ENGINEERING

College of Science and Engineering

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School of Engineering

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Graduate Coordinator: Hamid Shahnasser (Embedded Systems and Energy Systems)
Graduate Coordinator: Cheng Chen (Structural/Earthquake Engineering)

Mission and Goal

The mission of the School of Engineering is to educate students from a diverse and multicultural population to become productive members of the engineering profession and society at large. Educational objectives in support of this mission depend upon the major program and are stated below in the description of each program.

Program Scope

The School of Engineering offers Bachelor of Science programs in Civil, Computer, Electrical, and Mechanical Engineering, as well as a minor program in each discipline. Descriptions of the four major and minor programs follow this general introduction.

Civil engineering is concerned with the building of civil and environmental facilities, which are essential for the commerce of our society. Civil engineers design and construct bridges, buildings, wastewater treatment plants, water supply facilities, hazardous waste facilities, and transportation systems. The program at San Francisco State University provides a broad and practical education which prepares students for civil engineering employment and (for those who qualify) for graduate studies.

Computer engineering combines electrical engineering and computer science and deals with the design and application of computer systems. These computer systems can range from supercomputers to tiny microprocessors that are embedded in all kinds of apparatus such as automobiles, appliances, cellular phones, medical devices, office equipment, etc. The computer engineering program teaches students about computer hardware, software, integration, interfacing, and applications with a strong emphasis on analysis and design. Hence, students pursuing a computer engineering degree must have a solid foundation in mathematics and physical sciences. Students develop problem-solving and decision-making skills as well as an appreciation for the impact of technology in society. Graduates of the program can seek employment immediately or can continue studies for an advanced degree in computer engineering, computer science, electrical engineering, or other areas such as business, law, or medicine.

Electrical engineering is the profession that deals with the design and analysis of electrical and electronic devices and systems. This branch of engineering covers many diverse areas, including electrical power generation and distribution, the design and fabrication of electronic semiconductor devices, and the creation of components and systems for consumer, medical, telecommunications, and many other applications. Graduates with a B.S. in Electrical Engineering have a number of options available to them. They may engage in the analysis, modeling, simulation, design, testing, manufacturing, or field services of electrical, electronic, or magnetic equipment. Persons interested in research, development, or college-level teaching may pursue advanced degrees in a specified area of electrical engineering.

Mechanical engineering is the field responsible for the design of machines and devices used throughout society. Industries involved in the generation of electricity, in petroleum production, and in the design and manufacture of electronics, aircraft, automobiles, consumer, and industrial products typically employ large numbers of mechanical engineers. Mechanical engineers are also employed by companies involved in automated manufacturing as well as robotics and control. The program at San Francisco State prepares the student to enter into professional employment directly after graduation in addition to providing the needed foundation for graduate study.

Recognizing the value to certain students majoring in science broadening their education to include applications of their backgrounds in science to real-world physical systems, four minors in engineering are offered.

The master's program includes primary curricular areas of specialization in civil/structural, electrical/computer, and mechanical/energy engineering from which the student may choose a program of study upon advisement. The objectives of the program are to provide students with the advanced engineering education necessary for solving complex problems in engineering practice and to provide opportunities for updating and upgrading the skills of practicing engineers. These objectives are accomplished by a flexible program to meet individual student needs.

Career Outlook

Graduates with a B.S. in Civil Engineering may engage in the design and construction of buildings, bridges, roads, dams, water supply facilities, and environmental facilities for treating wastewater and hazardous wastes. Civil engineers find employment with industrial firms, government agencies, utilities, and public works departments, as well as engineering firms which consult for these enterprises. After gaining practical experience, some civil engineers form their own consulting firms.

Graduates with a B.S. in Computing Engineering may engage in the design, integration, interfacing, and application of computer hardware and software. Computer engineering is the fastest growing engineering profession, and it impacts all aspects of our lives. Since computers are everywhere, from supercomputers to embedded microprocessors, computer engineers are needed in design, development, testing, marketing, and technical support of a wide variety of industries. Examples of major industries that employ computer engineers include computers, semiconductors, instrumentation, communications, networks, medical equipment, and manufacturing.

Graduates with a B.S. in Electrical Engineering may engage in the analysis, modeling, simulation, design, testing, manufacturing, or field services of electrical, electronic, or magnetic equipment. They may also engage in the operation and maintenance of facilities for electrical power generation or telecommunication. High technology companies employ electrical engineers in the fields of electronic and computer manufacturing, as well as in power generation and communications.

Graduates with a B.S. in Mechanical Engineering may immediately engage in the design, analysis, testing, production, and maintenance of machines and mechanical systems. Most industries, including aerospace, electronics, manufacturing, automotive, chemical, power generation,

agriculture, food processing, textile, and mining, employ mechanical engineers.

Engineers interested in research, development, or college-level teaching return to college for an M.S. or Ph.D. in their specified field. Engineers interested in management and business aspects may return to college for a Master of Business Administration.

Professor

ADELBERT CHENG (2004), *Professor of Mechanical Engineering*; B.S. (1991), UCLA; S.M. (1994), MIT; Ph.D. (2002), University of California, Berkeley.

TIMOTHY B. D'ORAZIO (1984), *Professor of Civil Engineering*; B.S. (1975), M.S. (1976), University of Michigan; Ph.D. (1982), University of California, Berkeley.

AHMAD R. GANJI (1987), *Professor of Mechanical Engineering*; B.S. (1973), Sharif (Aryamehr) University of Technology (Tehran, Iran); M.S. (1975), Ph.D. (1979), University of California, Berkeley.

THOMAS HOLTON (1989), *Professor of Computer and Electrical Engineering*; B.A. (1974), Harvard College; M.S. (1977), Ph.D. (1981), Massachusetts Institute of Technology.

HAO JIANG (2007), *Professor of Computer and Electrical Engineering*; B.E. (1994), Tsinghua University, Beijing, China; Ph.D. (2000), University of California, San Diego.

HAMID MAHMOODI (2005), *Professor of Computer and Electrical Engineering*; B.S. (1998), Iran University of Science and Technology; M.S. (2000), University of Tehran, Iran; Ph.D. (2005), Purdue University, West Lafayette, Indiana.

WENSHEN PONG (1998), *Professor of Civil Engineering*; B.S. (1985), National Chiao Tung University, Taiwan; M.S. (1989), Ph.D. (1994), State University of New York, Buffalo.

HAMID SHAHNASSER (1989), *Professor of Computer and Electrical Engineering*; B.E. (1981), McGill University; M.S. (1983), Carnegie-Mellon University; Ph.D. (1988), Drexel University.

DIPENDRA SINHA (1987), *Professor of Mechanical Engineering*; B.S. (1967), Patna University (Patna, India); M.S. (1978), Ph.D. (1981), University of Manchester, Institute of Science and Technology (England).

GUS TARAKJI (1986), *Professor of Civil Engineering*; B.E. (1978), American University of Beirut; M.S. (1980), University of Florida; Ph.D. (1983), Clemson University.

