

## Engineering Science

**Faculty:** All faculty in the David Crawford School of Engineering

The Engineering Science minor engages students in a exploration of a variety of topics in the engineering disciplines. Students who are not enrolled in an engineering curriculum may declare this minor, and must select six courses in one or more of the engineering disciplines, subject to the approval of the director of the School of Engineering.

### Engineering Science Minor Curriculum Map 2017-2018 Catalog

- Construction Management majors may elect this minor.
- Students who are engineering majors may not elect this minor.

Complete 6 engineering courses 200 level or above with a grade of C or higher, in a program approved by the Director of the David Crawford School of Engineering. ONE course must be an applied engineering course\*.

Choose from the following Engineering subjects

CE, EE, EG or ME Elective (200 level or higher)

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CE, EE, EG or ME Elective (200 level or higher)

CE, EE, EG or ME Elective (200 level or higher)

CE, EE, EG or ME Elective (200 level or higher)

Total Cr.

18

\* EE 215, EE 321, EE 373, EE 411, EG 201, EG 301, EG 303, CE 211, CE 321, CE 322, CE 336, CE 348, ME 381, ME 382

### Civil Engineering Courses

#### CE 211 Surveying 3 Cr.

A course in the theory and practice of plane surveying. Horizontal and vertical control, design of circular and parabolic curves, tachometry, construction surveys and earthwork quantities are covered in lecture. Fieldwork presents the practical applications of lecture material with the use of transits, tapes, levels, electronic distance measuring devices and theodolites. Classroom 2 hours, laboratory 3 hours. Prerequisite: MA 107.

#### CE 214 Site Development and Engineering 4 Cr.

A course that teaches the tasks and considerations involved in environmentally sound land development. Road design and it's interaction with development sites will be presented. Other topics covered include contours, drainage utilities, cut and fill, and aesthetic considerations. Codes and legal requirements will also be covered. CADD (Computer Aided Drawing and Design) software specific to Civil Engineering work will be introduced and employed extensively on student projects. Classroom 3 hours, laboratory 3 hours. Prerequisite: CE 211.

#### CE 220 Introduction to Environmental Technology 4 Cr.

A study of the fundamentals of environmental control technology. The course covers the topics of air pollution, water pollution, solid and hazardous wastes, and radioactive wastes. Noise pollution and control are also covered. The generation and treatment of wastes along with their effects on the environment are included in the course. The laboratory includes the basic methods of measuring pollution. Three Credits: Classroom 3 hours. Four Credits Classroom 3 hours, laboratory 2 hours. Prerequisite: CH 103. Not open to engineering students.

#### CE 264 Specifications and Estimating 1 Cr.

A laboratory in plan reading, quantity analysis and cost estimating of Civil Engineering projects. Students will be exposed to standard formats for specifications and estimating. Students will write sample specifications and will gain experience in construction estimation. Laboratory 3 hours. Co-requisites: CE 211.

#### CE 299 Special Topics: 1-4 Cr.

#### CE 318 Soil Mechanics 3 Cr.

An introduction to the engineering properties of soil: soil classification; soil structure and mineralogy; water flow through soils; compressibility and consolidation; shear strength. Laboratory testing of soils and soil exploration. Offered to allow students from other institutions to transfer 3 credit equivalent courses.

#### CE 321 Materials Laboratory 1 Cr.

A laboratory course in the application of basic mechanics of materials principles to cement, aggregate, concrete, steel and wood. Operation of various types of testing machines and gauges. Tests of tension, compression, flexure, torsion, impact, shear, hardness and fatigue. Laboratory observations, analysis, interpretation and reports. Classroom 1 hour, laboratory 2 hours. Corequisite: EG 301 or CE 351.

#### CE 322 Fluid Mechanics Laboratory 1 Cr.

A laboratory course in which the principles of fluid mechanics are applied to civil engineering problems. The design and implementation of a laboratory research study, the analysis of data, the presentation of results, and the development of engineering conclusions are integral parts of this course. Lab topics include hydrostatics, pipeflow, open channel flow, flow measurement, and resistance to flow. Classroom 1 hour, laboratory 2 hours. Prerequisite or concurrent enrollment: EG 303.

#### CE 328 Soil Mechanics 4 Cr.

An introduction to the engineering properties of soil: soil classification; soil structure and mineralogy; water flow through soils; compressibility and consolidation; shear strength. Laboratory testing of soils and soil exploration. Classroom 3 hours, laboratory 2 hours. Prerequisite: EG 301 or permission of the instructor.

