ELECTRICAL ENGINEERING UNDERGRADUATE MAJOR

COVID-19-Related Degree Requirement Changes

For information on how Electrical Engineering degree requirements have been affected by the pandemic, see the "COVID-19 Policies tab (http://exploredegrees.stanford.edu/schoolofengineering/electricalengineering/#covid19policiestext)" in the "Electrical Engineering" of this bulletin. For University-wide policy changes related to the pandemic, see the "COVID-19 and Academic Continuity (http://exploredegrees.stanford.edu/covid-19-policy-changes/)" section of this bulletin.

See the "Department of Electrical Engineering (http://exploredegrees.stanford.edu/schoolofengineering/electricalengineering/)" section of this bulletin for additional information on the department, and its programs and faculty.

The department offers a B.S. as well as a minor in Electrical Engineering.

Electrical Engineering (EE)

Completion of the undergraduate program in Electrical Engineering leads to the conferral of the Bachelor of Science in Electrical Engineering.

Mission of the Undergraduate Program in Electrical Engineering

The mission of the undergraduate program of the Department of Electrical Engineering is to augment the liberal education expected of all Stanford undergraduates, to impart basic understanding of electrical engineering and to develop skills in the design and building of systems that directly impact societal needs.

The program includes a balanced foundation in the physical sciences, mathematics and computing; core courses in electronics, information systems and digital systems; and develops specific skills in the analysis and design of systems. Students in the major have broad flexibility to select from disciplinary areas beyond the core, including hardware and software, information systems and science, and physical technology and science, as well as electives in multidisciplinary areas, including bio-electronics and bio-imaging, energy and environment and music.

The program prepares students for a broad range of careers—both industrial and government—as well as for professional and academic graduate education.

Requirements

		Units
MATHEMATICS AND SCIENCE		
Minimum 40 units Math and Science combined.		
Mathematics [1]		
Select one sequence: May also be satisfied with AP Calculus.		10
MATH 19 & MATH 20 & MATH 21	Calculus and Calculus and Calculus	
Select one 2-course sequence:		10
CME 100 & CME 102	Vector Calculus for Engineers and Ordinary Differential Equations for Engineers (Same as ENGR 154 and ENGR 155A)	
MATH 51 & MATH 53	Linear Algebra, Multivariable Calculus, and Modern Applications and Ordinary Differential Equations with Linear Algebra [2]	
EE Math. One additional 100-level course. Select one:		3
CS 103	Mathematical Foundations of Computing	
ENGR 108	Introduction to Matrix Methods (Preferred) [3]	
MATH 113	Linear Algebra and Matrix Theory	
Statistics/Probability		3-4
EE 178	Probabilistic Systems Analysis [3]	
Science		
Minimum 12 units		
Select one sequence:		12
PHYSICS 41 & EE 65	Mechanics and Modern Physics for Engineers [4]	
PHYSICS 61 & EE 65	Mechanics and Special Relativity and Modern Physics for Engineers [4]	
Science elective. One additional 4-5 unit course from approved list in Undergraduate Handbook, Figure 4-2.		4-5
TECHNOLOGY IN SOCIETY		
One course, see Basic Requirement 4 in the School of Engineering section. The course taken must be on the School of Engineering Approved Courses list, Fig 4-3, the year it is taken.		3-5
ENGINEERING TOPICS		
Minimum 60 units comprised of: Engineering Fundamentals (minimum 10 units), Core Electrical Engineering Courses (minimum 16 units) Disciplinary Area (minimum 17 units), Electives (maximum 17 units, restrictions apply).		
Engineering Fundamentals		**10**
2 courses required; minimum 10 units.		
Select one:		
CS 106B or CS 106X	Programming Abstractions Programming Abstractions	5
Choose one Fundamental from the Approved List; Recommended: ENGR 40A and ENGR 40B or ENGR 40M (recommended before taking EE 101A); taking CS 106A or a second ENGR 40-series course not allowed for the Fundamentals elective. Choose from table in Undergraduate Handbook, Approved List.		5
Core Electrical Engineering Courses		**16**
Minimum 16 units.		
EE 42	Introduction to Electromagnetics and Its Applications [5]	
EE 100	The Electrical Engineering Profession [6]	
EE 101A	Circuits I	
EE 102A	Signal Processing and Linear Systems I	
EE 108	Digital System Design	
Disciplinary Area		**17**
Minimum 17 units, 5 courses: 1-2 Required, 1 WIM/Design and 2-3 disciplinary area electives.		
Writing in the Major (WIM)		**3-5**
Select one. A single course can concurrently meet the WIM and Design Requirements.		
EE 109	Digital Systems Design Lab (WIM/Design)	
EE 133	Analog Communications Design Laboratory (WIM/Design)	
EE 134	Introduction to Photonics (WIM/Design)	
EE 153	Power Electronics (WIM/Design)	
EE 155	Green Electronics (WIM/Design)	

