ENGINEERING (EGR)

The mission of the engineering major is to educate students in an engineering curriculum that embraces and supports the unique culture of Wake Forest by combining the liberal arts core, innovative entrepreneurship, and engineering. The program provides an undergraduate engineering education that embodies the teacher-scholar ideal, emphasizing the close faculty-student engagement that is the hallmark of the Wake Forest community. Our goal is to attract enthusiastic students from around the US and the world who will make important contributions to solving society's most pressing problems, fulfilling the *Pro Humanitate* motto of Wake Forest University.

Declaring a Major

In declaring Engineering as a major, we recommend students declare as soon as they complete 40 credit hours at WFU. All students majoring in Engineering will be assigned an Engineering Faculty Major Advisor to support progress towards degree completion. We encourage students to first declare the major before declaring an Engineering Concentration.

Students choosing to double major in Engineering and another major may count any class *required* by both majors as fulfilling the requirements of both majors. The courses required for the Bachelor of Science in Engineering degree that fall into this category are: EGR 111, EGR 112, EGR 211, EGR 212, EGR 311, EGR 312, EGR 313, EGR 314, EGR 315, CHM 111/CHM 111L, PHY 113/PHY 113L, MTH 111, MTH 112, MTH 113, and MTH 205. Any courses not on this list are considered electives. Electives towards the required 47 credits of engineering may be counted for only one major. However, electives towards the required 30 credits of Math/Basic Science may count towards other majors as well, whether required or not.

Note that when a student declares a major or minor, the requirements for the major or minor that are in effect *at the time* of declaration will apply. See the Requirements for Degrees (https://bulletin.wfu.edu/undergraduate/requirements-degrees/) section for further details.

Study Abroad

Students considering study abroad should consult with the Engineering Academic Advisor. The second year or fall of the third year are the most flexible semesters for Engineering students to study abroad. Students are recommended to go to the Study Abroad office to discuss potential programs during their first year. Students cannot take courses abroad to count towards any core Engineering courses (EGR 111, EGR 112, EGR 211, EGR 212, EGR 311, EGR 312, EGR 313, EGR 314, or EGR 315), however, they can take courses to count towards any other major or minor requirements. Courses taken to count towards EGR technical elective requirements are not pre-approved by the Engineering Department. To seek approval, the student must submit the course syllabus to the Engineering Academic Advisor for pre-screening and then submit all course work after course completion to be considered.

Undergraduate Research

At the start of each semester, we source research projects that our students can pursue via EGR 281s or EGR 381s. Students are encouraged to talk with Engineering Faculty if they are interested in pursuing research.

Internships

Unpaid internships may be eligible for course credit and the possibility of engineering technical elective credit. Students should consult with their Engineering major advisor about course-credit options for internship opportunities.

Special Note. Students enrolled at Wake Forest may not take courses in engineering at other institutions to satisfy the divisional requirement.

Contact Information

Department of Engineering (http://college.wfu.edu/engineering/)
Wake Downtown
455 Vine Street
Bldg 60 South, Rm 460X
Phone 336-702-1926

Programs

Major

- Engineering, B.S. (https://bulletin.wfu.edu/undergraduate/departments-programs/engineering/bs-engineering/)

Minor

- Engineering, Minor (https://bulletin.wfu.edu/undergraduate/departments-programs/engineering/minor-engineering/)

Courses

Engineering Courses for Divisional Credit

EGR 110. Introduction to Human-Centered Engineering Design. (4 h)
Introduction to the study and practice of engineering, systems thinking, human-centered design, research, creative and analytical problem-solving practices, and engineering for humanity. With laboratory. This course is targeted at students who are not interested in majoring nor minoring in Engineering. Credit for both EGR 110 and EGR 111 is not allowed. (D)

EGR 111. Introduction to Engineering Design. (4 h)
Introduction to the study and practice of engineering, systems thinking, design, research, creative and analytical problem-solving practices, and engineering for humanity. With laboratory. This course is targeted at students who are interested in majoring or minoring in Engineering. Credit for both EGR 110 and EGR 111 is not allowed. (D).

