Course Catalog

Engineering Science

Faculty

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Jack Leifer, Ph.D., Associate Professor
Kevin Nickels, Ph.D., Associate Professor
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Emma Treadway, Assistant Professor
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Overview

Mission

The mission of the Engineering Science Department at Trinity University is to provide students with a broad-based undergraduate engineering education by offering a design-oriented, multi-disciplinary engineering science curriculum in the context of the University’s traditions of the liberal arts and sciences.

Objectives

The Engineering Science Department graduates are expected to attain the following objectives within a few years after graduation:

1. Successful practice of engineering design and analysis in their field;
2. Application of a broad background in liberal arts and sciences when solving engineering problems with humanistic dimensions in their professional practice;
3. Advancement in their engineering careers with increased responsibility and leadership roles;
4. Effective oral and written communication with diverse groups of people;
5. The pursuit of continuing or advanced education relevant to professional interests.

The curriculum emphasizes an in-depth understanding of the fundamentals of the physical sciences, mathematics, and engineering science that form the foundation for technical work in all fields of engineering. Some specialization is available through elective courses in Chemical, Electrical, and Mechanical Engineering, taken during the junior and senior years. The program provides significant hands-on experience in engineering laboratories and participation in engineering design projects throughout the eight-semester engineering design course sequence. The emphasis on fundamentals is intended to prepare students for dealing with the rapid pace of technological change and the interdisciplinary demands of today’s, and tomorrow’s, engineering practice. The laboratory and design portions of the program provide the student with a balanced perspective of the realities and limitations required for practical problem solving. The professional practice of engineering requires skill and resourcefulness in applying science and technology to the solution of problems in our complex technological society. The successful engineer must possess a thorough understanding of social and economic forces and have an appreciation of cultural and humanistic traditions. The Trinity Engineering Science Program encourages the development of this kind of graduate by providing a broad technical background and a significant liberal education in the humanities and social sciences.

Accreditation

Trinity’s undergraduate Engineering Science Program is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

Requirements

- Admission to the Engineering Science Major
- Bachelor of Science in Engineering Science Degree
- Four-year class schedule
- Prerequisite Requirement

Admission to the Engineering Science Major

I. Students will normally apply for acceptance to the Engineering Science major during the second semester of their sophomore year. Those students who do not apply in this period, but do apply later, will be handled as transfers. The transfer criteria for acceptance are consistent with those listed below, and they generally apply to all courses taken up to the time of application.

II. For full acceptance a student must ordinarily satisfy the following requirements:

   A. Completion of MATH 1311, 1312, and 2321 with an average of 2.0 or better.
B. Completion of PHYS 1311, 1111, 1312, 1112 and CHEM 1318 and 1118 with a minimum grade of C- in each course and an average of 2.0 or better.

C. Completion of ENGR 1381, 1382, 1313, 2314, 2320/2120, and 2181 with a minimum grade of C- in each course and an average of 2.0 or better.

D. A grade of C or better in ENGR 1313, 2314, 2320/2120 (No more than 4 credits taken at another institution after matriculation at Trinity may be used to satisfy this requirement).

E. Approval by the Chair of the Department.

III. Provisional acceptance may be granted to applicants with no more than two grades of C- in the courses listed in 2d.

IV. After completing ENGR 2311, 2364/2164, 3355/3155, and 3327, the progress of provisional students will be reviewed. Upon recommendation of the faculty advisor and approval by the Chair of the Department, full acceptance will be granted.

V. Requests for exceptions to this policy will be considered by the Chair of the Department.

Bachelor of Science in Engineering Science Degree

Engineering students normally follow programs of study specifically tailored to long term career objectives. Each program is composed of a combination of required and elective courses. The electives are chosen through required consultation with the engineering science adviser.

Requirements for the Bachelor of Science in Engineering Science degree are as follows:

I. Engineering Science departmental requirements:

A. ENGR 1313, 1381, 1382, 2181, 2182, 2309, 2311, 2314, 2320/2120, 2364/2164, 3181, 3182, 3323/3123, 3327, 3355/3155, 4326/4126, 4341, 4381, and 4382, totaling 54 credit hours.