#### CE 332 Engineering Hydrology 3 Cr.

A study of the location, movement, and distribution of the waters of the earth for practical applications to society. This course includes the study of the engineering aspects of precipitation, evaporation, infiltration, steamflow and flood and drought prediction. The application of hydrological statistics and computer applications are stressed. Classroom 3 hours. Prerequisite: EG 303 or permission of the instructor.

**CE 336 Introduction to Transportation Engineering 3 Cr.**

An introduction to different modes of transportation with emphasis on roadway and traffic engineering. Topics include transportation planning, highway geometric and pavement design, drainage, construction, traffic-control devices, traffic operations and management, and highway capacity analysis. Classroom 3 hours. Prerequisites: CE 211: Surveying.

**CE 348 Structural Analysis 3 Cr.**

A course on the analysis of statically determinate and indeterminate beams, frames and trusses. Topics include loads to buildings, shear and moment diagrams, influence lines and classical methods of analysis. Computer applications are introduced using a general frame analysis program. The use of analysis in the overall design process is stressed using a semester-long project. Classroom 3 hours. Prerequisite: EG 301.

**CE 351 Statics and Mechanics of Materials 4 Cr.**

A study of elementary, primarily two-dimensional engineering mechanics. Fundamental concepts and basic laws of statics, force systems, structures, and support reactions for loading patterns. Stress-strain relationships to forces: concepts and applications. Consideration of engineering materials and their suitability in various structures and mechanisms. Classroom 4 hours. Prerequisites: MA 107 and PS 201. Not open to engineering students.

**CE 419 Foundation Engineering 3 Cr.**

A course on the use of soil properties to determine bearing capacity and settlement of shallow and deep foundations. Design of earth and earth supporting structures. Classroom 3 hours. Prerequisite: CE 328 or permission of the instructor.

**CE 421 Environmental Engineering 4 Cr.**

This course covers the basics of air, water, waste and noise pollution in the context of quality, control and treatment design using sustainable engineering practices. New and emerging contaminants as well as their impact on the environment will be covered along with a primer on risk assessment and other contemporary environmental engineering issues. Classroom 3 hours, Laboratory 3 hours, Co/Prerequisite: EG 303 and CH 104, or instructor permission.

**CE 422 Waste and Water Treatment 3 Cr.**

A study of physical, chemical and biological processes for water and wastewater treatment. The course emphasizes the evaluation of unit processes and the design of water and wastewater treatment facilities. Classroom 3 hours. Prerequisite: CE 421.

**CE 432 Solid and Hazardous Waste Engineering 3 Cr.**

A course on the state-of-the-art techniques for disposal of solid and hazardous waste material. Aspects covered will be system design, public health protection, and environmental protection. Classroom 3 hours. Prerequisites: CH 104 and junior or senior status in engineering or science.

**CE 441 Transportation Engineering 3 Cr.**

The planning, design, and construction of transportation systems to meet the mobility requirements of society while considering economic, environmental, and societal constraints. System maintenance and administration are also included. Classroom 3 hours. Prerequisite: CE 211 or permission of the instructor.

**CE 442 Design of Steel Structures 3 Cr.**

An introduction to the design of metal structures using the LRFD-AISC code as the basis. Topics include design of tension, compression and bending members; bolted and welded connections. Classroom 3 hours. Prerequisite: CE 348.

**CE 444 Reinforced Concrete Design 3 Cr.**

An introduction to the design of reinforced concrete members under bending, shear and axial loadings according to ACI 318R code requirements. Topics also include one-way slabs, footings and retaining walls and an introduction to pre-stressed concrete. Use of the computer as a design tool is introduced. Classroom 3 hours. Prerequisite: CE 348.

**CE 446 Soils in Construction 4 Cr.**

This is the first course in geotechnical engineering, one of the sub-disciplines of Civil Engineering. Its purpose is to impart knowledge of the engineering properties and behavior of soils that are used for construction of foundations and earth structures. Classroom 3 hours, laboratory 2 hours. Prerequisite: Junior standing or higher.

**CE 450 Air Pollution Control 3,4 Cr.**

A course presenting sources of air pollution and the effect on the environment, the measurement of air pollutants, modeling of air pollutant dispersion, and design of control measures. Use of manual monitoring techniques and physical and chemical fundamentals to measure air quality. Course may be taken for three credits without the lab. Classroom 3 hours, laboratory 3 hours. Prerequisite: EG 206.

