

University of Pennsylvania



School of Engineering & Applied Science Undergraduate Program

CHOOSING YOUR PROGRAM

Penn Engineering is defining a new type of undergraduate education. An education that connects engineering with business, medicine, and science. An education that links theory with real-world practice. In the classroom and in the laboratory, you will be working with renowned faculty whose cutting-edge research spans subjects from intelligent machines and biotransport phenomena to the structure of matter. Our interconnections with other schools at Penn mean that you will have access to a program of study that other schools of engineering would find difficult to duplicate.

Undecided about your major?

Check out Engineering 101

"I know I want to be an engineer but I'm not sure what kind of engineer I want to be." No problem. We designed our new ground-breaking Engineering 101 for students like you. EAS 101 is a hands-on introduction to all branches of engineering at Penn. The course centers on a series of laboratory experiences in each department from Bioengineering to Systems Science and Engineering. Use EAS 101 to discover what field of engineering interests you most.

Bioengineering...

PREPARES YOU TO APPLY ENGINEERING ANALYSIS, SIMULATION AND DESIGN TO BIOMEDICAL PROBLEMS

Bioengineers, also known as biomedical engineers, use principles from electrical, mechanical, chemical, and materials engineering to solve problems in medicine and the biological sciences. The growing field of bioengineering now ranges beyond its more traditional scope of technical design, basic and applied research, health professions, and industry, particularly the medical device industry. Bioengineers now also pursue careers in business, investing, intellectual property law, and government, including the regulation of patents and medical devices.

The Department of Bioengineering, consistently ranked as one of the nation's top programs and renowned as a pioneer in the field, offers a program that provides a solid

foundation in science and engineering, exposure to a wide variety of bioengineering areas, and extensive research opportunities.

The BSE degree, with a major in bioengineering, is for those who want a fully accredited professional engineering degree. The BAS degree, with a major in biomedical sciences, offers greater flexibility than the BSE program and is often chosen by students interested in dual-degree programs or advanced study in non-engineering fields. Pre-medical students, among others, may choose either the BSE or BAS degree program. Both programs are identical for the first two years, and students may easily change from one program to the other as their career plans become clearer.

EDUCATIONAL OBJECTIVES OF BE PROGRAM

- Provide an education that offers:
- A broad flexible curriculum that allows students to investigate a wide range of subject areas across the University
 - Core abilities and knowledge in areas such as mathematics, physical and life science, engineering science, and design that prepare students for a range of technical and interfacial fields
 - Opportunities for students to function at a professional level, using teamwork and communication skills and taking responsibility for their own life-long education

BIOENGINEERING PROGRAM FACILITY

Bioengineering Undergraduate Laboratory

BE SAMPLE CURRICULUM

	Fall	Spring
Year 1	Calculus I General Chemistry I & Lab Principles of Physics I Introduction to Bioengineering	Calculus II General Chemistry II & Lab Principles of Physics II SSH elective (Social Sciences & Humanities)
Year 2	Calculus III Bioengineering Lab I Molecular Biology Biomechanics & Biomaterials SSH elective	Calculus IV Bioengineering Lab II Cell Biology Free elective SSH elective
Year 3	Vertebrate Physiology or Engineering Principles of Human Physiology Chemical Basis of Bioengineering II Bioengineering Signals & Systems Ethics & Professional Standards Free elective	Bioengineering Lab III Transport Processes in Living Systems Clinical Preceptorship Free elective Professional environment elective
Year 4	Senior Design Project I BE 400-500 quantitative elective Free elective SSH elective	Senior Design Project II BE 400/500-level course Two free electives SSH elective

Chemical and Biomolecular Engineering...

PREPARES YOU TO DEVELOP CHEMICAL AND BIOLOGICAL PROCESSES AND APPLY THEM TO CHANGE RAW MATERIALS INTO USEFUL ONES

The Chemical Engineering program at Penn, in continuous operation since 1893, ranks among the finest in the country. The recent name change to include the word "Biomolecular" recognizes the important role modern disciplines such as molecular biology and genetic engineering now play in our profession.

Our modern program combines engineering principles with concepts from chemistry, physics, and biology. Our flexible CBE curriculum includes theory, problem-solving techniques and experimental work. Small classes encourage professor-student interactions and the senior process design course utilizes the expertise of industrial colleagues from local chemical and pharmaceutical companies.

