NUCLEAR ENGINEERING, B.S.

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

Program Description

The overall educational objective of the Nuclear Engineering program is to help prepare our graduates to function effectively in the marketplace in a wide range of career paths in Nuclear Engineering. The technical part of the curriculum, emphasizes nuclear power engineering, which refers to complex systems used to generate electricity. Because of our strong educational and research emphasis in nuclear power engineering, and because a shortage for this expertise exists in the industry, generally the industry values our graduates highly. We recognize that nuclear science, including nuclear security and non-proliferation, is an important growth area. We constantly assess and review the needs of our undergraduate students and their most frequent employers and use this feedback to consider revisions to our curriculum so that it is responsive to the needs of our constituents.

The first two years of the program stress fundamentals in mathematics, chemistry, physics, computer programming, and engineering sciences such as mechanics, materials, and thermodynamics. The last two years provide the breadth and depth in nuclear science, behavior of heat and fluids, reactor theory and engineering, and radiation measurement. The laboratory work includes experiments using the University's 1,000-kilowatt research reactor. Engineering design is incorporated in many courses from the freshman year to the senior year, but is particularly emphasized in the senior capstone design course, which integrates the critical elements of reactor theory, reactor engineering, safety considerations and economic optimization into a reactor design.

Many graduates are employed by electric power companies that use nuclear power plants, or by companies that help service and maintain those plants. They use their knowledge of engineering principles, radioactive decay, interactions of radiation with matter, and nuclear reactor behavior to help assure that the power plants meet the demand for reliable, economic electricity while ensuring a safe environment. To do this, graduates must be problem solvers who can develop and use complex computer models and sophisticated monitoring systems, design systems to handle radioactive waste, determine if the materials in the plant are becoming brittle or corroded, or manage the fuel in the reactor to get the maximum energy from it. Other graduates work in industries that use radioactive or radiation to detect problems or monitor processes. Jobs are also found in branches of the government as designers of the next generation of reactors for submarines, aircraft carriers, or space probes, or to manage and clean up contaminated wastes. They could also be involved with regulation of nuclear power or radiation uses, or in research to develop advanced technologies that will be used in next-generation power plants. Graduates who want to further their education in the fields of health physics, radiation biology, or nuclear medical applications find this degree to be a useful preparation.

What is Nuclear Engineering?

Nuclear engineering is a multidisciplinary field that goes beyond providing nuclear power for electrical production. Nuclear engineers may apply radiation in disease treatment and food supplies, operate nuclear energy systems, develop regulations to ensure safety, or facilitate space exploration.

You Might Like This Program If...

You'd like the opportunity to help mold the future in exciting new ways. Nuclear technology touches our lives in many ways and nuclear engineers solve everyday problems in health and safety.

Entrance to Major

This program currently has administrative enrollment controls. Administrative Enrollment Controls are initiated when limitations of space, faculty, or other resources in a major prevent accommodating all students who request them. Students must follow the administrative enrollment controls that are in effect for the semester that they enter the university.

First-Year Students Entering Summer 2018, Fall 2018, Spring 2019

In order to be eligible for entrance to this major, students must satisfy the following requirements:

- completed 40-59 credits at Penn State (actual credits taken at the University)
- completed with a grade of C or better: CHEM 110, MATH 140, MATH 141, MATH 250 or MATH 251, PHYS 211, and PHYS 212
- earned a minimum of 2.60 cumulative GPA

Students Who Entered Prior to Summer 2018

Students who entered the University prior to the summer 2018 semester should view the administrative enrollment controls for the semester that they entered the university (http://advising.psu.edu/entrance-major-requirements) on the Academic Advising Portal.

Degree Requirements

For the Bachelor of Science degree in Nuclear Engineering, a minimum of 129 credits is required:

<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>111</td>
</tr>
</tbody>
</table>

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
requirements/#82-44).