**CE 451 Air Pollution Control Equipment Design 3 Cr.**

This course builds on and amplifies material studied in CE 450. Properties of air pollutant emissions and thermodynamics, fluid mechanics and heat transfer principles are utilized to design air pollution control equipment. Several major design projects are undertaken by student teams; interim and final design reports are required. In addition, a module on air quality modeling is included. Classroom 3 hours. Prerequisite: CE 450.

**CE 452 Introduction to Air Pollution Control 3 Cr.**

A course presenting sources of air pollution and the effect on the environment, the measurement of air pollutants, modeling of air pollutant dispersion, and design of control measures. Classroom 3 hours, laboratory 3 hours. Prerequisite: EG 206.

**CE 455 Structures I 3 Cr.**

This course builds directly on the material learned in CE 351 and is specifically directed to the study of the response of structural systems to various loadings. Gravity and lateral loads as well as load combinations on a structure are developed using appropriate building codes. The response of the structural system to imposed loading is studied by classical and computer analysis techniques. Finally, this course introduces the students to the design of simple steel structures that meet the appropriate building code. Classroom 3 hours. Prerequisite: CE 351. Not open to engineering majors.

**CE 456 Structures II 3 Cr.**

This course is intended to introduce the students to and develop an understanding of, structural design of wood, concrete and masonry. Particular attention will be given to failure modes of the member types and materials. Each of the principal member types, beam and column as well as connections, will be studied and members designed to meet the appropriate code. Classroom 3 hours. Prerequisite: CE 455. Not open to engineering majors.

**CE 457 Wood, Steel, and Concrete Structures 4 Cr.**

This course builds directly on the material learned in CE 351 and is specifically directed to the study of the response of structural systems to various loadings. Gravity and lateral loads as well as load combinations on a structure are developed using appropriate building codes. The response of the structural system to imposed loading is studied by classical and computer analysis techniques. This course introduces the students to applications - the design of simple structures of wood, steel, concrete and other materials that meet the appropriate building code. Classroom 4 hours. Prerequisite: CE 351. Not open to engineering majors.

**CE 458 Structural Issues for Construction 3 Cr.**

This course is intended to introduce the students to structural building applications, and to develop knowledge and comprehension of structural design of steel, wood, concrete, and masonry. Particular attention will be given to concrete members, concrete form design requirements, steel connections, failure modes of the member types and materials. Detailed construction issues with each material will be emphasized. Each of the principal member types, beam and column as well as connections, will be studied and members designed to meet the appropriate code. Lecture 3 hours. Prerequisites: CE 455 or CE 457. Not open to engineering majors.

**CE 460 Construction Management 3 Cr.**

A course on the organization, scheduling and management of the construction project utilizing CPM and PERT. Survey of management functions by which construction is authorized, purchased, supervised, accomplished, inspected and accepted, including labor management relations and site design. Classroom 3 hours. Prerequisite: MA 107 AND CE 264.

**CE 475 Senior Project Planning 1 Cr.**

Each student will work with a mentor and together will define and analyze a project so that an efficient design can be completed. The project scope will be developed, tasks will be laid out, and a schedule to complete the project will be created. All of this will be presented orally and in written form in a project proposal. Prerequisite: Senior status. Corequisite: CE 460.

**CE 480 Senior Design 3 Cr.**

A capstone course in civil engineering. This course builds on and integrates the engineering concepts developed in prior course work into the complete design of a major civil engineering project. The course will require a written and an oral presentation of the completed design to include, where appropriate, plans and specifications. Prerequisites: CE 328, CE 348, and CE 421, or departmental approval.

**CE 490 Advanced Topics 4 Cr.**

A course that provides instruction in an area of the instructor's special competence and student interests. Advanced topics would be presented in such areas as air pollution control, water and wastewater treatment, bioremediation, and nuclear radiation. Offered as the occasion demands. Prerequisite: senior standing.

**Common Engineering Courses****EG 043 Conference 0 Cr.**

A scheduled weekly conference hour with the faculty and senior engineering students for discussions of topics such as placement, professional registration, professional ethics, and professional growth after graduation. The course includes a substantial writing component on ethics. A grade of satisfactory (S) is required for graduation. Classroom 1 hour. Prerequisite: senior standing.