Our interdisciplinary approach prepares students for leadership roles in industry, academia, and the public sector in a variety of technical areas including chemical, petro-chemical and materials processing; biotechnology; pharmaceutical manufacturing; environmental remediation; and energy storage and conversion. The breadth of our curriculum is also of particular value to those seeking additional education in medicine, law, and business.

CBE SAMPLE CURRICULUM

	Fall	Spring
Year 1	Fundamentals of Biotechnology Calculus I General Chemistry I & Lab SSH elective (Social Sciences & Humanities) Writing Requirement (SSH)	Intro to Chemical Engineering Calculus II General Chemistry II & Lab Principles of Physics I Free elective
Year 2	Material & Energy Balances Calculus III Organic Chemistry I Principles of Physics II Free elective	Thermodynamics of Fluids Calculus IV Organic Chemistry II or Biochemistry Engineering computer course SSH elective
Year 3	Fluid Mechanics Adv. Chemical Engineering Science Physical Chemistry I Non-CBE engineering elective SSH elective	Heat & Mass Transport Separation Processes Chemistry lab elective SSH elective
Year 4	Intro to Process Design Chemical Engineering Lab Chemical Reactor Design Technical elective SSH elective	Process System Design Projects Chemical Process Control CBE elective Technical elective SSH elective Free elective

www.seas.upenn.edu/cbe/ugrad-progs.html

Computer Science...

PREPARES YOU TO COMBINE ENGINEERING THEORY AND DESIGN WITH COMPUTING PRINCIPLES

Computers are everywhere in our society. The infrastructure of business, government, science, and everyday life is increasingly based on computers and digital communication. Whether you are listening to your digital music player, instant messaging with friends, driving a modern car, trading stocks, producing a movie, performing or undergoing a medical procedure, playing a video game, or submitting an income tax return, you depend on networks of computers that store, exchange, and process information in increasingly elaborate ways.

Understanding the foundation of this technology — what it can and cannot do, how it relates to information

processing in living things and society, and how you can use it — will enable you to utilize, analyze and create information processing systems for whatever career, advanced education or personal interests you choose to pursue.

Computing is a critical tool for controlling and shaping the processes of modern society. If you want to be in the driver's seat for this amazing ride, consider one of several options that the Department of Computer and Information Science offers, from a single introductory course to a minor or major.

CS SAMPLE CURRICULUM

	Fall	Spring
Year 1	Intro to Programming Calculus I Principles of Physics I Natural science lab SSH elective (Social Sciences & Humanities) Free elective	Programming Languages & Techniques I Calculus II Math Foundations of Computer Science SSH elective Natural science elective
Year 2	Intro to Computer Architecture Principles of Physics II Discrete Probability, Stochastic Processes, and Statistical Inference or Engineering Probability or Engineering Statistics Natural science lab Two SSH electives	Programming Languages & Techniques II Digital System Organization/Design & lab Math elective Two SSH electives
Year 3	Automata, Computability & Complexity Computing Operating Systems & Lab CSE elective Technical elective	Intro to Algorithms Two CSE electives Technical elective Math elective
Year 4	Senior Design I Two technical electives SSH elective Free elective	Senior Design II Two technical electives Free elective

www.cis.upenn.edu/ugrad

EDUCATIONAL OBJECTIVES OF CS PROGRAM

Prepare students to:

- Identify, formulate, and solve challenging computer science problems
- Develop professional skills that prepare them for immediate employment or graduate study in computer science and related disciplines
- Understand and apply the scientific and relevant mathematical foundations of computer science
- Understand the social and human context in which their computer science work will be used
- Communicate ideas and collaborate effectively with other members of research and development teams

CS PROGRAM FACILITIES

Institute for Research in Cognitive Science; Center for Human Modeling and Simulation; Center for Bioinformatics; Digital Systems Laboratory; General Robotics and Active Sensory Perception Laboratory; Language, Information, and Computation Laboratory

Digital Media Design...

PREPARES YOU TO UNDERSTAND AND APPLY THEORETICAL, ARTISTIC, AESTHETIC, AND EXPERIENTIAL PRINCIPLES ASSOCIATED WITH DIGITAL MEDIA DESIGN

Computer-generated imagery is transforming communication — from educational software and motion picture special effects to architectural simulations and medical visualizations. With these new technologies come new questions about the creation and design of virtual environments and their impact upon society.

