ENGINEERING

EGR 100df Topics: Engineering for Everyone-Design for the Future (4 Credits)
This class explores a range of future societal challenges before settling in on a "grand challenge" of particular interest to students to focus on with our design work. Through readings, discussions, short assignments and a semester-long collaborative design project, students work together to identify unmet needs and learn a process for creating solutions to meet those needs. Students start by developing an initial understanding of a need area through relevant background research and then spend the majority of their time continually improving solution ideas through prototyping, testing, feedback and revision. Enrollment limited to 20. {N}
Fall, Spring, Annually

EGR 100ee Topics: Engineering for Everyone-Energy and the Environment (4 Credits)
Through readings, discussion, labs and lectures students learn about human activity related to energy usage and the consequences to Earth's environment. This knowledge is applied to motivate, design and build scale models of net-zero energy buildings. Through simple lab exercises, students learn to program microcontrollers that measure temperatures and control features within their model buildings, and corresponding analyses enables students to demonstrate how energy from the sun can be utilized in design to reduce carbon-based energy sources. Enrollment limited to 20. {N}
Fall, Spring, Variable

EGR 100hh Topics: Engineering for Everyone-Challenges in Human Health (4 Credits)
We will explore broadly how engineering design approaches can be used to address a variety of challenges in human health. Through readings, discussions, lab experiences, short design assignments, and a semester-long team design project, we will work to identify open unmet biomedical needs, and learn a process for how to develop solutions to meet those needs. The emphasis will be on first gaining a throrough understanding of an unmet need, and then on continually improving solution ideas, through testing and seeking feedback on the current set of possible solutions, and learning from failure. {N}
Fall, Spring, Variable

EGR 100mr Topics: Engineering for Everyone-Mobile Robot Design (4 Credits)
Through readings, presentations and group activities, students are introduced to the principles of human-centered design. The engineering design process is explored through assignments that guide students in ideation, testing and documentation of an engineering system. Students engage in hands-on workshops to learn and practice new technical skills, and they apply these tools towards completing a semester-long collaborative project to design, build and program an autonomous mobile robot. Enrollment limited to 20. {N}
Fall, Variable

EGR 100se Topics: Engineering for Everyone-Sustainable Energy (4 Credits)
This course focuses on the global transition of energy systems toward sustainability and net-zero emissions. There is interest across the planet to transition to energy systems that emit zero pollutant emissions – but is this actually possible? Students learn about both the engineering elements of energy systems and the societal and government initiatives for The Energy Transition. Students work in teams to design sustainable energy systems, balancing the tradeoffs in cost, reliability, community needs, consumer responsibility and the environment, that are required to achieve "net-zero." Students also learn about what it means to be an engineer, engineering science, ethics, decision making and how to navigate through the engineering program at Smith. Enrollment limited to 20. {N}
Fall, Spring, Variable

EGR 100sw Topics: Engineering for Everyone-Sustainable Water Resources (4 Credits)
We investigate and design water resources infrastructure – for hydropower, water supply, wastewater treatment, stormwater management, and irrigation. Those technologies are introduced through historical and contemporary examples, along with a theme of the importance of place in engineering design. In contrast to design as invention, this course puts the emphasis on the adaptation of common designs to particular places, as influenced by climate, physical geography, culture, history, economics, politics, and legal frameworks. Examples include the historic Mill River, Northampton's water resources, Boston's Deer Island wastewater treatment facility, San Francisco's water supply system, California's State Water Project and the Bay-Delta system, the Colorado River, and water recycling and reclamation. {N}
Fall, Spring, Variable

EGR 110 Fundamental Engineering Principles (4 Credits)
The design and analysis of engineered or natural systems and processes relies on a command of fundamental scientific and engineering principles. This course provides an introduction to these fundamental underpinnings through a study of the conservation of mass, energy and charge in both steady and transient conditions with non-reactive systems. Specific topics covered include a review of process variables and their relationships, open and closed systems, differential and integral balances, and basic thermodynamics. Prerequisite: MTH 112, may be taken concurrently. Enrollment limited to 20. {N}
Spring