Required Engineering Courses for the Bachelor of Science in Engineering Degree

EGR 111. Introduction to Engineering Design. (4 h)
Introduction to the study and practice of engineering, systems thinking, design, research, creative and analytical problem-solving practices, and engineering for humanity. With laboratory. This course is targeted at students who are interested in majoring or minoring in Engineering. Credit for both EGR 110 and EGR 111 is not allowed. (D).

EGR 112. Introduction to Engineering Experimentation. (4 h)
Exploration of tools, processes, and quantitative and qualitative analysis for modern engineering practice. With laboratory.

EGR 211. Materials and Mechanics. (4 h)
Fundamentals of materials and mechanics (statics and dynamics) for engineering applications. With laboratory. P-CHM 111/111L, EGR 111, 112, MTH 111, PHY 113. P or C-MTH 112.

EGR 212. Transport Phenomena. (4 h)
An integrated course in the fundamentals of thermodynamics, fluid mechanics, and heat transfer with emphasis on principles of conservation and transport of mass, energy, and momentum. With laboratory. P-CHM 111/111L, EGR 111, 112, MTH 111, 112, PHY 113. P or C-MTH 113.

EGR 311. Control Systems and Instrumentation. (4 h)
Fundamentals of circuits and semiconductor electronics as applied to the analysis and design of engineering instrumentation and control systems. With laboratory. P-EGR 211, MTH 112 P or C - MTH 205 (or MTH 121 and MTH 251). Credit not allowed for EGR 311 and PHY 230. Engineering majors MUST take EGR 311.

EGR 312. Computational Modeling in Engineering. (4 h)
Fundamentals of computational problem solving tools (programming, systems modeling, numerical methods) for diverse engineering applications, with consideration of the economic and ethical outcomes of decisions that are made using such techniques. With laboratory. P-EGR 211, 212, MTH 113, 205 (or MTH 121 and MTH 251). (STA 111 highly encouraged but not required).

EGR 313. Capstone Design I. (1 h)
The first course of the capstone design experience. P or C-EGR 311 P or C-EGR 312.

EGR 314. Capstone Design II. (4 h)
The second course of the capstone design experience. With laboratory. P-EGR 311, 312, and EGR 313.

EGR 315. Capstone Design III. (4 h)
The third course of the capstone design experience. With laboratory. P-EGR 314.

General Elective Courses in Engineering

EGR 113. Integrated Sciences. (4 h)
An integrated basic science course covering topics in the biological, chemical, and physical sciences. With laboratory.

EGR 280. Projects with Engineering for Non-Majors. (1-4 h)
Specialized and focused learning via experiential projects. With laboratory. May be repeated for credit.

EGR 281. Introductory Projects with Engineering for Majors. (1-4 h)
Specialized and focused learning via experiential projects. Does not count towards engineering technical elective credit. With laboratory. May be repeated for credit.

EGR 301. Special Topics in Engineering. (1-4 h)
Seminar and/or lecture and/or project-based and/or laboratory courses in selected topics. Does not count towards engineering technical elective credit unless a designation of "Technical Elective" is noted. May be repeated if the course title changes.

EGR 302. Engineering Internship. (0 h)
Independent study in Engineering under faculty mentorship. May be repeated. P-POI.

EGR 310. Capstone Design for Non-Majors. (1-4 h)
This course is designed for Engineering Minors or other students interested in participating in the engineering capstone design experience. May be repeated for credit. POI.

EGR 380. Fundamentals of Engineering Exam Prep. (1 h)
Review of engineering fundamentals in preparation for Fundamentals of Engineering exam. May be repeated for credit. P or C -EGR 311, EGR 312.

EGR 381. Engineering Research. (1-4 h)
Engineering research project conducted under the guidance of a research mentor. Does not count towards engineering technical elective credit unless a designation of “Technical Elective” is in the course title. Upon completion and review of project deliverables, engineering technical elective credit may be granted. May be repeated for credit. A total of two or more hours of approved EGR 381 technical elective credit can be used to count as one course toward a concentration.

Engineering Technical Elective Courses

EGR 213. Mechanical Computer Aided Design I. (2 h)
Introduction to Computer Aided Design (CAD) for mechanical assemblies and civil applications using a variety of CAD software tools. The course covers design planning of additive and subtractive techniques. Counts for ME and CEE Concentration. P-EGR 111.

