ENGINEERING

The engineering program at Hope College offers a B.S. degree with a major in engineering that is accredited by the Engineering Accreditation Commission of ABET.

Our program emphasizes small class sizes, the opportunity to carry out research with faculty and state-of-the-art laboratories. Hope engineering students are often double majors or participants in athletics. At Hope, we offer the kind of one-on-one attention that insures that each student reaches his or her potential. Faculty are focused on the success of undergraduate students as our most important goal.

ABOUT THE PROGRAM

Our engineering curriculum is designed to help students identify and define their interests and provide the technical background needed to begin work as an engineer or continue on to advanced graduate study. Our approach to engineering education includes challenging coursework in engineering fundamentals in the classroom and laboratory. Other aspects include rigorous study of science and mathematics and a broad education in the humanities and social sciences.

The Hope College engineering program has an excellent record of placing students after graduation, either in graduate schools or industry. Our recent graduates have taken jobs with such industry leaders as: Intel, Ford, Honda, Pfizer, Lockheed-Martin and Hewlett-Packard. About one-third of our students directly enter graduate school, many at top ranked schools, including Massachusetts Institute of Technology, the University of Michigan, Stanford University and Princeton University.

The mission of the Hope College Engineering Program is to provide engineering students with a solid foundation in engineering and the underlying mathematics and sciences within the framework of a liberal arts education, and to contribute to the education of other Hope College students.

The professional practice of engineering requires an understanding of analytical methods, design techniques, social and economic influences, and an appreciation for cultural and human traditions. Our program supports these needs by offering each engineering student the opportunity to acquire a broad yet individualized technical and liberal education. At the core of the curriculum is a sequence of mathematics, physics and engineering courses that foster analytical and design skills applicable to a range of engineering disciplines. Elective courses, design projects and undergraduate research opportunities allow students to pursue specific areas of interest. Hope's strong liberal arts core curriculum provides engineering students with critical thinking skills, proficiency in a foreign language, and exposure to a diversity of views and cultures. Graduates of the program are prepared to begin a professional career or continue study in graduate school.
Hope College Engineering Educational Objectives

The goal of the Hope College Engineering Program is to prepare our graduates for professional practice or advanced studies by providing a broad education in engineering fundamentals in a liberal arts environment. Hope College Engineering graduates will:

1. Be active in engineering practice or find that their engineering background and problem-solving skills were helpful in non-engineering fields such as law, medicine, and business.
2. Continue their career development by engaging in life-long learning that builds upon foundational knowledge acquired as part of their undergraduate education.
3. Find that their undergraduate liberal arts education helped prepare them to contribute to the greater benefit of society.

PREREQUISITE POLICY

Many courses in the department have prerequisites listed. A grade of C- or better is required in these prerequisite courses. If this is not the case, then it is the view of the department that the prerequisite has not been fulfilled and the course may not be taken without written permission of the instructor and the department chairperson.

Engineering Honors Designation

The honors designation in engineering provides an opportunity for students to be challenged beyond the minimum requirements for the major and to pursue opportunities to enhance their career preparation.

Graduates with honors in engineering will:

Fulfill the requirements for a BS in engineering and will complete one of the following options:

• 2 minors and participation in research or internship for at least one semester.
• 1 minor and participation in research for at least 3 semesters or the equivalent.
• 1 minor and completion of an honors project under the guidance of an engineering faculty member approved by the department. The honors project should have a topic and format that complements the student's career interests developed in collaboration with an engineering faculty mentor. The honors project is intended to be separate from work used to fulfill course assignments.

AND

Demonstrate communication skills as evidenced by creation of publications, presentations, published abstracts, or other public communications describing the results of research,
internship, or honors project work to a broad audience. These publications and presentations should be separate from work done to fulfill course assignments.

AND

Display a commitment to community service or leadership through activities such as serving as an officer in a student organization, serving as a teaching assistant, significant outreach activities, or other service to the community as approved by the engineering honors advisor.

AND

Maintain a high GPA of at least 3.0 in engineering courses.

Additional activities may be considered upon approval of the department.

Students interested in engineering honors should coordinate their plan with the engineering honors advisor.

Dual Majors

In case of a dual major, the engineering courses required are those described here. The additional mathematics and science requirements shall be established by agreement between the student and the department. Recent dual majors have included engineering/dance, engineering/chemistry, engineering/computer science, engineering/English and engineering/economics.

MAJORS

BACHELOR OF SCIENCE IN ENGINEERING

The Bachelor of Science in Engineering is accredited by the Engineering Accreditation Commission of ABET. The major provides preparation for engineering employment in industry or for graduate study in engineering.

The department offers several different concentrations designed to meet a variety of students’ needs. Students with a possible interest in physics should also see that section.
BIOCHEMICAL ENGINEERING CONCENTRATION

A Bachelor of Science degree with a major in engineering and a concentration in biochemical engineering includes the following coursework in math, science and engineering:

MATH/SCIENCE REQUIREMENTS

- PHYS 121 General Physics I
- PHYS 141 Physics Laboratory I
- PHYS 122 General Physics II
- PHYS 142 Physics Laboratory II
- MATH 131 Calculus I
- MATH 132 Calculus II
- MATH 231 Multivariable Mathematics I
- MATH 232 Multivariable Mathematics II
- CHEM 125 General Chemistry I
- CHEM 127 General Chemistry I Laboratory