KWOK-SIONG TEH (2006), *Professor of Mechanical Engineering*; B.S. (1997), University of Illinois, Urbana-Champaign; M.S. (2001), University of Michigan, Ann Arbor; Ph.D. (2004), University of California, Berkeley.

Associate Professor

CHENG CHEN (2009), *Associate Professor of Civil Engineering*; B.S. (1999), M.S. (2002), Tongji University, Shanghai; Ph.D. (2007), Lehigh University.

ELAHE ENSSANI (1998), *Associate Professor of Civil Engineering*; B.S. (1976), Sharif (Aryamehr) University of Technology (Iran); M.S. (1978), M.Eng. (1980), Ph.D. (1987), University of California, Berkeley.

XIAORONG ZHANG (2013), *Associate Professor of Computer and Electrical Engineering*; B.S. (2006), Huazhong University of Science and Technology; M.S. (2009), Ph.D. (2013), University of Rhode Island.

Assistant Professor

MOJTABA AZADI (2015), *Assistant Professor of Mechanical Engineering*; B.S. (1998), University of Tehran; M.S. (2000), Sharif University of Technology; Ph.D. (2010), University of Alberta.

ZHAOSHUO JIANG (2014), *Assistant Professor of Civil Engineering*; B.A. (2003), Guangzhou University, Guangzhou; M.S. (2006), University of Connecticut; Ph.D. (2012), University of Connecticut.

FATEMEH KHALKHAL (2018), *Assistant Professor of Mechanical Engineering*; B.Sc. (1999), M.Sc. (2003), Sharif University of Technology; Ph.D. (2012), École Polytechnique de Montréal.

DAVID QUINTERO (2018), *Assistant Professor of Mechanical Engineering*; B.S. (2006), Texas AM University; M.S. (2008), Stanford University; Ph.D. (2018), University of Texas at Dallas.

FATEMEH TEHRANIPOOR (2017), *Assistant Professor of Electrical Engineering*; B.S. (2011), University of Mazandaran; M.S. (2013), Shahid Beheshti University; Ph.D. (2017), University of Connecticut

JENNA WONG (2016), *Assistant Professor of Civil Engineering*; B.S. (2008), M.S. (2009), Ph.D. (2014), University of California, Berkeley.

JIN YE (2015), *Assistant Professor of Electrical Engineering*; B.S. (2008), M.S. (2011), Xi'an Jiaotong University; Ph.D. (2014), McMaster University.

Majors

- Bachelor of Science in Civil Engineering (http://bulletin.sfsu.edu/colleges/science-engineering/engineering/bs-civil-engineering/)
- Bachelor of Science in Computer Engineering (http://bulletin.sfsu.edu/colleges/science-engineering/engineering/bs-computer-engineering/)
- Bachelor of Science in Electrical Engineering (http://bulletin.sfsu.edu/colleges/science-engineering/engineering/bs-electrical-engineering/)
- Bachelor of Science in Mechanical Engineering (http://bulletin.sfsu.edu/colleges/science-engineering/engineering/bs-mechanical-engineering/)

Minors

- Minor in Civil Engineering (http://bulletin.sfsu.edu/colleges/science-engineering/engineering/minor-civil-engineering/)
- Minor in Computer Engineering (http://bulletin.sfsu.edu/colleges/science-engineering/engineering/minor-computer-engineering/)
- Minor in Electrical Engineering (http://bulletin.sfsu.edu/colleges/science-engineering/engineering/minor-electrical-engineering/)
- Minor in Mechanical Engineering (http://bulletin.sfsu.edu/colleges/science-engineering/engineering/minor-mechanical-engineering/)

Masters

- Master of Science in Engineering: Concentration in Structural/Earthquakes (http://bulletin.sfsu.edu/colleges/science-engineering/engineering/ms-engineering-concentration-structural-earthquakes/)
- Master of Science in Engineering: Concentration in Embedded Electrical and Computer Systems (http://bulletin.sfsu.edu/colleges/

science-engineering/engineering/ms-engineering-concentration-embedded-electrical-computer-systems/)

- Master of Science in Engineering: Concentration in Energy Systems (http://bulletin.sfsu.edu/colleges/science-engineering/engineering/ms-engineering-concentration-energy-systems/)

ENGR 100 Introduction to Engineering (Unit: 1)
Prerequisites: High school algebra and trigonometry.

Description of the major engineering fields and their subfields. Day to day activities of engineers. Engineering professionalism, ethics, communication skills, lifelong learning, and career planning. Survival skills. Safety issues and School of Engineering policies. Laboratory. (Plus-minus letter grade only)

ENGR 101 Engineering Graphics (Unit: 1)
Prerequisite: ENGR 100* (may be taken concurrently).

Engineering drawing as a means of communication. Principles of engineering graphics. Freehand sketching and introduction to AutoCAD. Basic AutoCAD commands. Engineering drawing with AutoCAD. Orthographic projection. Lines and dimensioning. Reading blueprints. Normal, inclined, and cylindrical surfaces. Sectional views. Laboratory. (Plus-minus letter grade only)

ENGR 102 Statics (Units: 3)
Prerequisites: MATH 227* and PHYS 220* or equivalents.

Vector treatment of force systems acting on particles and rigid bodies. Centroids and moments of inertia. Trusses, machines, fluid statics, shear and moment diagrams for beams, and friction. Applications to structural and mechanical problems. (Plus-minus letter grade only)

ENGR 103 Introduction to Computers (Unit: 1)
Prerequisite: MATH 226* or equivalent with a grade of C or better.

Introductory course on programming using a high-level language. Use of algorithms. Program organization, formulation, and solution of engineering problems. Laboratory. (Plus-minus letter grade only)

ENGR 121 Gateway to Computer Engineering (Unit: 1)
Prerequisites: High school algebra and trigonometry.

Hands-on introduction to embedded computer systems. Basic laboratory instrumentation, electronic circuit assembly, measurement, and testing. Introduction to hardware and software of robots. Activity. (Plus-minus letter grade only)

ENGR 200 Materials of Engineering (Units: 3)
Prerequisite: CHEM 115* or CHEM 180* or equivalent.

Application of basic principles of physics and chemistry to engineering materials; their structures and properties and the means by which these materials can be made of better service to all fields of engineering. Lecture, 2 units; laboratory, 1 unit. Extra fee required. (Plus-minus letter grade only)

ENGR 201 Dynamics (Units: 3)
Prerequisite: ENGR 102* or equivalent.

Vector treatment of kinematics and kinetics of particles, systems of particles and rigid bodies. Methods of work, energy, impulse, and momentum. Vibrations and time response. Applications to one- and two-dimensional engineering problems. (Plus-minus letter grade only)

ENGR 203 Materials of Electrical and Electronic Engineering (Units: 3)
Prerequisite: CHEM 115* or CHEM 180* or equivalent.

Application of basic principles of physics and chemistry to electrical and electronic engineering materials. Conductors, insulators, and semiconductors; electrical conductors; mechanical properties of conductors; manufacturing conductors; electrochemistry; electrical insulators; plastics; magnetic materials; superconductors and optical fibers. (Plus-minus letter grade only)

ENGR 204 Engineering Mechanics (Units: 3)
Prerequisites: MATH 227* and PHYS 220* or equivalents.