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>PHYS 212</td>
<td>General Physics: Electricity and Magnetism</td>
<td>4</td>
</tr>
<tr>
<td>MATH 251</td>
<td>Ordinary and Partial Differential Equations</td>
<td>4</td>
</tr>
<tr>
<td>NUCE 301</td>
<td>Fundamentals of Reactor Physics</td>
<td>4</td>
</tr>
<tr>
<td>NUCE 302</td>
<td>Introduction to Reactor Design</td>
<td>4</td>
</tr>
<tr>
<td>NUCE 309</td>
<td>Analytical Techniques for Nuclear Concept</td>
<td>3</td>
</tr>
<tr>
<td>NUCE 450</td>
<td>Radiation Detection and Measurement</td>
<td>3</td>
</tr>
<tr>
<td>NUCE 430</td>
<td>Design Principles of Reactor Systems</td>
<td>3</td>
</tr>
</tbody>
</table>

Additional Courses

Select 1 credit of First-Year Seminar
Select one of the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECON 102</td>
<td>Introductory Microeconomic Analysis and Policy</td>
<td>3</td>
</tr>
<tr>
<td>ECON 104</td>
<td>Introductory Macroeconomic Analysis and Policy</td>
<td></td>
</tr>
<tr>
<td>EBF 200</td>
<td>Introduction to Energy and Earth Sciences Economics</td>
<td></td>
</tr>
<tr>
<td>ENGL 15</td>
<td>Rhetoric and Composition</td>
<td>3</td>
</tr>
<tr>
<td>or ENGL 30</td>
<td>Honors Freshman Composition</td>
<td></td>
</tr>
<tr>
<td>CAS 100A</td>
<td>Effective Speech</td>
<td>3</td>
</tr>
<tr>
<td>or CAS 100B</td>
<td>Effective Speech</td>
<td></td>
</tr>
</tbody>
</table>

Select 6 credits, of which 3 credits must be designated as design, of the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMPSC 200</td>
<td>Programming for Engineers with MATLAB</td>
<td>3</td>
</tr>
<tr>
<td>or CMPSC 201</td>
<td>Programming for Engineers with C++</td>
<td></td>
</tr>
<tr>
<td>BME 406</td>
<td>Medical Imaging</td>
<td></td>
</tr>
</tbody>
</table>
NUCE 405 Nuclear and Radiochemistry
NUCE 406 Introduction to Statistical Thermodynamics
NUCE 408 Radiation Shielding
NUCE 409 Nuclear Materials
NUCE 420 Radiological Safety
NUCE 428 Radioactive Waste Control
NUCE 446 Reliability and Risk Concepts in Design
NUCE 470 Power Plant Simulation
NUCE 490 Introduction to Plasmas
NUCE 496 Independent studies
NUCE 497 Special Topics
500-level NUCE courses with approval of adviser

Supporting Courses and Related Areas
Select 3 credits in General Technical Elective (GTE) courses from department list 1 2

1 These courses may have to be chosen so that the engineering design or engineering science requirements for the major are met.
2 Students who complete Basic ROTC may substitute 6 of the ROTC credits for 3 credits of GTE and 3 credits of GHW.

Program Educational Objectives
Accordingly, we will endeavor to maintain and provide a curriculum that prepares our graduates such that:

- Within two to three years of graduation, we expect the majority of our B.S. graduates to:
  - be working in industry, especially related to nuclear power engineering,
  - be working in government agencies or national laboratories,
  - be pursuing advanced degrees.
- We expect that our students will continue to develop professionally and establish themselves in their careers and in this way may take the opportunity to further their education and training by attending graduate school or by pursuing other professional development.

Program Outcomes (Student Outcomes)
The Program outcomes are knowledge, skills, and/or behavior that are derived from the program educational objectives.

a. Students will demonstrate a knowledge of the fundamentals in mathematics, physics, chemistry and the engineering sciences necessary to the nuclear engineering profession.
b. Students will demonstrate an ability to apply the fundamentals to understand, analyze and design nuclear systems; demonstrate knowledge of the contemporary issues affecting the nuclear engineering profession.
c. Students will demonstrate the ability to use appropriate methods and technology for detection and measurement of radiation and for nuclear science.
d. Students will be proficient in the oral and written communication of their work and ideas; show the ability to learn independently using appropriate technology; show ability to work well in teams.
e. Students will demonstrate the ability to operate in a modern, diverse work environment; understand their professional and ethical responsibilities; and be aware of the safety, environmental, and societal consequences of their work in a global contexts.