ENGINEERING CORE REQUIREMENTS

- ENGS 100 Introduction to Engineering
- ENGS 122 Introduction to Material Science
- ENGS 150 Conservation Principles
- ENGS 170 Computer Aided Design
- ENGS 210 Engineering Computing or approved programming course
- ENGS 220 Statics
- ENGS 241 Circuit Analysis and Applications
- ENGS 331 System Dynamics
- ENGS 333 System Dynamics Laboratory
- ENGS 340 Applied Thermodynamics
- ENGS 451 Introduction to Engineering Design
- ENGS 452 Engineering Design
- ENGS 080 Engineering Seminar (2 semesters)

BIOCHEMICAL ENGINEERING REQUIREMENTS

- ENGS 250 Process Calculations
- ENGS 346 Fluid Mechanics
- ENGS 348 Heat Transfer
- ENGS 371 Chemical Reaction Engineering
• ENGS 375 Phase Equilibrium & Separations I
• ENGS 376 Advanced Thermodynamics & Separations II
• BIOL 106 General Biology II
• CHEM 311 Biochemistry I
• CHEM 343 Physical Chemistry I

BIOMEDICAL ENGINEERING - BIOELECTRICAL ENGINEERING CONCENTRATION

A Bachelor of Science degree with a major in engineering and concentration in biomedical-bioelectrical engineering includes the following coursework in math, science and engineering:

MATH/SCIENCE REQUIREMENTS

• PHYS 121 General Physics I
• PHYS 141 Physics Laboratory I
• PHYS 122 General Physics II
• PHYS 142 Physics Laboratory II
• MATH 131 Calculus I
• MATH 132 Calculus II
• MATH 231 Multivariable Mathematics I
• MATH 232 Multivariable Mathematics II
• CHEM 125 General Chemistry I
• CHEM 127 General Chemistry I Laboratory

ENGINEERING CORE REQUIREMENTS

• ENGS 100 Introduction to Engineering
• ENGS 122 Introduction to Material Science
• ENGS 150 Conservation Principles
• ENGS 170 Computer Aided Design
• ENGS 210 Engineering Computing or approved programming course
• ENGS 220 Statics
• ENGS 241 Circuit Analysis and Applications
• ENGS 331 System Dynamics
• ENGS 333 System Dynamics Laboratory
• ENGS 340 Applied Thermodynamics
• ENGS 451 Introduction to Engineering Design
• ENGS 452 Engineering Design
• ENGS 080 Engineering Seminar (2 semesters)
BIOELECTRICAL ENGINEERING REQUIREMENTS

- ENGS 242 Electronic Devices and Design
- ENGS 351 Signal Analysis and Communications
- ENGS 380 Biomedical Instrumentation
- ENGS 382 Bioelectrical Systems
- ENGS 385 Rehabilitation Engineering
- BIO 221 Human Physiology
- NSCI 211 Introduction to Neuroscience

ENGINEERING ELECTIVES (CHOOSE ONE)

- ENGS 326 Embedded Systems
- ENGS 322 Logic Circuit Design
- ENGS 332 Control Systems
- Approved Topics Course

BIOMEDICAL ENGINEERING - BIOMECHANICAL ENGINEERING CONCENTRATION

A Bachelor of Science degree with a major in engineering and concentration in biomedical-biomechanical engineering includes the following coursework in math, science and engineering:

MATH/SCIENCE REQUIREMENTS

- PHYS 121 General Physics I
- PHYS 141 Physics Laboratory I
- PHYS 122 General Physics II
- PHYS 142 Physics Laboratory II
- MATH 131 Calculus I
- MATH 132 Calculus II
- MATH 231 Multivariable Mathematics I
- MATH 232 Multivariable Mathematics II
- CHEM 125 General Chemistry I
- CHEM 127 General Chemistry I Laboratory

ENGINEERING CORE REQUIREMENTS

- ENGS 100 Introduction to Engineering
- ENGS 122 Introduction to Material Science
- ENGS 150 Conservation Principles
• ENGS 170 Computer Aided Design
• ENGS 210 Engineering Computing or approved programming course
• ENGS 220 Statics
• ENGS 241 Circuit Analysis and Applications
• ENGS 331 System Dynamics
• ENGS 333 System Dynamics Laboratory
• ENGS 340 Applied Thermodynamics
• ENGS 451 Introduction to Engineering Design
• ENGS 452 Engineering Design
• ENGS 080 Engineering Seminar (2 semesters)

BIOMECHANICAL ENGINEERING REQUIREMENTS
• ENGS 222 Principles of Engineering Materials
• ENGS 224 Mechanics of Materials Laboratory
• ENGS 361 Analytical Mechanics or ENGS 495 Mechanical Dynamics
• ENGS 380 Biomedical Instrumentation
• ENGS 381 Biomechanical Systems
• ENGS 385 Rehabilitation Engineering
• BIOL 222 Human Anatomy
• KIN 383 Biomechanics

Engineering ELECTIVES (CHOOSE ONE)
• ENGS 326 Embedded Systems
• ENGS 332 Control Systems
• ENGS 344 Mechanical Vibrations
• ENGS 346 Fluid Mechanics

CHEMICAL ENGINEERING CONCENTRATION

A Bachelor of Science degree with a major in engineering and concentration in chemical engineering includes the following coursework in math, science and engineering:

MATH/SCIENCE REQUIREMENTS
• PHYS 121 General Physics I
• PHYS 141 Physics Laboratory I
• PHYS 122 General Physics II
• PHYS 142 Physics Laboratory II
- MATH 131 Calculus I
- MATH 132 Calculus II
- MATH 231 Multivariable Mathematics I
- MATH 232 Multivariable Mathematics II
- CHEM 125 General Chemistry I
- CHEM 127 General Chemistry I Laboratory