B. MATH 1311, 1312, 2321, 3316, 3320, 3357; PHYS 1311/1111 and 1312/1112; CHEM 1318/1118 and a basic science or math elective (any course in biology or geosciences or a 2000 level course or higher in mathematics, physics, or chemistry) for a total of at least 33 credit hours.

C. CSCI 1312 or an equivalent course approved by the department chair.

II. Electives necessary to bring the total credit hours earned for the degree to 129.
Four-year class schedule

The suggested arrangement of courses for a four-year program leading to the degree of Bachelor of Science in Engineering Science should be determined in conference with the student's adviser. The recommended first-year program is shown below.

**First Year**

<table>
<thead>
<tr>
<th>Fall Semester</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>ENGR 1381</td>
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<tr>
<td>MATH 1311</td>
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<td>PHYS 1311</td>
<td>3</td>
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<tr>
<td>PHYS 1111</td>
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<tr>
<td>First-Year Experience</td>
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<tr>
<td><strong>Total</strong></td>
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<table>
<thead>
<tr>
<th>Spring Semester</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>ENGR 1382</td>
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<tr>
<td>ENGR 1313</td>
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<tr>
<td>MATH 1312</td>
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<tr>
<td>Pathways</td>
<td>3</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>16</strong></td>
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</tbody>
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**Prerequisite Requirement**

The Engineering Science Department enforces the University's policy on prerequisites.
Courses

ENGR-1313 Mechanics I
Forces and couples acting on rigid bodies in equilibrium using vector analysis including equivalent force systems, free body diagrams, truss analysis, friction, centroids, and moments of inertia. Prerequisites: MATH 1311 and PHYS 1311.

ENGR-1381 Engineering Analysis & Design I
Introduces students to the engineering design process utilizing a competitive design project. Small groups of students conceive, design, build, and test a structure or device to best achieve specified performance criteria under realistic constraints. Emphasis is placed on Computer Aided Design (CAD). Supporting topics include sketching, construction and testing techniques, measurement concepts, data analysis, communication, and time management.

ENGR-1382 Engineering Analysis & Design II
Continues the introduction to engineering design with another interactive team-oriented design project. Emphasis is placed on numerical analysis using computational software. Supporting topics include programming mathematical models of physical systems, and data gathering, analysis, and presentation. Consideration of alternate and past solutions. Prerequisite: ENGR 1381.

ENGR-2181 Engineering Design III
Continues the development of students’ design skills through a project emphasizing constraints including: ethics, health and safety, manufacturability, sustainability, economics, the environment, and social and political issues. Supporting topics include project management, literature search and communication skills. Oral and written reports are required. Prerequisite: Sophomore Standing

ENGR-2182 Engineering Design IV
Continuation of ENGR 2181: final design, construction, testing, and evaluation. Engineering economics and life-cycle costs are introduced in support of the project. Multimedia presentations are required. Prerequisite: ENGR 2181.

ENGR-2309 Professional Practice
This is a course designed for future professionals whose fields involve a technological component including aspiring engineers, scientists, managers, and others in technology-oriented fields. This course explores topics of enduring significance and with humanistic dimensions, specifically targeting future professionals whose fields involve a technological component. The course prepares students for making ethically and financially informed decisions in the workplace environment. Topics include: finance for professionals; the ethical dimensions of professional practice; industrial workplace safety; and contemporary issues in technological fields. Prerequisite: At least Sophomore standing
ENGR-2311 Mass and Energy Balances
Conservation of Mass and Energy concepts applied to open and closed systems with and without chemical reactions. Phase equilibria. (Offered every year). Prerequisites: Sophomore Standing.

ENGR-2314 Mechanics II
Accelerated rigid body motion including kinematics and kinetics of particles and bodies, work and energy, linear and angular impulse and momentum, and vibrations. Prerequisite: ENGR 1313 Corequisite: MATH 1312.

ENGR-2320 Electric Circuits
An introduction to the techniques of analysis and design of elementary linear electric circuits. Topics include mesh, node and equivalent circuit analyses, DC resistive circuits, operational amplifiers, modeling of RLC circuits using differential equations, transient responses and AC steady state. Prerequisite: MATH 1312 Corequisite: ENGR 2120.

