ENGINEERING SCIENCE, B.S.

Begin Campus: Any Penn State Campus
End Campus: University Park

Program Description

Engineering Science is a multidisciplinary honors program that emphasizes enhanced understanding and integrated application of engineering, scientific, and mathematical principles. The program is unique because it provides a broad foundation in the sciences and associated mathematics that underlie engineering and provides students the opportunity to obtain a depth of knowledge in an area of their choosing through technical electives and a senior thesis. The curriculum is designed for students who seek to link the engineering disciplines with science. In addition to taking core courses in mathematics, physics and chemistry - (and biology for students in premedicine), students study thermodynamics, heat transfer, electromagnetics, solid and fluid mechanics, electrical devices, materials science, and topics selected as foundational and technical electives. During the junior year, students investigate a variety of research fields and identify a topic for their honor thesis research and design project. During the senior year, all students complete a capstone project on their chosen topic by writing a thesis that applies the scientific principles of research, design and analysis to engineering. Focus areas of study include, but are not limited to: electrical, mechanical, civil, biomedical, and materials engineering and are expected to be interdisciplinary. Hence, Engineering Science students achieve both depth and breadth in engineering and science, are able to function across disciplines, and graduate well prepared for advanced studies as well as professional employment.

The specific program objectives are tied to the mission of the program as described above. They target the major outcomes expected of Engineering Science students and are flexible and readily adaptable to meet changing constituent needs.

Enrollment is limited to students who have demonstrated that they can benefit from the advanced courses of the curriculum; therefore a minimum grade-point average of 3.0 is required. Qualified students can participate in the integrated undergraduate graduate (IUG) program to streamline the process of earning B.S. and M.S. degrees.

What is Engineering Science?

Engineering science is a broad discipline that encompasses many different scientific principles and associated mathematics that underlie engineering. It integrates engineering, biological, chemical, mathematical, and physical sciences with the arts, humanities, social sciences, and the professions to tackle the most demanding challenges and advance the well-being of global society. The unique knowledge and interdisciplinary skill set of engineering scientists allows them to merge multidisciplinary resources to propose and develop innovative, enduring solutions and transform the latest scientific discoveries into enabling new technologies. Engineering scientists research, develop, and design new materials, devices, sensors, and processes for a diverse range of applications.

You Might Like This Program If...

• You are interested in merging multidisciplinary resources to propose and develop innovative, enduring solutions and transforming the latest scientific discoveries into enabling new technologies.
• You’re seeking to link science with the engineering disciplines such as electrical, mechanical, chemical, civil, and biomedical.

Entrance to Major

In addition to the minimum grade-point average (GPA) requirements described in the University Policies, all College of Engineering entrance-to-major course requirements must also be completed with a minimum grade of C: CHEM 110, MATH 140, MATH 141, MATH 250 or MATH 251, PHYS 211, and PHYS 212. All of these courses must be completed by the end of the semester during which the admission to major process is carried out.

1 Since Engineering Science is an honors program, admission is limited to students who attain a cumulative GPA of at least 3.0 by the end of the entrance-to-major semester. In the event that the major is under enrollment control, a higher minimum cumulative grade-point average is likely to be needed and students must be enrolled in the College of Engineering or Division of Undergraduate Studies at the time of confirming their major choice.

Degree Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Education</td>
<td>45</td>
</tr>
<tr>
<td>Requirements for the Major</td>
<td>113</td>
</tr>
</tbody>
</table>

For the non-Honors B.S. degree in Engineering Science, 131 credits and a 2.50 grade-point average are required. The Honors degree requires the same number of total credits but a minimum of 16 honors Jr./Sr. year credits and a higher grade-point average as determined by the faculty.

General Education

Connecting career and curiosity, the General Education curriculum provides the opportunity for students to acquire transferable skills necessary to be successful in the future and to thrive while living in interconnected contexts. General Education aids students in developing intellectual curiosity, a strengthened ability to think, and a deeper sense of aesthetic appreciation. These are requirements for all baccalaureate students and are often partially incorporated into the requirements of a program. For additional information, see the General Education Requirements (http://bulletins.psu.edu/undergraduate/general-education/baccalaureate-degree-general-education-program) section of the Bulletin and consult your academic adviser.