ENGINEERING CORE REQUIREMENTS

- ENGS 100 Introduction to Engineering
- ENGS 122 Introduction to Material Science
- ENGS 150 Conservation Principles
- ENGS 170 Computer Aided Design
- ENGS 210 Engineering Computing or approved programming course
- ENGS 220 Statics
- ENGS 241 Circuit Analysis and Applications
- ENGS 331 System Dynamics
- ENGS 333 System Dynamics Laboratory
- ENGS 340 Applied Thermodynamics
- ENGS 451 Introduction to Engineering Design
- ENGS 452 Engineering Design
- ENGS 080 Engineering Seminar (2 semesters)

CHEMICAL ENGINEERING REQUIREMENTS

- ENGS 250 Process Calculations
- ENGS 346 Fluid Mechanics
- ENGS 348 Heat Transfer
- ENGS 371 Chemical Reaction Engineering
- ENGS 375 Phase Equilibrium & Separations I
- ENGS 376 Advanced Thermodynamics & Separations II
- CHEM 343 Physical Chemistry I
- Chemistry or Biochemistry Minor

CIVIL ENGINEERING CONCENTRATION

A Bachelor of Science degree with a major in engineering and concentration in civil engineering includes the following coursework in math, science and engineering:
MATH/SCIENCE REQUIREMENTS

- PHYS 121 General Physics I
- PHYS 141 Physics Laboratory I
- PHYS 122 General Physics II
- PHYS 142 Physics Laboratory II
- MATH 131 Calculus I
- MATH 132 Calculus II
- MATH 231 Multivariable Mathematics I
- MATH 232 Multivariable Mathematics II
- CHEM 125 General Chemistry I
- CHEM 127 General Chemistry I Laboratory
- Plus 2 credits of approved Math/Science

ENGINEERING CORE REQUIREMENTS

- ENGS 100 Introduction to Engineering
- ENGS 122 Introduction to Material Science
- ENGS 150 Conservation Principles
- ENGS 170 Computer Aided Design
- ENGS 210 Engineering Computing or approved programming course
- ENGS 220 Statics
- ENGS 241 Circuit Analysis and Applications
- ENGS 331 System Dynamics
- ENGS 333 System Dynamics Laboratory
- ENGS 340 Applied Thermodynamics
- ENGS 451 Introduction to Engineering Design
- ENGS 452 Engineering Design
- ENGS 080 Engineering Seminar (2 semesters)

CIVIL ENGINEERING REQUIREMENTS

- ENGS 222 Mechanics of Materials
- ENGS 224 Mechanics of Materials Laboratory
- ENGS 346 Fluid Mechanics
- ENGS 355 Structural Analysis
- ENGS 360 Geotechnical Engineering
- ENGS 364 Steel Structures
- ENGS 365 Reinforced Concrete
COMPUTER ENGINEERING CONCENTRATION

A Bachelor of Science degree with a major in engineering computer and concentration in computer engineering includes the following coursework in math, science and engineering:

MATH/SCIENCE REQUIREMENTS

- PHYS 121 General Physics I
- PHYS 141 Physics Laboratory I
- PHYS 122 General Physics II
- PHYS 142 Physics Laboratory II
- MATH 131 Calculus I
- MATH 132 Calculus II
- MATH 231 Multivariable Mathematics I
- MATH 232 Multivariable Mathematics II
- CHEM 125 General Chemistry I
- CHEM 127 General Chemistry I Laboratory
- Plus 2 credits of approved Math/Science

ENGINEERING CORE REQUIREMENTS

- ENGS 100 Introduction to Engineering
- ENGS 122 Introduction to Material Science
- ENGS 150 Conservation Principles
- ENGS 170 Computer Aided Design
- ENGS 210 Engineering Computing or approved programming course
- ENGS 220 Statics
- ENGS 241 Circuit Analysis and Applications
- ENGS 331 System Dynamics
- ENGS 333 System Dynamics Laboratory
- ENGS 340 Applied Thermodynamics
- ENGS 451 Introduction to Engineering Design
- ENGS 452 Engineering Design
- ENGS 080 Engineering Seminar (2 semesters)

COMPUTER ENGINEERING REQUIREMENTS

- ENGS 242 Electronic Devices and Design
- ENGS 322 Logic Circuit Design
- ENGS 326 Embedded Systems
• ENGS 351 Signal Analysis & Communication
• CSCI 265 Intro. to Comp. Org. and Architecture
• CSCI 376 Computer Networking
• Computer Science Minor or equivalent

ELECTRICAL ENGINEERING CONCENTRATION

A Bachelor of Science degree with a major in engineering and concentration in electrical engineering includes the following coursework in math, science and engineering:

MATH/SCIENCE REQUIREMENTS

• PHYS 121 General Physics I
• PHYS 141 Physics Laboratory I
• PHYS 122 General Physics II
• PHYS 142 Physics Laboratory II
• MATH 131 Calculus I
• MATH 132 Calculus II
• MATH 231 Multivariable Mathematics I
• MATH 232 Multivariable Mathematics II
• CHEM 125 General Chemistry I
• CHEM 127 General Chemistry I Laboratory
• Plus 2 credits of approved Math/Science

ENGINEERING CORE REQUIREMENTS

• ENGS 100 Introduction to Engineering
• ENGS 122 Introduction to Material Science
• ENGS 150 Conservation Principles
• ENGS 170 Computer Aided Design
• ENGS 210 Engineering Computing or approved programming course
• ENGS 220 Statics
• ENGS 241 Circuit Analysis and Applications
• ENGS 331 System Dynamics
• ENGS 333 System Dynamics Laboratory
• ENGS 340 Applied Thermodynamics
• ENGS 451 Introduction to Engineering Design
• ENGS 452 Engineering Design
• ENGS 080 Engineering Seminar (2 semesters)
### Electrical Engineering Requirements

