# 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

<table>
<thead>
<tr>
<th>Select one of the following sequences:</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 51 &amp; MATH 52</td>
<td>Linear Algebra, Multivariable Calculus, and Modern Applications and Integral Calculus of Several Variables</td>
</tr>
<tr>
<td>CME 100 &amp; CME 104</td>
<td>Vector Calculus for Engineers and Linear Algebra and Partial Differential Equations for Engineers</td>
</tr>
<tr>
<td>MATH 53</td>
<td>Ordinary Differential Equations with Linear Algebra</td>
</tr>
<tr>
<td>or CME 102</td>
<td>Ordinary Differential Equations for Engineers</td>
</tr>
<tr>
<td>MATH 131P</td>
<td>Partial Differential Equations (or MATH 173 or MATH 220 or PHYSICS 111)</td>
</tr>
</tbody>
</table>

### Science

| PHYSICS 41 | Mechanics (or PHYSICS 61) | 4 |
| PHYSICS 42 | Classical Mechanics Laboratory (or PHYSICS 62) | 1 |
| PHYSICS 43 | Electricity and Magnetism (or PHYSICS 63) | 4 |
| PHYSICS 67 | Introduction to Laboratory Physics | 2 |
| PHYSICS 45 | Light and Heat (or PHYSICS 65) | 4 |
| PHYSICS 46 | Light and Heat Laboratory (or PHYSICS 67) | 1 |
| PHYSICS 70 | Foundations of Modern Physics (if taking the 40 series) | 4 |

### 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:

<table>
<thead>
<tr>
<th>One advanced math elective such as</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE 261</td>
<td>The Fourier Transform and Its Applications</td>
</tr>
<tr>
<td>PHYSICS 112</td>
<td>Mathematical Methods for Physics</td>
</tr>
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## Electronics Lab

<table>
<thead>
<tr>
<th>Select one of the following:</th>
<th>Units</th>
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<tbody>
<tr>
<td>ENGR 40A &amp; ENGR 40B</td>
<td>Introductory Electronics and Introductory Electronics Part II (ENGR 40A alone is not allowed)</td>
</tr>
<tr>
<td>EE 101B</td>
<td>Circuits II</td>
</tr>
<tr>
<td>PHYSICS 105</td>
<td>Intermediate Physics Laboratory I: Analog Electronics</td>
</tr>
<tr>
<td>APPPHYS 207</td>
<td>Laboratory Electronics</td>
</tr>
</tbody>
</table>

## Writing in the Major (WIM)

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

## Quantum Mechanics

Select one of the following sequences: |

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**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 3-8

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:

**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

**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**

- **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**
  Introduction to Graphical Models

**Electromechanical System Design:**

- **ME 104**
  Mechanical Systems Design (formerly ME 112)

- **ME 80**
  Mechanics of Materials

- **ME 210**
  Introduction to Mechatronics

- **ME 346**
  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

- **EE 169**
  Introduction to Bioimaging

- **or EE 369A**
  Medical Imaging Systems I

**Total Units** 93-119

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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 3 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.