EGR 214. Embedded Microcontroller Systems. (2 h)
Examination of the structure of digital electronic systems with specific focus on microcontroller architectures for embedded system applications, as well as interfacing with analog and digital peripherals. With laboratory. Counts for ECE Concentration. P- EGR 112 and CSC 111 (or POI)

EGR 215. Digital Electronics. (2 h)
Design and hardware implementation of digital electronic systems using basic boolean logic gates and other common digital logic tools such as multiplexers, decoders, flip-flops, shift registers, and counters. With laboratory. Counts for ECE Concentration. P—EGR 112.

EGR 316. Mechanical Computer Aided Design II. (2 h)
Advanced Computer Aided Design (CAD) for mechanical systems with consideration of material properties, stress analysis, and manufacturability. Counts for ME Concentration. P-EGR 211, EGR 213.

EGR 317. Renewable Energy Systems. (2 h)
Fundamentals of renewable energy systems, including wind, solar, biomass, and hydroelectric with economic evaluation and understanding technological innovations. With laboratory. Counts for ME Concentration. P-EGR 212.

EGR 318. Biomimetic Engineering. (2 h)
Fundamentals of bioinspired design, functional modeling, and reverse engineering principles towards innovative solutions. Counts for ME Concentration. P-EGR 211 or EGR 212.

EGR 319. Environmental Engineering. (2 h)
Fundamentals of environmental systems, including water supply, water quality, water treatment, air pollution, soil remediation, environmental risk assessment, and climate variation. Explore how engineers both leverage and sustain these systems and inform environmental and public health policies. With laboratory. Counts for CEE Concentration. P-EGR 211, EGR 212.

EGR 320. Biomedical Engineering Applications. (2 h)
An overview of biomedical engineering applications such as cardiovascular fluid mechanics, biomechanics, biomaterials, tissue engineering, signal processing and instrumentation, and biomedical ethics. With laboratory. Counts for BME Concentration. P-EGR 211, EGR 212, and MTH 205 (or MTH 121 and MTH 251).

EGR 321. Chemical Engineering Separations. (2 h)
Theory and design of chemical separation processes, and related flow diagrams, by applying material and energy balances and chemical equilibria fundamentals. Includes distillation, liquid-liquid extraction, ion exchange, and gas absorption. With laboratory. Counts for MCE Concentration. P-EGR 212, MTH 205 (or MTH 121 and MTH 251), CHM 122 (or CHM 123), CHM 280.

EGR 322. Materials Engineering and Characterization. (2 h)
Relationships between atomic structure, microstructure, and observable properties of metallic, ceramic, and polymeric materials. Measurement and modification of material properties. With laboratory. Counts for MCE Concentration. P-EGR 211, MTH 112.

EGR 323. Chemical Reaction Engineering. (2 h)
Rates of homogeneous, catalytic, and biological reactions; reactor design and analysis, and related flow diagrams. With laboratory. Counts for MCE Concentration. P-EGR 212, MTH 205 (or MTH 121 and MTH 251), CHM 122 (or CHM 123), CHM 280.

EGR 324. Hydrologic and Hydraulic Engineering. (2 h)
Fundamentals of hydrologic processes, estimating hydrologic fluxes, watershed-scale modelling, and open channel hydraulics. With laboratory. Counts for CEE and ME Concentration. P-EGR 211, 212.

EGR 325. Medical Product Design. (2 h)
Fundamentals of innovative and user-centered product design processes. Use of clinical observations and client interviews to derive new medical device designs and analysis for improving system performance. With Laboratory. Counts for BME Concentration. P—EGR 211, EGR 212.

EGR 326. Human Factors Engineering. (2 h)
A systems approach to understanding human-machine interfaces, psychology of design, ergonomics, human error and system reliability. With laboratory. P-EGR 211 and 212.

EGR 327. Microengineering. (2 h)
An overview of microengineering systems and an exploration of how size affects critical scaling law parameters, material properties, fabrication techniques, design and use. With laboratory. P-EGR 211 and 212.