- ENGS 242 Electronic Devices and Design
- ENGS 351 Signal Analysis & Communication
- ENGS 322 Logic Circuit Design
- ENGS 326 Embedded Systems
- ENGS 332 Control Systems

### Environmental Engineering Concentration

A Bachelor of Science degree with a major in engineering and concentration in environmental engineering includes the following coursework in math, science and engineering:

### Math/Science Requirements

- PHYS 121 General Physics I
- PHYS 141 Physics Laboratory I
- PHYS 122 General Physics II
- PHYS 142 Physics Laboratory II
- MATH 131 Calculus I
- MATH 132 Calculus II
- MATH 231 Multivariable Mathematics I
- MATH 232 Multivariable Mathematics II
- CHEM 125 General Chemistry I
- CHEM 127 General Chemistry I Laboratory

### Engineering Core Requirements

- ENGS 100 Introduction to Engineering
- ENGS 122 Introduction to Material Science
- ENGS 150 Conservation Principles
- ENGS 170 Computer Aided Design
- ENGS 210 Engineering Computing or approved programming course
- ENGS 220 Statics
- ENGS 241 Circuit Analysis and Applications
- ENGS 331 System Dynamics
- ENGS 333 System Dynamics Laboratory
- ENGS 340 Applied Thermodynamics
- ENGS 451 Introduction to Engineering Design
• ENGS 452 Engineering Design
• ENGS 080 Engineering Seminar (2 semesters)

ENVIRONMENTAL ENGINEERING REQUIREMENTS
• ENGS 250 Process Calculations
• ENGS 346 Fluid Mechanics
• ENGS 348 Heat Transfer
• ENGS 371 Chemical Reaction Engineering
• ENGS 375 Phase Equilibrium and Separations I
• ENGS 376 Advanced Thermodynamics & Separations II
• CHEM 126 General Chemistry II or CHEM 131 Accelerated General Chemistry
• CHEM 128 General Chemistry Laboratory II or CHEM 132 Accelerated General Chemistry Lab
• CHEM 221 Organic Chemistry I
• CHEM 255 Organic Chemistry Laboratory I
• CHEM 343 Physical Chemistry I
• GES 211 Earth Environmental Systems I

ENVIRONMENTAL ENGINEERING ELECTIVES (CHOOSE ONE)
• GES 430 Environmental Geochemistry
• GES 450 Hydrogeology

MECHANICAL ENGINEERING CONCENTRATION

A Bachelor of Science degree with a major in engineering and concentration in mechanical engineering includes the following course work in math, science and engineering:

MATH/SCIENCE REQUIREMENTS
• PHYS 121 General Physics I
• PHYS 141 Physics Laboratory I
• PHYS 122 General Physics II
• PHYS 142 Physics Laboratory II
• MATH 131 Calculus I
• MATH 132 Calculus II
• MATH 231 Multivariable Mathematics I
• MATH 232 Multivariable Mathematics II
• CHEM 125 General Chemistry I
• CHEM 127 General Chemistry I Laboratory
• Plus 2 credits of approved Math/Science

ENGINEERING CORE REQUIREMENTS

• ENGS 100 Introduction to Engineering
• ENGS 122 Introduction to Material Science
• ENGS 150 Conservation Principles
• ENGS 170 Computer Aided Design
• ENGS 210 Engineering Computing or approved programming course
• ENGS 220 Statics
• ENGS 241 Circuit Analysis and Applications
• ENGS 331 System Dynamics
• ENGS 333 System Dynamics Laboratory
• ENGS 340 Applied Thermodynamics
• ENGS 451 Introduction to Engineering Design
• ENGS 452 Engineering Design
• ENGS 080 Engineering Seminar (2 semesters)

MECHANICAL ENGINEERING REQUIREMENTS

• ENGS 222 Mechanics of Materials
• ENGS 224 Mechanics of Materials Laboratory
• ENGS 346 Fluid Mechanics
• ENGS 361 Analytical Mechanics or ENGS 495 Mechanical Dynamics

MECHANICAL ENGINEERING ELECTIVES (CHOOSE THREE)

• ENGS 326 Embedded Systems
• ENGS 332 Control Systems
• ENGS 344 Mechanical Vibrations
• ENGS 348 Heat Transfer
• ENGS 355 Structural Analysis

General Engineering

A Bachelor of Science degree with a major in engineering includes the following coursework in math, science and engineering:
MATH/SCIENCE REQUIREMENTS

- PHYS 121 General Physics I
- PHYS 141 Physics Laboratory I
- PHYS 122 General Physics II
- PHYS 142 Physics Laboratory II
- MATH 131 Calculus I
- MATH 132 Calculus II
- MATH 231 Multivariable Mathematics I
- MATH 232 Multivariable Mathematics II
- CHEM 125 General Chemistry I
- CHEM 127 General Chemistry I Laboratory
- Plus 2 credits of approved Math/Science

ENGINEERING CORE REQUIREMENTS

- ENGS 100 Introduction to Engineering
- ENGS 122 Introduction to Material Science
- ENGS 150 Conservation Principles
- ENGS 170 Computer Aided Design
- ENGS 210 Engineering Computing or approved programming course
- ENGS 220 Statics
- ENGS 241 Circuit Analysis and Applications
- ENGS 331 System Dynamics
- ENGS 333 System Dynamics Laboratory
- ENGS 340 Applied Thermodynamics
- ENGS 451 Introduction to Engineering Design
- ENGS 452 Engineering Design
- ENGS 080 Engineering Seminar (2 semesters)

Additional ENGINEERING REQUIREMENTS

- ENGS 346 Fluid Mechanics or ENGS 351 Signal Analysis and Communications
- A minimum of 15 additional credits must be chosen from other engineering courses

A maximum of one credit of internship (ENGS 499) and research (ENGS 490) may be counted toward the major. All engineering majors must select one of the options. In general, approved
mathematics or basic science courses are those appropriate for majors in that discipline. Twenty-four hours of work at the level of 300 or above must be completed at Hope College.

