ENGINEERING AND APPLIED SCIENCE

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Courses in Engineering and Applied Science fall into three categories: those intended primarily for students majoring in one of the several engineering and applied science disciplines; those designed for students majoring in subjects other than engineering, the applied sciences, and the natural sciences; and those designed to meet common interests of students majoring in engineering, the applied sciences, or the natural sciences.


The School of Engineering and Applied Science (http://seas.yale.edu) is responsible for courses in the other two categories: technology for students majoring in subjects other than engineering, the applied sciences, and the natural sciences; and topics common to students majoring in engineering, the applied sciences, and the natural sciences. Courses for non–science majors are intended for all students seeking a broad perspective on issues of scientific and technological import, and they introduce students who may be planning careers in law, business, or public service to concepts and methods of engineering and applied science. Courses for science and engineering majors include topics in applied mathematics and computation.

* ENAS 430b / CENG 430b, Renewable Energy Technologies  André Taylor

Using renewable energy technologies to address real-world energy problems in underdeveloped regions, with an international hands-on learning experience during spring break. Topics include: solar energy and battery technologies; how next generation solar cells and batteries are developed and characterized in the Yale Transformati ve Materials and Devices (TMD) Laboratory; how solar energy systems are installed commercially on Yale’s campus; and an overview of how government policies play a role in renewable energy technologies. Students prepare engineering simulations to tackle sample case studies of real world energy problems and exercise various problem-based practices to define and solve problems related to renewable energy. Class size is limited to six junior and senior undergraduate students. Permission by the instructor is required for registration.

Courses without Prerequisites in Engineering

* ENAS 100b / APHY 100b / EVST 100b / G&G 105b / PHYS 100b, Energy Technology and Society  Daniel Prober, Michael Oristaglio, and Julie Paquette

The technology and use of energy. Impacts on the environment, climate, security, and economy. Application of scientific reasoning and quantitative analysis. Intended for non–science majors with strong backgrounds in math and science. Enrollment limited to 24. For application instructions, visit the course site on Classes*v2 (http://classesv2.yale.edu). QR, SC

* ENAS 118a, Introduction to Engineering, Innovation, and Design  Vincent Wilczynski and Lawrence Wilen

An introduction to engineering, innovation, and design process. Principles of material selection, stoichiometry, modeling, data acquisition, sensors, rapid prototyping, and elementary microcontroller programming. Types of engineering and the roles engineers play in a wide range of organizations. Lectures are interspersed with practical exercises. Students work in small teams on an engineering/innovation project at the end of the term. Priority to freshmen. RP

* ENAS 120b / CENG 120b / ENVE 120b, Introduction to Environmental Engineering  Jordan Peccia

Introduction to engineering principles related to the environment, with emphasis on causes of problems and technologies for abatement. Topics include air and water pollution, global climate change, hazardous chemical and emerging environmental technologies. Prerequisites: high school calculus and chemistry or CHEM 161, 165 or CHEM 163, 167 (may be taken concurrently) or permission of instructor. QR, SC

ENAS 156b / ASTR 156b, Introduction to Digital Dome Media  Michael Faison

The design and production of planetarium shows, art projects, or other immersive or interactive projects with a digital dome projection system, including the ScidomeHD digital system and the stereo projector system, both located at the Leitner Family Observatory and Planetarium (LOFOP) and with the portable Starlab dome. Topics include real-time and scripted control of 3D graphics engines; mapping of images and video onto a spherical dome; 3D rendering using Blender, Processing, and vpython; audio and video editing for dome
content; interactive projects; and basic design principles for narrative and interactive educational shows. Some programming or digital media experience is recommended. SC ½ Course cr

**ENAS 335a / EP&E 204a, Professional Ethics**  Mercedes Carreras
A theoretical and case-oriented approach to ethical decision making. Concepts, tools, and methods for constructing and justifying solutions to moral problems that students may face as professionals. SO