To address these questions, Penn Engineering, in collaboration with the University's Annenberg School for Communication and the School of Design created the Digital Media Design (DMD) program, an elite BSE degree program for a limited number of students.

The curriculum gives students a foundation in three areas: 1) computational basis for the creation of digital media imagery, including simulation of 3D environments; 2) informed understanding of the aesthetic aspects of digital media design; and 3) theory and research concerning viewers' psychological responses to, and uses of, visual media as well as broader socio-cultural effects. Students in the program are expected to participate in one or two summers of real-world experience in a major multimedia industry.

DMD SAMPLE CURRICULUM

	Fall	Spring
Year 1	Programming Languages I & Lab	Programming Languages II & Lab
	Calculus I	Calculus II
	Drawing I	Drawing II
	Writing Seminar	Math Foundations of Computer Science
	SSH elective (Social Sciences & Humanities)	Art as Communication
Year 2	Intro to Computer Architecture	Virtual World Design
	Principles of Physics I	Principles of Physics II
	Automata, Computability & Complexity 3D	Art as Communication
	Computer Modeling	Math elective
	Psychology (Perception, Learning, etc.)	SSH elective
Year 3	Mixed Media Animation	Computer Graphics
	Introduction to Algorithms	Visual Communication
	Communications elective	Fine Arts elective
	CSE elective	SSH elective
	SSH elective	Free elective
Year 4	Senior Project	Communication elective
	Computer Animation	Fine Arts elective
	Two SSH electives	Two SSH electives
	Free elective	Free elective

Electrical Engineering...

PREPARES YOU TO DEVELOP NEW TECHNOLOGIES TO ACQUIRE, TRANSMIT, STORE, AND PROCESS INFORMATION AS ELECTRICAL AND OPTICAL SIGNALS

Today's world has become increasingly dependent on advances made in technology and engineering. These advances span a wide spectrum of products and services, ranging from communication systems, computers, and computer network to instruments for health care and diagnostics. These products are, in part, the result of work done by electrical engineers.

Penn's Electrical Engineering (EE) curriculum covers all major areas of electrical engineering including telecommunications and networks,

imaging, remote sensing, micro-electronics and integrated circuits, computer engineering, image and speed processing, robotics, video coding, neural computation, self-organizing systems, electro-magnetics and photonics, electronic materials, silicon micromechanics, and nanofluidics. Each program of study and area of specialization is shaped by the student's intended career goal or plan for graduate study.

EDUCATIONAL OBJECTIVES OF DMD PROGRAM

Prepare students to:

- Use their superior technical expertise and communication skills to bridge the barriers that currently exist between artists and engineers in the world of computer graphics
- Excel in influential industry positions such as technical directors, project directors, creative directors, and animation supervisors
- Excel in graduate studies and research careers

DMD PROGRAM FACILITIES

Penn Engineering's Center for Human Modeling and Simulation and School of Design's Cartographic Modeling Lab, Urban Simulation Lab and Digital Design Research Lab.

EE SAMPLE CURRICULUM

	Fall	Spring
Year 1	Calculus I	Calculus II
	Principles of Physics I & Lab	Principles of Physics II & Lab
	Intro to Electrical & Systems Engineering	Intro to Electrical & Systems Engineering
	SSH elective (Social Sciences & Humanities)	General Chemistry & Lab or General Biology & Lab
Year 2	Calculus III	Calculus IV
	Electrical Systems & Circuits I	Electrical Systems & Circuits II
	Natural science elective	Intro to Digital Signal Processing
	SSH* elective	Engineering breadth elective
	Free elective	SSH elective
Year 3	Engineering Probability	Two technical electives
	Ethics & Soc for Engineers	Engineering-depth elective
	Two engineering-breadth electives	SSH elective
	SSH elective	Free elective
Year 4	Senior Design Project I	Senior Design Project II
	Engineering-breadth elective	Engineering-depth elective
	Engineering-depth elective	Two technical electives
	SSH elective	
	Free elective	

EDUCATIONAL OBJECTIVES OF EE PROGRAM

Prepare students to:

- Integrate fundamentals of electrical engineering with design/realization practice to develop innovative solutions to complex technological problems
- Communicate effectively, excel in multi-disciplinary/cultural teams, and value non-technical disciplines
- Pursue careers or graduate studies in electrical engineering or their chosen field; and engage in life-long learning
- Be recognized in their chosen fields for their leadership, integrity, and sensitivity to global societal issues

EE PROGRAM FACILITIES

EE Undergraduate Laboratory, Special Projects Laboratory, Fred Ketterer Laboratory, Microfabrication Facility, VLSI Design Laboratory

Materials Science and Engineering...