EGR 220 Engineering Circuit Theory (5 Credits)
Analog and digital circuits are the building blocks of computers, medical technologies and all things electrical. This course introduces both the fundamental principles necessary to understand how circuits work and mathematical tools that have widespread applications in areas throughout engineering and science. Topics include Kirchhoff's laws, Thévenin and Norton equivalents, superposition, responses of first-order and second-order networks, time-domain and frequency-domain analyses, and frequency-selective networks. Required laboratory taken once a week. Corequisite: PHY 210. Prerequisite: MTH 212. Enrollment limited to 20. Engineering majors only. {N}
Spring

EGR 270 Engineering Mechanics I (5 Credits)
This course introduces the basic theoretical concepts, procedures and methodologies needed to understand the mechanical behavior of objects in static equilibrium. Topics to be covered include 2d and 3d particle and rigid body equilibrium; analysis of frames, trusses, beams and machines; centroids; distributed loading; moment of inertia; internal forces and moments; and an introduction to stress and strain. In addition to developing competence in applying standard problem-solving procedures, students will also apply their understanding in real world contexts. Prerequisites: PHY 117 and MTH 112 or equivalent. Engineering majors only. Enrollment limited to 20. {N}
Fall

EGR 290 Engineering Thermodynamics (4 Credits)
Modern civilization relies profoundly on efficient production, management and consumption of energy. Thermodynamics is the science of energy transformations involving work, heat and the properties of matter. Engineers rely on thermodynamics to assess the feasibility of their designs in a wide variety of fields including chemical processing, pollution control and abatement, power generation, materials science, engine design, construction, refrigeration and microchip processing. Course topics include first and second laws of thermodynamics, power cycles; combustion and refrigeration; phase equilibria; ideal and nonideal mixtures, conductive, convective and radiative heat transfer. Prerequisite EGR 110; CHM 111 or CHM 118; and MTH 212 (may be concurrent). Enrollment limited to 20. Engineering majors only. {N}
Fall, Spring

EGR 312 Seminar: Atmospheric Processes (4 Credits)
This course explores key topics including atmospheric circulation, global warming, stratospheric ozone depletion and urban air pollution. How does ground-level ozone form and why is it harmful to people and agriculture? What are high-pressure systems and why are they associated with fair weather? How do clouds form and what impact do they have on the climate? What instruments are being used to measure the properties of the atmosphere and how do these instruments work? This course is recommended for anyone with a solid grounding in math and science and is for students who want a better understanding of the environment. Prerequisites: CHM 111, EGR 110 and EGR 374 (may be concurrent) or equivalent. Enrollment limited to 12. Junior and senior engineering majors only. {N}
Fall, Spring, Alternate Years

EGR 314 Seminar: Contaminants in Aquatic Systems (4 Credits)
Chemical and microbiological contamination of freshwater is a growing concern around the world. Understanding how these contaminants behave in the environment is essential when considering ecosystem implications and engineering approaches towards remediation. Topics covered include water chemistry, water policy and regulation and chemical contaminant partitioning. The class explores how contaminants enter the ecosystem, the fate of these contaminants due to environmental action and the potential for remediation to help restore freshwater health using a course based research approach. In addition, current and historical water quality events are reviewed as case studies. Through the research-based course project, students have an opportunity to explore a chosen topic of interest related to water quality and/or aquatic chemical or microbiological contamination. Prerequisites: CHM 111 and SDS 220. Enrollment limited to 12. Junior and senior engineering majors only. {N}
Fall, Spring, Variable

EGR 315 Seminar: Ecohydrology (4 Credits)
This seminar focuses on the measurement and modeling of hydrologic processes and their interplay with ecosystems. Material includes the statistical and mathematical representation of infiltration, evapotranspiration, plant uptake and runoff over a range of scales (plot to watershed). The course addresses characterization of the temporal and spatial variability of environmental parameters and representation of the processes. The course introduces students to the Pioneer Valley, the cloud forests of Costa Rica and African savannas. Prerequisites: MTH 112 and SDS 220. Enrollment limited to 12. Juniors and senior Engineering majors only.
Fall, Spring, Variable

