS (3) LEC. 3. Departmental approval. Interactions between materials and proteins, cells, and tissue as related to medicine and biotechnology including tissue culture, cardiovascular, drug delivery, tissue engineering and other applications. Thermodynamics of protein adsorption. Cell biology of adhesion. Analytical methods, sterilization and regulations.

MATL 6720 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 6970 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 DEFORMATION AND FAILURE OF ENGINEERING MATERIALS (3) LEC. 3. Departmental approval. Theoretical presentation of the fundamental principles of deformation and failure in materials systems.

MATL 7120 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 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 7320 THIN FILM SCIENCE AND TECHNOLOGY (3) LEC. 3. Departmental approval. Structure, properties, characterization, processing and application of thin films.

MATL 7330 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 7420 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 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 7610 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 7630 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 DIRECTED READINGS IN MATERIALS ENGINEERING (1-6) DSL/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 SPECIAL TOPICS IN MATERIALS ENGINEERING (1-3) DSL. 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 MASTER MATERIALS ENGINEERING PROJECT (1-3) LEC. 3. SU. Special design project report directed by major faculty. Topics to be determined by the student's graduate committee. Course may be repeated for a maximum of 3 credit hours.

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

MATL 8990 RESEARCH AND DISSERTATION (1-15) DSL/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 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. 3. 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 2130 with a grade of C or higher.

MECH 2220 COMPUTER-AIDED ENGINEERING (3) LEC. 2. LAB. 3. Pr. (ENGR 1110 or ENGR 1113) and (COMP 1200 or COMP 1220 or COMP 1230) 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 3020 THERMODYNAMICS II (3) LEC. 3. Pr. ENGR 2010. Gas and Vapor power cycles, Refrigeration cycles, Gas and gas-vapor mixtures, Chemical reactions, Chemical and phase equilibrium, Thermodynamic property relations. Pr. ENGR 2010 with a grade of C or higher.

MECH 3030 FLUID MECHANICS (3) LEC. Pr. MECH 2130 and ENGR 2010 and MATH 2650 and 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. Pr. MECH 2130 with a grade of C or higher, and ENGR 2010 with a grade of C or higher.

MECH 3040 HEAT TRANSFER (3) LEC. 3. Pr. MECH 3020 and MECH 3030. Fundamentals of heat transfer by conduction, convection, and radiation. Introduction to heat exchangers.

MECH 3050 MEASUREMENT AND INSTRUMENTATION (3) LEC. 2. LAB. 3. Pr. MECH 3030 and P/C ELEC 3810. 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. 3. Pr. MECH 2130 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 (Grade of C or higher required in MECH 2130.)

MECH 3140 SYSTEM DYNAMICS AND CONTROLS (3) LEC. 3. Pr. 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. 1. Pr. MECH 2130 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 2130 with a grade of C or higher.

MECH 3230 MACHINE DESIGN (3) LEC. 3. Pr. MECH 3120 and MECH 2020 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 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. MECH 3140. 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 3120. 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. 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 4700 INTEGRATED ENGINEERING THEORY AND PRACTICE (3) LEC. 3. Pr. MECH 3200 and MECH 2020. 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 (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 9 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 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. Pr. MECH 2220 and MECH 3120. 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 3120. 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 3120. 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 2020. 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 3120. 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 3120 and ELEC 3810. Stress and strain analysis of microelectronic packages and electronic assemblies using analytical, experimental and numerical methods.

MECH 5320 ENGINEERED FLEXIBLE STRUCTURES (3) LEC. 3. LAB. 0, LEC. 0. Pr. (MECH 3120 or AERO 3610 or CHEN 3090 or CIVL 3310 or MATL 3200). Fiber to fabric design, engineering, manufacturing, testing and applications. Principles of modern machinery and techniques for flexible material manufacturing.

MECH 5330 INTRODUCTION TO BIOMECHANICAL ENGINEERING (3) LEC. 3. Pr. MECH 2140 and MECH 3120 and MECH 2130. Introduction to the multidisciplinary field of study called Biomechanical Engineering – a mechanics and calculus-based examination of energy and forces within living systems and the physical effects produced by such energy and forces. Topics covered include 1) human musculoskeletal physiology and anatomy, 2) mechanics of biological materials, 3) biomechanically relevant rigid body dynamics, 4) engineering of technology and applications to biomechanical systems, 5) medical imaging technology, and 6) applications of biomechanical engineering study.

