ENGINEERING (ENGR)

ENGR 1010 Introduction to Engineering: Energy, Environment and Sustainability
This course is intended to introduce students to the field of engineering. It will expose students to the engineering disciplines through hands-on laboratory experiences. In addition, the course will provide tutorials on how to use important software packages as well as a "Professional Preparation" module through studies of communication (writing and speaking skills), ethics, leadership and teamwork. This course is ideal for any freshman interested in exploring the possibility of studying engineering at Penn. The course counts as an engineering requirement in SEAS.
Fall
1 Course Unit

ENGR 1050 Introduction to Scientific Computing
This course will provide an introduction to computation and data analysis using Python - an industry standard programming and visualization environment. The course will cover the fundamentals of computing including: variables, functions, decisions, and iteration. These concepts will be illustrated through examples and assignments which show how computing is applied to various scientific and engineering problems. Examples will be drawn from the simulation of physical and chemical systems, the analysis of experimental data, image processing, and the creation of graphical user interfaces. This course does not assume any prior programming experience but will make use of basic concepts from calculus and Newtonian physics.
1 Course Unit

ENGR 1400 Penn Global Seminar: Robotics and Rehabilitation
This course focuses on understanding the design of intelligent technologies for rehabilitation diagnostics and intervention, which include using biomechanics, computer science, robotics and mechatronics design principles Beyond technology, this course explores the design process in which medical technology is developed for foreign economies, cultures, and healthcare systems. Student projects focus on understanding stake-holders needs and developing technology able to address a Jamaican client rehabilitation needs.
Spring
1 Course Unit

ENGR 2120 Concepts in Micro- and Nanotechnology
Seminar/Lecture course on micro- and nanotechnology intended for nonspecialists. This course will discuss how very small structures and devices, as well as systems comprising these devices, are fabricated and characterized, with application examples from microelectronics, microelectromechanical systems, and quantum devices and systems. Current societal and ethical implications of micro- and nanotechnology, as well as creation and exploitation of commercial opportunities, will be discussed. Prerequisite: If course requirement not met, permission of instructor.
Fall or Spring
1 Course Unit

ENGR 2500 Energy Systems, Resources and Technology
The course will present a comprehensive overview of the global demand for energy, and the resource availability and technology used in its current and future supply. Through a personal energy audit, students will be made aware of the extensive role that energy plays in modern life, both directly, through electricity and transportation fuel, and indirectly in the manufacturing of goods they use. The course will cover how that energy is supplied, the anticipated global growth in energy demand, the resource availability and the role of science and technology in meeting that demand in a world concerned about climate change. The roles of conservation, improved efficiency and renewable energy in meeting future demand in a sustainable, environmentally benign way will be covered.
Prerequisite: Basic understanding of chemisrty and physics
Fall
1 Course Unit

ENGR 3300A Discover, Design, Build and Test: A Hands-On Introduction to Product and Device Design
Part one of a two semester lab and classroom-based design sequence. Engineers design molecules, medicines, materials, products and processes. This course introduces students to the practical elements of such design. It offers a hands-on introduction to the design and realization of practical products and devices that leverage chemical engineering principles for their operation. Students work in small teams to realize a specific design objective - a working device that meets cost and performance-based design specifications. The first part of the course is centered on lab safety, exploring the physical and chemical principles associated with the design objective, conducting basic market research, surveying intellectual property, and developing the required maker space skills in instrumentation and fabrication that are required to build the design target. The second part of the course entails the fabrication and evaluation of prototypes, and iterative refinement of designs.
Two Term Class, Student must enter first term; credit given after both terms are complete
Also Offered As: CBE 3300A
Prerequisites: Two semesters of Math/Calculus. One semester of introductory Chemistry, Physics, or Biology.
0-0.5 Course Units

ENGR 3300B Discover, Design, Build and Test: A Hands-On Introduction to Product and Device Design
Part two of a two semester lab and classroom-based design sequence. Engineers design molecules, medicines, materials, products and processes. This course introduces students to the practical elements of such design. It offers a hands-on introduction to the design and realization of practical products and devices that leverage chemical engineering principles for their operation. Students work in small teams to realize a specific design objective - a working device that meets cost and performance-based design specifications. The first part of the course is centered on lab safety, exploring the physical and chemical principles associated with the design objective, conducting basic market research, surveying intellectual property, and developing the required maker space skills in instrumentation and fabrication that are required to build the design target. The second part of the course entails the fabrication and evaluation of prototypes, and iterative refinement of designs. Prerequisites: . Two semesters of Math/Calculus. One semester of introductory Chemistry, Physics, or Biology.
Two Term Class, Student must enter first term; credit given after both terms are complete
Also Offered As: CBE 3300B
Prerequisite: CBE 3300A OR ENGR 3300A
0-0.5 Course Units

ENGR 3440 Answering Questions with Data, for Everyone
This course targets undergraduate students, such as Juniors and Seniors. Just about every student at UPenn and in particular in engineering is using progressively larger datasets to ask scientific questions. This course will break down how we use data and modeling to ask scientific questions and teach the basic toolkits to do so. The goal of this course is to allow any student who needs to use data to ask questions to see which computational tools they need to use and to use existing tools to ask those questions. All teaching will be small group and team based. The course will use a broad set of data representative of the school. The course is open to upper level undergraduate students who have some knowledge of Python.
1 Course Unit