EGR 320 Signals and Systems (4 Credits)
The concepts of linear system theory (e.g., signals and systems) are fundamental to all areas of engineering, including the transmission of radio signals, signal processing techniques (e.g., medical imaging, speech recognition, etc.) and the design of feedback systems (e.g., in automobiles, power plants, etc.). This course introduces the basic concepts of linear system theory, including convolution, continuous and discrete time Fourier analysis, Laplace and Z transforms, sampling, stability, feedback, control and modulation. Examples are utilized from electrical, mechanical, biomedical, environmental and chemical engineering. The course includes several short laboratory experiences to help understand the relevant concepts. Prerequisites: EGR 220 and PHY 210. Enrollment limited to 20. Junior and senior Engineering majors only. {M}
Fall, Spring, Annually

EGR 322 Seminar: Acoustics (4 Credits)
Acoustics describes sound transmission through solids and fluids; the focus here is on sound transmission through air. This seminar provides an overview of the fundamentals of acoustics, including derivation of the acoustic wave equation, the study of sound wave propagation (plane and spherical waves), the study of sound transmission through pipes, waveguides and resonators impedance analogies, an overview of the acoustics related to the human auditory system and an introduction to room acoustics. The course includes several short hands-on experiments to help understand the relevant concepts. Prerequisite: EGR 220 or equivalent. Enrollment limited to 12. Junior and senior engineering majors only. {M}{N}
Fall, Spring, Variable

EGR 323 Seminar: Introduction to Microelectromechanical Systems (MEMS) (4 Credits)
Miniature and micro-scale electromechanical systems (MEMS) have applications ranging from navigation systems in your phone to disease diagnosis at your doctor's office. This course asks and answers questions related to MEMS fabrication, design and modeling. Application including inertial sensors, biological and chemical sensors, microfluidics and wearable devices are discussed. Students complete a final project by applying a MEMS sensor to an application of their choice. Prerequisites: EGR 220 and EGR 270. Enrollment limited to 12. Junior and senior engineering majors only. {N}
Fall, Spring, Variable

EGR 324 Seminar: Fundamentals of Microelectronics (4 Credits)
The electronic world relies on transistors, amplifiers and other microelectronic circuits. This course introduces the principles required to analyze and design basic microelectronic circuits. Topics will include the device principles of diodes, bipolar junction transistors and field effect transistors, the design of simple analog and digital circuits and microelectronic circuit analysis using simulation software (SPICE). Prerequisite: EGR 220. Enrollment limited to 12. Juniors and seniors only. {N}
Fall, Spring, Variable

EGR 325 Seminar: Sustainable Electric Power Systems (4 Credits)
Electric power systems across the globe, from continental to neighborhood-sized grids-are undergoing a comprehensive shift referred to as "The Energy Transition." In this course, students learn modeling and analysis tools for integrating alternative energy sources (including geothermal and new storage technologies), as well as conventional technologies, into power systems. The class discusses barriers and possible solutions to the widespread desire to electrify everything, when the electric power grid itself is not yet sustainable, clean or reliable enough to absorb the new demand for electricity. Prerequisite: EGR 220. Enrollment limited to 12. Junior and senior engineering majors only. {N}
Fall, Spring, Variable

EGR 326 Dynamic Systems and Introduction to Control Theory (4 Credits)
Dynamic systems are systems that evolve with time, such as plants growing, populations migrating, systems storing energy (RLC circuits, rolling carts, heated building), national economy behavior, etc. They occur throughout nature and the built environment. Understanding dynamic systems leads to the ability to control them, so they behave according to the engineer's design. This course introduces students to both linear dynamic system and modern control theories, so that students will be able to design and control simple dynamic systems. Through design projects, students gain practical experience in designing a simple controller for a dynamic system. Prerequisites: EGR 220, CSC 110 or CSC 120, and a basic linear algebra from course such as PHY 210 or MTH 211. Enrollment limited to 20. Engineering majors only. {N}
Fall, Spring, Annually