EE 168	Introduction to Digital Image Processing (WIM/Design)	
EE 191W	Special Studies and Reports in Electrical Engineering (WIM; Department approval required) [7]	
EE 264W	Digital Signal Processing (WIM/Design)	
EE 267W	Virtual Reality (WIM/Design)	
CS 194W	Software Project (WIM/Design)	
Design Course		**3-5**
Select one. Students may select their Design course from any Disciplinary Area.		
EE 109	Digital Systems Design Lab (WIM/Design)	
EE 133	Analog Communications Design Laboratory (WIM/Design)	
EE 134	Introduction to Photonics (WIM/Design)	
EE 153	Power Electronics (WIM/Design)	
EE 155	Green Electronics (WIM/Design)	
EE 168	Introduction to Digital Image Processing (WIM/Design)	
EE 185C	Engineering a Smart Object - Adding connectivity and Putting it ALL together (Design)	
EE 262	Three-Dimensional Imaging (Design)	
EE 264	Digital Signal Processing (Design) [8]	
EE 264W	Digital Signal Processing (WIM/Design)	
EE 267	Virtual Reality (Design) [8]	
EE 267W	Virtual Reality (WIM/Design)	
CS 194	Software Project (Design)	
CS 194W	Software Project (WIM/Design)	
Electives [9]		**17**
Minimum 17 units. The elective units should be sufficient to meet the 60 unit total for the major, over and above the 40 units of Math and Science. Depending on units completed in the Disciplinary Area, elective units will be in the range of 17 units or less. Students may select electives from the disciplinary areas; from the multidisciplinary elective areas; or any combination of disciplinary and multidisciplinary areas. May include up to two additional Engineering Fundamentals and any letter graded EE courses (minus any previously noted restrictions). Freshman and Sophomore seminars, EE 191 and CS 106A do not count toward the 60 units. Students may have fewer elective units if they have more units in their disciplinary area.		

1 MATH 41 and MATH 42 are no longer offered and have been replaced by MATH 19, MATH 20, and MATH 21.

2 MATH 51 may be replaced by MATH 52. MATH 53 may be replaced by CME 102.

3 If used for math, ENGR 108 may not be used as an EE disciplinary elective. Students may petition to use CS 109 in place of EE 178.

4 Students may petition to have either PHYSICS 65 or the combination of PHYSICS 45 and PHYSICS 70 count as an alternative to EE 65.

5 Students may petition to use PHYSICS 43 or PHYSICS 63 in place of EE 42. The EE introductory class ENGR 40A and ENGR 40B or ENGR 40M may be taken concurrently with either EE 42 or PHYSICS 43. There are no prerequisites for ENGR 40A and ENGR 40B or ENGR 40M.

6 For upper division students, a 200-level seminar in their disciplinary area will be accepted, on petition.

7 EE 191W may satisfy WIM only if it is a follow-up to an REU, independent study project or as part of an honors thesis project where a faculty agrees to provide supervision of writing a technical paper and with suitable support from the Writing Center.