**EG 044 Conference 0 Cr.**

A scheduled weekly conference hour with the faculty and senior engineering students for preparation of the Fundamentals of Engineering (FE) exam. The student must take the FE exam to receive a satisfactory grade in this course. EG 044 is not required if the student has already passed the FE exam. Classroom 1 hour. Prerequisite: senior standing.

**EG 109 Introduction to Engineering I 3 Cr.**

An introduction to engineering as a profession, this course presents the concepts and methods of engineering design and their application to solving problems from various engineering disciplines. The use of fundamental engineering skills and the associated tools to aid in defining problems and developing solutions is introduced (e.g. graphical communication/sketching, algorithmic problem solving, data analysis and visualization). The non-technical aspects of engineering required for career success-teamwork, written and oral communication, and problem-solving are practiced. Classroom 2 hours; laboratory 3 hours.

**EG 110 Introduction to Engineering II 3 Cr.**

A follow-on to EG 109, this course introduces discipline-specific tools as a context for designing and conducting experiments as well as solving engineering problems related to a specific discipline or a thematic problem area of societal importance. Design projects will include the technical and non-technical aspects of engineering design. This course presumes an understanding of engineering design and problem solving processes. Prerequisite: EG 109 or permission of the David Crawford School of Engineering Director. Classroom 2 hours; laboratory 3 hours.

**EG 111 Fundamentals of Engineering I 3 Cr.**

An introduction to engineering and the concepts of engineering design. Includes an introduction to graphical communication skills used in engineering through the use of sketching and computer-aided design (CAD) on personal computers. The concepts of orthographic and isometric drawings are stressed and extended to include sections and dimensions. The use of spreadsheets in engineering is also included. This course is open only to students in an Engineering major or those with permission of the Engineering Division Head. Classroom 2 hours, laboratory 3 hours.

**EG 112 Fundamentals of Engineering II 4 Cr.**

A continuation of the concepts of engineering design. Includes an introduction to engineering computing through the design of algorithms using structured techniques that employ a high-level engineering computer language. This course is open only to students in an Engineering major or those with permission of the Engineering Division Head. Classroom 3 hours, laboratory 2 hours.

**EG 201 Engineering Mechanics (Statics, Dynamics) 3 Cr.**

A course in elementary engineering mechanics. Vector notation. Force systems, moments, equilibrium, the free body diagram. Friction, simple frames, trusses, beams, centroids, and second moments. Kinematics: rectilinear and curvilinear motion; translation and rotation; relative motion. Kinetics: force, mass, and acceleration; impulse and momentum; work and energy. Elementary vector calculus. Classroom 3 hours. Corequisites: MA 122 and PS 211.

**EG 202 Engineering Mechanics (Statics,Dynamics) 3 Cr.**

A course in elementary engineering mechanics. Vector notation. Force systems, moments, equilibrium, the free body diagram. Friction, simple frames, trusses, beams, centroids, and second moments. Kinematics: rectilinear and curvilinear motion; translation and rotation; relative motion. Kinetics: force, mass, and acceleration; impulse and momentum; work and energy. Elementary vector calculus. Classroom 3 hours. Prerequisites: EG 201 and MA 122.

**EG 203 Materials Science 3 Cr.**

An introduction to the science of materials based on the physics and chemistry of their internal structures. The effects of structure on the properties and behavior of metallic, polymeric, ceramic, semiconductor, and composite materials. Classroom 3 hours. Prerequisite: CH 103.

**EG 206 Thermodynamics I 3 Cr.**

A study of the fundamental concepts and laws of thermodynamics and of the properties of pure substances, with applications to engineering processes and operations. Classroom 3 hours. Corequisite: MA 122.

**EG 301 Mechanics of Materials 3 Cr.**

A course on the concepts of stress and strain; effect of loads; analysis of plane stress and strain; deformations of beams, shafts, and axial members; buckling and combined stresses. Classroom 3 hours. Prerequisite: EG 201.

**EG 303 Fluid Mechanics 3 Cr.**

A study of fluid properties and their significance. Fundamental mechanics of compressible and incompressible fluid motion with application to engineering problems. Topics include resistance of fluids in laminar and turbulent flow; open-channel flow; fluid statics; dimensional analysis and similitude. Classroom 3 hours. Prerequisite: MA 122; Prerequisite or concurrent enrollment: EG 206 or permission of the instructor.