Students interested in **Aerospace Engineering** should consult with the engineering chairperson as early as possible.

**Bachelor of Science in Engineering Science**

The Bachelor of Science in engineering science major conforms to the minimum requirements for a Bachelor of Science degree at Hope College and is not accredited by the Engineering Accreditation Commission of **ABET**. The accredited major can be found under the Major/Minor tab.

The major consists of a total of 36 credits which must include the following courses:

- ENGS 100, 122, 150, 170, 220, 241, 331, 333, 340, 451 and 452. Two semesters of ENGS 080 are also required.
- The remaining credits may be fulfilled through any other engineering courses.
- A maximum of only one credit of internship or research may be counted toward the major.
- Programming Competency is required and may be satisfied through ENGS 210.

In addition, 28 credits in science and mathematics courses are required, including:

- PHYS 121, 141, 122, 142
- MATH 131, 132, 231 and 232
- CHEM 125 and 127

Courses may be substituted for the required courses with prior approval of the department.

**MINORS**

**Engineering Minor**

A minor in engineering consists of 20 credits of engineering courses. It must include ENGS 150, 220, 241 and at least one 300 level course. The remaining courses are to be chosen by the student in consultation with the department chairperson and the student’s advisor. The exact courses will depend upon the intended major program of the student. Prior approval of the courses by the department is required.
COURSES

ENGINEERING

ENGS 080 - Engineering Seminar
All students interested in engineering are encouraged to attend departmental seminars. Registered students are required to attend at least 80 percent of the seminars presented. Seminars present topics of current interest in engineering and questions of concern in engineering research. Seminars provide students the opportunity to discuss state of the art engineering advances with speakers actively engaged in the field.
Credits Awarded: 0
Terms Offered: Fall, Spring

ENGS 100 - Introduction to Engineering
This course introduces students to the basic principles of engineering and the various disciplines that constitute the field. Major engineering accomplishments are studied from historical, political, artistic and economic viewpoints. Students work in teams to solve engineering design problems and undertake laboratory investigations. Foundations of engineering science including force equilibrium, concepts of stress and strain, Ohm’s Law, and Kirchhoff’s Voltage and Current Laws are studied.
Credits Awarded: 4
Terms Offered: Fall
Attribute: Natural Science I with lab (NSL)

ENGS 122 - Introduction to Engineering Materials
An introduction to the science and engineering of materials with an emphasis on application to engineering design. Topics will include structure-processing-property relationships in materials, atomic bonding, crystal structure, phase diagrams, control of deformation in metals, a survey of common engineering materials and their properties, and materials selection for engineering design.
Credits Awarded: 2
Terms Offered: Spring
Prerequisites: Engs 100 with a grade of C- or better, or Chem 125 or Chem 131 with a grade of C- or better, or Math 125 or Math 131 with a grade of C- or better

ENGS 150 - Conservation Principles
An introduction to chemical engineering calculations, emphasizing the conservation of mass and energy. Systems studied will include batch and continuous processes, and separation processes. Concepts of steady-state and transient balances will be used in process analysis.
Credits Awarded: 2
Terms Offered: Spring
Prerequisites: Engs 100 with a grade of C- or better, or Chem 125 or Chem 131 with a grade of C- or better, or Math 125 or Math 131 with a grade of C- or better
ENGS 170 - Computer Aided Design
An introduction to computer aided design. Students will learn to use a solid modeling design system for the purpose of creating their own designs. Design methods and techniques will be studied through development of increasingly complex devices. Each student is expected to design a device of his/her own choosing.

Credit Awarded: 1
Terms Offered: Spring
Prerequisites: Engs 100 with a grade of C- or better, or Math 125 or Math 131 with a grade of C- or better

ENGS 210 - Engineering Computing
This course introduces students to the fundamental computer programming concepts, principles, and methods necessary for solving engineering problems encountered in engineering courses, industry, and research. Students are exposed to basic problem solving and programming techniques, fundamental algorithms and data structures, and use of programming logic in solving engineering problems. Students are expected to complete assignments in a collaborative learning environment.

Credits Awarded: 3
Terms Offered: Fall, Spring
Prerequisites: Engs 100 with a grade of C- or better

ENGS 220 - Statics
This course covers the response of rigid objects in equilibrium to applied forces. Topics include: vector description of forces and moments, free body diagrams, frictional forces, centroids, area moments of inertia, and distributed loads. These topics are applied to the equilibrium analysis of trusses, beams, frames, and machines in two and three dimensions.

Credits Awarded: 3
Terms Offered: Fall
Prerequisites: Engs 100 or Phys 121 with a grade of C- or better, Math 132 with a grade of C- or better

ENGS 222 - Mechanics of Materials
An introduction to the fundamentals of mechanics of deformable bodies. Topics include analysis of the stresses and deformations in structures including axial loading of bars, torsion of circular rods, bending of beams, thin-walled pressure vessels, and problems with combined loadings. Additional topics consist of stress and strain transformations and buckling and elastic stability of structures. Students may take Math 231 either prior to enrollment in or concurrently with the class.