The keystone symbol appears next to the title of any course that is designated as a General Education course. Program requirements may also satisfy General Education requirements and vary for each program.

Foundations (grade of C or better is required.)

• Quantification (GQ): 6 credits
• Writing and Speaking (GWS): 9 credits

Knowledge Domains

• Arts (GA): 6 credits
• Health and Wellness (GHW): 3 credits
• Humanities (GH): 6 credits
Engineering Science, B.S.

- Social and Behavioral Sciences (GS): 6 credits
- Natural Sciences (GN): 9 credits

Integrative Studies (may also complete a Knowledge Domain requirement)
- Inter-Domain or Approved Linked Courses: 6 credits

27 of these 45 credits are included in the Requirements for the Major.

University Degree Requirements

First Year Engagement
All students enrolled in a college or the Division of Undergraduate Studies at University Park, and the World Campus are required to take 1 to 3 credits of the First-Year Seminar, as specified by their college First-Year Engagement Plan.

Other Penn State colleges and campuses may require the First-Year Seminar; colleges and campuses that do not require a First-Year Seminar provide students with a first-year engagement experience.

First-year baccalaureate students entering Penn State should consult their academic adviser for these requirements.

Cultures Requirement
6 credits are required and may satisfy other requirements
- United States Cultures: 3 credits
- International Cultures: 3 credits

Writing Across the Curriculum
3 credits required from the college of graduation and likely prescribed as part of major requirements.

Total Minimum Credits
A minimum of 120 degree credits must be earned for a baccalaureate degree. The requirements for some programs may exceed 120 credits. Students should consult with their college or department adviser for information on specific credit requirements.

Quality of Work
Candidates must complete the degree requirements for their major and earn at least a 2.00 grade-point average for all courses completed within their degree program.

Limitations on Source and Time for Credit Acquisition
The college dean or campus chancellor and program faculty may require up to 24 credits of course work in the major to be taken at the location or in the college or program where the degree is earned. Credit used toward degree programs may need to be earned from a particular source or within time constraints (see Senate Policy 83-80 (http://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#82-44)). For more information, check the Suggested Academic Plan for your intended program.

Requirements for the Major
This includes 27 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses.

To graduate, a student enrolled in the major must earn a grade of C or better in each course designated by the major as a C-required course, as specified by Senate Policy 82-44 (http://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#82-44).

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 111</td>
<td>Experimental Chemistry I</td>
<td>1</td>
</tr>
<tr>
<td>EDSGN 100</td>
<td>Introduction to Engineering Design</td>
<td>3</td>
</tr>
<tr>
<td>MATH 220</td>
<td>Matrices</td>
<td>2-3</td>
</tr>
<tr>
<td>MATH 230</td>
<td>Calculus and Vector Analysis</td>
<td>4</td>
</tr>
<tr>
<td>ME 302</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>PHYS 214</td>
<td>General Physics: Wave Motion and Quantum Physics</td>
<td>2</td>
</tr>
<tr>
<td>EE 210</td>
<td>Circuits and Devices</td>
<td>4</td>
</tr>
<tr>
<td>ESC 312</td>
<td>Engineering Applications of Wave, Particle, and Ensemble Concepts</td>
<td>3</td>
</tr>
<tr>
<td>ESC 409</td>
<td>Senior Research and Design Project Preparation, Honors</td>
<td>1</td>
</tr>
<tr>
<td>ESC 433</td>
<td>Engineering Science Research Laboratory Experience</td>
<td>1</td>
</tr>
<tr>
<td>ESC 410</td>
<td>Senior Research and Design Project I, Honors</td>
<td>3</td>
</tr>
<tr>
<td>ESC 411</td>
<td>Senior Research and Design Project II, Honors</td>
<td>2</td>
</tr>
<tr>
<td>ENGL 202C</td>
<td>Effective Writing: Technical Writing</td>
<td>3</td>
</tr>
</tbody>
</table>