Vector treatment of force systems, kinematics and kinetics. Centroids and moments of inertia. Equilibrium of internal stresses. Methods of acceleration, work, energy and momentum. Kinetic differential equations. Vibrations and time response. (Plus-minus letter grade only)

ENGR 205 Electric Circuits (Units: 3)
Prerequisites: PHYS 230* and MATH 245*(may be taken concurrently) or equivalents.

Circuit analysis, modeling, equivalence, circuit theorems. PSpice simulation. Ideal transformers and operational amplifiers. Transient response of 1st-order circuits. AC response, phasor analysis, impedance, power. (Plus-minus letter grade only)

ENGR 206 Circuits and Instrumentation Laboratory (Unit: 1)
Prerequisite: ENGR 205* (may be taken concurrently) or equivalent.

Electrical measurements and laboratory instrumentation. Verification of circuit laws and theorems. Operational amplifier circuits. AC steady-state behavior and frequency response. Transient characteristics of first-order circuits. Introduction to PSpice. Laboratory. Extra fee required. (Plus-minus letter grade only)

ENGR 212 Introduction to Unix and Linux for Engineers (Units: 2)
Prerequisite: Restricted to Computer Engineering majors and minors. Other majors admitted on a space-available basis by consent of the instructor.

Introduction to software development and program development in the Unix/Linux environment. File system organization and management, editors, utilities, network environment, pattern and file searching, command line interface, scripting languages. Lecture, 1 unit; laboratory, 1 unit. (Plus-minus letter grade only)

ENGR 213 Introduction to C Programming for Engineers (Units: 3)
Prerequisite: MATH 226* or equivalent with a grade of C or better.

Introduction to C programming; defining and analyzing problems; design of algorithms; implementation, testing, debugging, maintenance and documentation of programs; coverage of basic algorithms, programming concepts, and data types; C programming of microcontrollers. (Plus-minus letter grade only)

ENGR 235 Surveying (Units: 3)
Prerequisites: ENGR 100* or equivalent and MATH 226* or equivalent with a grade of C or better.

Surveying: distance, elevation, and direction measurements; traverse analysis; contours; topography; areas calculations. Introduction to GPS and GIS. The US public lands system. Lecture, 2 units; laboratory, 1 unit. (Plus-minus letter grade only)

ENGR 271 Introduction to MATLAB (Unit: 1)
Prerequisite: MATH 226* or equivalent with a grade of C or better.

Basic introduction to MATLAB language: array manipulations; control-flow; script and function files; simple 2-D plotting and editing; Simulink; graphical user interface. (Plus-minus letter grade only)

ENGR 272 Engineering Project Management (Unit: 1)
Prerequisites: Restricted to Engineering students with sophomore standing or above.

An introduction to various concepts and tools associated with engineering project management. (Plus-minus letter grade only)

ENGR 290 Modular Elective (Unit: 1)
Prerequisites: Restricted to Engineering students with sophomore standing or above.

Topic to be specified in Class Schedule. May be repeated for a total of 3 units when topics vary. (Plus-minus letter grade only)

ENGR 291 Introduction to Creo Parametric (Unit: 1)
Prerequisites: Restricted to Engineering students with sophomore standing or above.

Introduction to 3D modeling using Creo Parametric. Fundamental concepts and user interface. Selection and editing of geometry, features, and models. (Plus-minus letter grade only)

ENGR 292 Introduction to Solid Works - Level I (Unit: 1)
Prerequisites: Restricted to Engineering students with sophomore standing or above.

Introduction to fundamentals of 3D modeling in SolidWorks. Focus on file management, templates, sketching, and modeling techniques, and producing manufacturing drawings. (Plus-minus letter grade only)

ENGR 294 Introduction to Microcontrollers (Unit: 1)
Prerequisite: Restricted to Engineering students with sophomore standing or above.

Introduction to the operating principles of microcontrollers. Programming of microcontrollers to read sensor inputs and produce control outputs. Hands-on applications involving actuators, peripherals, and electromechanical circuits. (Plus-minus letter grade only)

ENGR 295 Design Methodology (Unit: 1)
Prerequisites: Restricted to Engineering students with sophomore standing or above.

Systematic methods for the design of engineering systems. Strategies to resolve technical and non-technical issues in engineering design. (Plus-minus letter grade only)

ENGR 300 Engineering Experimentation (Units: 3)
Prerequisites: ENGR 200* or ENGR 206*; ENGR 205*; or equivalents with grades of C- or better.

Characteristics of instrumentation and computerized data acquisition. Design, planning, and documentation of experiments. Common methods of probability and statistics. Lecture, 2 units; laboratory, 1 unit. Extra fee required. (Plus-minus ABC/NC grading only)

ENGR 301 Microelectronics Laboratory (Unit: 1)
Prerequisite: ENGR 353* (may be taken concurrently) or equivalent.

Measurement techniques, device characterization, experimental verification, and PSpice simulation. Second-order transient and frequency responses. Characterization of diodes, BJTs, and FETs. Diode circuits, transistor amplifiers, simple logic gates. Laboratory. Extra fee required. (Plus-minus ABC/NC grading only)

ENGR 302 Experimental Analysis (Unit: 1)
Prerequisites: ENGR 300*, ENGR 304* (may be taken concurrently), and ENGR 309* or equivalents.

Experimental investigation and analysis of engineering systems including structural elements, fluid devices, and thermal systems. Use of computers for data acquisition. Laboratory. Extra fee required. (Plus-minus ABC/NC grading only)

ENGR 303 Engineering Thermodynamics (Units: 3)
Prerequisite: PHYS 240* or equivalent.

Application of thermodynamics to a variety of energy exchanging devices; properties of the pure substance, ideal gases, and mixtures; power and refrigeration cycles. (Plus-minus letter grade only)

ENGR 304 Mechanics of Fluids (Units: 3)
Prerequisites: ENGR 201* and PHYS 240* or equivalents.

Statics and dynamics of incompressible fluids, dimensional analysis, and similitude; fluid friction, laminar, and turbulent flow in pipes; forces on submerged structures; fluid measurements. (Plus-minus letter grade only)

ENGR 305 Linear Systems Analysis (Units: 3)
Prerequisites: ENGR 205* with a grade of C- or better and MATH 245* or equivalent.

Signal and linear system analysis in the time and frequency domains. System response to continuous and discontinuous signals. Convolution. Fourier series, Fourier transform and Laplace transform. State-space methods. (Plus-minus letter grade only)

ENGR 306 Electromechanical Systems (Units: 3)
Prerequisite: ENGR 205* or equivalent with a grade of C- or better.

Electromechanical energy conversion. Operating characteristics of transformers; DC and AC rotating machines: speed, torque, and profile control. Motion control system using stepper motors. System design, specifications, and simulation. (Plus-minus letter grade only)

ENGR 309 Mechanics of Solids (Units: 3)
Prerequisites: ENGR 102* and ENGR 200* (may be taken concurrently) or equivalents.