**EG 350 Engineering Economics and Decision Analysis 3 Cr.**

Engineering Economics and Decision Analysis (3cr.) This course focuses on the application of cost benefit analysis to engineering and other technical projects. Time value of money and accounting perspectives are used to evaluate projects. The concept of risk and its importance to financial decision making is also introduced.

**EG 400 Design Thinking and Innovation 3 Cr.**

This course explores the experience and practice of innovation by examining creativity as the ability to turn ideas into action. It examines the development, management, evolution, and broad context of emerging technologies and associated ventures. Students will complete innovation challenges from start to finish and leave with an understanding of the key tenets of design thinking and a sense for ways they can incorporate them into their work. This 'hands-on', project-based course involves students in the design and development of 'visual brand languages' for emerging technologies, foundation exercises in creativity, and case studies based on pivotal products from the past 50 years. Prerequisite: Not open to freshmen students.

**EG 447 Special Projects (Technical Elective) 1-6 Cr.**

A report on an approved engineering design project or topic area to meet the specific objectives of a student in a particular area of study. Limited to students who have organized plans and/or projects that can be related to their engineering interests. Hours and credits to be arranged. Prerequisite: permission of the curriculum department chair and advisor.

**EG 450 Professional Issues 3 Cr.**

A course to prepare the engineering student for the non-technical aspects of the engineering profession. Topics covered include engineering registration, ethical responsibilities, malpractice and legal responsibilities, and the business aspects of the engineering profession. Classroom 2 hours. Recitation 2 hours. Prerequisites: junior or senior status.

**Electrical Engineering Courses****EE 200 Engineering Programming 3 Cr.**

Introduction to a high level programming language such as C/C++. Topics include structure and organization of a computer program, variables and basic data types, flow of control, functions, file I/O, arrays and strings, computer memory, CPU and pointers, user defined structures, computer algorithms, modular design and documentation. Introduction to object oriented programming concepts. This course is offered once a year.

**EE 204 Electrical Circuits I 3 Cr.**

A study of principles and methods of analysis of electric circuits with both direct and time varying sources in the steady state. KCL, KVL, mesh and nodal techniques. Network theorems are developed and applied to the analysis of networks. Energy storage elements. First order and second order circuits with forced and natural responses. Sinusoidal analysis, complex numbers, phasor diagrams. Power; average effective, and complex power in single phase systems. Classroom: 3 hours. Corequisite: MA 122.

**EE 215 Fundamentals of Digital Design 4 Cr.**

An introductory course on formal design techniques for combinational and sequential logic circuits. Topics include combinational logic networks, minimization techniques, registers, synchronous sequential networks, and control units. Applications of the concept developed in the classroom will be implemented in the laboratory. Classroom 3 hours, laboratory 2 hours.

**EE 240 Electrical Concepts and Applications 3 Cr.**

A course on the theory and application of electrical devices and circuits. Discussions include magnetic circuits, transformers, electric machines, diodes, bipolar transistors, and field effect transistors. Integrated circuits are introduced. Digital switching circuits are treated, including logic gates, flip-flops, and counters. Operational amplifiers and their major applications are studied. Offered to qualified students not majoring in Electrical Engineering. Classroom 2 hours, laboratory 3 hours. Prerequisite: EE 204.

**EE 242 Digital Systems Design 4 Cr.**

Topics are hierarchical design methods, design and debugging of digital hardware, determination of circuit behavior, control and timing, machine organization, control unit implementation, and interface design. A hardware design language will be used and students will acquire design experience implementing digital hardware. Classroom 3 hours, laboratory 2 hours. Prerequisite: EE 215.

**EE 303 Electromagnetic Field Theory I 3 Cr.**

Maxwell's Equations are developed from the experimental laws of electric and magnetic fields. Topics involving electric fields include Gauss's Law, divergence, energy, potential, conductors, dielectrics, and capacitance. Topics involving magnetic fields include the Biot-Savart Law, Ampere's Law, magnetic forces, magnetic materials, and inductance. Maxwell's Equations are used to describe wave motion in free space and in dielectric media. Classroom 3 hours. Prerequisites: MA 223, EE 204.

**EE 315 Electrical Energy Systems 3 Cr.**

A course on the design and implementation of electrical energy systems. Topics include thermal, wind, solar, and hydro renewable electrical energy facilities, electric transmission and distribution systems, and electrical substations. Introductory topics include basic circuit analysis, transformers, motors and drive systems, and instrumentation. Includes hands-on demonstrations and experiments. Offered to qualified students not majoring in Electrical Engineering. Classroom 3 hours. Prerequisite: MA 122.