Prescribed Courses: Require a grade of C or better

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 110</td>
<td>Chemical Principles I</td>
<td>3</td>
</tr>
<tr>
<td>MATH 140</td>
<td>Calculus With Analytic Geometry I</td>
<td>4</td>
</tr>
<tr>
<td>MATH 141</td>
<td>Calculus with Analytic Geometry II</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 211</td>
<td>General Physics: Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>MATH 251</td>
<td>Ordinary and Partial Differential Equations</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 212</td>
<td>General Physics: Electricity and Magnetism</td>
<td>4</td>
</tr>
<tr>
<td>ESC 407</td>
<td>Computer Methods in Engineering Science, Honors</td>
<td>3</td>
</tr>
<tr>
<td>ESC 414</td>
<td>Elements of Material Engineering</td>
<td>3</td>
</tr>
<tr>
<td>ESC 404</td>
<td>Analysis in Engineering Science</td>
<td>3</td>
</tr>
</tbody>
</table>

Additional Courses
Select 1 credit of First-Year Seminar
Choose one of the following:
- ESC 261 Computational Methods in Engineering
- CMPSC 201 Programming for Engineers with C++
- CMPSC 202

Select 1 credit of First-Year Seminar
Choose one of the following:
- ECON 102 Introductory Microeconomic Analysis and Policy
- ECON 104 Introductory Macroeconomic Analysis and Policy
- ECON 14 Principles of Economics

Choose one of the following:
- CAS 100A Effective Speech
- or CAS 100B Effective Speech

Additional Courses: Require a grade of C or better

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMCH 210H</td>
<td>Statics and Strength of Materials, Honors</td>
<td>5</td>
</tr>
<tr>
<td>or EMCH 210</td>
<td>Statics and Strength of Materials</td>
<td></td>
</tr>
<tr>
<td>EMCH 212H</td>
<td>Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>or EMCH 212</td>
<td>Dynamics</td>
<td></td>
</tr>
</tbody>
</table>

Supporting Courses and Related Areas
Integrated Undergraduate/Graduate Study - B.S. Engineering Science - M.S. Engineering Science and Mechanics

The flexibility and strength in fundamentals of the Engineering Science curriculum provides an opportunity for Engineering Science undergraduate students to participate in the ESM Integrated Undergraduate/Graduate (IUG) program. Application for IUG status may be made in the fifth or subsequent semesters.

The IUG program promotes the interchange of ideas across all branches of the scientific and engineering disciplines from both theoretical and experimental perspectives. Students in the composite degree program are expected to pursue interdisciplinary studies in areas that encompass nano- and bionanotechnology, advanced materials, electromagnetic, mechanics, microelectronics, nanoelectronics and bioelectronics, neural engineering, photonics and photovoltaics (among others) and they are expected to embrace multidisciplinary perspectives across departmental, College, and University boundaries.

Program Educational Objectives

The expected accomplishments of Engineering Science graduates in the first several years following graduation are:

1. participate in lifelong learning activities including, but not limited to, masters, doctorate, medical, and law degrees, continuing education, leadership development, management training, and global involvement/awareness;
2. engage in practice in a wide variety of fields including, but not limited to, electrical systems, electronics, mechanical systems, materials development, forensics, biomaterials, medicine, law, and business;
3. research, develop, design and/or utilize new products, processes, materials, devices, systems, and/or tools;
4. communicate findings and best practices at conferences and meetings, and to the general public through presentations, technical publications (journals, reports, memoranda), and patents;
5. use state-of-the-art tools for the benefit of society;
6. participate in and promote the values of diversity and sustainability in society; and
7. encourage and foster future generations of engineers through mentoring, service, and outreach.

Program Outcomes (Student Outcomes)

a. an ability to apply knowledge of mathematics, science, and engineering
b. an ability to design and conduct experiments, as well as to analyze and interpret data
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. an ability to function on multidisciplinary teams

e. an ability to identify, formulate, and solve engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
h. a recognition of the need for, and an ability to engage in life-long learning
i. a knowledge of contemporary issues
j. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Academic Advising

The objectives of the university’s academic advising program are to help advisees identify and achieve their academic goals, to promote their intellectual discovery, and to encourage students to take advantage of both in-and out-of-class educational opportunities in order that they become self-directed learners and decision makers.

Both advisers and advisees share responsibility for making the advising relationship succeed. By encouraging their advisees to become engaged in their education, to meet their educational goals, and to develop the habit of learning, advisers assume a significant educational role. The advisee’s unit of enrollment will provide each advisee with a primary academic adviser, the information need to plan the chosen program of study, and referrals to other specialized resources.