8 To satisfy Design, must take EE 264 or EE 267 for 4 units and complete the laboratory project.

9 A course may only be counted towards one requirement; it may not be double-counted. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum Combined GPA for all courses in Engineering Fundamentals and Depth is 2.0.

Disciplinary Areas

		Units
Hardware and Software		
EE 180	Digital Systems Architecture (Required)	4
EE 104	Introduction to Machine Learning	3-5
EE 107	Embedded Networked Systems	3
EE 109	Digital Systems Design Lab (WIM/Design)	4
EE 118	Introduction to Mechatronics	4
EE 155	Green Electronics (Design)	4
EE 185C	Engineering a Smart Object - Adding connectivity and Putting it ALL together (Design)	3
EE 264	Digital Signal Processing (Design)	3-4
EE 264W	Digital Signal Processing (WIM/Design)	5
EE 267	Virtual Reality (Design)	3-4
EE 267W	Virtual Reality (WIM/Design)	5
EE 271	Introduction to VLSI Systems	3
EE 272A	Design Projects in VLSI Systems I	3-4
EE 272B	Design Projects in VLSI Systems II	3-4
EE 273	Digital Systems Engineering	3
EE 282	Computer Systems Architecture	3
EE 285	Embedded Systems Workshop	3
CS 107	Computer Organization and Systems (Required prerequisite for EE 180; CS 107E preferred)	3-5
or CS 107E	Computer Systems from the Ground Up	
CS 108	Object-Oriented Systems Design	3-4
CS 110	Principles of Computer Systems	3-5
CS 131	Computer Vision: Foundations and Applications	3-4
CS 140	Operating Systems and Systems Programming	3-4
CS 143	Compilers	3-4
CS 144	Introduction to Computer Networking	3-4
CS 145	Data Management and Data Systems	3-4
CS 148	Introduction to Computer Graphics and Imaging	3-4
CS 149	Parallel Computing	3-4
CS 155	Computer and Network Security	3
CS 194W	Software Project (WIM/Design)	3
CS 221	Artificial Intelligence: Principles and Techniques	3-4
CS 223A	Introduction to Robotics	3
CS 224N	Natural Language Processing with Deep Learning	3-4
CS 225A	Experimental Robotics	3
CS 229	Machine Learning	3-4
CS 231A	Computer Vision: From 3D Reconstruction to Recognition	3-4
CS 231N	Convolutional Neural Networks for Visual Recognition	3-4
CS 241	Embedded Systems Workshop	3

