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

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td><strong>Mathematics</strong></td>
<td></td>
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<tr>
<td>Select one of the following sequences:</td>
<td>10</td>
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<tr>
<td>MATH 51 &amp; MATH 52 Linear Algebra, Multivariable Calculus, and Modern Applications and Integral Calculus of Several Variables</td>
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<tr>
<td>CME 100 &amp; CME 104 Vector Calculus for Engineers and Linear Algebra and Partial Differential Equations for Engineers</td>
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<tr>
<td>MATH 53 Ordinary Differential Equations with Linear Algebra</td>
<td>5</td>
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<tr>
<td>or CME 102 Ordinary Differential Equations for Engineers</td>
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<tr>
<td>MATH 131P Partial Differential Equations (or MATH 173 or MATH 220 or PHYSICS 111)</td>
<td>3</td>
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<tr>
<td><strong>Science</strong></td>
<td></td>
</tr>
<tr>
<td>PHYSICS 41 Mechanics (or PHYSICS 61)</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 42 Classical Mechanics Laboratory (or PHYSICS 62)</td>
<td>1</td>
</tr>
<tr>
<td>PHYSICS 43 Electricity and Magnetism (or PHYSICS 63)</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 67 Introduction to Laboratory Physics 1</td>
<td>2</td>
</tr>
<tr>
<td>PHYSICS 45 Light and Heat (or PHYSICS 65)</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 46 Light and Heat Laboratory (or PHYSICS 67)</td>
<td>1</td>
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<tr>
<td>PHYSICS 70 Foundations of Modern Physics (if taking the 40 series)</td>
<td>4</td>
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<tr>
<td><strong>Technology in Society</strong></td>
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<tr>
<td>One course required; course must be on the School of Engineering Approved List, Fig 4-3 in the UGB, the year it is taken. See Basic Requirement 4.</td>
<td>3-5</td>
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<tr>
<td><strong>Engineering Fundamentals</strong></td>
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<tr>
<td>Two courses minimum (CS 106A or X recommended)</td>
<td>6-10</td>
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<tr>
<td><strong>Engineering Physics Depth (core)</strong></td>
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<tr>
<td>Advanced Mathematics:</td>
<td></td>
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<tr>
<td>One advanced math elective such as</td>
<td>3-5</td>
</tr>
<tr>
<td>EE 261 The Fourier Transform and Its Applications</td>
<td></td>
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<tr>
<td>PHYSICS 112 Mathematical Methods for Physics</td>
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</table>

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) 3

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

APPPHYS 215 Numerical Methods for Physicists and Engineers
CME 108 Introduction to Scientific Computing
CME 206/ME 300C Introduction to Numerical Methods for Engineering
PHYSICS 113 Computational Physics

Electronics Lab

Select one of the following: 3-5

ENGR 40A & ENGR 40B Introductory Electronics and Introductory Electronics Part II (ENGR 40A alone is not allowed)
EE 101B Circuits II
EE 122A
PHYSICS 105 Intermediate Physics Laboratory I: Analog Electronics
APPPHYS 207 Laboratory Electronics

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 only)
EE 134 Introduction to Photonics (for Photonics specialty only)
EE 155 Green Electronics (for Renewable Energy specialty only)
ME 112 Mechanical Systems Design (for Electromechanical System Design specialty only)
ME 131A & ME 140 Heat Transfer and Advanced Thermal Systems (for Energy Systems specialty only)
MATSCI 161 Energy Materials Laboratory (Okay for Materials Science and Renewable Energy specialties)
### 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 & 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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICS 170 &amp; PHYSICS 171</td>
<td>Thermodynamics, Kinetic Theory, and Statistical Mechanics I and Thermodynamics, Kinetic Theory, and Statistical Mechanics II</td>
</tr>
<tr>
<td>or ME 346A</td>
<td>Introduction to Statistical Mechanics</td>
</tr>
</tbody>
</table>

### 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**
  - 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

<table>
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<tbody>
<tr>
<td><strong>MATSCI 302</strong></td>
<td>Solar Cells</td>
</tr>
<tr>
<td><strong>MATSCI 316</strong></td>
<td>Nanoscale Science, Engineering, and Technology</td>
</tr>
<tr>
<td><strong>ME 260</strong></td>
<td>Fuel Cell Science and Technology</td>
</tr>
</tbody>
</table>

**Biophysics:**
- **APPPHYS 205**
  - Introduction to Biophysics
- **BIO 132**
  - Advanced Imaging Lab in Biophysics
- **BIOE 41**
- **BIOE 42**
  - Physical Imaging Lab
- **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

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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 thesis 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.