READ SENATE POLICY 32-00: ADVISING POLICY (http://senate.psu.edu/policies-and-rules-for-undergraduate-students/32-00-advising-policy)

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Suggested Academic Plan
Engineering Science - Ending at University Park Campus

The course series listed below provides only one of the many possible ways to move through this curriculum. The University may make changes in policies, procedures, educational offerings, and requirements at any time. This plan should be used in conjunction with your degree audit (accessible in LionPATH as either an Academic Requirements or What If report). Please consult with a Penn State academic adviser on a regular basis to develop and refine an academic plan that is appropriate for you.

If you are starting at a campus other than the one this plan is ending at, please refer here:

http://advising. engr.psu.edu/degree-requirements/academic-plans-by-major.aspx

First Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 110 (GN)</td>
<td>3</td>
<td>CHEM 111</td>
<td>1</td>
</tr>
<tr>
<td>ECON 102 or 104 (GS)</td>
<td>3</td>
<td>ENGL 15, 30, or ESL 15 (GWS)</td>
<td>3</td>
</tr>
<tr>
<td>EDSGN 100</td>
<td>3</td>
<td>ESC 261 or CMPSC 201</td>
<td>3</td>
</tr>
<tr>
<td>MATH 140 or 140E (GQ)</td>
<td>4</td>
<td>MATH 141 or 141E (GQ)</td>
<td>4</td>
</tr>
</tbody>
</table>

*#†‡
‡†#"
### General Education Course

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Spring</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGL 202C (GWS)</td>
<td>2</td>
<td>ESC 411</td>
<td>ENGL 202C</td>
</tr>
<tr>
<td>ESC 404</td>
<td>3</td>
<td>Technical Elective</td>
<td>ESC 404</td>
</tr>
<tr>
<td>ESC 410</td>
<td>3</td>
<td>Technical Elective</td>
<td>ESC 410</td>
</tr>
<tr>
<td>Technical Elective</td>
<td>3</td>
<td>General Education Course</td>
<td>Technical Elective</td>
</tr>
<tr>
<td>Technical Elective</td>
<td>3</td>
<td>General Education Course</td>
<td>Technical Elective</td>
</tr>
<tr>
<td>General Education Course (GHW)</td>
<td>1.5</td>
<td>General Education Course (GHW)</td>
<td>General Education Course</td>
</tr>
</tbody>
</table>

**Total Credits: 131-132**

- * Course requires a grade of C or better for the major
- † Course requires a grade of C or better for General Education
- # Course is an Entrance to Major requirement
- † Course satisfies General Education and degree requirement

### Career Paths

Career opportunities for engineering science graduates are limited only by their imagination. Because of the breadth of their training, engineering scientists are well prepared to lead national and international interdisciplinary teams in a diverse array of science and engineering endeavors, in addition to careers in law, medicine, business, politics, and government service. Engineering science graduates are extremely well prepared for graduate study in most engineering disciplines, including mechanical, electrical, aerospace, industrial, and materials, as well as graduate study in physics and mathematics.

### Careers

Penn State engineering science and mechanics alumni are successful entrepreneurs, business executives, captains of industry, leaders in national laboratories, startup founders, physicians, professors, and academic officials. Starting salaries for engineering science graduates in
past years have been among the highest for all graduates in the College of Engineering.

MORE INFORMATION (http://www.esm.psu.edu/academics/resources/career-resources.aspx)

Opportunities for Graduate Studies
The ESM department offers the following graduate degree options:

- Master of Engineering (M.Eng.) in Engineering Mechanics
- Master of Engineering (M.Eng.) in Additive Manufacturing
- Master of Science (M.S.) in Engineering at the Nano-scale
- Master of Science (M.S.) in Engineering Science and Mechanics
- Master of Science (M.S.) in Additive Manufacturing
- Doctor of Philosophy (Ph.D.) in Engineering Science and Mechanics
- Doctor of Medicine and Doctor of Philosophy in Engineering Science and Mechanics (M.D./Ph.D.)
- Graduate Certificate in Laser-Materials Processing and Laser-Based Manufacturing

MORE INFORMATION (http://www.esm.psu.edu/academics/graduate/prospective-students.aspx)

Professional Resources
- Society for the Advancement of Materials and Process Engineering (http://www.nasampe.org)

Accreditation

MORE INFORMATION (http://www.abet.org)

Contact
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http://www.esm.psu.edu/