MECH 5390 FUNDAMENTALS OF THE FINITE ELEMENT METHOD (3) LEC. 3. LAB. 0. Pr. MECH 3040 and MATH 2660 and MECH 3120. Introduction to the fundamentals of the finite element method.

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 3120. Basic concepts, fabrication and operation of micromachined semiconductor, piezoelectric, piezoresistive, capacitive and fiber-optic sensors.

MECH 5450 NON-DESTRUCTIVE EVALUATION OF MATERIALS AND STRUCTURES (3) LEC. 3. Pr. MECH 3120. Non-destructive testing fundamentals. Ultrasonic, acoustic, vibration strain analysis of microelectronic packages and electronic assemblies using analytical, experimental and numerical methods.

MECH 5500 ENGINEERING IN THE ARTS (3) LEC. 3. This course will educate students on the engineering associated with multiple forms of art such as the playing of musical instruments, painting, Renaissance architecture, and dance. Students will also learn about key historical figures of the Renaissance that held major influence on the origins of Western engineering, architecture, and art.

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 5520 MANUFACTURING OF POLYMERIC STRUCTURES (3) LEC. 3. LAB. 0, LEC. 0. Pr. MECH 3120 or AERO 3610 or CHEN 3090 or CIVL 3310 or MATL 3200. Characteristics and flow properties of polymers; film and fiber extrusion, compression and injection molding technology, polymer material selection and processing.

MECH 5610 MECHANICAL VIBRATION (3) LEC. 3. Pr. MECH 2140 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 2140 and ELEC 3810. Introduction to the integration of mechanisms, sensors, controllers and actuators for machines, and design of automatic machinery.

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 5840 APPLIED MECHATRONICS (3) LEC. 3. LAB. 0, LEC. 0. Pr. (P/C MECH 3140). Implementation basic circuits, power electronics, analog (continuous) and digital (discrete) control topics in multiple design projects.

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 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. 3. An overview of renewable energy options with an emphasis on available resources, advantages & disadvantages, and design principles.

MECH 6120 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 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 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 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 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 6300 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 6310 MECHANICS OF ELECTRONIC PACKAGING (3) LEC. 3. Stress and strain analysis of Microelectronic packages and electronic assemblies using analytical, experimental and numerical methods.

MECH 6320 ENGINEERED FLEXIBLE STRUCTURES (3) LEC. 3. LAB. 0, DSL/LEC. 0. Fiber to fabric design, engineering, manufacturing, testing and applications. Principles of modern machinery and techniques for flexible material manufacturing.

MECH 6330 INTRODUCTION TO BIOMECHANICAL ENGINEERING (3) LEC. 3. Introduction to the multidisciplinary field of study called Biomechanics – the examination of energy and forces within living systems and the physical effects produced by such energy and forces. Topics covered include 1) human musculoskeletal physiology and anatomy, 2) properties of biological materials, 3) biomechanically relevant mechanics, 4) methods and practice of measuring biomechanical systems, and 5) applications of biomechanical study.

MECH 6390 FUNDAMENTALS OF THE FINITE ELEMENT METHOD (3) LEC. 3. LAB. 0. Introduction to the fundamentals of the finite element method.

MECH 6420 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 BASICS OF SENSOR APPLICATIONS (3) LEC. 3. Basic concepts, fabrication and operation of micro machined semiconductor, piezoelectric, piezoresistive, capacitive and fiber-optic sensors.

MECH 6450 NON-DESTRUCTIVE EVALUATION OF MATERIALS AND STRUCTURES (3) LEC. 3. Non-destructive testing fundamentals. Ultrasonic, acoustic, vibration, and eddy current techniques. Case studies.