Shear and bending moment diagrams. Analysis of bending and shear stresses in beams. Stress transformation and failure theories. Deformation of beams. Column buckling. Torsion. Elastic and ultimate resistance of materials. (Plus-minus letter grade only)

ENGR 315 Systems Analysis Lab (Unit: 1)
Prerequisite: ENGR 305* (may be taken concurrently) or equivalent.

Laboratory exercises on signal and linear systems in time and frequency domains using Matlab. Linearity and time invariance. Solution of differential equations. Convolution. Fourier series and Fourier transform. Laplace Transform. State-space methods. Laboratory. (Plus-minus letter grade only)

ENGR 323 Structural Analysis (Units: 3)
Prerequisites: Restricted to upper-division Civil Engineering majors and minors. ENGR 309* or equivalent.

Structural engineering, including standards and codes. Determination of loads, discussion of load path. Analysis of statically determined structures. Forces within statically indeterminate structures. Structural analysis software. Lecture, 2 units; laboratory, 1 unit. (Plus-minus letter grade only)

ENGR 350 Introduction to Engineering Electromagnetics (Units: 3)
Prerequisites: MATH 245* and PHYS 240* or equivalents with grades of C- or better.

Transmission lines. Vector analysis. Static electric and magnetic fields. Boundary value problems. Maxwell's equations.

ENGR 353 Microelectronics (Units: 3)
Prerequisites: ENGR 205* and ENGR 206* or equivalents with grades of C- or better.

PN Diodes, BJTs, and MOSFETs. Semiconductor device basics, characteristics, and models. Diode applications. Transistor biasing, basic amplifier configurations, and basic logic circuits. PSpice simulation. (Plus-minus letter grade only)

ENGR 356 Digital Design (Units: 3)
Prerequisite: ENGR 205* or equivalent with a grade of C- or better.

Number systems. Design of combinational and sequential circuits. Logic simplification. Digital functional units such as adders, decoders, multiplexers, registers, and counters. State-machine design. Storage and programmable devices. Register transfer level.

ENGR 357 Digital Design Laboratory (Unit: 1)
Prerequisite: ENGR 356* (may be taken concurrently) or equivalent.

Circuit construction and troubleshooting techniques. EDA tools and simulation. Combinational and sequential circuits. Semiconductor memory. Laboratory. Extra fee required. (Plus-minus letter grade only)

ENGR 364 Materials and Manufacturing Processes (Units: 3)
Prerequisites: ENGR 201* and ENGR 309* with grades of C- or better.

Integration of stress analysis and failure theories with knowledge of materials and manufacturing processes in machine design. (Plus-minus letter grade only)

ENGR 378 Digital Systems Design (Units: 3)
Prerequisite: ENGR 356* or equivalent with a grade of C- or better.

CMOS digital circuits and their electrical properties. Logic circuit design with functional units. Algorithmic sequential machine design. Design with programmable logic devices. Hardware description and simulation language. Lecture, 2 units; laboratory, 1 unit. (Plus-minus letter grade only)

ENGR 410 Process Instrumentation and Control (Units: 3)
Prerequisites: ENGR 300* and ENGR 305* or equivalents.

Principles of control and instrumentation. Control of level, flow, temperature, and pressure. Actuators and transducers. Process modeling. (Plus-minus letter grade only)

ENGR 411 Instrumentation and Process Control Laboratory (Unit: 1)
Prerequisite: ENGR 410* or equivalent (may be taken concurrently).

Instrumentation for measurement of flow, temperature, level, and pressure. Experiments on level, flow, and temperature control. P, PI, PID, and programmable logic controllers. Laboratory. (Plus-minus letter grade only)

ENGR 415 Mechatronics (Units: 4)
Prerequisite: ENGR 305* or equivalent with a grade of C- or better.

Basics of a multidisciplinary field that combines electronics, mechanical design and simulation, and control systems. Simulation and design of systems with sensors, controllers, and actuators. System elements, including common sensors, actuators, and various electronic controllers. Lecture, 3 units; laboratory, 1 unit. (Plus-minus letter grade only)

ENGR 425 Reinforced Concrete Structures (Units: 3)
Prerequisite: ENGR 323* or equivalent (may be taken concurrently).

Design of reinforced concrete structural systems. Elements of systems including beams, slabs, columns, connections. Ultimate strength approach to safety and serviceability: bending, shear, and axial loads. (Plus-minus letter grade only)

ENGR 426 Steel Structures (Units: 3)
Prerequisite: ENGR 323* (may be taken concurrently) or equivalent.

Design of steel structures, members, and connections. Effects of loads causing flexure, shear and axial force, and their combinations in design choices. Steels and sections used in structural design. Use of design specifications. (Plus-minus letter grade only)

ENGR 427 Wood Structures (Units: 3)
Prerequisite: ENGR 323* (may be taken concurrently) or equivalent.

Design of wood structures. Design procedures and specifications of the wood structural members subjected to tension, compression, flexure, and combined bending with axial forces. Design building codes and seismic provisions of wood structures. (Plus-minus letter grade only)

ENGR 429 Construction Management (Units: 3)
Prerequisite: ENGR 235* or equivalent.

Construction engineering and management; professional practice and ethics; bidding and contracting; planning and scheduling, network diagrams, scheduling computations, resource management, computer applications; cost estimating; construction safety. (Plus-minus letter grade only)

ENGR 430 Soil Mechanics (Units: 3)
Prerequisite: ENGR 309* or equivalent.

Soil as an engineering material with emphasis on identification, physical, and mechanical properties. Evaluation of water flow through soil, settlement, soil strength, earth pressure, pile pullout capacity, and basic slope stability. Laboratory-based term project. Lecture, 2 units; laboratory, 1 unit. Extra fee required. (Plus-minus letter grade only)

ENGR 431 Foundation Engineering (Units: 3)
Prerequisite: ENGR 430* or equivalent.

Settlement of structures on deep and shallow foundations. Evaluation of undrained and drained soil strength. Analysis and design of gravity, cantilever, and anchored walls. Ultimate capacity of deep and shallow foundations. (Plus-minus letter grade only)

ENGR 432 Finite Element Methods in Structural and Continuum Mechanics (Units: 3)
Prerequisite: ENGR 309* or equivalent.

Fundamental concepts of the finite element method for one- and two-dimensional elements. Applications in the areas of structural analysis, plane stress and plane strain, and two-dimensional groundwater flow. Computer implementation of finite element techniques. (Plus-minus letter grade only)

ENGR 434 Principles of Environmental Engineering (Units: 3)
Prerequisites: CHEM 115* or CHEM 180*; ENGR 304* (may be taken concurrently); or equivalents.

Fundamentals of environmental engineering: water quality, water chemistry, water treatment, air quality, and solid waste management. (Plus-minus letter grade only)

ENGR 435 Environmental Engineering Design (Units: 3)
Prerequisite: CHEM 115* or CHEM 180* or equivalent.

Design concepts for environmental engineering systems relating to municipal and industrial wastewater treatment, disposal, and reuse. (Plus-minus letter grade only)

ENGR 436 Transportation Engineering (Units: 3)
Prerequisites: ENGR 235* and ENGR 430* (may be taken concurrently) or equivalents.