**EE 321 Embedded Systems 4 Cr.**

The use of computing devices in embedded applications is introduced. Computer organization topics include the functional architecture of microcontrollers, timing and control, memory, serial and parallel I/O ports, and the bus system. Additional topics include peripheral interface control, interrupts, serial communication, and applications. Programs are written and run in assembly language or higher-level languages. This course presumes and introductory-level understanding of structured programming techniques. Classroom 3 hours, laboratory 2 hours. Prerequisite: EG 110 or EE 200 or CS 140.

**EE 323 Computer Architecture 3 Cr.**

Compare different machine architectures – analyze machine performance relationships, do computer classifications, and compare different computer description languages. Consider alternative machine architectures and the software influences on computer design. Topics include digital logic, microarchitecture level, instruction set level, operating system level, assembly language level, parallel computer architectures. Examples are drawn from the Core i7, OMAP4430 and ATmega168, hardware as well as ARM and AVR instruction sets. Classroom 3 hours. Prerequisite: None.

**EE 325 Computer Architecture and Operating Systems 3 Cr.**

Machine architecture - machine performance relationships, computer classification, and computer description languages. Consideration of alternative machine architectures. Software influences on computer design. Topics include digital logic, VLSI components, instruction sets, addressing schemes, memory hierarchy cache and virtual memories, integer and floating point arithmetic, control structures, buses, RISC vs. CISC, multiprocessor and vector processing (pipelining) organizations. Examples are drawn from Pentium and Sparc microcomputers. The primary focus is on the attributes of a system visible to an assembly level programmer. This course also introduces the fundamentals of operating systems. Topics include concurrency, scheduling, memory and device management, file system structure, security, and system performance evaluation. Lecture 3 hours. Offered once per year.

**EE 350 Linear Systems 3 Cr.**

This course provides the foundations of signal and system analysis. Linear, time-invariant, causal, and BIBO stable analog and digital systems are discussed. System input-output descriptions, convolution and the impulse response are covered. Additional topics include singularity functions, Fourier and Laplace circuit analysis, circuit transfer functions, Bode plots, ideal filters, and real filters including Butterworth, Chebyshev, and Elliptic. Discrete topics include the transform, difference equations, FIR and IIR filters, the bilinear transformation, the DTFT, the DFT, and the FFT. Classroom 3 hours. Prerequisite EE 356.

**EE 356 Electrical Circuits II 3 Cr.**

This course is a continuation of Electric Circuits I (EE 204). The complete solutions of linear circuits by Laplace transforms are developed. The concepts of frequency response, resonance, network functions, two port networks including hybrid parameters are studied in depth. The concepts of transformers, power, coupled circuits, multi-phase circuits, and Fourier series are introduced. Computer-based circuit simulation is used throughout. Classroom 3 hours. Prerequisite: EE 204.

**EE 357 Electronics I 3 Cr.**

The basic building blocks used in electronic engineering are studied. Diodes, bipolar transistors, and MOS transistors are modeled and then used to describe the operation of logic gates and amplifiers. Emphasis is placed on the operation and applications of standard integrated circuit chips. Classroom 3 hours. Prerequisite: EE 204.

**EE 359 Electrical Engineering Laboratory 1 Cr.**

Implementation, analysis, and design of electric and electronic circuits involving resistors, inductors, capacitors, diodes, bipolar transistors, MOS transistors, operational amplifiers and filters. Study and practice in the use of standard electrical engineering laboratory instrumentation. Laboratory 2 hours. Prerequisite: EE 215; corequisites: EE 356, EE 357.

**EE 366 Electronics II 4 Cr.**

This course is a continuation of Electronics I (EE 357). Analog and digital circuits are discussed. Analog topics include frequency response, real world applications of operational amplifiers, power amplifiers, filters, oscillators and A/D and D/A converters. Digital electronic building blocks are discussed, including flip-flops, counters, coding and decoding circuits and memory. Classroom 3 hours, laboratory 2 hours. Prerequisites: EE 357, EE 359.

**EE 373 Electrical Energy Conversion 4 Cr.**

A course on principles of energy conversion in electromechanical devices and machines. Analysis of transformers, polyphase synchronous and asynchronous machines, single phase fractional horsepower machines, and DC machines. Classroom 3 hours, laboratory 2 hours. Prerequisite: EE 356; corequisite: MA 224.