EGR 328. Inverse Problems in Engineering. (2 h)
Fundamental approaches and techniques in solving inverse problems using mathematical, numerical, and statistical formulations. Applications include satellite remote sensing of the earth and environment, medical imaging, image and signal processing, and machine learning. With laboratory. Counts for CEE Concentration. P-EGR 211, MTH 205 (or MTH 121 and MTH 251), MTH 113. (STA 111 highly encouraged but not required).

EGR 329. Functional Advanced Materials Characterization. (2 h)
Relationships between atomic structure, microstructure, and observable properties of functional and advanced materials. Measurement and modification of material properties. With laboratory. Counts for MCE Concentration. P-EGR 211, MTH 113.

EGR 330. Infrastructure Systems Design. (2 h)
Explore principles of infrastructure systems through experiential learning and application of concepts to design or redesign a local system with consideration of technical, social, environmental, and economic factors. With laboratory. Counts for CEE Concentration. P-EGR 211, EGR 212.

EGR 331. Thermal Fluid Systems. (2 h)
Applying fundamentals of fluid mechanics, heat transfer, and thermodynamics across diverse engineering applications in the analysis and design of thermal fluid systems. With laboratory. Counts for ME Concentration. P-EGR 212, MTH 205 (or MTH 121 and MTH 251)

EGR 332. Structural Engineering I. (2 h)
An introduction to structural engineering systems and materials such as steel, wood, and concrete. Emphasis on understanding the load path within real structures and how that impacts their design. With laboratory. Counts for CEE Concentration. P—EGR 211.

EGR 333. Tissue Engineering. (2 h)
Fundamentals of biomaterials, stem cells, and imaging technologies to analyze novel tissue engineering applications. With laboratory. Counts for BME Concentration. P-EGR 211, EGR 212, BIO 111 or BIO 150 or HES 365 (or POI)

EGR 334. Mobile Robotics. (2 h)
Introduction to mobile robotics, from hardware (energy, locomotion, sensors) and software (signal processing, control, localization, trajectory planning, high-level control). With laboratory. Counts for ECE Concentration. P-EGR 311.

EGR 335. Field Programmable Gate Array (FPGA) Design and Implementation. (2 h)
An introduction to field programmable gate array (FPGA) design and system implementation. With laboratory. Counts for ECE Concentration. P—EGR 215 or CSC 250.

EGR 336. Healthcare Engineering. (2 h)
Beyond biomedical engineering, engineers play a critical role in bettering healthcare systems via big data analytics, next generation technologies, translational science and engineering, precision medicine, and diagnostic AI. With laboratory. Counts for BME Concentration. P – EGR 312.

EGR 337. Biofluid Mechanics. (2 h)
Introduction to Bioengineering principles applied to the cardiovascular system. Specifically, this course will apply relevant theories in Fluid Mechanics and Solid Mechanics to the cardiovascular system. With laboratory. Counts for BME and ME Concentration. P – EGR 211, EGR 212.

EGR 338. Bioprinting and Biofabrication. (2 h)
Engineering principles applied to bioprinting and biofabrication with fundamentals of biomaterials, tissue engineering, and tissue construct design principles. Counts for BME and MCE Concentration. P—EGR 211.

EGR 339. Engineering Reynolda. (2 h)
A historical engineering perspective with the historic Reynolda House as a case study. Fundamentals of reverse engineering and research in the context historical structures and systems. Introduction to design as it relates to existing structures. With laboratory. Counts for CEE Concentration. P—EGR 211, EGR 212.

EGR 340. Acoustics. (2 h)
Fundamentals in acoustics involving concepts of wave phenomena and sound perception, governing principles and mathematical modeling of acoustics applications. Counts for ME Concentration. P-EGR 212.

EGR 341. 3D Modeling and Additive Manufacturing. (2 h)
Fundamentals of a variety of 3D printing techniques for rapid prototyping, 3D modeling of standard machine elements, creation of engineering drawings and animations. Counts for ME Concentration. P-EGR 211.

EGR 342. Design of Machine Elements. (2 h)
Application of design theories to practical machine elements and selection of machine components for diverse applications. Counts for ME Concentration. P-EGR 211.

EGR 343. Biomaterials. (2 h)
Fundamentals of different types of biomaterials and their application across a diverse set of biomedical scenarios. Counts for BME and MCE Concentration. P-EGR 211.

