ENGINEERING PHYSICS
UNDERGRADUATE MAJOR

COVID-19-Related Degree Requirement Changes
The Engineering Physics program counts all courses taken in academic year 2020-21 with a grade of 'CR' (credit) or 'S' (satisfactory) towards satisfaction of undergraduate degree requirements that otherwise require a letter grade.

Students who take Physics 61 and 63 in the Fall and Winter quarters may take either Physics 65 in Summer 2021 or EE 65 in Spring 2021 to complete the requirement of an introductory physics sequence for the Engineering Physics 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:

<table>
<thead>
<tr>
<th>Units</th>
<th>Mathematics Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>MATH 51 &amp; MATH 52</td>
</tr>
<tr>
<td></td>
<td>Linear Algebra, Multivariable Calculus, and Modern Applications and Integral Calculus of Several Variables</td>
</tr>
<tr>
<td></td>
<td>CME 100 &amp; CME 104</td>
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<tr>
<td></td>
<td>Vector Calculus for Engineers and Linear Algebra and Partial Differential Equations for Engineers</td>
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<tr>
<td>5</td>
<td>MATH 53 or CME 102</td>
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<tr>
<td></td>
<td>Ordinary Differential Equations with Linear Algebra or Ordinary Differential Equations for Engineers</td>
</tr>
<tr>
<td>3</td>
<td>MATH 131P</td>
</tr>
<tr>
<td></td>
<td>Partial Differential Equations (or CME 204 or MATH 173 or MATH 220 or PHYSICS 111)</td>
</tr>
</tbody>
</table>

Science

<table>
<thead>
<tr>
<th>Units</th>
<th>Science Courses</th>
</tr>
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<tbody>
<tr>
<td>4</td>
<td>PHYSICS 41</td>
</tr>
<tr>
<td></td>
<td>Mechanics (or PHYSICS 61)</td>
</tr>
<tr>
<td>1</td>
<td>PHYSICS 42</td>
</tr>
<tr>
<td></td>
<td>Classical Mechanics Laboratory (or PHYSICS 62)</td>
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<tr>
<td>4</td>
<td>PHYSICS 43</td>
</tr>
<tr>
<td></td>
<td>Electricity and Magnetism (or PHYSICS 63)</td>
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<tr>
<td>2</td>
<td>PHYSICS 67</td>
</tr>
<tr>
<td></td>
<td>Introduction to Laboratory Physics</td>
</tr>
<tr>
<td>4</td>
<td>PHYSICS 45</td>
</tr>
<tr>
<td></td>
<td>Light and Heat (or PHYSICS 65 or EE 65 in 2020-21)</td>
</tr>
<tr>
<td>1</td>
<td>PHYSICS 46</td>
</tr>
<tr>
<td></td>
<td>Light and Heat Laboratory (or PHYSICS 67)</td>
</tr>
</tbody>
</table>

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 B recommended; PHYSICS 105 allowed) 2

Engineering Physics Depth (core)
Advanced Mathematics:
One advanced math elective such as

<table>
<thead>
<tr>
<th>Units</th>
<th>Advanced Mathematics Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-5</td>
<td>EE 261 The Fourier Transform and Its Applications</td>
</tr>
<tr>
<td></td>
<td>PHYSICS 112 Mathematical Methods for Physics</td>
</tr>
<tr>
<td></td>
<td>CS 109 Introduction to Probability for Computer Scientists</td>
</tr>
<tr>
<td></td>
<td>CME 106 Introduction to Probability and Statistics for Engineers</td>
</tr>
</tbody>
</table>

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.

Intermediate Electricity and Magnetism
6-8
Select one of the following sequences:

<table>
<thead>
<tr>
<th>Units</th>
<th>Intermediate Electricity and Magnetism Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-4</td>
<td>PHYSICS 120 &amp; PHYSICS 121 Intermediate Electricity and Magnetism I and Intermediate Electricity and Magnetism II</td>
</tr>
<tr>
<td></td>
<td>EE 142 Engineering Electromagnetics and Electromagnetic Waves</td>
</tr>
</tbody>
</table>

Numerical Methods
Select one of the following:

<table>
<thead>
<tr>
<th>Units</th>
<th>Numerical Methods Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-4</td>
<td>CME 108 Introduction to Scientific Computing</td>
</tr>
<tr>
<td></td>
<td>CME 206/ME 300C Introduction to Numerical Methods for Engineering</td>
</tr>
<tr>
<td></td>
<td>PHYSICS 113 Computational Physics</td>
</tr>
</tbody>
</table>

Electronics Lab
Select one of the following:

<table>
<thead>
<tr>
<th>Units</th>
<th>Electronics Lab Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-5</td>
<td>EE 101A Circuits I</td>
</tr>
<tr>
<td></td>
<td>EE 101B Circuits II</td>
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<tr>
<td></td>
<td>ENGR 40M An Intro to Making: What is EE (or ENGR 40A+ENGR 40B; must take both [not offered 2019-20])</td>
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<tr>
<td></td>
<td>PHYSICS 104 Electronics and Introduction to Experimental Methods (2020-21 only)</td>
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<tr>
<td></td>
<td>PHYSICS 105 Intermediate Physics Laboratory I: Analog Electronics</td>
</tr>
<tr>
<td></td>
<td>APPPHYS 207 Laboratory Electronics</td>
</tr>
</tbody>
</table>

Writing in the Major (WIM)
Select one of the following:

<table>
<thead>
<tr>
<th>Units</th>
<th>Writing in the Major (WIM) Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-5</td>
<td>AA 190 Directed Research and Writing in Aero/Astro (for Aerospace specialty only)</td>
</tr>
<tr>
<td></td>
<td>ENGR 102W Technical and Professional Communication</td>
</tr>
<tr>
<td></td>
<td>ENGR 199W Writing of Original Research for Engineers (for students pursuing an independent research project)</td>
</tr>
<tr>
<td></td>
<td>BIOE 131 Ethics in Bioengineering (for Biophysics specialty only)</td>
</tr>
</tbody>
</table>
CS 181W  Computers, Ethics, and Public Policy (for Computational Science specialty or other specialty with prereq)
CS 182W  Ethics, Public Policy, and Technological Change (for Computational Science specialty or other specialty with prereq)
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 (if taken 2019-20 or earlier)

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

PHYSICS 170 & PHYSICS 171  Thermodynamics, Kinetic Theory, and Statistical Mechanics I and Thermodynamics, Kinetic Theory, and Statistical Mechanics II (or MATSCI 310 or ME 346A; may not be offered every year)

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 103  Product Realization: Design and Making
ME 210  Introduction to Mechatronics
PHYSICS 108  Advanced Physics Laboratory: Project

Specialty Tracks
See Undergraduate Engineering Handbook for important details. 9-12
Select three courses from one specialty area:

Aerospace Physics:
AA 203  Optimal and Learning-based Control
AA 205  Rarefied and Ionized Gases
AA 244A  Introduction to Plasma Physics and Engineering
AA 244B  Advanced 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 153  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

BIOE 221  Physics and Engineering of Radionuclide-based Medical Imaging
EE 169 or EE 369A  Introduction to Bioimaging

Computational Science:
CME 212  Advanced Software Development for Scientists and Engineers
CME 215A
CME 215B
Any CME course with course number greater than 300 and less than 390
CS 103  Mathematical Foundations of Computing
CS 154  Introduction to the Theory of Computation
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

Electromechanical System Design:
Take two of
ME 80  Mechanics of Materials
ME 104  Mechanical Systems Design (prereqs of ME 80, ME 102, & ME 103)
CS 223A  Introduction to Robotics

Take either
ME 210  Introduction to Mechatronics
or EE 118  Introduction to Mechatronics
ENGR 240  Introduction to Micro and Nano Electromechanical Systems (2020-21 only)

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

Quantum Science & Engineering (See UGHB for further important details.)

APPPHYS 203  Atoms, Fields and Photons
APPPHYS 225  Probability and Quantum Mechanics
APPPHYS 228  Quantum Hardware
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 106  Experimental Methods in Quantum Physics
PHYSICS 134  Advanced Topics in Quantum Mechanics
PHYSICS 182  Quantum Gases
PHYSICS 230  Graduate Quantum Mechanics I
PHYSICS 231  Graduate Quantum Mechanics II
STATS 376A  Information Theory

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

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