ENGR-2120 Electric Circuits Laboratory
Laboratory course accompanying ENGR 2320. An introduction to the measurement of voltage and current, uses of simulation and experimentation for analysis and design, and the design of elementary electric circuits. The writing of technical reports and the interpretation and documentation of experimental results is emphasized. Corequisite: ENGR 2320.

ENGR-2359 Fundamentals of Environmental Engineering
Engineering analysis and design of treatment processes for industrial pollution of air, water, and soil. Topics include contaminants, their sources, and cleanup. Economic and legal consideration. (Offered every other year). Prerequisite: CHEM 1318 and Sophomore standing.

ENGR-2364 Electronics I
An introduction to the techniques of analysis, design, and understanding of elementary electronic devices and circuits. Modeling of linear and non-linear electronic devices and systems such as diodes, bipolar junction, and field effect transistors, operational amplifiers, and digital logic devices. Analysis and design of circuits using device and system models. An introduction to digital logic, including analysis and design techniques. Prerequisite: ENGR 2320. Corequisite: ENGR 2164.

ENGR-2164 Electronics I Laboratory
Laboratory course accompanying ENGR 2364. A continuation of the topics in ENGR 2120, with emphasis on electronic devices and systems. Experiments and design projects employing diodes, transistors, operational amplifiers, and combinational and sequential digital logic. Corequisite: ENGR 2364.

ENGR-3181 Engineering Design V
Builds on the students’ background in electrical engineering with emphasis on the design of digital logic based systems. Supporting topics include combinatorial and sequential circuits, programmable logic, finite state machines, microprocessor-based systems, introductory programming, and functional block diagrams. (Offered every year). Prerequisites: ENGR 2364 and 2164.
ENGR-3182 Engineering Design VI
Introduces students to the fundamentals of instrumentation and mechanical measurements that support thermal fluids designs. Students conduct measurements of quantities such as temperature, strain, pressure, and fluid flow. Topics include: operating principles, calibration procedure and techniques for obtaining measurements; computerized data acquisition, analysis, and visualization. Includes development of projects and other preparation for Senior Design. Oral and/or written reports are required. (Offered every Spring.) Prerequisite: Junior Standing

ENGR-3321 Signals and Systems
The analysis of signals and linear systems in the time and frequency domains using transform methods. Topics include: methods of modeling signals and systems, convolution, frequency response, impulse response, the Fourier and Laplace transforms, and transfer functions as applied to circuits and general linear systems. Prerequisites: ENGR 2320 and MATH 3316.

ENGR-3121 Signals and Systems Laboratory
Laboratory to accompany ENGR 3321. A mix of experiments and short design projects intended to motivate, illustrate, and apply concepts from ENGR 3321. Modern methods of simulation and computer-aided design of linear systems are introduced. Corequisite: ENGR 3321.

ENGR-3323 Fluid Mechanics I
An introduction to the fundamentals of fluid mechanics, including hydrostatics, conservation of mass, momentum, and energy for a control volume, dimensional analysis and similarity, flow measurement, and pipe flow. Prerequisites: ENGR 3327 and 2314. Corequisites: ENGR 3123 and MATH 3357.

ENGR-3123 Fluid Mechanics I Laboratory
Experimental investigations in fluid mechanics including instrumentation and measurements, analysis, design, and reporting of results. Corequisite: ENGR 3323

ENGR-3327 Thermodynamics I
Basic principles of macroscopic thermodynamics including pressure-volume-temperature relationship of pure substances, work, heat, first and second laws of thermodynamics, entropy and the degradation of energy, thermodynamic system analysis, computer-aided design, and analysis of simple power and refrigeration systems. Prerequisites: ENGR 2311

ENGR-3339 Mechanics of Materials
Stresses and deflections of structural elements including stress strain relations, Mohr’s circle, tierods, columns, beams, torque tubes, and statically indeterminate systems for both elastic and plastic stress levels. Prerequisite: ENGR 1313.

