ENGINEERING PHYSICS UNDERGRADUATE MAJOR

Engineering Physics (EPHYS)

Completion of the undergraduate program in Engineering Physics leads to the conferral of the Bachelor of Science in Engineering. The subplan “Engineering Physics” appears on the transcript and on the diploma.

Mission of the Undergraduate Program in Engineering Physics

The mission of the undergraduate program in Engineering Physics is to provide students with a strong foundation in physics and mathematics, together with engineering and problem-solving skills. All majors take high-level math and physics courses as well as engineering courses. This background prepares them to tackle complex problems in multidisciplinary areas that are at the forefront of 21st-century technology such as aerospace physics, biophysics, computational science, quantum science & engineering, materials science, nanotechnology, electromechanical systems, renewable energy, and any other engineering field that requires a solid background in physics. Because the program emphasizes science, mathematics, and engineering, students are well prepared to pursue graduate work in engineering, physics, or applied physics.

Requirements

Mathematics

Select one of the following sequences:

- **MATH 51 & MATH 52**: Linear Algebra, Multivariable Calculus, and Modern Applications and Integral Calculus of Several Variables
- **CME 100 & CME 104**: Vector Calculus for Engineers and Linear Algebra and Partial Differential Equations for Engineers
- **MATH 53**: Ordinary Differential Equations with Linear Algebra
- **or CME 102**: Ordinary Differential Equations for Engineers
- **MATH 131P**: Partial Differential Equations (or CME 204 or MATH 173 or MATH 220 or PHYSICS 111)

Science

- **PHYSICS 41**: Mechanics (or PHYSICS 61)
- **PHYSICS 42**: Classical Mechanics Laboratory (or PHYSICS 62)
- **PHYSICS 43**: Electricity and Magnetism (or PHYSICS 63)
- **PHYSICS 67**: Introduction to Laboratory Physics
- **PHYSICS 45**: Light and Heat (or PHYSICS 65)
- **PHYSICS 46**: Light and Heat Laboratory (or PHYSICS 67)
- **PHYSICS 70**: Foundations of Modern Physics (if taking the 40 series)

Technology in Society

One course required; course must be on the School of Engineering Approved List, Fig 4-3 in the UGHB, the year it is taken. See Basic Requirement 4.

Engineering Fundamentals

Two courses minimum (CS 106A or AX or X recommended)

Engineering Physics Depth (core)

Advanced Mathematics:

One advanced math elective such as

- EE 261: The Fourier Transform and Its Applications
- PHYSICS 112: Mathematical Methods for Physics

Electronics Lab

Select one of the following:

- **CS 109**: Introduction to Probability for Computer Scientists
- **CME 106**: Introduction to Probability and Statistics for Engineers

Also qualified are EE 263, any Math or Statistics course numbered 100 or above, and any CME course numbered 200 or above, except CME 206.

Advanced Mechanics:

- **3-4**
- **AA 242A**: Classical Dynamics (or ME 333 or PHYSICS 110)

Intermediate Electricity and Magnetism

- **6-8**

Select one of the following sequences:

- **PHYSICS 120 & PHYSICS 121**: Intermediate Electricity and Magnetism I and Intermediate Electricity and Magnetism II
- **EE 142 & EE 242**: Engineering Electromagnetics and Electromagnetic Waves

Numerical Methods

Select one of the following:

- **3-4**
- **CME 108**: Introduction to Scientific Computing
- **CME 206/ME 300C**: Introduction to Numerical Methods for Engineering
- **PHYSICS 113**: Computational Physics

Writing in the Major (WIM)

Select one of the following:

- **4-5**
- **AA 190**: Directed Research and Writing in Aero/Astro (for Aerospace specialty only)
- **ENGR 199W**: Writing of Original Research for Engineers (for students pursuing an independent research project)
- **BIOE 131**: Ethics in Bioengineering (for Biophysics specialty only)
- **CS 181W**: Computers, Ethics, and Public Policy (for Computational Science specialty or other specialty with prereqs)
- **CS 182W**: Ethics, Public Policy, and Technological Change (for Computational Science specialty or other specialty with prereqs)
- **EE 134**: Introduction to Photonics (for Photonics specialty only. Not offered 2019-20)
- **MATSCI 161**: Energy Materials Laboratory (for Materials Science and Renewable Energy specialties)
- **MATSCI 164**: Electronic and Photonic Materials and Devices Laboratory (for Materials Science and Renewable Energy specialties)
- **PHYSICS 107**: Intermediate Physics Laboratory II: Experimental Techniques and Data Analysis (for Quantum Science & Engineering or other specialty)

Quantum Mechanics

Select one of the following sequences:

- **6-8**

Stanford Bulletin 2019-20
Engineering Physics Undergraduate Major

EE 222 & EE 223
Applied Quantum Mechanics I and Applied Quantum Mechanics II

PHYSICS 130 & PHYSICS 131
Quantum Mechanics I and Quantum Mechanics II

Thermodynamics and Statistical Mechanics

PHYSICS 170 & PHYSICS 171
Thermodynamics, Kinetic Theory, and Statistical Mechanics I and Thermodynamics, Kinetic Theory, and Statistical Mechanics II

or ME 346A
Introduction to Statistical Mechanics

Design Course
Select one of the following:

3-4

AA 236A
Spacecraft Design

CS 108
Object-Oriented Systems Design

EE 133
Analog Communications Design Laboratory

ME 203
Design and Manufacturing

ME 210
Introduction to Mechatronics

PHYSICS 108
Advanced Physics Laboratory: Project

Specialty Tracks
See Undergraduate Engineering Handbook for important details.

Select three courses from one specialty area:

9-12

Aerospace Physics:

AA 203
Optimal and Learning-based Control

AA 244A
Introduction to Plasma Physics and Engineering

AA 251
Introduction to the Space Environment

AA 279A
Space Mechanics

ME 161
Dynamic Systems, Vibrations and Control

Biophysics:

APPPHYS 205
Introduction to Biophysics

BIO 132
Advanced Imaging Lab in Biophysics

BIOE 42
Physical Biology

BIOE 44
Fundamentals for Engineering Biology Lab

BIOE 101
Systems Biology

BIOE 103
Systems Physiology and Design

BIOE 123
Bioengineering Systems Prototyping Lab

BIOE 211
Biophysics of Multi-cellular Systems and Amorphous Computing

BIOE 214
Representations and Algorithms for Computational Molecular Biology

EE 169
or EE 369A
Introduction to Bioimaging

Medical Imaging Systems I

Computational Science:

CME 212
Advanced Software Development for Scientists and Engineers

CME 215A
Advanced Computational Fluid Dynamics

CME 215B
Advanced Computational Fluid Dynamics

Any CME course with course number greater than 300 and less than 390

Any CME course with course number greater than 300 and less than 390

CS 103
Mathematical Foundations of Computing

CS 154
Introduction to Automata and Complexity Theory

CS 161
Design and Analysis of Algorithms

CS 205L
Continuous Mathematical Methods with an Emphasis on Machine Learning

CS 221
Artificial Intelligence: Principles and Techniques

CS 228
Probabilistic Graphical Models: Principles and Techniques

CS 229
Machine Learning

STATS 202
Data Mining and Analysis

STATS 213
Electromechanical System Design:

ME 104
Mechanical Systems Design (formerly ME 112)

ME 80
Mechanics of Materials

ME 210
Introduction to Mechatronics

or EE 118
Introduction to Mechatronics

Materials Science:

Any MATSCI courses numbered 151 to 199 (except 159Q) or PHYSICS 172

Quantum Science & Engineering

APPPHYS 203
Atoms, Fields and Photons

APPPHYS 225
Probability and Quantum Mechanics

CS 254
Computational Complexity

CS 269Q
Elements of Quantum Computer Programming

EE 234
Photonics Laboratory

EE 236C
Lasers

EE 243
Semiconductor Optoelectronic Devices

EE 340
Optical Micro- and Nano-Cavities

PHYSICS 134
Advanced Topics in Quantum Mechanics

PHYSICS 182
Quantum Gases

PHYSICS 230
Graduate Quantum Mechanics I

PHYSICS 231
Graduate Quantum Mechanics II

Renewable Energy:

CEE 176B
100% Clean, Renewable Energy and Storage for Everything

EE 153
Power Electronics

EE 155
Green Electronics

EE 293B
Fundamentals of Energy Processes

MATSCI 156
Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution

MATSCI 302
Solar Cells

MATSCI 316
Nanoscale Science, Engineering, and Technology

ME 260
Fuel Cell Science and Technology

Total Units

93-119

1 PHYSICS 67 Introduction to Laboratory Physics (2 units), recommended in place of PHYSICS 44 Electricity and Magnetism Lab.

2 The Engineering Fundamental courses are to be selected from the Basic Requirements list. Fundamentals courses acceptable for the core program may also be used to satisfy the fundamentals requirement as long as 45 unduplicated units of Engineering are taken.

3 Although not required, PHYSICS 59 (https://explorecourses.stanford.edu/search?view=catalog&filter-coursestatus-Active=on&page=0&catalog=&academicYear=&q=physics59&collapse=) (Frontiers in Physics Research, 1 unit) and PHYSICS 91SI (https://explorecourses.stanford.edu/search?view=catalog&filter-coursestatus-Active=on&page=0&catalog=&academicYear=&q=physics91si&collapse=) (Practical Computing for Scientists, 2 units) are highly recommended.
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.

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

Honors Program

The School of Engineering offers a program leading to a Bachelor of Science in Engineering: Engineering Physics with Honors.

Honors Criteria

1. Minimum overall GPA of 3.5.
2. Independent research conducted at an advanced level with a faculty research adviser and documented in an honors thesis. The honors candidate must identify a faculty member who will serve as his or her honors research adviser and a second reader who will be asked to read the thesis and give feedback before endorsing the thesis. One of the two must be a member of the Academic Council and in the School of Engineering.

Application: The deadline to apply is November 1 in Autumn Quarter of the senior year. The application documents should be submitted to the Student Services Officer. Applications are reviewed by a subcommittee of the faculty advisers for Engineering Physics majors. Applicants and thesis advisers receive written notification when the application is approved. An application consists of three items:

1. One-page description of the research topic
2. The Honors Application form is available on Engineering Physics (https://ughb.stanford.edu/majors-minors/major-programs/engineering-physics-program) page of the Undergraduate handbook. It must be signed by honors thesis adviser.
3. Unofficial Stanford transcript

Requirements and Timeline for Honors in Engineering Physics:

1. Declare the honors program in Axess (ENGR-BSH, Subplan: Engineering Physics)
2. Obtain application form from the student services officer.
3. Apply to honors program by November 1 in the Autumn Quarter of the senior year.
4. Maintain an overall GPA of at least 3.5.
5. Optional: Under direction of the thesis adviser, students may enroll for research units in ENGR 199W Writing of Original Research for Engineers or in departmental courses such as AA 190 Directed Research and Writing in Aero/Astro or ME 191H Honors Research.
6. Submit a completed thesis draft to the research adviser and second reader by April 15.
7. Present the thesis work in an oral presentation or poster session in an appropriate forum (e.g., an event that showcases undergraduate research and is organized by the department of the adviser, the school of the adviser, or the University).
8. Incorporate feedback, which the adviser and second reader should provide by April 30, and obtain final endorsement signatures from the thesis adviser and second reader by May 15.
9. Submit a pdf of the thesis, including the signature page signed by both readers, to the student services officer by May 15. Students are sent email instructions on how to archive a permanent electronic copy in Terman Engineering library.