MECH 6500 ENGINEERING IN THE ARTS (3) LEC. 3. This course will educate students on the engineering associated with multiple forms of art such as the playing of musical instruments, painting, Renaissance architecture, and dance. Students will also learn about key historical figures of the Renaissance that held major influence on the origins of Western engineering, architecture, and art. Sample lecture topics include 1) Science and Engineering in The Renaissance, 2) Leonardo da Vinci, 3) Musical Vibrations and Acoustics, and 4) Architecture and Biomimicry.

MECH 6520 MANUFACTURING OF POLYMERIC STRUCTURES (3) LEC. 3. LAB. 0, DSL/LEC. 0. Characteristics and flow properties of polymers; film and fiber extrusion, compression and injection molding technology, polymer material selection and processing.

MECH 6610 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 6710 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 CONTROL OF ROBOTIC MOTION (3) LEC. 3. Application of various algorithms for robot manipulators.

MECH 6810 MECHATRONICS (3) LEC. 3. Introduction to the integration of mechanisms, sensors, controllers and actuators for machines and design of automatic machinery.

MECH 6830 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 6840 APPLIED MECHATRONICS (3) LEC. 3. Implementation basic circuits, power electronics, analog (continuous) and digital (discrete) control topics in multiple design projects.

MECH 6930 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 INTERMEDIATE SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) DSL. 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 ADVANCED THERMODYNAMICS (3) LEC. 3. Classical and statistical treatment of the laws and properties of thermodynamic systems; applications.

MECH 7110 ADVANCED FLUID MECHANICS I (3) LEC. 3. Mass Conservation, Linear and Angular Momentum Equations; Energy Equation for Fluid Systems; Foundations of Inviscid Flows.

MECH 7120 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 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 TURBULENCE (3) LEC. 3. Pr. MECH 7130 or MECH 7136. Properties of Turbulence; Governing Conservation, Momentum and Energy Equations; Time-averaging, Vorticity Equation; Turbulence Models; Shear Flows; Jets, Wakes and Boundary Layers; Experimental Techniques.

MECH 7210 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 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 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 NUMERICAL METHODS IN HEAT TRANSFER (3) LEC. 3. Advanced topics in finite element and finite difference methods; solution techniques, stability and convergence.

MECH 7250 BOILING AND CONDENSATION (3) LEC. 3. Hydrodynamics of vapor-liquid flow, pool boiling, forced convective boiling, condensation, instabilities in two-phase systems, augmentation of boiling and condensation.

MECH 7300 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 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 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 7330 EXPERIMENTAL MECHANICS (3) LEC. 3. Experimental methods for measurement of stress, strain and displacement. Strain gauges, transducers and brittle coatings. Transmission photoelasticity and photoelastic coatings. Introduction to moire' and coherent optical techniques.

MECH 7340 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 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 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 7390 VARIATIONAL MECHANICS (3) LEC. 3. Energy methods in solid mechanics. Virtual work, stationary potential energy, and variational calculus. Elastic strain energy. Applications to bars, trusses, beams, frames, and plates. Castigliano's Theorem and the Ritz Method.

MECH 7410 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 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 7610 ADVANCED DYNAMICS (3) LEC. 3. Dynamics of particles and systems of particles applied to engineering problems. Work-energy and impulse-momentum principles. Lagrange's equations and Hamilton's Principle.

MECH 7620 NONLINEAR SYSTEMS (3) LEC. 3. Introduction, geometrical concepts, analytical methods, Poincare' maps, strange attractors, bifurcation, normal forms, center manifold theory, Liapunov stability, Liapunov exponents, linearization about periodic orbits, Floquet theory, bifurcation analysis.

MECH 7630 MECHANICAL IMPACT (3) LEC. 3. Departmental approval. Investigation of the fundamental concepts used to solve collision problems with friction.

MECH 7710 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 ADVANCED SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) DSL. 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 3400 FUNDAMENTALS OF COLORATION (4) LEC. 3. LAB. 3. Pr. PFEN 3100. Fundamentals of aqueous chemistry, interfacial processes, interactions of chemicals and fibrous/polymeric materials, color perception and coloration of fiber/polymers.

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 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 PFEN 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 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 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 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 8990 RESEARCH AND DISSERTATION (1-10) DSR. PhD Research and Dissertation. Course may be repeated with change in topics.