ENGR-3355 Control Systems
Techniques of modeling and analyzing mechanical and electrical systems, linear systems including feedback control systems, solutions to system differential equations using classical techniques, both analytical using the
Laplace transform, and numerical methods; transfer functions, transient and steady-state response, stability, and frequency response. Prerequisites: ENGR 2320, MATH 3316. Corequisite: ENGR 3155.

ENGR-3155 Control Systems Laboratory
Experimental observation of the behavior of physical systems and comparison with the mathematical models. Construction and analysis of simple control systems with examples taken from the thermal, fluid, mechanical, and electrical sciences. Corequisite: ENGR 3355.

ENGR-4326 Heat Transfer
A study of conduction, convection, and radiation separately and in combination; steady and unsteady states; analytical and numerical methods including explicit and implicit finite differences. Prerequisites: ENGR 3323, MATH 3357. Corequisites: ENGR 4126.

ENGR-4126 Heat Transfer Laboratory
Experimental investigations in heat transfer including instrumentation and measurements, analysis, design, and reporting of results. (Offered every year). Corequisite: ENGR 4326.

ENGR-4328 High-Frequency Electromagnetics
The fundamental theory of electromagnetic waves is developed and applied to the design of high-frequency electrical circuits. Topics include: how electromagnetic waves travel and are usefully directed; how to design signal transmission lines, filters and couplers; analysis of high-frequency circuit networks, and high-frequency circuit concepts such as distributed impedance. Students will also prepare an individually researched assignment on a subject of their choice exploring an emerging technology in the electrical engineering area. (Also listed as PHYS 4328.) Prerequisite: MATH 2321 and either ENGR 2320 or PHYS 2131.

ENGR-4341 Engineering Materials
Principles underlying the structure-property-application relationships of various engineering materials including metals, ceramics, glasses, polymers, composites, semiconductors, and superconductors. Analysis of material microstructures with respect to thermal, mechanical, electrical, optical, magnetic, and chemical properties. The role of material selection in engineering design. Laboratory work includes material testing, uses of x-ray diffractometer and the electron scanning microscope. Supplemental of x-ray diffractometer and the electron scanning microscope. Supplemental movies on advances in engineering materials. Individual project.

ENGR-4342 Bioengineering Science
Structure, function, and modeling of transport systems in the human body with emphasis on cardiovascular, pulmonary, and related systems. Mathematical modeling and system responses to environmental changes. Homeostasis and control systems. Prerequisites: CHEM 1318 and MATH 1311.

ENGR-4356 Modern Control System Design
Selected topics from the broad range of modern methods of control system analysis and design, such as: state-space and modern transfer function models and methods; discrete-time and/or nonlinear systems; multivariable
systems; computer-aided control system design.

ENGR-4357 Chemical Reaction Engineering
Chemical reaction kinetics and its relationship to the design and scale-up of chemical reactors. Mathematical analysis of batch, mixed flow and plug flow reactors, advanced topics including multireaction analysis, heat and mass transfer in chemical reactors and catalytic reactors. Computer simulation. Prerequisites: ENGR 2311

ENGR-4358 Biochemical Engineering
The fundamentals of analysis and design of bioprocesses. Topics include enzyme kinetics, immobilized enzyme reactors, cell cultivation, growth kinetics, and bioreactor design. Prerequisite: ENGR 2311.

ENGR-4365 Digital Logic Design
A comprehensive study of digital logic design and analysis techniques for combinational and sequential circuits. Small-scale and medium scale integrated circuits as well as several varieties of programmable logic are used as design components. Includes a case study of complex sequential circuit such as a microprocessor.

ENGR-4165 Digital Logic Design Laboratory
Laboratory to accompany ENGR 4365. A series of short design projects intended to motivate, illustrate, and apply design techniques taught in ENGR 4365. Projects are implemented using various programmable logic devices. Corequisite: ENGR 4365.

