Engineering

See additional information on the P.C. Rossin College of Engineering and Applied Science (http://catalog.lehigh.edu/coursesprogramsandcurricula/engineeringandappliedscience/).

ENGINEERING MINOR

See additional information on the Engineering Minor under the heading of the P.C. Rossin College of Engineering and Applied Science (http://catalog.lehigh.edu/coursesprogramsandcurricula/engineeringandappliedscience/).

Core Prerequisites to begin the program		
MATH 051	Survey of Calculus I (or equivalent) [1]	
PHY 005	Concepts In Physics (or equivalent) [1]	
Required Courses		
EMC 001	Macro and Micro View of Engineering	3
EMC 002	Engineering Practicum	3
Electives		
Select three of the following: [2]		9
Group A - Engineering Fundamentals		
EMC 105	Engineering Structures and Motion	
EMC 110	Energy Engineering	
EMC 115	Engineering Materials and Electronics	
EMC 120	Systems Engineering	
Group B - Integrated Engineering		
EMC/CSE 042	Game Design	
EMC 150	Information and Knowledge Engineering	
EMC 155	Enterprise Engineering	
EMC 156	Embedded Systems	
EMC 160	Computer Aided Engineering and Control Systems	
EMC/ISE 168	Production Analysis	
EMC 170	Software Engineering and Collaborative Environments	
EMC/CHE/CEE/ES 171	Fund of Environmental Technology	
EMC 174	Process Engineering	
Total Credits		**15**

1 May be taken concurrently with EMC 001 and EMC 002.

2 Three electives are required and must include one from the Engineering Fundamentals course group and one from the Integrated Engineering course group. The student is free to choose the third elective from either group.

Number of credits to fulfill minor is 15 credits

Note: The Minor in Engineering is not open to RCEAS students.

Engineering Minor Course Courses

EMC 001 Macro and Micro View of Engineering 3 Credits
A course designed to be exciting and stimulate a student's further interest in the engineering minor. Hands-on experience with engineering problem solving, modeling, simulation, and analysis tools. Macro view of what engineering is and what engineers do. Interaction with practicing engineers; visits to local engineering facilities.

EMC 002 Engineering Practicum 3 Credits
Techniques and processes used in the creation of engineered products. Exposure to engineering tasks and processes in a hands-on laboratory; mechanical and electronic manufacturing and fabrication techniques. Disassembly and reassembly of common engineered products to assess how they work and are manufactured.

EMC 042 (CSE 042) Game Design 3 Credits
From the early text-based, one-player computer games to the modern 3D games with thousands of gamers sharing the same virtual gaming world simultaneously, computer games have gone through a remarkable evolution. Despite this evolution, principles of computer game design are not well understood. In this course we will study the broad issue of game design, particularly tailored towards video games. We will present an experimental model for game design and analyze various modern computer games from the perspective of this model.

EMC 105 Engineering Structures and Motion 3 Credits
Practical limits imposed on stationary or moving structures; why exceeding these limits can lead to failure. Basic principles governing both stationary structures; e.g. buildings and bridges, and things that move, e.g. cars and satellites, and how these principles apply in engineering practice. How a stationary structure effectively supports both its own weight and the weight of its users and why a structure will undergo deflections and deformations during use. How forces and energy are associated with a moving structure and how these affect the motion of the structure.

EMC 110 Energy Engineering 3 Credits
The amount of energy used by a modern society is quite staggering, and a clear understanding of energy processes and constraints is essential knowledge for every citizen. The basics of energy, its measurement, principles governing its use and conversion, methods of production, and the associated consequences on the environment. Fossil, nuclear, and renewable, energy sources. Energy utilization developed in a simple form and employed to examine the use of energy in large and small engineering systems and products, from power plants to air conditioners.

EMC 115 Engineering Materials and Electronics 3 Credits
"Materials" are the "stuff" from which we build TV's, cell phones, cars, skyscrapers, etc., and affect design, performance, costs, and environmental impacts. How electronics, communications, and structures depend on advances in materials engineering: materials behavior, modeling and simulation of materials properties and performance; methods and databases for materials selection; and engineering processes to control material composition and structure.

EMC 120 Systems Engineering 3 Credits
Systems approach to problem solving in fields such as environmental planning, large-scale infrastructure systems, manufacturing, telecommunication, and delivery of services. Systems analysis concepts and their relation to the determination of preferred plans and designs of complex, large-scale engineering systems. Performance and cost in project engineering decisions that balance resource investments across the major stages of life of an engineering system. Development of functional requirements and satisfactory designs.