CS 244	Advanced Topics in Networking	3-4
Information Systems and Science		
EE 102B	Signal Processing and Linear Systems II (Required)	4
EE 104	Introduction to Machine Learning	3-5
EE 107	Embedded Networked Systems	3
EE 118	Introduction to Mechatronics	4
EE 124	Introduction to Neuroelectrical Engineering	3
EE 133	Analog Communications Design Laboratory (WIM/Design)	3-4
EE 155	Green Electronics (WIM/Design)	4
EE 168	Introduction to Digital Image Processing (WIM/Design)	3-4
EE 169	Introduction to Bioimaging	3
EE 179	Analog and Digital Communication Systems	3
EE 260A	Principles of Robot Autonomy I	3-5
EE 260B	Principles of Robot Autonomy II	3-4
EE 261	The Fourier Transform and Its Applications	3
EE 262	Three-Dimensional Imaging (Design)	3
EE 263	Introduction to Linear Dynamical Systems	3
EE 264	Digital Signal Processing (Design)	3-4
EE 264W	Digital Signal Processing (WIM/Design)	5
EE 266	Introduction to Stochastic Control with Applications	3
EE 267	Virtual Reality (Design)	3-4
EE 267W	Virtual Reality (WIM/Design)	5
EE 269	Signal Processing for Machine Learning	3
EE 276	Information Theory	3
EE 278	Introduction to Statistical Signal Processing	3
EE 279	Introduction to Digital Communication	3
ENGR 105	Feedback Control Design	3
ENGR 205	Introduction to Control Design Techniques	3
CS 107	Computer Organization and Systems	3-5
CS 229	Machine Learning	3-4
Physical Technology and Science		
EE 101B	Circuits II (Required)	4
EE 107	Embedded Networked Systems	3
EE 114	Fundamentals of Analog Integrated Circuit Design	3-4
EE 116	Semiconductor Devices for Energy and Electronics	3
EE 118	Introduction to Mechatronics	4
EE 124	Introduction to Neuroelectrical Engineering	3
EE 133	Analog Communications Design Laboratory (WIM/Design)	3-4
EE 134	Introduction to Photonics (WIM/Design)	4
EE 142	Engineering Electromagnetics	3
EE 153	Power Electronics (WIM/Design)	3-4
EE 155	Green Electronics (WIM/Design)	4
EE 157	Electric Motors for Renewable Energy, Robotics, and Electric Vehicles	3
EE 212	Integrated Circuit Fabrication Processes	3
EE 214B	Advanced Integrated Circuit Design	3
EE 216	Principles and Models of Semiconductor Devices	3
EE 222	Applied Quantum Mechanics I	3
EE 223	Applied Quantum Mechanics II	3
EE 236A	Modern Optics	3
EE 236B	Guided Waves	3
EE 242	Electromagnetic Waves	3
EE 247	Introduction to Optical Fiber Communications	3
EE 264	Digital Signal Processing (Design)	3-4
EE 264W	Digital Signal Processing (WIM/Design)	5
EE 267	Virtual Reality (Design)	3-4
EE 267W	Virtual Reality (WIM/Design)	5
EE 271	Introduction to VLSI Systems	3
EE 272A	Design Projects in VLSI Systems I	3-4
EE 272B	Design Projects in VLSI Systems II	3-4
EE 273	Digital Systems Engineering	3
EE 282	Computer Systems Architecture	3
ENGR 105	Feedback Control Design	3
ENGR 205	Introduction to Control Design Techniques	3
CS 107	Computer Organization and Systems	3-5

Multidisciplinary Area Electives

Bio-electronics and Bio-imaging		
EE 101B	Circuits II	4
EE 102B	Signal Processing and Linear Systems II	4
EE 107	Embedded Networked Systems	3
EE 124	Introduction to Neuroelectrical Engineering	3
EE 134	Introduction to Photonics (WIM/Design)	4
EE 168	Introduction to Digital Image Processing (WIM/Design)	4
EE 169	Introduction to Bioimaging	3
EE 225	Biochips and Medical Imaging	3
EE 235	Analytical Methods in Biotechnology	3
BIOE 131	Ethics in Bioengineering	3
BIOE 248	Neuroengineering Laboratory	3
MED 275B	Biodesign Fundamentals	4
Energy and Environment		
EE 101B	Circuits II	4
EE 116	Semiconductor Devices for Energy and Electronics	3
EE 134	Introduction to Photonics (WIM/Design)	4
EE 153	Power Electronics (WIM/Design)	3-4
EE 155	Green Electronics (WIM/Design)	4
EE 157	Electric Motors for Renewable Energy, Robotics, and Electric Vehicles	3
EE 168	Introduction to Digital Image Processing (WIM/Design)	3-4
EE 180	Digital Systems Architecture	4
EE 263	Introduction to Linear Dynamical Systems	3
EE 293	Energy storage and conversion: Solar Cells, Fuel Cells, Batteries and Supercapacitors	3
EE 293B	Fundamentals of Energy Processes	3
CEE 107A	Understanding Energy (Formerly CEE 173A)	3-5
CEE 155	Introduction to Sensing Networks for CEE	3-4
CEE 176A	Energy Efficient Buildings	3
CEE 176B	100% Clean, Renewable Energy and Storage for Everything	3-4
ENGR 105	Feedback Control Design	3
ENGR 205	Introduction to Control Design Techniques	3