**EE 399 Electrical Engineering Topics 3 Cr.****EE 3XX Electrical Engineering Transfer Elective 4 Cr.****EE 411 Infrastructure Control Systems 4 Cr.**

This course deals with organization, operation and design of systems where the microprocessor controls special interfaces to non-standard devices and responds to external events in a timely fashion. Topics include interface of special purpose peripherals, data structures, control structures, program and data organization and real time operating systems. Application to communications, automated measurement, process and servo control are discussed. Classroom 3 hours, laboratory 2 hours.

**EE 459 Electric Power Systems 3 Cr.**

An introduction to the fundamentals of electric power systems generation, transmission and distribution, with emphasis on current trends, issues and technologies. Topics include a review of ac power fundamentals, per unit quantities, system component models, short-circuit analysis, load flow, smart grid concepts, communications and control, power systems economics, and renewable energy systems. Lecture: 3 hours. Offered once per year.

**EE 463 Communication Systems 4 Cr.**

Analog transmission of information signals by communication systems is analyzed. The component parts of transmitters and receivers including AM/FM modulators, filters, detectors and decoders are discussed. Mathematical concepts include the Fourier Series, Fourier Transform, dirac delta function and sinc function. Signal classification and digital modulation techniques such as ASK, FSK, PSK, PAM and QAM. Classroom 3 hours, laboratory 2 hours. Prerequisites: EE 356, EE 357, EE 359.

**EE 468 Solid State Materials 3 Cr.**

Solid state materials, physics of electronic devices and integrated circuit design are studied. Topics include silicon crystal properties, diffusion, implantation, lithography and circuit fabrication. Device models are derived for junction diodes, bipolar and MOS transistors. Classroom 3 hours. Prerequisites: EE 303, EE 357.

**EE 478 Control Systems 3 Cr.**

Analysis and design of continuous-time and discrete-time control systems using classical and state-space methods. Laplace transforms, transfer functions and block diagrams. Transient-response analysis, Routh-Hurwitz stability criterion, and steady-state error analysis. Analysis of control systems using the root-locus and frequency-response methods. Computer-aided design and analysis. Lecture: 3 hours. Prerequisites: EE 204 and MA 224. Offered once per year.

**EE 486 Digital Signal Processing 3 Cr.**

An introductory level course that discusses the conversion of analog signals to discrete time signals. Emphasis will be on the processing of discrete signals using both time-domain and frequency-domain analysis. These techniques will be applied to the design of digital filters. Classroom 3 hours. Prerequisite: EE 350 or instructor's permission.

**EE 487 Digital Signal Processing Lab 1 Cr.**

Implementation analysis and design of digital signal processing functions and techniques. Study and practice in the use of software and hardware platforms used for digital signal processing applications. Laboratory: 3 hours. Prerequisite: EE 350. This course is offered once a every spring.

**EE 490 Advanced Topics 3 Cr.**

A course that provides advanced study in an area of the instructor's special competence. Courses that have been offered in the past include Power System Stability, Electrical Communications II, Microwave Theory and Techniques and Digital Systems. Offered as the occasion demands. Classroom 3 hours. Prerequisite: senior standing.

**EE 491 Electrical System Design I 3 Cr.**

Introduction to design problems. Application of concepts of electrical engineering to a capstone design project. The first of a two-semester sequence, this course focuses on the problem statement, specification, preliminary design, design review and approval stages of the design processes, the design process involves exploring alternate solutions and design optimization and simulation. Economic constraints and human factors are considered in the design process. The course requires nine hours per week of directed reading, research and experimentation. Prerequisite: seventh semester standing and permission of the instructor.

**EE 494 Electrical System Design II 3 Cr.**

This course is the second in the two-semester capstone design project sequence. It focuses on the final stages of the design process-finalized design, implementation and testing. A written project report and an oral presentation to students and faculty is required. Nine hours per week of directed readings, research, and experimentation. Prerequisite: EE 491.

**Mechanical Engineering Courses****ME 211 Mechanical Engineering Tools I 2 Cr.**

An extension of EG 109 with a more in-depth treatment of 3-D solid model generation including extrusion, revolving, sweeping and lofting. Further development and modification of 3-D solid drawings. Laboratory: 3 hours. Prerequisite: EG 109.

**ME 307 Thermodynamics II 3 Cr.**

Applications of thermodynamics to power and refrigeration cycles, combustion mechanisms, mixture and flow processes. Development of thermodynamic relationships and equations of state. Classroom 3 hours. Prerequisite: EG 206.