EMC 150 Information and Knowledge Engineering 3 Credits
How computers manage information for making decisions automatically or for advising decision makers. Characterization of database systems, of web technologies, of multimedia, and of the relationships among them. Representations of knowledge and the use of artificial intelligence techniques. Automated help-desk systems and computer generation of project plans.

EMC 155 Enterprise Engineering 3 Credits
The key elements of modeling and engineering the corporation. Enterprise engineering, decision analysis, application of quantitative methods to facilities planning, engineering economy, production planning and control, forecasting, material requirements planning, and agile business practices.
Prerequisites: EMC 001 or EMC 002
Can be taken Concurrently: EMC 001, EMC 002

EMC 156 Embedded Systems 3 Credits
Use of small computers embedded as part of other machines. Limited resource microcontrollers and state machines from high-level description language. Embedded hardware: RAM, ROM, flash, timers, UARTs, PWM, A/D, multiplexing, debouching. Development and debugging tools running on host computers. Real-Time Operating System (RTOS) semaphores, mailboxes, queues. Task priorities and rate monotonic scheduling. Software architectures for embedded systems.
Prerequisites: EMC 001 or EMC 002
Can be taken Concurrently: EMC 001, EMC 002

EMC 160 Computer Aided Engineering and Control Systems 3 Credits
Use of computer-based technologies to design and manufacture products. The design cycle to create product concepts. Analysis of product design. Specifications for the control of manufacturing processes. How control systems are used in creating agile manufacturing environments: discrete and analog signals, analog to digital conversion, and application case studies. Hands-on application(s) and sample exercises from real world examples.

EMC 168 (ISE 168) Production Analysis 3 Credits
A course for students not majoring in industrial engineering. Engineering economy; application of quantitative methods to facilities analysis and planning, operations planning and control, work measurement, and scheduling.

EMC 170 Software Engineering and Collaborative Environments 3 Credits
Discover why building large software systems is very different from using large databases, or designing products such as automobiles with CAD, etc. Design and implementation of a large team project involving complex data management in a collaborative environment. Learn why and how collaborative environments are becoming essential to modern engineering projects and require the tools and techniques of software engineering to succeed.
Prerequisites: EMC 001 or EMC 002
Can be taken Concurrently: EMC 001, EMC 002

EMC 171 (CEE 171, CHE 171, ES 171) Fund of Environmental Technology 4 Credits
Water and air quality; water, air, and soil pollution. Chemistry of common pollutants. Water purification, wastewater treatment, solid and hazardous waste management, environmental remediation, and air quality control. Global changes, energy, and the environment. Constraints of environmental protection on technology development and applications. Constraints of economic development on environmental quality. Environmental life cycle analysis and environmental policy.

EMC 174 Process Engineering 3 Credits
Semiconductor process engineering, including technology to process raw silicon wafer to electronics integrated circuits (ICs). Crystal growth, thin film deposition, photolithography, doping technology.
Prerequisites: EMC 001 or EMC 002
Can be taken Concurrently: EMC 001, EMC 002

EMC 252 (CSE 252) Computers, the Internet, and Society 3 Credits
An interactive exploration of the current and future role of computers, the Internet, and related technologies in changing the standard of living, work environments, society and its ethical values. Privacy, security, depersonalization, responsibility, and professional ethics; the role of computer and Internet technologies in changing education, business modalities, collaboration mechanisms, and everyday life.

EMC 300 Apprentice Teaching 1-3 Credits
Repeat Status: Course may be repeated.

Engineering Courses

ENGR 005 Introduction to Engineering Practice 2 Credits
First year practical engineering experience; introduction to concepts, methods and principles of engineering practice. Problem solving, design, project planning, communication, teamwork, ethics and professionalism; innovative solution development and implementation. Introduction to various engineering disciplines and degree programs. Mandatory for and open only for first year RCEAS students.

ENGR 010 Applied Engineering Computer Methods 2 Credits
Introduction to programming for engineering tasks. Use of Matlab to program and solve engineering problems. Interfacing sensors and actuators to a microcontroller board and programming to interact with the world. Computer lab setting. Final project controls engineering equipment.
Attribute/Distribution: ND

ENGR 050 Directed Study 1-3 Credits
Engineering project work either as an individual or team member. Projects directed by faculty within the Rossin College of Engineering and Applied Science with possible interaction from outside consultants, community and industry leaders. Written report required. RCEAS permission required.
Repeat Status: Course may be repeated.