MATSCI 142	Quantum Mechanics of Nanoscale Materials (Formerly MATSCI 157)	4
MATSCI 152	Electronic Materials Engineering	4
MATSCI 156	Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution	3-4
ME 227	Vehicle Dynamics and Control	3
ME 271E		4
Music		
EE 102B	Signal Processing and Linear Systems II	4
EE 109	Digital Systems Design Lab (WIM/Design)	4
EE 264	Digital Signal Processing (Design)	3-4
EE 264W	Digital Signal Processing (WIM/Design)	5
MUSIC 250A	Physical Interaction Design for Music	3-4
MUSIC 256A	Music, Computing, Design: The Art of Design	3-4
MUSIC 256B	Music, Computing, Design II: Virtual and Augmented Reality for Music	3-4
MUSIC 257	Neuroplasticity and Musical Gaming	3-5
MUSIC 320A	Introduction to Audio Signal Processing Part I: Spectrum Analysis	3
MUSIC 320B	Introduction to Audio Signal Processing Part II: Digital Filters	3-4
MUSIC 420A	Signal Processing Models in Musical Acoustics [2]	3-4
MUSIC 421A	Time-Frequency Audio Signal Processing [2]	3-4
MUSIC 422	Perceptual Audio Coding [2]	3
MUSIC 424	Signal Processing Techniques for Digital Audio Effects [2]	3-4

[1] ENGR 108 may be used for disciplinary area if not used for EE Math.

[2] Best taken as a coterm student.

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu).

Honors Program in Electrical Engineering

The Department of Electrical Engineering offers a program leading to a Bachelor of Science in Electrical Engineering with Honors. This program offers a unique opportunity for qualified undergraduate majors to conduct independent study and research at an advanced level with a faculty mentor, graduate students, and fellow undergraduates.

Admission to the honors program is by application. Declared EE majors with a grade point average (GPA) of at least 3.5 in Electrical Engineering are eligible to submit an application. Applications must be submitted by Autumn Quarter of the senior year, be signed by the thesis advisor and second reader (one must be a member of the EE Faculty), and include an honors proposal. Students need to declare honors on Axess.

In order to receive departmental honors, students admitted to the honors program must:

1. Submit an application, including the thesis proposal, by Autumn Quarter of senior year signed by the thesis advisor and second reader (one must be a member of the Electrical Engineering faculty).
2. Declare the EE Honors major in Axess before the end of Autumn Quarter of senior year.
3. Maintain a grade point average of at least 3.5 in Electrical Engineering courses.
4. Complete at least 10 units of EE 191 or EE 191W with thesis adviser for a letter grade. EE 191 units do not count toward the required 60 units, with the exception of EE 191W if approved to satisfy WIM.
5. Submit one final copy of the honors thesis approved by the advisor and second reader to the EE Degree Progress Officer by May 15.
6. Attend poster and oral presentation held at the end of Spring Quarter or present in another suitable forum approved by the faculty advisor.

Electrical Engineering (EE) Minor

The options for completing a minor in EE are outlined below. Students must complete a minimum of 23-25 units, as follows:

		Units
Select one:		5
EE 42	Introduction to Electromagnetics and Its Applications	
EE 65	Modern Physics for Engineers	
ENGR 40A & ENGR 40B	Introductory Electronics and Introductory Electronics Part II	
ENGR 40M	An Intro to Making: What is EE	
Select one:		8
Option I:		
EE 101A	Circuits I	
EE 101B	Circuits II	
Option II:		
EE 102A	Signal Processing and Linear Systems I	
EE 102B	Signal Processing and Linear Systems II	
Option III:		
EE 102A	Signal Processing and Linear Systems I	
ENGR 108	Introduction to Matrix Methods	
Option IV:		
EE 108	Digital System Design	
EE 180	Digital Systems Architecture	
In addition, four letter-graded EE courses at the 100-level or higher must be taken (12 units minimum). CS 107 is required as a prerequisite for EE 180, but can count as one of the four classes.		12