

ELECTRICAL ENGINEERING, BSE

Electrical engineering connects the physical world with the information world. Electrical engineers apply physics and chemistry in modern nanotechnology devices, encode and manipulate information in circuits and networks, and mathematically understand and reason with large amounts of data in real time. This makes electrical engineering one of the broadest forms of engineering, resulting in a multitude of possible careers. The societal impact of electrical engineering can be found in numerous domains, from smartphones, 5G wireless, and medical imaging to electric/driverless cars and the Internet of Things. Electrical engineering includes the engineering of electrons, magnets, photons, electro-magnetic waves, quantum states, and electro-mechanical structures. Electrically engineering systems provide communication, sensing, actuation, display, storage, conversion, control, and computation. The electrical engineering discipline includes both the design and implementation of physical realizations (devices, circuits, antennas) and the mathematical tools for optimizing the exploitation of these systems (control theory, information theory, digital logic, signal processing).

For more information: <https://www.seas.upenn.edu/prospective-students/undergrad/majors/electrical-engineering/>

Electrical Engineering (EE) Major Requirements

37 course units are required.

Code	Title	Course Units
Engineering		
CIS 1100	Introduction to Computer Programming	1
ESE 1110	Atoms, Bits, Circuits and Systems ¹	1
CIS 1200 or CIS 2400	Programming Languages and Techniques I Introduction to Computer Systems	1
ESE 2150	Electrical Circuits and Systems	1.5
ESE 2180	Electronic, Photonic, and Electromechanical Devices	1.5
ESE 2240	Signal and Information Processing	1.5
<i>Intermediate or Advanced ESE Elective</i>		
<i>Advanced ESE courses</i>		
Choose four advanced electives from the following lists:		4-4.5
<i>Circuits and Computer Engineering:</i>		
ESE 3190	Fundamentals of Solid-State Circuits	
ESE 3500	Embedded Systems/Microcontroller Laboratory	
ESE 3700	Circuit-Level Modeling, Design, and Optimization for Digital Systems	
ESE 4190	Analog Integrated Circuits	
ESE 5160	IoT Edge Computing	
ESE 5320	System-on-a-Chip Architecture	
ESE 5780	RFIC (Radio Frequency Integrated Circuit) Design	
ESE 5900	Systems Methodology	
ESE 6720	Integrated Communication Systems	

Nanodevices and Nanosystems:

ESE 3100	Electric and Magnetic Fields I
ESE 3300	Principles of Optics and Photonics
ESE 3360	Nanofabrication of Electrical Devices
ESE 4600	The Principles and Practice of Microfabrication Technology
ESE 5100	Electromagnetic and Optics
ESE 5210	The Physics of Solid State Energy Devices
ESE 5230	Quantum Engineering
ESE 6110	Nanophotonics: Light at the Nanoscale
ESE 6210	Nanoelectronics
ESE 6730	Integrated Photonic Systems

Information and Decision Systems:

ESE 3030	Stochastic Systems Analysis and Simulation
ESE 3050	Foundations of Data Science
ESE 3250	Fourier Analysis and Applications in Engineering, Mathematics, and the Sciences
ESE 4070	Introduction to Networks and Protocols
ESE 5000	Linear Systems Theory
ESE 5010	Networking - Theory and Fundamentals
ESE 5040	Intro to Linear, Nonlinear and Integer Optimization
ESE 5050	Feedback Control Design and Analysis
ESE 5120	Dynamical Systems for Engineering and Biological Applications
ESE 5270	Design of Smart Systems
ESE 5280	Estimation and Detection Theory
ESE 5310	Digital Signal Processing
ESE 5450	Data Mining: Learning from Massive Datasets
ESE 5460	Principles of Deep Learning
ESE 5480	Transportation Planning Methods
ESE 5500	Advance Transportation Seminar
ESE 5670	Risk Analysis and Environmental Management
ESE 5900	Systems Methodology
ESE 6050	Modern Convex Optimization
ESE 6500	Learning in Robotics
ESE 6740	Information Theory

One of the Advanced Electives may be an Advanced ESE elective, BE 5210 or CIS 4710 or CIS 5200

Design and Project Courses ²

ESE 2900 & ESE 2910	Introduction to Electrical and Systems Engineering Research Methodology and Introduction to Electrical and Systems Engineering Research and Design	1.5
or ESE 3190 or ESE 3360 or ESE 3500 or ESE 4210 or BE 4700	Fundamentals of Solid-State Circuits Nanofabrication of Electrical Devices Embedded Systems/Microcontroller Laboratory Control For Autonomous Robots Medical Devices	
ESE 4500	Senior Design Project I - EE and SSE	1

ESE 4510	Senior Design Project II - EE and SSE	1
Math and Natural Science		
MATH 1400	Calculus, Part I	1
MATH 1410	Calculus, Part II	1
MATH 2400	Calculus, Part III	1
ESE 3010	Engineering Probability	1
MEAM 1100	Introduction to Mechanics	1
or PHYS 0140	Principles of Physics I (without laboratory)	
or PHYS 0150	Principles of Physics I: Mechanics and Wave Motion	
or PHYS 0170	Honors Physics I: Mechanics and Wave Motion	
ESE 1120	Engineering Electromagnetics (students passing the ESE E&M review module may substitute an ESE approved E&M course)	1.5
CHEM 1011	Introduction to General Chemistry I	1
or EAS 0091	Chemistry Advanced Placement/International Baccalaureate Credit (Engineering Students Only)	
or BIOL 1101	Introduction to Biology A	
or BIOL 1121	Introduction to Biology - The Molecular Biology of Life	
Math Elective		1
Math or Natural Science Elective		1
Natural Science Lab (if applicable) ³		.5
Professional Electives ⁴		
Math, Science, or Engineering Electives		3
Professional Elective - Select from the following:		1
Math, Science, or Engineering Elective		
ESE 4000	Engineering Economics	
EAS 5450	Engineering Entrepreneurship I	
EAS 5950	Foundations of Leadership	
MGMT 2370	Management of Technology	
OIDD 2360	Scaling Operations in Technology Ventures: Linking Strategy and Execution	
General Electives ⁵		
EAS 2030	Engineering Ethics	1
Select 4 Social Science or Humanities courses		4
Select 2 Social Science or Humanities or Technology in Business & Society courses		2
Total Course Units		37

1

If not taken freshman year, must be replaced by another department approved engineering course.

2

If BE 4700 is taken, an additional .5 CU engineering credit is required

3

If BIOL 1121, CHEM 1011, EAS 0091, MEAM 1100 or PHYS 0140 are taken, choose one natural science lab from the list: BIOL 1124 Introductory Organismal Biology Lab, PHYS 0050 Physics Laboratory I, MEAM 1470 Introduction to Mechanics Lab, CHEM 1101 General Chemistry Laboratory I or another department approved Natural Science lab.

4

At most, two freshman-level engineering courses may be used as a Professional Elective

5

Must include a Writing Seminar (a list of approved Writing Seminars can be found in the SEAS Undergraduate Handbook (<https://ugrad.seas.upenn.edu/student-handbook/courses-requirements/writing-courses/>))

Concentrations

Students may select one of six concentrations:

- Data Science
- Microsystems and Nanotechnology
- Mixed-Signal and RF Integrated Circuits
- Photonics and Quantum
- Robotics
- System-on-A-Chip Design

The degree and major requirements displayed are intended as a guide for students entering in the Fall of 2022 and later. Students should consult with their academic program regarding final certifications and requirements for graduation.