Credits Awarded: 3
Terms Offered: Spring
Prerequisites: Engs 220 with a grade of C- or better, Math 231 with a grade of C- or better
Corequisites: Math 231, Engs 224
ENGS 224 - Mechanics of Materials Laboratory
This course will introduce students to fundamental concepts in mechanical testing and metallurgy. Students will learn the basic components of a computerized data acquisition system and how these systems are used in mechanical testing. Students will also gain experience using an Instron testing machine to determine basic mechanical properties of a range of materials, including metals, woods, composites, and elastomers. The metallurgy component will include sample preparation for viewing with an optical microscope, heat treating metals, and Rockwell hardness testing. Students may take Math 231 either prior to enrollment in or concurrently with the class.
Credit Awarded: 1
Terms Offered: Spring
Prerequisites: Engs 220 with a grade of C- or better, Math 231 with a grade of C- or better
Corequisites: Math 231, Engs 222

ENGS 241 - Circuit Analysis and Applications
This course provides an introduction to analysis and design of DC and AC circuits including time domain and sinusoidal steady-state analysis of RLC circuits. Diodes are introduced and utilized in nonlinear circuit applications. Transistors are studied for applications as amplifiers and switches. Operational amplifiers and circuit applications are introduced and analyzed. A laboratory is included that will give students the opportunity to apply methods and test out the material learned in lecture. Composition of formal technical laboratory reports will be introduced and practiced.
Credit Awarded: 4
Terms Offered: Fall
Prerequisites: Math 126 or Math 131 with a grade of C- or better

ENGS 242 - Electronic Devices and Design
The course examines in detail the design and analysis of analog and digital circuits. Analog integrated circuits include bipolar junction transistor amplifiers, operational amplifiers, and active filters. Generalized Ohm’s law is employed to analyze and design active filters. Logic circuit design is presented and digital circuits are analyzed and designed. Cross-listed with Phys 242.
Credit Awarded: 4
Terms Offered: Spring, Even Years
Prerequisites: Engs 241 with a grade of C- or better

ENGS 250 - Process Calculations
Continuation of Engs 150. An introduction to chemical engineering calculations, emphasizing the conservation of mass and energy. Systems studied will include batch and continuous processes, complex processes with recycle, processes in which chemical reactions take place, and separation processes. Concepts of steady-state and transient balances will be used in process analysis.
Credit Awarded: 2
Terms Offered: Spring
Prerequisites: Engs 150 with a grade of C- or better

ENGS 290 - Independent Studies
With departmental approval, freshmen or sophomores may engage in independent studies at a level appropriate to their ability and class standing, in order to enhance their understanding of engineering. Students may enroll each semester.
Credit Awarded: 1-3
Terms Offered: Fall, Spring
Prerequisites: Permission of instructor
**ENGS 295 - Studies in Engineering**
A course offered in response to student and instructor interest. Topics are not generally covered in the regular course listings. Course may be taken multiple times if topics are different.

**Credits Awarded:** 2-4  
**Terms Offered:** Fall, Spring

**ENGS 322 - Logic Circuit Design**
The course addresses switching theory and digital logic devices. Topics covered include: Boolean algebra, algebraic simplification, Karnaugh maps, Quine-McCluskey method, multi-level networks, combinational and sequential network design, flip-flops, and counters.

**Credits Awarded:** 3  
**Terms Offered:** Spring, Odd Years  
**Prerequisites:** Engs 241 with a grade of C- or better

**ENGS 326 - Embedded Systems**
This course introduces the student to the fundamental concepts and skills necessary to understand and use embedded systems. Topics include: digital electronics, computer architecture, programming, and microcontroller interfaces. Students build and program small computing systems that demonstrate the principles on which all information processing devices are based.

**Credits Awarded:** 3  
**Terms Offered:** Fall  
**Prerequisites:** Programming competency, as outlined in the engineering degree audit, Engs 241 with a grade of C- or better

**ENGS 331 - Dynamic Systems**
Introduction to the mathematical modeling, analysis, and control of mechanical, electrical, hydraulic and thermal systems. Derivation of governing state (differential) equations. Analysis of the free and forced response of systems by direct analysis and computer simulation. Introduction to the design of feedback control systems including analyzing stability and characterizing system behavior. Includes laboratory component.

**Credits Awarded:** 3  
**Terms Offered:** Fall  
**Prerequisites:** Math 231 with a grade of C- or better  
**Corequisites:** Engs 333

**ENGS 332 - Control Systems**
Design of linear feedback control for dynamic systems. Topics include stability analysis, root locus compensation and design, frequency response techniques, state space and digital controls. The mathematical software MATLAB is used extensively to analyze and simulate control systems.