PREPARES YOU TO USE CHEMISTRY, PHYSICS, AND BIOLOGICAL PRINCIPLES IN CREATING AND MANIPULATING THE STRUCTURAL AND FUNCTIONAL PROPERTIES OF ADVANCED MATERIALS

Key to the explosive growth in modern technology is the development of advanced materials by materials science engineers and scientists. New materials from nanostructured and biomedical materials to electronic ceramics and co-polymers are paving the way for the new fields, new ideas, and new technologies that are changing the way we live and work. Penn's nationally-ranked Materials Science and Engineering (MSE) program stresses core principles (thermodynamics, structure, bonding, and phase transformations) and area of concentration) and areas

of concentration (nano-scale materials, biomaterials, polymers, ceramics, mechanical properties, and electronic material). The program offers students advantages seldom found in other MSE programs: the opportunity to tailor the curriculum to their own interests, guaranteed research experience; a broad education that is also suited to a Management and Technology degree or business major, and an excellent student/faculty ratio.

MSE SAMPLE CURRICULUM

	Fall	Spring
Year 1	Fall Calculus I General Chemistry I & Lab Principles of Physics I Intro to Engineering	Spring Calculus II General Chemistry II & Lab Principles of Physics II Intro to Nanotechnology
Year 2	Structural and Biomaterials Quantum Physics of Materials Calculus III Intro to Computer Programming Writing requirement	Intro to Nanoscale Functional Materials Nanoscale Materials Lab Calculus IV Energetics of Macro/Nanoscale Materials SSH elective (Social Sciences/Humanities)
Year 3	Polymers & Biomaterials Structure of Materials Advanced Linear Algebra Engineering elective SSH elective	Polymers & Biomaterials Materials Selection Engineering elective SSH elective Free elective
Year 4	Senior Design Project I Two engineering electives Two SSH electives	Senior Design Project II Fuel Cells & Energy Storage Technology SSH elective Free elective

www.seas.upenn.edu/mse/ugrad/index.html

Mechanical Engineering and Applied Mechanics...

PREPARES YOU TO UNDERSTAND AND DESIGN COMPONENTS AND SYSTEMS FOR A WIDE RANGE OF APPLICATIONS

Mechanical engineers design and develop everything we think of as a machine — from rocket engines and nano motors to toasters and power tools.

Penn's Mechanical Engineering & Applied Mechanics (MEAM) program deals with the study of forces, deformations and motions of solid bodies and fluids, heat generation and transport, and applications to analysis, design, and manufacture of components, machines, and systems.

Students follow a program which contains basic groundwork in all aspects of mechanical engineering, while flexibility in the curriculum allows them to pursue elective programs in fields such as aeronautics, robotics, computers, electronics, automatic controls, and materials.

Career opportunities for mechanical engineers are perhaps the broadest among all the fields of engineering. Aerospace, automotive, electronics, computers, and robotics are but a few of the fields that employ mechanical engineers. Positions range from research and development to design and manufacturing to field engineering and marketing. Some recent graduates have taken positions with consulting and financial institutions while others have gone on to graduate studies in engineering, business, law, and medicine.

MEAM SAMPLE CURRICULUM

	Fall	Spring
Year 1	Principles of Physics I & Lab Calculus I Intro to Scientific Computing or Intro to Chemistry & Lab SSH elective (Social Sciences/Humanities)	Principles of Physics II & Lab Calculus II Intro to CAD/CAM Natural science elective Writing requirement
Year 2	Statics and Strengths of Materials Mechanical Engineering Lab IA Calculus III Intro to Scientific Computing or Intro to Chemistry & Lab Engineering elective SSH elective	Thermodynamics I Mechanical Engineering Lab IB Calculus IV Engineering Mechanics: Dynamics Math elective SSH elective
Year 3	Fluid Mechanics Vibrations Mechanics of Solids Mechanical Engineering Lab IIA SSH elective	Mechanical Engineering Design Project I Design of Thermal/Fluid Systems Heat and Mass Transfer Mechanical Engineering Lab IIB Engineering elective SSH elective
Year 4	Mechanical Engineering Design Project II Two engineering electives SSH elective Free elective	Two engineering electives SSH elective Two free electives

www.me.upenn.edu/undergrad/

EDUCATIONAL OBJECTIVES OF MEAM PROGRAM

Provide a program that will:

- Educate students in the fundamental principles of mathematics, science, and engineering and train them in modern problem-solving tools used by mechanical engineers
- Train students to apply their basic knowledge of mechanical engineering principles and techniques to analyze, synthesize and design engineering systems
- Offer students a flexible broad-based curriculum and a skill set that allows them to think critically and contribute to areas beyond the traditional boundaries of mechanical engineering
- Prepare students to be engineering professionals by training them to communicate and function effectively as members/leaders of multi-disciplinary teams and by making them aware of social, ethical, and environmental issues that may be relevant to their work
- Support and prepare students who wish to pursue advanced degrees by providing opportunities for them to participate in research and mentoring interactions with faculty and graduates.

MEAM PROGRAM FACILITIES

General Motors Laboratory, Wind Tunnel, Design and Prototyping Laboratory

Systems Science and Engineering...

PREPARES YOU TO DESIGN AND IMPLEMENT SYSTEMS THAT ASSURE EFFECTIVE OPERATION OF TECHNOLOGICAL SYSTEMS AS A WHOLE

The field of systems engineering was born at Penn in 1953 when the Moore School held a series of seminars to help industry address the growing complexity in military systems. Since then, complexity has become a central feature in many areas that directly affect national life. Designing effective systems in the face of growing complexity continues to be a high priority at Penn.

The Systems Science and Engineering (SSE) program specializes in those aspects of engineering that pertain to effectiveness of whole systems.

In contrast to other engineering specialties which are grounded in certain aspects of science, system engineering is grounded primarily in mathematics and methodology. The core curriculum focuses on mathematical modeling and simulation, rather than on particular physical sciences. To assure that designs are responsive to real needs, students learn how to model, simulate, optimize, integrate, and evaluate systems.

SSE SAMPLE CURRICULUM

	Fall	Spring
Year 1	Calculus I General Chemistry & Lab or General Biology & Lab Intro to ESE — Devices SSH elective (Social Sciences/Humanities)	Calculus II Principles of Physics I & Lab Intro to ESE — Systems SSH elective
Year 2	Calculus III Principles of Physics II & Lab Intro to Dynamic Systems SSH elective Free elective	Calculus IV Focus elective Engineering elective Two SSH electives
Year 3	Probability Stochastic Systems Analysis/ Simulation Engineering Economics Engineering elective Focus elective	Statistics Microcontroller Lab Optimization of Systems Control of Systems Senior Design I
Year 4	Senior Design II Project Management Engineering elective SSH elective Free elective	Ethics & Soc for Engineers Two focus electives Free elective

www.seas.upenn.edu/ease/ugrad/sys-sse.html

EDUCATIONAL OBJECTIVES OF SSE PROGRAM

Prepare students to:

- Integrate fundamentals of systems science and engineering with design tools/methodologies to architect innovative solutions to complex technological problems
- Communicate effectively, excel in multi-disciplinary/multi-cultural teams, and value non-technical disciplines
- Pursue careers or graduate studies in systems engineering or their chosen field and engage in life-long learning
- Be recognized in their chosen fields for their leadership, integrity, and sensitivity to global societal issues.

SSE PROGRAM FACILITIES:

- Environmental Resources Laboratory, Transportation Logistics Laboratory, Telecommunication Networks Laboratory, Manufacturing Laboratory

ABET — ANOTHER GREAT REASON FOR CHOOSING PENN

Accreditation by the Accreditation Board for Engineering and Technology (ABET)* assures that a college/university program meets the quality standards set by the profession for which it prepares its students. Whether you study computer science or engineering, ABET accreditation is an important indicator of your program's commitment to quality and may be a key to your professional future. The following BSE programs are ABET accredited...

Bioengineering

Chemical and Biomolecular Engineering

Computer and Telecommunications Engineering

Computer Science

Electrical Engineering

Materials Science and Engineering

Mechanical Engineering and Applied Mechanics

Systems Science and Engineering

*Accredited by Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012. Telephone 410.347.7700. The Computer Science program is accredited by the Computing Accreditation Commission of ABET, Inc.