ENGR 089 Introduction to Design Thinking for Innovation 3 Credits
Design Thinking is a proven process for identifying problems and creating solutions to address them. Key tools and terminology of Design Thinking and related processes that encourage creativity as a way to innovate will be explored. The emphasis is on learning by doing and focuses on practicing the 5 steps in Design thinking: Empathize, Define, Ideate, Prototype, Test that can be applied to virtually any area where new solutions are needed.

ENGR 130 Engineering Communications 1 Credit
Experience and theory in oral and written communications preparing students for their first Co-Op work assignments. Required of all Engineering Co-Op students.
Prerequisites: ENGR 200 or ENGR 198
Can be taken Concurrently: ENGR 200, ENGR 198

ENGR 160 Engineering Internship 1-3 Credits
Offers students who have attained at least Jr2 standing an opportunity to complement coursework with a work experience. Detailed rules can be obtained from the Associate Dean of Engineering. Report required. P/F grading.

ENGR 200 Engineering Co-op 3 Credits
Supervised cooperative work assignment to obtain practical experience. Must have acceptance into the program. P/F grading.
Repeat Status: Course may be repeated.

ENGR 300 Apprentice Teaching 1-3 Credits

ENGR 400 Engineering Co-op for Graduate Students 1-3 Credits
Supervised cooperative work assignment to obtain practical experience in field of study. Requires consent of department chairperson. When on a cooperative assignment, the student must register for this course to maintain continuous student status. Limit to at most three credits per registration period. No more than six credits may be applied towards a master's program and no more than nine credits may be used throughout a student's entire graduate study at Lehigh.
Repeat Status: Course may be repeated.

ENGR 401 Teaching/Presentation Skills 1 Credit
Development of teaching and presentation skills for scientific professionals. Presentation effectiveness, teaching/presentation methodologies, classroom management, course development/content preparation, lecture/presentation development and lecture/presentation delivery. Individualized undergraduate course specific modules selected by student. Enrollment limited to Rossin Doctoral Fellows.

ENGR 402 Preparing for the Professoriate 1 Credit
Overview of the job search, research program development and service skills for graduate students entering academic careers. Transition from graduate student to faculty responsibilities, the post-doctoral experience, time management, CV/resume preparation, faculty search process, tenure and promotion, research leadership and program development, research proposal preparation and research sponsorship. Enrollment limited to Rossin Doctoral Fellows.

ENGR 430 Technical Writing for Engineering and the Sciences 1 Credit
Formal composition and technical writing skills for advanced non-native English writers in Engineering and the Sciences. Instructor and peer review of writing, self-editing strategies, how to incorporate technical vocabulary and formulas, advanced sentence structure, and appropriate citation of research. Field-specific readings, which students must compile, critique, and model in their own writing. Designed for international graduate students who are writing or preparing to write publishable quality articles, theses, or dissertations.

ENGR 440 Intensive Teaching Workshop 0 Credits
Two-day intensive teaching workshop designed to prepare doctoral students for a teaching practicum experience. Various faculty will discuss a range of topics including fundamentals of effective teaching, motivating students, inclusive teaching, principles of teaching under a research perspective, explaining difficult topics, assessing student learning and enhancing learning with instructional technology. Students will be required to prepare and lead micro-teaching sessions. Course requires Dean's office permission and may not be repeated.

ENGR 441 Teaching Practicum 1-3 Credits
Mentored teaching experience focused on the design, organization, pedagogy and assessment of university courses in engineering. Students will work with a faculty member to develop teaching and communication skills and apply best practices in university teaching while receiving feedback. Specific course assignments will be determined by the student's home department and must be approved by the department chair. Course may be repeated for credit.
Repeat Status: Course may be repeated.
Prerequisites: ENGR 440

ENGR 452 (BIOE 452, CHE 452, ME 452) Mathematical Methods In Engineering I 3 Credits
Analytical techniques relevant to the engineering sciences are described. Vector spaces; eigenvalues; eigenvectors. Linear ordinary differential equations; diagonalizable and non-diagonalizable systems. Inhomogeneous linear systems; variation of parameters. Non-linear systems; stability; phase plane. Series solutions of linear ordinary differential equations; special functions. Laplace and Fourier transforms; application to partial differential equations and integral equations. Sturm-Liouville theory. Finite Fourier transforms; planar, cylindrical, and spherical geometries.

ENGR 490 Thesis (Moc) 1 Credit

ENGR 499 Dissertation (Moc) 1 Credit