Principles, theories, and practice of transportation planning and design. (Plus-minus letter grade only)

ENGR 437 Water and Energy Recovery from Liquid and Solid Waste (Units: 3)
Prerequisite: CHEM 115* or CHEM 180* or equivalent.

Definitions, liquid waste (wastewater, sludge), solid waste, physical processes, chemical processes, biological (aerobic, anaerobic) processes, chemical reaction kinetics, biological reaction kinetics, fundamentals of process design, conservation of mass, conservation of energy, oxidation-reduction reactions, energy content of organic matter natural processes. (Plus/Minus Letter grade only)

ENGR 438 Transportation Planning (Units: 3)
Prerequisites: ENGR 271* and MATH 245* (may be taken concurrently).

Introduction to the principles and methods of planning transportation infrastructure. Techniques and tools to estimate traffic generated by land use development and forecast traffic growths. Applications of decision and economic theory on travel behaviors and congestion pricing. Environmental impact analysis in the context of transportation-land use systems. Planning methods and design guidance for bikes and pedestrians. Lecture, 2 units; laboratory, 1 unit. (Plus-minus letter grade only)

ENGR 439 Construction Engineering (Units: 3)
Prerequisites: ENGR 309* and ENGR 430* (may be taken concurrently) or equivalents.

Topics in construction engineering; construction methods and equipment, excavating, loading, hauling, and finishing; production of construction materials; compressed air and water systems; concrete form design; quality control. (Plus-minus letter grade only)

ENGR 441 Fundamentals of Composite Materials (Units: 3)
Prerequisites: Restricted to Engineering majors and minors; MATH 245* and ENGR 309* or equivalents.

Mechanics of long-, short-, and particle-reinforced composites. Stress, strain, and stiffness transformations. Mechanics of a single orthotropic ply. Laminated plate theory. Residual stress, fracture mechanics, delamination, fatigue; environmental effects, and thermomechanical properties. Manufacturing processes. Composites design, sustainability, and recycling. (Plus-minus letter grade)

ENGR 442 Operational Amplifier Systems Design (Units: 3)
Prerequisite: ENGR 305* or equivalent with a grade of C- or better.

Design of op-amp amplifiers, signal converters, conditioners, filters. Negative feedback, practical op-amp limitations. Voltage comparators, Schmitt triggers, nonlinear signal processing. Sinewave oscillators, multivibrators, timers. Design project, PSpice simulation. (Plus-minus letter grade only)

ENGR 445 Analog Integrated Circuit Design (Units: 4)
Prerequisites: ENGR 301* and ENGR 353* or equivalents with grades of C- or better.

Integrated circuit technology, transistor characteristics, and models. Analysis and design of monolithic op-amps. Frequency response, negative feedback, stability, PSpice simulation. Lecture, 3 units; laboratory, 1 unit. Extra fee required. (Plus-minus letter grade only)

ENGR 446 Control Systems Laboratory (Unit: 1)
Prerequisite: ENGR 447* (may be taken concurrently) or equivalent.

Simulation and modeling of control systems using Matlab and Simulink. Control experiments using servomotors and industrial emulators. Control project. Laboratory. (Plus-minus letter grade only)

ENGR 447 Control Systems (Units: 3)
Prerequisite: ENGR 305* or equivalent with a grade of C- or better.

Analysis and design of continuous and discrete control systems. Systems modeling and stability. System compensation using root-locus and frequency domain techniques. Z-transforms, discrete transfer functions, and state-space representation. Control of digital systems using state-space methods. (Plus-minus letter grade only)

ENGR 448 Electrical Power Systems (Units: 3)
Prerequisite: ENGR 306* or equivalent with a grade of C- or better.

Operating characteristics of transmission lines, transformers, and machines. Symmetrical component theory and sequence network method. Use commercial programs to conduct load flow study, short circuit analysis, and economic dispatch problems. State estimation, unit commitment, and system transient and stability issues. (Plus-minus letter grade only)

ENGR 449 Communication Systems (Units: 3)
Prerequisite: ENGR 305* or equivalent with a grade of C- or better.

Review of linear systems. Amplitude (AM), frequency (FM), and phase (PM) modulation systems. Transmitter and receiver design. Frequency and time-domain multiplexing. Digital modulation techniques: line coding, pulse shaping, channel equalization techniques. Error-correcting techniques.

ENGR 451 Digital Signal Processing (Units: 4)
Prerequisites: ENGR 305*; ENGR 213* or CSC 210* or ENGR 271*; or equivalents with grades of C- or better.

Properties of discrete-time systems. Convolution. Difference equations. Sampling and reconstruction of analog signals. Z-transforms and inverse z-transforms. Design of FIR and IIR filters. Discrete Fourier series and transform. Fast Fourier transform algorithms. Lecture, 3 units; laboratory, 1 unit. (Plus-minus letter grade only)

ENGR 453 Digital Integrated Circuit Design (Units: 4)
Prerequisites: ENGR 301*, ENGR 353*, and ENGR 356* or equivalents with grades of C- or better.

Integrated circuit technology, transistor characteristics, and models. MOS and bipolar logic families, noise margins, speed, power, fanout, interfacing, PSpice simulation. Regenerative circuits and memories. Lecture, 3 units; laboratory, 1 unit. Extra fee required. (Plus-minus letter grade only)

ENGR 454 Application Specific Integrated Circuit Design (Units: 4)
Prerequisite: ENGR 356* with a grade of C- or better.

Concepts and methodologies established for design and automated ASIC implementation of complex digital designs. Design at the system level using hardware description language. Implementing design in hardware using the ASIC design flow. Standard cell ASIC design flow involving steps of automated logic synthesis and optimization to gate-level, and layout generation using automated placement and routing. Lecture, 3 units; laboratory, 1 unit.

ENGR 455 Power Electronics (Units: 4)
Prerequisites: ENGR 301*, ENGR 305*, ENGR 306*, and ENGR 353* or equivalents with grades of C- or better.

Power device characteristics. Circuit and component design and analysis concepts. Uncontrolled and phase-controlled rectifier circuits. DC to DC converters. Switching DC power supply. Pulse width modulation. DC to AC inverter. Utility interface and harmonic issues. Lecture, 3 units; laboratory, 1 unit. Extra fee required.

ENGR 456 Computer Systems (Units: 3)
Prerequisites: ENGR 356*; ENGR 213* or CSC 210*; or equivalents with grades of C- or better.

Computer performance measurements. Instruction set architecture. Program sequencing. Basic processor organization, arithmetic-logic unit, simple and pipelined datapaths. Hardwired and microprogrammed control. Memory system configuration, cache, and virtual memory management. (Plus-minus letter grade only)

ENGR 458 Renewable Electrical Power Systems and Smart Grid (Units: 3)
Prerequisite: ENGR 306* or equivalent with a grade of C or better.

Introduction to electric power industry; electric circuit and electric power; transmission lines; transformers; synchronous generators; photo-voltaic systems; wind power systems; smart grid. (Plus-minus letter grade only)

ENGR 461 Mechanical and Structural Vibrations (Units: 3)
Prerequisites: ENGR 201*, ENGR 309*, and MATH 245* or equivalents.