EGR 328/ CSC 328 Seminar: Digital Circuits and Sensors (4 Credits)
Offered as CSC 328 and EGR 328. Previously EGR 390dc. Digital circuits are everywhere, from basic thermostat controls and stop light sequencers to smart phones, computers and even Mars Rovers! This course covers the basic building blocks for all electronics. Students investigate basic logic circuits, combinatorial logic and sequential logic with an introduction to the basic digital circuits such as encoders and multiplexers. The second part of the semester focuses on microprocessors, using the Arduino. Students will build a variety of circuits with input (from a computer, or from the environment via sensors) and programmed output (LEDs, sound, data sent to a computer), in order to learn how information from our analog world can be converted into digital data. There will be a lab about every other week, and a final project for students to explore an area of their choosing in more depth. Prerequisites: CSC 110 or CSC 120, and either EGR 220 or CSC 231. Enrollment limited to 12. Junior and senior engineering majors only. {N}
Fall, Spring, Variable

EGR 340 Seminar: Geotechnical Engineering (4 Credits)
What is quicksand and can one really drown in it? Why is Venice sinking? In this seminar students are introduced to the engineering behavior of soil within the context of a variety of real-world applications that include constructing dams, roads and buildings; protecting structures from earthquake and settlement damage; and preventing groundwater contamination. Topics covered include soil classification, permeability and seepage; volume changes; and effective stress, strength and compaction. Students use a variety of approaches to learning including discussion, hands-on activities, labs, projects, field trips and in-depth explorations of topics chosen by the students. Prerequisite: EGR 270 or GEO 241. Enrollment limited to 12. Junior and senior engineering majors only. {N}
Fall, Spring, Variable

EGR 351 Seminar: Introduction to Biomedical Engineering (4 Credits)
There are countless challenges in medicine that engineering can help to address, from the molecular scale to the level of the entire human body. This course introduces students to engineering problem solving approaches to explore important biomedical questions. The class integrates learning of underlying biological systems with developing engineering thinking to examine those systems. Students use mathematical tools to interpret and model the behavior of various biological phenomena. Upon completion of this course, students are able to identify open medical needs and propose ways in which engineering can contribute to understanding and meeting those needs. Prerequisites: PHY 210 or equivalent. Enrollment limited to 12. Junior and senior engineering majors only.
Fall, Spring, Annually

EGR 360 Seminar: Advanced Thermodynamics (4 Credits)
Significant challenges underlie our ability to effectively harness, convert and distribute energy. This course builds on a fundamental knowledge of thermodynamics to understand the operating principles behind, and characterize the limits of, energy generation and conversion technologies. Methods of power generation are examined, including combustion engines, nuclear reactors and hydrogen fuel cells. Topics covered in this course include: exergy, advanced cycle analysis, ideal gas mixtures, thermodynamic relations and energy analysis of reacting systems. Prerequisites: CHM 111, EGR 290 and MTH 212. Enrollment limited to 12. Junior and senior engineering majors only. {N}
Fall, Spring, Annually

EGR 363 Mass and Heat Transfer (4 Credits)
This upper-level course introduces the processes and accompanying mathematical representations that govern the transport of heat and mass, including advection, dispersion, adsorption, conduction, convection and radiation. Applications include environmental transport and mixing, cooling and heat exchange, and separation processes. Prerequisites: EGR 290 and EGR 374. Enrollment limited to 20. Engineering majors only. {N}
Fall, Spring, Annually

EGR 373 Seminar: Skeletal Biomechanics (4 Credits)
Knowledge of the mechanical and material behavior of the skeletal system is important for understanding how the human body functions and how the biomechanical integrity of the tissues comprising the skeletal system are established during development, maintained during adulthood and restored following injury. This course provides a rigorous approach to examining the mechanical behavior of the skeletal tissues, including bone, tendon, ligament and cartilage. Engineering, basic science and clinical perspectives are integrated to study applications in the field of orthopaedic biomechanics. Prerequisites: EGR 375. Enrollment limited to 12. Junior and senior Engineering majors only. {N}
Fall, Spring, Variable

EGR 374 Fluid Mechanics (5 Credits)
This is the second course in a two-semester sequence designed to introduce students to fundamental theoretical principles and analysis of mechanics of continuous media, including solids and fluids. Concepts and topics to be covered in this course include intensive and extensive thermophysical properties of fluids; control-volume and differential expressions for conservation of mass, momentum and energy; dimensional analysis; and an introduction to additional topics such as aerodynamics, open-channel flow and the use of fluid mechanics in the design process. Required concurrent laboratory. Prerequisites: EGR 270 and MTH 212. Enrollment limited to 20. EGR majors only. {N}
Fall, Spring