**Credits Awarded:** 3  
**Terms Offered:** Spring  
**Prerequisites:** Engs 331 with a grade of C- or better
ENGS 333 - Dynamic Systems Laboratory
A laboratory to accompany Engs 331. The laboratory investigates the dynamic properties of systems of first and second order mechanical systems. Both linear and rotary systems are investigated. Systems with multiple masses and springs are studied. Controllers are developed and applied to some of the systems.
Credit Awarded: 1
Terms Offered: Fall
Prerequisites: Programming competency, as outlined in the engineering degree audit, Math 231 with a grade of C- or better
Corequisites: Engs 331

ENGS 340 - Applied Thermodynamics
Thermodynamics is the study of energy and its conversion among various forms, particularly heat and work. Laws of thermodynamics are presented in the context of mass and energy conservation using properties such as internal energy, enthalpy, and entropy. These concepts are then applied to a variety of processes including cyclic processes used for power generation and refrigeration.
Credit Awarded: 2
Terms Offered: Fall
Prerequisites: Engs 150 with a grade of C- or better, Math 126 or Math 131 with a grade of C- or better

ENGS 344 - Mechanical Vibrations
This course covers free and forced response of single and multiple degree of freedom lumped mass systems and continuous systems with an emphasis on developing mathematical models of physical systems. Topics include viscously damped mechanical systems, systems with rotating imbalances, directly and seismically forced structures, eigenvalue problems, accelerometers, and vibration of continuous systems, such as, beams and rods. Analytical and numerical methods for solving vibration problems are covered including solutions using MatLab.
Credit Awarded: 3
Terms Offered: Fall, Even Years
Prerequisites: Engs 220 with a grade of C- or better, Math 231 with a grade of C- or better

ENGS 346 - Fluid Mechanics
The study of fluid mechanics is essential in analyzing any physical system involving liquids and gases. The properties of a fluid and the concepts of fluid statics, the integral and differential analyses of fluid motion, and incompressible flow are presented. Applications of these concepts to various engineering situations, such as propulsion systems, aerodynamics, and piping systems, are examined.
Credit Awarded: 3
Terms Offered: Spring
Prerequisites: Math 231 with a grade of C- or better, Engs 250 or Engs 340 with a grade of C- or better
ENGS 348 - Heat Transfer
This course introduces the fundamental concepts of heat transfer. The three modes of heat transfer are addressed: conduction, convection, radiation. Both steady state and time varying situations are considered. The energy balance is applied extensively, and physical and mathematical principles underlying the concepts of heat transfer are presented. Rectangular, cylindrical and spherical coordinate systems are used in the analysis.

Credits Awarded: 3
Terms Offered: Spring, Even Years
Prerequisites: Math 231 with a grade of C- or better, Engs 250 or Engs 340 with a grade of C- or better

ENGS 351 - Signal Analysis and Communications
This course will introduce students to the basics of signal modulation and radio frequency analysis and design. The approach is tailored to a careful development of the mathematical principles upon which such systems are based. A wide variety of current communication systems will be presented. The emphasis in this course is the design and analysis of Amplitude Modulation (AM), Frequency (angle) Modulation (FM), and Pulse Width Modulation (PWM), and understanding the differences between these types of modulations. The students will also be introduced to band-pass filters that are extensively used in signal demodulation.

Credits Awarded: 3
Terms Offered: Spring, Odd Years
Prerequisites: Engs 331 with a grade of C- or better

ENGS 352 - Optics
A course in geometrical and physical optics. Cross-listed with Phys 352. A full description may be found there.

Terms Offered:

ENGS 355 - Structural Analysis
This course covers the analysis of determinate and indeterminate structures using various techniques. Topics include influence lines, moment-area theorems, conjugate beam methods, analyses of deflections of beams, trusses, and frames, and an introduction to matrix methods in structures.

Credits Awarded: 3
Terms Offered: Fall, Odd Years
Prerequisites: Engs 222 with a grade of C- or better

ENGS 360 - Geotechnical Engineering
This course examines the fundamental topics of geotechnical engineering. Topics include soil classification methods, soil compaction, flow of water in soils, compressibility and consolidation, settlement, shear strength and failure, and applications to foundations. Engs 222 may be taken either prior to enrollment in or concurrently with the class.

Credits Awarded: 3
Terms Offered: Spring, Odd Years
Prerequisites: Engs 222 with a grade of C- or better
Corequisites: Engs 222

ENGS 361 - Analytical Mechanics
This course covers classical mechanics. Cross-listed with PHYS 361. A full description may be found there.

Credits Awarded: 4
Terms Offered: Fall
Prerequisites: Phys 121, Phys 280
ENGS 364 - Steel Structures
This course examines the design of steel members and connections and their use in buildings and bridges. The course uses relevant design specifications and codes to design tension and compression members, beams, columns, beam-columns, and connections.
Credits Awarded: 3
Terms Offered: Fall, Even Years
Prerequisites: Engs 222 with a grade of C- or better

ENGS 365 - Reinforced Concrete
This course examines the design of reinforced concrete members and their use in buildings and bridges. The course uses relevant design specifications and codes to analyze the flexural and shear strength of beams, one-way slabs, and columns. Topics also include examining the interaction between reinforcing steel and plain concrete.
Credits Awarded: 3
Terms Offered: Spring, Even Years
Prerequisites: Engs 222 with a grade of C- or better

ENGS 371 - Chemical Reaction Engineering
Determination and application of reaction rate variables, stoichiometry, equilibrium, and kinetics to batch and continuous reactor types. Design calculations for reactors including temperature, fluid flow and heat transfer considerations. Analysis of multiple reactions, chain reactions, biological reactions, and catalytic reactions.
Credits Awarded: 3
Terms Offered: Fall, Odd Years
Prerequisites: Engs 250 with a grade of C- or better, Junior standing

ENGS 375 - Phase Equilibrium and Separations I
Study of the concepts of thermodynamic phase equilibrium and their application to large-scale separation processes used in industrial practice. Topics studied will include vapor-liquid and liquid-liquid equilibrium, nonideal solution behavior, single and multiple equilibrium stage calculations, distillation, absorption and extraction, binary and multicomponent systems, and equipment design considerations.
Credits Awarded: 4
Terms Offered: Fall, Even Years
Prerequisites: Engs 250 with a grade of C- or better, Junior standing