Dynamic excitation and response of mechanical and structural systems. Frequency and time domain; energy methods, Rayleigh's principle, modal analysis. Vibration damping, resonance, isolation, absorption parametric excitation, and influence coefficients. (Plus-minus letter grade only)

ENGR 463 Thermal Power Systems (Units: 3)
Prerequisites: ENGR 302* and ENGR 467* or equivalents with grades of C- or better.

Application of thermodynamics, fluid mechanics, and heat transfer to the design of energy systems. Economic and environmental aspects stressed as design criteria. Lecture, 2 units; laboratory, 1 unit. Extra fee required. (Plus-minus letter grade only)

ENGR 464 Mechanical Design (Units: 3)
Prerequisite: ENGR 364* or equivalent with a grade of C- or better.

Application of principles of mechanics, materials science, and stress analysis to the design of components and machines. Mechanical behavior of materials. Synthesis and analysis of a major machine design project. Lecture, 2 units; laboratory, 1 unit. Extra fee required. (Plus-minus letter grade only)

ENGR 465 Principles of HVAC (Units: 3)
Prerequisite: ENGR 303* or equivalent with a grade of C- or better.

Air requirements in buildings, heating, and cooling load calculation methods and computer software, heating and cooling equipment, flow in pipes and ducts, and cleanroom technology. (Plus-minus letter grade only)

ENGR 466 Gas Dynamics and Boundary Layer Flow (Units: 3)
Prerequisites: ENGR 303* and ENGR 304* or equivalents.

Review of the fundamentals of fluid dynamics, formulation, and application of compressible fluid flow, shock waves. Concept and formulation of laminar and turbulent boundary layers, external flows, flow around immersed bodies. (Plus-minus letter grade only)

ENGR 467 Heat Transfer (Units: 3)
Prerequisites: ENGR 303* and ENGR 304* or equivalents with grades C- or better.

Fundamental principles of heat transfer with applications to design. Examination of conduction, transient and steady-state, free and forced convection, radiation, and heat exchangers. Heat exchangers. (Plus-minus letter grade only)

ENGR 468 Applied Fluid Mechanics and Hydraulics (Units: 3)
Prerequisite: ENGR 304* or equivalent.

Fluid mechanics: incompressible flow to steady and transient flow problems in piping networks, turbo-machines, and open channels. (Plus-minus letter grade only)

ENGR 469 Alternative and Renewable Energy Systems (Units: 3)
Prerequisite: ENGR 303* or equivalent.

Theory and practical applications of renewable energy systems, including solar, hydro, and wind power. Biomass and biofuels. Environmental, social, and economic factors related to energy conversion processes. (Plus-minus letter grade only)

ENGR 470 Biomechanics (Units: 3)
Prerequisite: ENGR 200* or equivalent with a grade of C- or better.

Understanding and characterizing the mechanical behavior of biological tissues and systems. Emphasis on the fundamentals of biomechanics including force analysis, mechanics of deformable bodies, stress analysis, and viscoelasticity. (Plus-minus letter grade only)

ENGR 476 Computer Communications Networks (Units: 3)
Prerequisites: ENGR 356*; ENGR 213* or CSC 210*; or equivalents with grades of C- or better.

Technological precedence and alternatives in setting up a computer communication network. OSI, DSL, cable modems, PPP, Ethernet, TCP/IP, wireless LANs, Frame Relay, ATM, and SONET topics. Lecture, 2 units; laboratory, 1 unit. (Plus-minus letter grade only)

ENGR 478 Design with Microprocessors (Units: 4)
Prerequisites: ENGR 356*; ENGR 213* or CSC 210*; or equivalents with grades of C- or better.

Assembly language programming. System bus. Interfacing with memory and I/O devices. Serial and parallel communications. Timer and counter functions. Polling and interrupt. A-D conversion. Fuzzy logic. Lecture, 3 units; laboratory, 1 unit. (Plus-minus letter grade only)

ENGR 491 Real-time Digital Signal Processing (Units: 3)
Prerequisites: Restricted to upper-division standing; ENGR 213* and ENGR 451* or equivalents.

Implementation of real-time digital signal processing algorithms on special-purpose hardware. Use of assembly and C languages to develop and test IIR and FIR filters, FFT, and waveform generation for modern DSP chips, Fast Convolution. Sampling aliasing and jitter. Scaling for fixed-point arithmetic. Special analysis, DSP applications, including sound synthesis and real-time audio signal processing. Lecture, 2 units; laboratory, 1 unit. (Plus-minus letter grade only)

ENGR 492 Hardware for Machine Learning (Units: 3)
Prerequisites: ENGR 213*, ENGR 353*, and ENGR 356* with grades of C- or better.

Introduction to various neural networks, and their circuit implementation for machine learning. Focus on the synergy among algorithms, software, and hardware in pursuit of energy efficiency neural network computing technologies. Cover basic programming languages such as Pythons, C/C++ with CUDA, and basic circuit simulation tools, such as hspice. (Plus-minus letter grade only)

ENGR 498 Advanced Design with Microcontrollers (Units: 4)
Prerequisite: ENGR 478* with a grade of C- or better.

Advanced topics on design with modern microcontrollers including advanced microcontroller architecture, system bus and interfacing with memory and I/O devices, advanced serial interfaces, direct memory access, pulse width modulation, memory and power management, and introduction to real-time operating systems. Develop microcontroller-based real-time embedded systems. (Plus-minus letter grade only)

ENGR 610 Engineering Cost Analysis (Units: 3)
Prerequisites: ENGR 103* or ENGR 213* (may be taken concurrently); and MATH 227* (may be taken concurrently).

Quantifying alternative for decision making, time-value of money, project investment evaluation, comparison of alternatives, engineering practice applications, and introduction to value engineering. (Plus-minus letter grade only)

ENGR 693 Cooperative Education Program (Units: 3-12)
Prerequisite: Restricted to upper-division standing or consent of the instructor.

Intended for engineering majors. Supervised employment in an academically relevant field of study. Units do not count toward the major. May be repeated for a total of 24 units. (CR/NC grading only)

ENGR 694 Cooperative Education in Engineering (Unit: 1)
Prerequisite: Consent of the adviser.

Written and oral report of work performed with outside agency. Evaluation of work by engineering adviser and/or faculty committee. (CR/NC grading only)

ENGR 696 Engineering Design Project I (Unit: 1)
Prerequisites: Restricted to senior standing with 21 upper-division ENGR units; ENGR 300* or ENGR 301* or equivalent.

Selection of design project, methods of research, time management, and engineering professional practice and ethics. This course is 3rd in a series of courses (ENGR 300, ENGR 301 or ENGR 302, ENGR 696, and ENGR 697GW) that, when completed with a C or better, will culminate in the satisfaction of the University Written English Proficiency/GWAR if taken Fall 2009 or later. Laboratory. (Plus-minus ABC/NC grading only)

ENGR 697GW Engineering Design Project II - GWAR (Units: 2)
Prerequisite: GE Area A2; ENGR 696* or equivalent.