ENGR-4366 Unit Operations
Mass transfer in multi-component systems and its relationship to fluid mechanics and heat transfer. Techniques of design of transfer operations including distillation, gas absorption, liquid extraction and cooling towers. Computer aided design and simulation. Prerequisite: ENGR 2311

ENGR-4367 Mechatronics
This course surveys topics underlying the design of mechatronic systems such as electronics, system modeling and control, and computer control systems. Components supporting system design such as sensors, actuators, and data acquisitions are also covered. Case studies of mechatronic systems, including discussion of tradeoffs between mechanical, electrical, electronic, and microcomputer control, are studied. A final project involving the design and implementation of a mechatronic system puts these principles into practice. Prerequisites: ENGR 2314, 2364, and 3355.

ENGR-4369 Embedded Microcomputer Systems
Study of microprocessor and microcontroller systems: hardware, including basic system architectures, processors, memory, and peripheral devices; software, including assembly language programming; and system design, including electrical and mechanical applications. Hands-on experience in a typical development environment, including interfacing and programming. Includes a case study of a typical embedded system.

ENGR-4370 Mechanics of Continuous Media
Mechanics of solids including elasticity, plasticity, advanced strength of materials, energy methods, experimental stress analysis, and an introduction to the finite element method. Prerequisite: ENGR 3339.

ENGR-4371 Machine Design
Topics chosen from among static and fatigue theories of failure, fracture, probabilistic design, shafts and shaft components, springs, welded and bolted connections, and gear design. Prerequisite: ENGR 3339

ENGR-4372 Computational Methods in Engineering
Application of contemporary numerical methods to problems in chemical, electrical and mechanical engineering. Formulation of governing differential equations, weighted residuals, finite-difference, and control volume finite-element methods. Prerequisite: MATH 3316

ENGR-4373 Thermal/Fluid Applications
This course covers advanced topics in fluid mechanics, heat transfer, and thermodynamics. Applications in which the interdependence of these fields is critical to the understanding of engineering systems will be emphasized. Prerequisite: ENGR 3327.

ENGR-4375 Structural Dynamics
Free and forces vibrations of single and multiple degree of freedom systems with and without damping, structural response to dynamic loads, eigenvalue problems, energy methods, differential equation methods, forcing functions, and numerical analysis. Prerequisites: ENGR 2314 and MATH 3316

ENGR-4377 Electronics II
Analysis and design of digital electronic circuits using MOS transistors; analysis and design and operational amplifiers; feedback amplifiers and frequency response of amplifiers. Prerequisite: ENGR 2364.

ENGR-4177 Electronics II Laboratory
Laboratory to accompany ENGR 4377. Computer-aided design of integrated circuits and verification of design using simulation and/or laboratory experimentation. Corequisite: ENGR 4377.

ENGR-4381 Engineering Design VII
A capstone design experience with small groups of students, each group advised by a designated faculty member. Includes the establishment of objectives and criteria, modeling, analysis and synthesis, and aesthetics for the preliminary design stages of each group’s project. Projects will involve realistic design constraints such as ethics, health and safety, manufacturability, sustainability, economics, the environment, and social and political issues. Oral and written reports and design journals are required. Prerequisite: Full admission to the major; two of ENGR 3327, 3355, and 3323; ENGR 3155 or 3123; and ENGR 3181 or 3182.

ENGR-4382 Engineering Design VIII
The capstone experience continued, including final design, construction, testing, and evaluation of the projects started in ENGR 4381. Oral and written reports and design journals are required. Prerequisite: ENGR 4381 or
consent of Department Chair.

ENGR-3-90 Directed Research
Individual research conducted under faculty supervision. Oral and written communication of results is required, including an end-of-semester written report. Credit may vary from 1 to 3 hours. The course may be repeated for additional credit. Prerequisites: Consent of instructor and the department chair.

ENGR-1-90 Directed Research - Introductory Level
Individual research conducted under faculty supervision. Oral and written communication of results is required, including an end-of-semester written report. Credit may vary from 1 to 3 hours. The course may be repeated for additional credit. Prerequisites: Consent of instructor and department chair.

ENGR-2-91 Problems in Engineering
Independent work on problems in engineering as indicated by the student’s preparation and interest. 1 to 6 semester hours. Prerequisite: Consent of Instructor

ENGR-4-91 Problems in Engineering
Independent work on problems in engineering as indicated by the student’s preparation and interest. 1 to 6 semester hours. Prerequisite: Consent of Department Chair.