# 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, energy 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>Sequence</th>
<th>Description</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>
<td>10</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>
<td>5</td>
</tr>
<tr>
<td>MATH 53</td>
<td>Ordinary Differential Equations with Linear Algebra</td>
<td>5</td>
</tr>
<tr>
<td>or CME 102</td>
<td>Ordinary Differential Equations for Engineers</td>
<td>3</td>
</tr>
<tr>
<td>MATH 131P</td>
<td>Partial Differential Equations (or MATH 173 or MATH 220 or PHYSICS 111)</td>
<td>3</td>
</tr>
</tbody>
</table>

### Science

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>PHYSICS 41</td>
<td>Mechanics (or PHYSICS 61)</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 42</td>
<td>Classical Mechanics Laboratory (or PHYSICS 62)</td>
<td>1</td>
</tr>
<tr>
<td>PHYSICS 43</td>
<td>Electricity and Magnetism (or PHYSICS 63)</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 67</td>
<td>Introduction to Laboratory Physics</td>
<td>2</td>
</tr>
<tr>
<td>PHYSICS 45</td>
<td>Light and Heat (or PHYSICS 65)</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 46</td>
<td>Light and Heat Laboratory (or PHYSICS 67)</td>
<td>1</td>
</tr>
<tr>
<td>PHYSICS 70</td>
<td>Foundations of Modern Physics (if taking the 40 series)</td>
<td>4</td>
</tr>
</tbody>
</table>

### Technology in Society

One course required; 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 X recommended) | 6-10 |

### Engineering Physics Depth (core)

**Advanced Mathematics:**

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE 261</td>
<td>The Fourier Transform and Its Applications</td>
<td>3-5</td>
</tr>
<tr>
<td>PHYSICS 112</td>
<td>Mathematical Methods for Physics</td>
<td>3-5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CME 106</td>
<td>Introduction to Probability and Statistics for Engineers</td>
<td>3-4</td>
</tr>
<tr>
<td>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.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Advanced Mechanics:**

- **CS 109** | Introduction to Probability for Computer Scientists | 3-4 |
- **CME 106** | Introduction to Probability and Statistics for Engineers | 3-4 |

**Intermediate Electricity and Magnetism:**

- **PHYSICS 120 & PHYSICS 121** | Intermediate Electricity and Magnetism I and Intermediate Electricity and Magnetism II | 6-8 |
- **EE 142 & EE 242** | Engineering Electromagnetics and Electromagnetic Waves | 6-8 |

**Numerical Methods**

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHPS 215</td>
<td>Numerical Methods for Physicists and Engineers</td>
<td>3-4</td>
</tr>
<tr>
<td>CME 108</td>
<td>Introduction to Scientific Computing</td>
<td>3-4</td>
</tr>
<tr>
<td>CME 206/ME 300C</td>
<td>Introduction to Numerical Methods for Engineering</td>
<td>3-4</td>
</tr>
<tr>
<td>PHYSICS 113</td>
<td>Computational Physics</td>
<td>3-4</td>
</tr>
</tbody>
</table>

**Electronics Lab**

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 40A &amp; ENGR 40B</td>
<td>Introductory Electronics and Introductory Electronics Part II (ENGR 40A alone is not allowed)</td>
<td>3-5</td>
</tr>
<tr>
<td>EE 101B</td>
<td>Circuits II</td>
<td>3-5</td>
</tr>
<tr>
<td>EE 122A</td>
<td>Circuits III</td>
<td>3-5</td>
</tr>
<tr>
<td>PHYSICS 105</td>
<td>Intermediate Physics Laboratory I: Analog Electronics</td>
<td>3-5</td>
</tr>
<tr>
<td>APPPHYS 207</td>
<td>Laboratory Electronics</td>
<td>3-5</td>
</tr>
</tbody>
</table>