ENGR 4215 Energy and Sustainability: Science, Engineering and Technology
Engineers will play an essential role in redesigning systems across scales to meet energy and sustainability goals in mitigating the global climate crisis. This is a foundational course applying chemical engineering principles, in particular mass and energy balances and thermodynamics, to connect microscopic and macroscopic aspects of “energy” from fundamental considerations of heat capacity and electrochemistry to limiting conversion efficiencies of thermal engines and solar cells and planetary energy balances. We will explore technical aspects of device engineering, policy requirements for technology implementation, and societal implications of such implementations. Finally, we will analyze local systems and design and justify possible changes to improve their sustainability. Prerequisites: An undergraduate course in Thermodynamics or Physical Chemistry or a closely related subject
Fall
Also Offered As: CBE 4215
1 Course Unit

ENGR 4500 Modern Biotechnology for Engineers
This course will start with the fundamentals of biotechnology, and no prior knowledge of biotechnology is necessary. Some chemistry is needed to understand how biological systems work. We will cover basic concepts in biotechnology, including DNA, RNA, the Central Dogma, proteins, recombinant DNA technology, polymerase chain reaction, DNA sequencing, the functioning of the immune system, acquired vs. innate immunity, viruses (including HIV, influenza, adenovirus, and coronavirus), gene therapy, CRISPR-Cas9 editing, drug discovery, types of pharmaceuticals (including small molecule inhibitors and monoclonal antibodies), vaccines, clinical trials. Some quantitative principles will be used to quantifying the strength of binding, calculate the dynamics of enzymes, writing and solving simple epidemiological models, methods for making and purifying drugs and vaccines. The course will end with specic case study of coronavirus pandemic, types of drugs proposed and their mechanism of action, and vaccine development.
Fall
Mutually Exclusive: ENGR 5500
1 Course Unit

ENGR 5030 Engineering in Oil, Gas and Coal, from Production to End Use
While conventional wisdom is that the world is running out of fossil fuels, technical advances such as deep water production, directional drilling, hydrofracturing, and the refining of non-conventional crude oil sources has increased the resource base significantly and there are well over 100 years of reserves of oil, natural gas and coal. The effect of technology advances has been most profound in the United States, where net energy imports are projected to fall to 12% of consumption by 2020. Excellent, highly technical careers are available in these industries, with opportunities to reduce their impact on the environment and in particular on climate change. The course will cover engineering technology in oil, natural gas and coal from production through end use. It will equip graduating students with the knowledge to contribute in these industries and to participate in informed debate about them.
Spring
1 Course Unit

ENGR 5040 Fundamental Concepts in Nanotechnology
This is a Master's level course that seeks to teach the physics needed to begin a study of engineering and science at the nanometer scale. Since the nanometer scale is so close to the quantum scale, much of the course deals with an introduction to quantum mechanics but the course also includes discussions in solid-state physics, electricity and magnetism and mechanics. The objective of the course is to teach the physics that an engineering student would need to have in order to do experimental work at the nanometer scale. In addition, this course will prepare the student to take more advanced courses in the Nanotechnology Program. Prerequisite: Senior or Master's standing in Engineering or permission of the instructor. Classical Physics (PHYS 0150, PHYS 0151) or equivalent and some of MATH 2400 (ODEs) would be desirable but not necessary.
Fall or Spring
1 Course Unit

ENGR 5215 Energy and Sustainability: Science, Engineering and Technology
Engineers will play an essential role in redesigning systems across scales to meet energy and sustainability goals in mitigating the global climate crisis. This is a foundational course applying chemical engineering principles, in particular mass and energy balances and thermodynamics, to connect microscopic and macroscopic aspects of “energy” from fundamental considerations of heat capacity and electrochemistry to limiting conversion efficiencies of thermal engines and solar cells and planetary energy balances. We will explore technical aspects of device engineering, policy requirements for technology implementation, and societal implications of such implementations. Finally, we will analyze local systems and design and justify possible changes to improve their sustainability. Prerequisite: An undergraduate course in Thermodynamics or Physical Chemistry or a closely related subject
Fall
Also Offered As: CBE 5215
1 Course Unit

ENGR 5400 Engineering Economics
Topics include: money-time relationships, discrete and continuous compounding, equivalence of cash flows, internal and external rate of return, design and production economics, life cycle cost analysis, depreciation, after-tax cash flow analysis, cost of capital, capital financing and allocation, parametric cost estimating models, pricing, foreign exchange rates, stochastic risk analysis, replacement analysis, benefit-cost analysis, and analysis of financial statements. Case studies apply these topics to engineering systems.
1 Course Unit

ENGR 5500 Modern Biotechnology for Engineers
This course will start with the fundamentals of biotechnology, and no prior knowledge of biotechnology is necessary. Some chemistry is needed to understand how biological systems work. We will cover basic concepts in biotechnology, including DNA, RNA, the Central Dogma, proteins, recombinant DNA technology, polymerase chain reaction, DNA sequencing, the functioning of the immune system, acquired vs. innate immunity, viruses (including HIV, influenza, adenovirus, and coronavirus), gene therapy, CRISPR-Cas9 editing, drug discovery, types of pharmaceuticals (including small molecule inhibitors and monoclonal antibodies), vaccines, clinical trials. Some quantitative principles will be used to quantifying the strength of binding, calculate the dynamics of enzymes, writing and solving simple epidemiological models, methods for making and purifying drugs and vaccines. The course will end with specific case study of coronavirus pandemic, types of drugs proposed and their mechanism of action, and vaccine development.
Fall
Mutually Exclusive: ENGR 4500
1 Course Unit