EGR 375 Strength of Materials (4 Credits)
This course introduces students to the fundamentals of mechanics of materials from a static failure analysis framework. Structural behavior is analyzed, along with the material and geometric contributions to this behavior. Lecture topics are complemented with hands-on project work designed to help students make connections between the theoretical and experimental behavior of materials. Prerequisite: EGR 270. Engineering majors only. {N}
Fall, Spring, Annually

EGR 376 Materials Science and Engineering (4 Credits)
Periods in human history have been defined by advancements in new materials. Discoveries in Materials Science have lead the way to new technologies in every engineering discipline and continue to be at the forefront of developing fields such as biomaterials and nanotechnology. This course will provide a broad introduction into the world of Materials Science with a special emphasis on the relationship between the composition, processing, structure, and properties of metals, ceramics, polymers, and composites. EGR Majors only. Prerequisites: EGR 270 and EGR 290. Enrollment limited to 20. {N}
Fall, Spring, Annually

EGR 377 Seminar: Aerial Vehicle Design (4 Credits)
Remotely piloted and autonomous aircraft are increasingly being used in scientific research, agriculture, disaster mitigation and national defense. These small and efficient aircraft offer major environmental benefits while, at the same time, raise complex ethical and policy issues. This seminar introduces the rapidly growing field of aerial vehicle design and low-Reynolds number aerodynamics through a major project in which students design, fabricate and test a remotely piloted aircraft. Prerequisites: EGR 374, CSC 111, and either EGR 220 or CSC 270. Enrollment limited to 12. Juniors and seniors only.
Fall, Spring, Variable

EGR 388 Seminar: Photovoltaic and Fuel Cell System Design (4 Credits)
This seminar applies fundamental principles of thermodynamics, electrochemistry and semi-conductor physics to the design, modeling and analysis of renewable energy power systems. Concepts covered in this course include extraterrestrial radiation, solar geometry, atmospheric effects, polarization curve characteristics, system components and configurations, stand-alone and hybrid system design and load interactions. This course applies these theoretical concepts in a laboratory setting involving the design and testing of fuel cell and photovoltaic systems. Corequisite: EGR 290. Prerequisites: EGR 220. Enrollment limited to 12. Junior and senior engineering majors only. {N}
Fall, Spring, Variable

EGR 389 Seminar: Techniques for Modeling Engineering Processes (4 Credits)
The goal of this seminar is to introduce students to several approaches used to model, understand, simulate and forecast engineering processes. One approach covered is the use of artificial neural networks—a branch of artificial intelligence (AI) with connections to the brain. Other approaches covered are based upon probability and statistics and include auto-regressive moving average (ARIMA) processes. Although students learn about the theory behind these approaches, the emphasis of the course is on their application to model processes throughout the field of engineering. Some examples include earthquake ground motion, financial markets, water treatment and electrical systems. Acknowledging the interdisciplinary nature of AI, students also investigate the possibilities of machine consciousness. Enrollment limited to 12. Junior and senior engineering majors only. {N}
Fall, Spring, Variable

EGR 390fe Seminar: Advanced Topics in Engineering-Finite Element Modeling (4 Credits)
Computer simulations are an increasingly large part of engineering research and design, but how do we know if the results on the screen match reality? This course is an introduction to finite element methods for the analysis of solids, fluids, and heat transfer. Topics covered include the creation of 1D, 2D, and 3D models of engineering problems in COMSOL Multiphysics (a commercial engineering program), comparison of modeled results to laboratory measurements, and the evaluation of modeled results. An emphasis will be not only on the creation of computer models, but also on how to validate those models with real world data. Small projects and modeling homework assignments will lead to a more complex final project on a chosen topic of interest. EGR majors only. Prerequisites: EGR 270, EGR 290 and EGR 374. Juniors and seniors only. Enrollment limited to 12. {N}
Fall, Spring, Variable