**Writing in the Major (WIM)**

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<thead>
<tr>
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<th>Description</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>
<td>4-5</td>
</tr>
<tr>
<td>ENGR 199W</td>
<td>Writing of Original Research for Engineers (for students pursuing an independent research project)</td>
<td>4-5</td>
</tr>
<tr>
<td>BIOE 131</td>
<td>Ethics in Biotechnology (for Biophysics specialty only)</td>
<td>4-5</td>
</tr>
<tr>
<td>CS 181W</td>
<td>Computers, Ethics, and Public Policy (for Computational Science specialty only)</td>
<td>4-5</td>
</tr>
<tr>
<td>EE 134</td>
<td>Introduction to Photonics (for Photonics specialty only)</td>
<td>4-5</td>
</tr>
<tr>
<td>EE 155</td>
<td>Green Electronics (for Renewable Energy specialty only)</td>
<td>4-5</td>
</tr>
<tr>
<td>ME 112</td>
<td>Mechanical Systems Design (for Electromechanical System Design specialty only)</td>
<td>4-5</td>
</tr>
<tr>
<td>ME 131A &amp; ME 140</td>
<td>Heat Transfer and Advanced Thermal Systems (for Energy Systems specialty only)</td>
<td>4-5</td>
</tr>
<tr>
<td>MATSCI 161</td>
<td>Energy Materials Laboratory (Okay for Materials Science and Renewable Energy specialties)</td>
<td>4-5</td>
</tr>
</tbody>
</table>
MATSCI 164  Electronic and Photonic Materials and Devices Laboratory (Okay for Materials Science and Renewable Energy specialties)

PHYSICS 107  Intermediate Physics Laboratory II: Experimental Techniques and Data Analysis (for Photonics or other specialty)

Quantum Mechanics
Select one of the following sequences: 6-8
EE 222  Applied Quantum Mechanics I
& EE 223  and Applied Quantum Mechanics II
PHYSICS 130  Quantum Mechanics I
& PHYSICS 131  and Quantum Mechanics II

Thermodynamics and Statistical Mechanics
PHYSICS 170  Thermodynamics, Kinetic Theory, and Statistical Mechanics I
& PHYSICS 171  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:
Aerospace Physics:
AA 203  Introduction to Optimal Control and Dynamic Optimization
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

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

Electromechanical System Design:
ME 80  Mechanics of Materials
ME 112  Mechanical Systems Design
ME 210  or EE 118  Introduction to Mechatronics

Energy Systems:
ME 131A  Heat Transfer
ME 131B  Fluid Mechanics: Compressible Flow and Turbomachinery
ME 140  Advanced Thermal Systems

Renewable Energy:
CEE 176B  100% Clean, Renewable Energy and Storage for Everything
EE 153  Power Electronics
EE 155  Green Electronics
EE 293A
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

Biophysics:
APPPHYS 205  Introduction to Biophysics
BIO 132  Advanced Imaging Lab in Biophysics
BIOE 41
BIOE 42  Physical Imaging
BIOE 44  Fundamentals for Engineering Biology Lab
BIOE 101  Systems Biology
BIOE 103  Systems Physiology and Design
BIOE 123  Biomedical System Prototyping Lab
BIOE 211  Biophysics of Multi-cellular Systems and Amorphous Computing
BIOE 214  Representations and Algorithms for Computational Molecular Biology

EE 169  Introduction to Bioimaging
or EE 369A  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
CS 103  Mathematical Foundations of Computing
CS 154  Introduction to Automata and Complexity Theory
CS 161  Design and Analysis of Algorithms
CS 205A
CS 205B
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

Quantum Science & Engineering
APPPHYS 203  Atoms, Fields and Photons
APPPHYS 225  Probability and Quantum Mechanics
APPPHYS 383
CS 254  Computational Complexity
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 230  Graduate Quantum Mechanics I
PHYSICS 231  Graduate Quantum Mechanics II
PHYSICS 282  Introduction to Modern Atomic Physics and Quantum Optics

Total Units 93-119

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

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 October 15 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
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 October 15 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 199(W) or in departmental courses such as AA 190 or ME 191(H).
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 one signed, single-sided copy 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.