Continued work on a design project with maximum independence under the supervision of a faculty adviser. Oral and written project reports required. May be repeated in the case of a double major. (Plus-minus ABC/NC grading only)
Course Attributes:

- Graduation Writing Assessment

ENGR 699 Independent Study (Units: 1-3)
Prerequisite: Approval of division and instructor.

Special study in the laboratory, field, or library under the direction of a member of the division. The student must present a detailed written report of the work accomplished. May be repeated.

ENGR 800 Engineering Communications (Units: 3)
Prerequisite: Restricted to Graduate Engineering students or consent of the instructor.

Types and modes of communications used by engineers in professional practice. Learning models for effective communications, both oral and written. (Plus-minus letter grade only)

ENGR 801 Engineering Management (Units: 3)
Prerequisite: Restricted to Graduate Engineering students or consent of the instructor.

History and evolution of engineering, ethics and professionalism, business aspects of contracts and specifications, litigation and arbitration, planning and scheduling, quality control, and personnel management. (Plus-minus letter grade only)

ENGR 820 Energy Resources and Sustainability (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 303 or equivalent; or consent of the instructor.

Overview of conventional and renewable energy resources. Energy conversion processes, flow pathways, and end uses. Environmental impacts, sustainability, and economics of energy systems.

ENGR 823 Introduction to Seismology (Units: 3)
Prerequisite: Restricted to Graduate Engineering students or consent of the instructor.

Fundamentals of seismic wave propagation using physical approaches, application of wave propagation theory in studying earth structure, thus earthquake evolution; seismometry fundamentals, applications to societal issues; foundation in theoretical seismology and earthquake engineering. (Plus-minus letter grade only)

ENGR 826 Seismic Hazard Analysis (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 425 or ENGR 426 or equivalent; or consent of the instructor.

Review of fundamentals of seismic hazard analysis, strong ground motions, attenuation relations; probabilistic and deterministic methods; seismic code provisions and ground motions. Introduction of appropriate selection of acceleration records for dynamic analysis. (Plus-minus letter grade only)

ENGR 827 Structural Design for Fire Safety (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 323 or equivalent; ENGR 425 or ENGR 426 or equivalent; or consent of the instructor.

Standard fire time-temperature curve and its limitations, properties of concrete, steel and fire protection materials at elevated temperature engineering; load capacity of structural components under fire; fire resistance design of steel, composite, concrete and timber structures. (Plus-minus letter grade only)

ENGR 828 Seismic Isolation and Energy Dissipation (Units: 3)
Prerequisites: Restricted to Graduate Structural/Earthquake Engineering students; ENGR 461 or equivalent; or consent of the instructor.

Concepts of base isolation and energy dissipation for seismic hazard mitigation.

ENGR 829 Advanced Topics in Structural Engineering (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 323 and ENGR 461 or equivalents; or consent of the instructor.

Theory of structures in historic perspective. Advanced structural analysis (matrix methods). Nonlinear theories and post-buckling. Introduction to structural stability. Introduction to nonlinear analysis and performance-based design. Concepts and application of Finite Element Analysis. (Plus-minus letter grade only)

ENGR 831 Advanced Concrete Structures (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 425 or equivalent; or consent of the instructor.

Advanced design of reinforced concrete structural systems. Design of reinforced concrete frames considering seismic loads. (Plus-minus letter grade only)

ENGR 832 Advanced Topics in Seismic Design (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 425, ENGR 426, and ENGR 461 or equivalents; or consent of the instructor.

Application of computer software for structural design. General concepts of energy dissipation systems. Current methods of structural control. Implementation issues, case studies, and seismic code provisions. (Plus-minus letter grade only)

ENGR 833 Principles of Earthquake Engineering (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 461 or equivalent; or consent of the instructor.

Earthquake ground motions; development of response spectra and effects of local site conditions on spectra. Dynamic response of single and multi-degree of freedom systems to earthquakes. Seismic damage to buildings. Earthquake resistive design. (Plus-minus letter grade only)

ENGR 835 Advanced Steel Structures (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 426 or equivalent; or consent of the instructor.

Advanced design of steel structures, plate girders, and connections. Steel structural design considering effects of torsion and combined bending and axial load. Design of steel frames considering seismic loads. Steel design emphasizing Load and Resistance Factor Design. (Plus-minus letter grade only)

ENGR 836 Structural Design for Earthquakes (Units: 3)
Prerequisite: Restricted to Graduate Engineering students; or ENGR 425 and ENGR 426; or equivalents; or consent of the instructor.

Earthquake resisting systems in buildings; seismic design criteria for structures; seismic upgrade and retrofit; computer applications in structural modeling and analysis for seismic forces.

ENGR 837 Geotechnical Earthquake Engineering (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 430 or equivalent; ENGR 461 or equivalent (may be taken concurrently); or consent of the instructor.

Vibration analysis of discrete and continuous systems. Earthquake engineering. Dynamic soil properties. Deterministic and probabilistic ground response analysis. Evaluation and mitigation of liquefaction hazards. (Plus-minus letter grade only)

ENGR 838 Smart Structures Technology (Units: 3)
Prerequisites: Restricted to Graduate Structural/Earthquake and Civil Engineering students; ENGR 323 and ENGR 461 or equivalents; or consent of instructor.

Focus on smart structure technologies in the applications to structures including areas of structural control, structural health monitoring, and smart sensing. Topics include structural system identification, stability analysis, sensor data acquisition systems, and signal processing tailored specifically for structural engineering. (Plus-minus letter grade)

ENGR 844 Embedded Systems (Units: 3)
Prerequisite: Restricted to Graduate Engineering students or consent of the instructor.

Trends and challenges of embedded systems. Introduction of design and use of single-purpose processors (hardware) and general-purpose processors (software). Discussion of memories and buses, advanced computation models, control systems, chip technologies, and modern design tools.

ENGR 845 Neural-Machine Interfaces: Design and Applications (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 478 or equivalent with a grade of C- or better; or consent of the instructor.

Introduction to the concepts, designs, and challenges of neural-machine interfaces (muscle-machine interfaces, brain-computer interfaces, etc.) and their applications (e.g., neuroprosthetics, gesture-controlled devices) from an engineering perspective. Design real-time neural-machine interfaces and applications by combining principles of neural signal processing, machine learning, and real-time computer system design. (Plus-minus letter grade only)

ENGR 848 Digital VLSI Design (Units: 3)
Prerequisite: Restricted to Graduate Engineering students; ENGR 353 or equivalent; or consent of the instructor.

Fundamental metrics for quantitative evaluation of design. Basics of CMOS transistors and technology. Silicon technology scaling different logic styles. Design of combinational and sequential circuits in CMOS. Interconnects. Layout techniques. Designing arithmetic building blocks. Memory technology and design. (Plus-minus letter grade only)

ENGR 849 Advanced Analog IC Design (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 353, ENGR 442, and ENGR 445 or equivalents; or consent of the instructor.

Fundamentals of analog integrated circuits design along with the nanometer CMOS technology; introduction of the mixed-signal IC design theories and practices; advanced analog IC blocks; practice of the analog design using state-of-art CAD tools. (Plus-minus letter grade only.)

ENGR 850 Digital Design Verification (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 378 or equivalent; or consent of the instructor.