EGR 344. Mechanics of Intelligent Material Systems. (2 h)
Fundamentals of material systems as actuator, sensors, and energy harvesters across diverse applications, including artificial muscle electroactive polymer technologies, with an emphasis on materials science and engineering design. Counts for MCE and BME Concentration. P-EGR 211.

EGR 345. System Engineering and Control Theory. (2 h)
Fundamentals of system engineering and control theory across diverse applications, including mechanical, electrical, environmental, biological, and socio-economic systems. With laboratory. P-EGR 311 and 312.

EGR 346. Engineering Analysis of Vibrations. (2 h)
Modeling and solution of free and forced vibrating dynamic systems, including single and multiple degree of freedom systems, as well as continuous systems. Applications includes earthquake modeling, beam and membrane vibrations, etc. Counts for ME and CEE Concentration. P-EGR 211.

EGR 347. Finite Element Analysis of Engineering Systems. (2 h)
Fundamentals of finite element methods and commercial finite element codes for solid mechanics, heat transfer, and fluid mechanics applications in one, two, and three dimensions. Counts for ME Concentration. P—EGR 312.

EGR 348. Advanced Fluid Mechanics. (2 h)
Advanced fluid kinematics, finite control volume analysis, and differential analysis of fluid flows. Includes applications of inviscid and viscous flows, similitude, dimensional analysis, open channel flows, compressible flows and flow in turbomachines. Counts for ME Concentration. P-EGR 212.

EGR 349. Human Biomechanics. (2 h)
Fundamentals of human movement and modeling of skeletal, muscular, and neurological motion. Kinematic analysis of human movement, and kinetics (forces) required to generate movement. Counts for BME and ME Concentration. P-EGR 211.

EGR 350. Advanced Electronics. (2 h)
Exploration and applications of operational amplifiers and other analog linear integrated circuits. With laboratory. Counts for ECE Concentration. P—EGR 311.

EGR 351. Biomechanics of Animal Locomotion. (2 h)
Biological and mechanical principles of animal movement on both solid ground and through fluids, including flight, swimming, running, jumping, climbing, etc. Considers force production and patterns of movement including muscular action and vortex behavior. Counts for BME and ME Concentration. P-EGR 211, EGR 212.

EGR 352. Natural Hazards Engineering. (2 h)
An introduction to how natural hazards, such as earthquakes, hurricanes, tsunamis, and others, affect the built environment and communities and how engineers can design for natural hazards considering life safety and resilience. Counts for CEE Concentration. P—EGR 211.

EGR 353. Green Energy Technologies. (2 h)
Fundamentals of energy conversion technologies and how “green” they are. Counts for CEE and MCE Concentration. P-EGR 211 and EGR 212.

EGR 354. Resilient Building Systems. (2 h)
This course will focus on how building codes and other industry standards impact building system design. We will look at how buildings are built (and have been built) to be resilient in the face of fires, hurricanes, earthquakes, and even the mundane day-to-day challenges. Counts for CEE Concentration. P-EGR 211 and 212.

EGR 355. Engineering Economics. (2 h)
Modeling and evaluation of economic benefits and costs of projects involving engineering design and analysis. Methods include cash flow analysis, time value of money, cost benefit analysis, forecasting, financial management of technologies over their lifecycle, evaluation of new ventures, etc. For EGR Majors or POI.

EGR 356. Financial Engineering. (2 h)
Modeling and evaluation of financial applications with engineering projects. Topics include accounting basics, financial optimization, quantitative risk management, asset management, operations research, data mining, etc. For EGR Majors or POI.

EGR 357. Engineering Management. (2 h)
Consulting basics in support of managing engineering projects, marketing basics, developing strategy and business planning, project management, financial reporting, production and distribution principles, etc. For EGR Majors or POI.

Faculty

Chair Michael Gross
Professors Michael Gross, Olga Pierrakos
Associate Professors Patricia Clayton, Saami Yazdani
Assistant Professors Hussein Abdeltawab, Courtney Di Vittorio, Erin Henslee, Lauren Lowman, Kyle Luthy, Kyana Young
Assistant Teaching Professors William Crowe, Melissa Kenny