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)

University Park
Eric Marsh
Associate Head for Undergraduate Programs
139 Reber Building
University Park, PA 16802
814-865-5242
emarsh@psu.edu

Suggested Academic Plan
Nuclear Engineering - 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 EMGL 15, 30, or ESL 15 (GWS) ††</td>
<td>CHEM 111 (GN)</td>
<td>1 MATH 141 or 141E (GQ) †‡</td>
</tr>
<tr>
<td>ECON 102 or 104 (GS) †</td>
<td>3 PHYS 211 (GN, PHYSICS 211L &amp; PHYSICS 211R) †‡</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>EDGSN 100</td>
<td>3 First Year Seminar †</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>MATH 140 or 140E (GQ) †‡</td>
<td>4 General Education Course †</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>General Education Course †</td>
<td>3 General Education Course (GHW) †</td>
<td>1.5</td>
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<td></td>
<td>17</td>
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<td>16.5</td>
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</table>

Second Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMPSC 201</td>
<td>3 EMCH 212</td>
<td>MATH 251 †§</td>
<td>4 MATH 230</td>
</tr>
<tr>
<td>EMCH 211</td>
<td>3 EMCH 213 or 213D</td>
<td></td>
<td></td>
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<tr>
<td>MATH 251 †§</td>
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*#†
‡†
‡‡
††
in the spring semester. These courses carry the GWS designation and replace both ENGL 30 and CAS 100. Each course is 3 credits.

**College Note**

**General Technical Elective (GTE):** Select from NUC E program lists. Students who complete the ROTC Program may substitute 3 ROTC credits for the GHW requirement and 3 ROTC credits for the GTE requirement. Students who complete three co-op rotations may substitute 3 co-op credits for the GTE requirement.

**Health and Physical Activity Elective:** Students who complete the ROTC Program may substitute 3 ROTC credits for the GHW requirement and 3 ROTC credits for the GTE requirement.

**Nuclear Engineering Elective (NETE):** Select from NUC E program lists.

These courses offered at University Park in fall semester only:

- NUC E 301
- NUC E 309
- NUC E 310
- NUC E 403
- NUC E 430
- NUC E 451

These courses offered at University Park in spring semester only:

- NUC E 302
- NUC E 431
- NUC E 450

**Career Paths**

Penn State’s nuclear engineering program relates theory to practice in a way that most universities cannot. Penn State is one of the few universities where undergrad students can work with a functioning nuclear reactor. The Breazeale Nuclear Reactor is the longest operating licensed research reactor in the country. Students also gain professional experience with an industry-sponsored project through our capstone design course. Penn State’s collaboration with Westinghouse as well as other nuclear companies and agencies, will give you an unmatched educational experience using the simulation and analysis codes currently used in industry.

**Careers**

Many nuclear engineering graduates work for electric power companies that use nuclear power plants or help service and maintain these plants. Other graduates work in industries that use radioactivity or radiation, such as medicine, food, and agriculture. These fields need nuclear engineers to detect problems, monitor processes, and protect the public. The federal government also hires nuclear engineers to design next generation reactors for submarines, aircraft carriers, and space probes; regulate nuclear power or radiation uses; and develop advanced technologies that will be used in future power plants. Other industries where nuclear engineers may work are: energy, government, medicine, agriculture, and space.

MORE INFORMATION (http://mne.psu.edu/students/undergraduate/what-is-an-engineer.aspx#NuclearEngineer)

**Opportunities for Graduate Studies**

We are one of the few universities in the U.S. with a research reactor on campus. Our students have the unique opportunity to learn and
research in state-of-the-art experimental facilities under the supervision of internationally renowned faculty, scientists, and engineers. We have especially strong research programs in nuclear power, reactor design, and nuclear materials.

MORE INFORMATION (http://mne.psu.edu/students/graduate/prospective.aspx)

Accreditation
The baccalaureate program in Nuclear Engineering is accredited by the Engineering Accreditation Commission of ABET, www.abet.org (http://www.abet.org).

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

Contact
University Park
DEPARTMENT OF MECHANICAL AND NUCLEAR ENGINEERING
137 Reber Building
University Park, PA 16802
814-865-2519
emarsh@psu.edu

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