Concepts and methodologies established for verification of complex digital designs, based on the language of System Verilog that has evolved as a standard language for verification and testbench design. Verification methodologies include random stimulus generation with automatic self-checking features to detect design bugs, and with coverage features as a measure of the level of confidence in verification.

ENGR 851 Advanced Microprocessor Architectures (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 456 or equivalent; or consent of the instructor.

Microprocessor architecture and register organization. Multiprogramming, process scheduling and synchronization, and multitasking. Memory management and privileged machine states. Examples of 32-bit machines. Reduced architectures: RISC approach, MIPS. (Plus-minus letter grade only)

ENGR 852 Advanced Digital Design (Units: 3)
Prerequisite: Restricted to Graduate Engineering students; ENGR 356 or equivalent; or consent of the instructor.

Design of fundamental and pulse mode circuits, design with programmable logic devices, computer simulation of digital circuits, reliable digital system design techniques, testing and design for testability. (Plus-minus letter grade only)

ENGR 853 Advanced Topics in Computer Communication and Networks (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 476 or equivalent with a grade of C or better; or consent of the instructor.

Computer communication networks for broadband services; current networking and communication technologies; new technologies and their utilization in emerging broadband multimedia applications.

ENGR 854 Wireless Data Communication Standards (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; background in communication systems; or consent of the instructor.

Characteristics of wireless channels. Wireless local area networks, Bluetooth, high-rate and low-rate wireless personal area networks, and wireless broadband access. Medium-access control layers, security and quality of service.

ENGR 855 Advanced Wireless Communication Technologies (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 449 and ENGR 451 or equivalents; or consent of the instructor.

Software radio architecture. Analysis and design of software radios. RF/IF conversion, ADC, and DAC. Radio resource management. Digital signal processing for software radio applications. Software characterization. Antenna diversity, smart antennas, programmable antennas, and advanced antenna systems. Applications of software radios. Ultra-wideband (UWB) communication systems. (Plus-minus letter grade only)

ENGR 856 Nanoscale Circuits and Systems (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 378, ENGR 453, ENGR 890 or equivalents; or consent of the instructor.

Advanced topics in VLSI device, circuit and system design including high-performance and low-power design issues, challenges of technology scaling, technologies and solutions at different levels of abstraction. Requires class project. (Plus-minus letter grade only)

ENGR 858 Hardware Security and Trust (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 356 or equivalent; or consent of the instructor.

Covers the state-of-the-art security methods and devices as well as emerging technologies and security trends for securing physical objects and components. Presents the possible vulnerabilities in the design & fabrication processes and provides strong solutions to prevent/protect malicious attacks on hardware/systems. Develops a deep understanding of attacks and the possible countermeasures against them. (ABC/NC grading only)

ENGR 863 Advanced Thermal-Fluids (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 303 and ENGR 304 or equivalents; or consent of the instructor.

Development of thermodynamics and fluid mechanics concepts at the graduate level. Topics include chemical reactions, chemical and phase equilibrium, and compressible flow. Emphasis on use of software tools for engineering analysis. (Plus-minus letter grade only)

ENGR 865 Energy-Efficient Buildings (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 467 or equivalent; or consent of the instructor.

Theory and implementation of energy-efficient building technologies. Topics include energy-efficient systems for HVAC, lighting, and water heating, building thermal management, and building energy simulation. (Plus-minus letter grade only)

ENGR 866 Air Quality Engineering (Units: 3)
Prerequisite: Restricted to graduate Engineering students or consent of the instructor.

Review of air quality standards and environmental and human health impacts of airborne pollutants. Analysis of pollutant formation mechanisms, atmospheric fate and transport, and engineering strategies for emissions measurement and control. (Plus-minus letter grade only)

ENGR 867 Energy Auditing and Measurement and Verification (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 205 and ENGR 467 or equivalents; or consent of the instructor.

Focus on detailed methods for energy audit and measurement and verification of energy savings in commercial and industrial facilities; details on utility rate schedules, benchmarking, and various energy efficiency and conversation measures and methods.

ENGR 868 Advanced Control Systems (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 447 or equivalent; or consent of the instructor.

Advanced feedback control and simulation techniques. Sensor filtering and estimation. State space control and modern control topics. Real-time control and implementation in embedded systems. (Plus-minus letter grade only)

ENGR 869 Robotics (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; ENGR 201, ENGR 305, ENGR 447 or equivalents with grades of B or better; or consent of the instructor.

Kinematics and kinetics of robotic manipulators including serial manipulators, parallel manipulators and legged robots. (Plus-minus letter grade only)

ENGR 871 Advanced Electrical Power Systems (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; MATH 245 or equivalent; or consent of the instructor.

Theoretical and practical aspects of transients in electric power systems, with a focus on the integration of renewable energy systems into the existing electrical grid. Topics include switching transients and commutation effects, surge phenomena and system protection, and reactive power. (Plus-minus letter grade only)

ENGR 890 RF Devices and Transceiver Principles and Design (Units: 3)
Prerequisite: Restricted to Graduate Engineering students; ENGR 350 or equivalent; or consent of the instructor.

RF devices: filter, duplexer, combiner, divider, coupler; baseband/RF devices: I/Q modulator and demodulator, mixer, ADC, DAC; receiver design: noise figure, IMD products, dynamic range, synthesizer, phase locked loop; transmitter design: amplifier classes, linearization techniques. (Plus-minus letter grade only)

ENGR 895 Applied Research Project (Units: 3)
Prerequisites: Restricted to graduate Engineering students with 12 units of graduate work and a passing GET score; SCI 614 or equivalent; consent of the instructor and approval of Advancement to Candidacy (ATC) and Culminating Experience (CE) forms by Graduate Studies.

Comprehensive research-based engineering study detailing the objectives, methods, and findings of the research. An oral presentation is required. Advancement to Candidacy and Proposal for Culminating Experience Requirement forms must be approved by the Division of Graduate Studies before registration. (Plus-minus letter grade, CR/NC, RP)

ENGR 897 Research (Units: 3)
Prerequisites: Restricted to Graduate Engineering students with nine units of graduate work; ENGR 800 and ENGR 801 or equivalents; or consent of the instructor.

Independent investigation or significant design project under the supervision of an Engineering faculty member. Intended as the research investigation leading to the master's thesis. May be repeated for a total of 6 units. (Plus-minus AB/NC, RP)

ENGR 898 Master's Thesis (Units: 3)
Prerequisites: Restricted to Graduate Engineering students; consent of the instructor and approval of Advancement to Candidacy (ATC) for the Master of Science in Engineering and Culminating Experience (CE) forms by Graduate Studies. ATC and Proposal for Culminating Experience Requirement Forms must be approved by the Graduate Division prior to registration.

(Plus-minus AB/NC, RP)

ENGR 899 Independent Study (Units: 1-3)
Prerequisites: Restricted to graduate Engineering students; consent of the department and instructor.

Special study of a particular problem or subject under the direction of a member of the department. Open only to graduate students in engineering. Students must present a detailed written report of the work accomplished to the department faculty. May be repeated for a total of 6 units.