**ME 311 Mechanical Engineering Tools II 2 Cr.**

An extension of ME 211 with additional application of computer based design and analysis methods. An emphasis will be placed on design for manufacturing and other tools appropriate to the mechanical engineering profession. Laboratory: 3 hours. Prerequisite: ME 211.

**ME 356 Manufacturing Processes 4 Cr.**

A study of the principles of manufacturing processes. Metal removal, casting, joining and deformation processes are covered as well as introductions to numerically controlled machinery, computer-aided manufacturing, rapid prototyping, robotics, computer integrated manufacturing and modern manufacturing systems. Classroom 3 hours, laboratory 3 hours. Prerequisite: ME 311, EG 203.

**ME 363 Kinematic and Kinetic Synthesis 3 Cr.**

A study of the principles of motion and the forces necessary to cause, and be created by motion. Applications to the design of typical machine elements such as gears, linkages and cams. Classroom 3 hours. Prerequisites: EG 202, MA 223.

**ME 368 Design of Machine Elements 3 Cr.**

A study of the application of the theories of mechanics and stress analysis to the design of fundamental machine parts. Some of the topics covered are shafts, springs, screws, belts, gears, rivets, bearings and lubrication. Classroom 3 hours. Prerequisites: EG 301.

**ME 370 Mechanical Systems Design 3 Cr.**

An introduction to the methodology of design including problem definition, generation and evaluation of alternatives, and design completion. Emphasis is placed on creativity, feasibility, and the effect of economic and societal factors on alternative selection. Goals are achieved through the use of case studies and small projects. Classroom 3 hours. Prerequisite: junior standing.

**ME 381 Mechanical Engineering Laboratory I 2 Cr.**

A study of the fundamentals of mechanical and electronic instruments and their use in measurement systems to obtain data on temperature, pressure, displacement, acceleration, and other physical variables. Introduction to experimental methods and procedures, reduction of data to significant form, and the organization of experimental results in written reports. Lecture 1 hour, laboratory 3 hours. Prerequisite: EE 204.

**ME 382 Mechanical Engineering Laboratory II 1 Cr.**

Application of instrumentation to observations of gas and liquid behavior, thermo-dynamic and mechanical aspects of machines and devices. Dynamic and transient considerations in instruments, physical systems, and experimental data. Laboratory 3 hours. Prerequisite: ME 381.

**ME 435 Mechanical Control Systems 3 Cr.**

Synthesis and analysis of mechanical control systems with feedback. Use of linearization techniques and Laplace Transform methods of analysis. Techniques for determining system stability. Emphasis is placed on operational characteristics of components and their effect on system design. Computer simulation of system operation. Classroom 3 hours. Prerequisites: MA 224, EG 202.

**ME 465 Heat Transfer 3 Cr.**

A study of the fundamentals of heat transfer by conduction, radiation, and convection. Steady and unsteady state conduction. Study will include boundary layer theory, internal and external convective flows, two-phase flow, and heat exchange design theory. Classroom 3 hours. Prerequisites: EG 206, EG 303, MA 224.

**ME 467 Mechanical Engineering Design I 3 Cr.**

A capstone design project is taken up to the point of prototype construction, testing and hardware specification. The specific skills and knowledge needed by practicing engineers in the product realization process are emphasized and developed. Classroom 3 hours. Prerequisite: senior standing, ME 370.

**ME 468 Mechanical Engineering Design II 3 Cr.**

Design completion of the capstone project initiated in ME 467 including hardware specification, instrumentation, laboratory testing, data reduction, and evaluation. Written design report required with oral presentation and defense. Prerequisite: ME 467.

**ME 487 Mechanical Engineering Laboratory III 2 Cr.**

A continuation of the Mechanical Engineering laboratory sequence with experiments stressing the performance characteristics of heat power equipment and the application of theory learned in thermodynamics and fluid flow. Classroom 1 hour, laboratory 2 hours. Prerequisite: EG 303. Corequisite: ME 307.

**ME 490 Advanced Topics 3,4 Cr.**

A course that provides specific work in an area of the instructor's special competence and indicated student interest. An extension of basic principles to applied areas such as HVAC, heat transfer, thermodynamics, stress analysis, environmental control, turbo-machinery, propulsion systems and aerodynamics. Classroom or seminar, 1-3 hours. Prerequisite: senior standing. Offered as occasion demands.