* **ENAS 344b / MUSI 371b, Musical Acoustics and Instrument Design**  Lawrence Wilen and Konrad Kaczmarek
Practical study of musical acoustics. The physics and design of musical instruments, with attention to all aspects of sound, from the origin of the vibration in the instrument to the perception by the listener. Student teams design and construct novel instruments and produce relevant applications. Requires a basic knowledge of physics, including concepts of kinetic and potential energy and Newton’s laws. QB, HU, SC RP

**ENAS 360b / ENVE 360b, Green Engineering and Sustainable Design**  Julie Zimmerman and Paul Anastas
Study of green engineering, focusing on key approaches to advancing sustainability through engineering design. Topics include current design, manufacturing, and disposal processes; toxicity and benign alternatives; policy implications; pollution prevention and source reduction; separations and disassembly; material and energy efficiencies and flows; systems analysis; biomimicry; and life cycle design, management, and analysis. Prerequisites: CHEM 161, 165 or 163, 167 (or CHEM 112, 113, or 114, 115), or permission of instructor.

**Applied Mathematics and Computation Courses**

**ENAS 130b, Introduction to Computing for Engineers and Scientists**  Corey O’Hern
An introduction to the use of the C and C++ programming languages and the software packages Mathematica and MATLAB to solve a variety of problems encountered in mathematics, the natural sciences, and engineering. General problem-solving techniques, object-oriented programming, elementary numerical methods, data analysis, and graphical display of computational results. Prerequisite: MATH 115 or equivalent. Recommended preparation: previous programming experience. QR

**ENAS 151a or b / APHY 151a or b / PHYS 151b, Multivariable Calculus for Engineers**  Staff
An introduction to multivariable calculus focusing on applications to engineering problems. Topics include vector-valued functions, vector analysis, partial differentiation, multiple integrals, vector calculus, and the theorems of Green, Stokes, and Gauss. Prerequisite: MATH 115 or equivalent. QR RP

**ENAS 194a or b / APHY 194a or b, Ordinary and Partial Differential Equations with Applications**  Staff
Basic theory of ordinary and partial differential equations useful in applications. First- and second-order equations, separation of variables, power series solutions, Fourier series, Laplace transforms. Prerequisites: ENAS 151 or equivalent, and knowledge of matrix-based operations. QR RP

**ENAS 440a / MENG 440a, Applied Numerical Methods I**  Beth Anne Bennett
The derivation, analysis, and implementation of various numerical methods. Topics include root-finding methods, numerical solution of systems of linear and nonlinear equations, eigenvalue/eigenvector approximation, polynomial-based interpolation, and numerical integration. Additional topics such as computational cost, error analysis, and convergence are studied in several contexts throughout the course. Prerequisites: MATH 115, and 222 or 225, or equivalents; ENAS 130 or some experience with Matlab, C++, or Fortran programming. QR RP

* **ENAS 450b / APHY 450b / MENG 450b, Advanced Synchrotron Techniques and Electron Spectroscopy of Materials**  Charles Ahn
Introduction to concepts of advanced x-ray and electron-based techniques used for understanding the electronic, structural, and chemical behavior of materials. Students learn from world-leading experts on fundamentals and practical applications of various diffraction, spectroscopy, and microscopy methods. Course highlights the use of synchrotrons in practical experiments. Prerequisites: physics and quantum mechanics/physical chemistry courses for physical science and engineering majors, or by permission of instructor. QR, SC

**ENAS 496b / MATH 251b / STAT 251b, Stochastic Processes**  Sahand Negahban
Introduction to the study of random processes including linear prediction and Kalman filtering, Poison counting process and renewal processes, Markov chains, branching processes, birth-death processes, Markov random fields, martingales, and random walks. Applications chosen from communications, networking, image reconstruction, Bayesian statistics, finance, probabilistic analysis of algorithms, and genetics and evolution. Prerequisite: STAT 241 or equivalent. QR