ENGS 376 - Advanced Thermodynamics and Separations II
Continuation of study of the concepts of thermodynamic phase equilibrium and their application to large-scale separation processes used in industrial practice. Topics studied will include vapor-liquid and liquid-liquid equilibrium, nonideal gas behavior, diffusion and mass transfer, rate-based continuous contact, distillation, absorption and extraction, binary and multicomponent systems, other separation processes, and equipment design considerations.
Credits Awarded: 3
Terms Offered: Spring, Odd Years
Prerequisites: Engs 375 with a grade of C- or better
ENGS 380 - Biomedical Instrumentation
This course introduces students to the techniques for acquisition and processing of biological signals. Example topics include electromyography (EMG), electroencephalography (EEG), electrocardiography (ECG), joint angles, biofeedback, gait analysis and motor control. During the last third of the semester, a novel research project is proposed and carried out, culminating in a final paper modeled after scientific articles.

Credits Awarded: 2
Terms Offered: Fall, odd years
Prerequisites: Programming competency, as outlined in the engineering degree audit

ENGS 381 - Biomechanical Systems
This course combines anatomical knowledge with engineering principles to mathematically model human movement. Kinetics and kinematics of human movement are covered as well as the basics of biomaterials. OpenSim, a freely available software package, is used to explore kinematics of the upper and lower limb.

Credits Awarded: 2
Terms Offered: Spring, odd years
Prerequisites: Biol 222 or Kin 200 with a grade of C- or better

ENGS 382 - Bioelectrical Systems
This course combines physiological knowledge of the nervous system with engineering principles to teach mathematical modeling of bioelectrical systems. Passive and active membrane properties are covered as well as derivation and use of the cable equation. Simulations on neural systems are performed using Matlab. Familiarity with Matlab is highly recommended prior to this course.

Credits Awarded: 2
Terms Offered: Spring, even years
Prerequisites: Programming competency, as outlined in the engineering degree audit, Engs 241 with a grade of C- or better, Or, Phys 122 with a grade of C- or better, Biol 221 or Nsci 211 with a grade of C- or better

ENGS 385 - Rehabilitation Engineering
This course exposes students to a variety of neurological and developmental disorders. The effects of the disease/injury, current treatments and engineering needs are explored both by lecture and observation at external sites such as Mary Free Bed Rehabilitation Hospital. Examples of topics include cerebral palsy, spinal cord injury, gait analysis, prosthetics, traumatic brain injury, and stroke. Students are also introduced to necessary considerations when performing research with human subjects such as the Institutional Review Board and Food and Drug Administration requirements.

Credits Awarded: 3
Terms Offered: Fall, even years
Prerequisites: Junior standing, Declared engineering major or minor
**ENGS 451 - Introduction to Engineering Design**

Engineers create products, systems, and processes to solve problems and meet social needs. This course introduces students to the art and science of engineering design. Methods and characteristics of the design process appropriate to product design, to system design, or to process design are studied. Exercises are carried out focusing on ethics in the workplace. Students learn oral and written communication skills needed in engineering design and carry out individual product, system, or process design projects focusing on the development of creativity, independent thinking, and the ability to overcome unexpected problems.

*Credits Awarded:* 3  
*Terms Offered:* Fall  
*Prerequisites:* Varies by section; see schedule

**ENGS 452 - Engineering Design**

Engineering design problems are usually solved by teams working in an industrial environment. In this course students work in teams to solve an engineering design problem. The scope of activity extends from problem definition and development of requirements, through construction of a working prototype. Other course work includes: basic techniques of engineering project management, a study of how the engineering design process is conducted within a typical industrial company or technical organization, building and working in an engineering design team, and development and refinement of communication skills needed in engineering design. Additionally, basic materials manufacturing processes for polymers, metals, and composite materials will be discussed.

*Credits Awarded:* 3  
*Terms Offered:* Spring  
*Prerequisites:* Enzs 451 with a grade of C- or better, Junior standing

**ENGS 490 - Research in Engineering**

With departmental approval, juniors or seniors may engage in independent studies at a level appropriate to their ability and class standing, in order to enhance their understanding of engineering. Students may enroll in each semester.

*Credits Awarded:* 0-2  
*Terms Offered:* Fall, Spring  
*Prerequisites:* Permission of instructor

**ENGS 495 - Topics in Engineering**

An advanced topic of engineering will be investigated in detail. The choice of the topic will vary from year to year to provide junior and senior students with the opportunity to study a field outside of the normally prescribed curriculum. Recent course offerings include microcontroller electronics.

*Credits Awarded:* 2-4  
*Terms Offered:* Fall, Spring

**ENGS 499 - Internship in Engineering**

This program provides engineering experience for students and is usually done off-campus under the supervision of a qualified engineer. A written report or oral department seminar presentation appropriate to the internship experience are required.

*Credits Awarded:* 1-4  
*Terms Offered:* Fall, Spring  
*Prerequisites:* Permission of chairperson
ENGS 501 - Internship in Engineering II
This program provides engineering experience for students and is to be performed off-campus under the supervision of a qualified engineer. It is expected that the participating student will engage in an internship opportunity with increasing responsibility over the position held for their ENGS 499 course or that the new position will be in a different engineering field than their prior position. A written report or oral department seminar presentation appropriate to the internship experience are required.

Credit Awarded: 1
Terms Offered: Fall, Spring
Prerequisites: Engs 499, Permission of chairperson

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