EGR 390ge Seminar: Advanced Topics in Engineering-Geothermal Engineering (4 Credits)
Roughly two thirds of the energy used in a typical home in the United States is for heating and cooling. Most often, this energy is produced by burning fossil fuels or pulling electricity from the grid to power inefficient space heaters or air conditioners. Geothermal systems have been used since the 1970s to efficiently provide environmentally sustainable heating and cooling capacity for structures as small as homes or as large as hospitals. Topics to be covered include the different types of geothermal systems used for heating and cooling, calculating heat exchange, evaluation of site geothermal potential, design of geothermal systems, as well as construction techniques and considerations. Course activities will include discussions, design projects and field trips to ongoing geothermal construction sites (when possible). Prerequisites: EGR 290. Enrollment limited to 12. Junior and senior engineering majors only. {N}
Fall, Spring, Variable

EGR 390rs Seminar: Advanced Topics in Engineering-Remote Sensing (4 Credits)
Engineers need data to solve problems, but what does one do when one can't gain access to a location or conduct intrusive tests? Remote Sensing explores technology such as radar, sonar, LiDAR, resistivity and other techniques used to collect data when engineers have to be "hands off." An emphasis on both research of cutting-edge techniques and practical application of field work and data collection. Course activities include discussions, research projects and field work using ground penetrating radar and other systems. Enrollment limited to 12. Juniors and seniors only. Engineering majors only. Instructor permission required. {N}
Fall, Spring, Variable

EGR 400 Special Studies (1-4 Credits)
Engineering majors only.
Fall, Spring

EGR 410D Engineering Design and Professional Practice (1 Credit)
This two-semester course focuses on the engineering design process and associated professional skills required for careers in engineering. Topics include a subset of the following: the engineering design process, project definition, design requirements, project management, concept generation, concept selection, engineering economics, design for sustainability, design for safety and risk reduction, design case studies, teamwork, effective presentations, professional ethics, networking, negotiation and intellectual property. This course is required of all senior engineering students pursuing the B.S. in engineering science and must be taken in conjunction with EGR 421D, EGR 422D or EGR 431D. EGR majors only. Seniors only.
Fall, Spring, Annually

EGR 421D Capstone Design with Faculty (3 Credits)
This two-semester course leverages students' previous coursework to address an engineering design problem. Students work on a design project sponsored by an individual member of the engineering faculty. Regular design meetings, progress reports, interim and final reports, and presentations are required. Prerequisites: Senior standing in engineering, EGR 220, EGR 270, EGR 290, EGR 374 and at least one additional 300-level engineering course, plus a clear demonstration of intent and a faculty sponsor. Corequisite EGR 410D.
Fall, Spring

EGR 422D Design Clinic (3 Credits)
This two-semester course leverages students' previous coursework to address an engineering design problem. Students collaborate in teams on real-world projects sponsored by industry and government. Regular team design meetings, weekly progress reports, interim and final reports, and multiple presentations are required. This course requires an ability to work on open-ended problems in a team setting. Corequisite EGR 410D. Prerequisites: EGR 100, EGR 220, EGR 270, EGR 290, EGR 374 and at least one additional 300-level engineering course, or equivalent. Enrollment limited to 36. Senior engineering majors only.
Fall, Spring, Annually

EGR 423 Engineering Capstone Immersion (1 Credit)
This course is intended for students currently enrolled in Design Clinic (EGR 422D) to augment the two-semester capstone design experience with immersive work over interterm. Activities students are likely to pursue during interterm as part of this course include learning new software specifically for their projects, traveling to project sites or sponsor offices, conducting experiments or prototyping. Work may be concentrated in the case of a week-long site visit or more spread out when doing experimentation or prototyping. S/U only. Limited to students in EGR 422D. Instructor permission required.
Interterm

EGR 430D Honors Project (4 Credits)
Independent work in any area of engineering with a faculty member for a total of 8 credits. This pathway is separate from the capstone design experience required for the B.S. degree. Senior engineering majors only. Requires permission of the department.
Fall, Spring, Annually

EGR 431D Honors Capstone Design with Faculty (4 Credits)
Honors version of EGR 421D. Corequisite: EGR 410D. Engineering majors only. Requires permission of the department.
Fall, Spring, Annually