

# NUCLEAR, PLASMA, AND RADIOLOGICAL ENGINEERING: PLASMA & FUSION SCIENCE & ENGINEERING, BS

*for the degree of Bachelor of Science in Nuclear, Plasma, & Radiological Engineering with a concentration in Plasma & Fusion Science & Engineering*

Nuclear, plasma, and radiological engineering encompasses a broad and diverse but complimentary set of engineering disciplines with a wide variety of applications. The first two years of the NPRE curriculum provides a strong foundation in sciences (physics, mathematics, and chemistry), in engineering (mechanics and thermodynamics), in computer use, and in nuclear energy systems. Most of the technical core and concentration coursework takes place in the third and fourth years of the curriculum. Students choose from among three concentrations: power, safety and the environment; plasma and fusion science and engineering; and radiological, medical and instrumentation applications. Each concentration requires students acquire a depth of understanding of the area but with flexibility to develop advanced technical expertise depending upon the student's specific educational and professional interests. Students demonstrate proficiency in the engineering design process in a senior design capstone course.

The plasma and fusion science and engineering concentration focuses on plasma processing for a myriad of applications including semiconductor production and on harnessing the power of nuclear fusion. Areas of scholarship and research in which students are involved include but are not limited to: plasma physics and fusion, plasma material interactions, plasma modeling, plasma code development, atmospheric plasma, extreme ultraviolet lithography and physical vapor deposition, plasma processing of semiconductors, fusion materials, plasma nanosynthesis, plasma sources and processing, and plasma manufacturing. Exploration of the plasma science and fusion areas involves both computational and experimental approaches. Students are exposed to modeling and simulation and numerical analysis and computational methods as well as to hands on experiments in a physical laboratory setting. Students confer with their academic advisor on a chosen course set to ensure that a strong program is achieved. Technical electives are chosen from among NPRE courses and courses outside the department in the subfields of physical science, electrical engineering, and electronic materials. The program prepares graduates for positions in semiconductor industry, research laboratories and federal and regulatory agencies as well for further graduate study.

## Current Program Educational Objectives

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## Graduation Requirements

Minimum hours required for graduation: 128 hours.

Minimum Overall GPA: 2.0

Minimum Technical GPA (<https://go.grainger.illinois.edu/TechnicalGPA/>): 2.0

TGPA is required for NPRE 200 and NPRE 247. See Technical GPA (<https://go.grainger.illinois.edu/TechnicalGPA/>) to clarify requirements.

## University Requirements

Minimum of 40 hours of upper-division coursework, generally at the 300- or 400-level. These hours can be drawn from all elements of the degree.

Students should consult their academic advisor for additional guidance in fulfilling this requirement.

The university and residency requirements can be found in the Student Code (<https://studentcode.illinois.edu/article3/part8/3-801/>) (§ 3-801) and in the Academic Catalog (<http://catalog.illinois.edu/general-information/degree-general-education-requirements/>).

## General Education Requirements

Follows the campus General Education (Gen Ed) requirements (<https://courses.illinois.edu/gened/DEFAULT/DEFAULT/>). Some Gen Ed requirements may be met by courses required and/or electives in the program.

Code	Title	Hours
	Composition I	4-6
	Advanced Composition	3
	Humanities & the Arts (6 hours)	6
	Natural Sciences & Technology (6 hours)	6
	fulfilled by CHEM 102, PHYS 211, PHYS 212	
	Social & Behavioral Sciences (6 hours)	6
	fulfilled by ECON 102 or ECON 103 and any other course approved as Social & Behavioral Sciences	
	Cultural Studies: Non-Western Cultures (1 course)	3
	Cultural Studies: US Minority Cultures (1 course)	3
	Cultural Studies: Western/Comparative Cultures (1 course)	3
	Quantitative Reasoning (2 courses, at least one course must be Quantitative Reasoning I)	6-10
	fulfilled by MATH 220 or MATH 221; and MATH 231, MATH 241, MATH 285, PHYS 211, PHYS 212; and CS 101 or CS 124	
	Language Requirement (Completion of the third semester or equivalent of a language other than English is required)	0-15

## Orientation and Professional Development

Code	Title	Hours
ENG 100	Grainger Engineering Orientation Seminar (External transfer students take ENG 300.)	1
NPRE 100	Orientation to NPRE	1
<b>Total Hours</b>		<b>2</b>

## Introductory Economics Elective

Code	Title	Hours
ECON 102	Microeconomic Principles	3
or ECON 103	Macroeconomic Principles	
<b>Total Hours</b>		<b>3</b>

**Foundational Mathematics and Science**

Code	Title	Hours
CHEM 102	General Chemistry I	3
CHEM 103	General Chemistry Lab I	1
MATH 221	Calculus I (MATH 220 may be substituted. MATH 220 is appropriate for students with no background in calculus. 4 of 5 credit hours count towards degree.)	4
MATH 231	Calculus II	3
MATH 241	Calculus III	4
MATH 257	Linear Algebra with Computational Applications	3
MATH 285	Intro Differential Equations	3
PHYS 211	University Physics: Mechanics	4
PHYS 212	University Physics: Elec & Mag	4
<b>Total Hours</b>		<b>29</b>

**Nuclear, Plasma, and Radiological Engineering Technical Core**

Code	Title	Hours
CS 101	Intro Computing: Engrg & Sci (CS 124 may be taken instead of CS 101.)	3
ECE 205	Electrical and Electronic Circuits	3
ME 200	Thermodynamics	3
ME 310 or TAM 335	Fundamentals of Fluid Dynamics Introductory Fluid Mechanics	4
NPRE 200	Mathematics for Nuclear, Plasma, and Radiological Engineering	2
NPRE 247	Modeling Nuclear Energy System	3
NPRE 321	Introduction to Plasmas and Applications	3
NPRE 330	Materials in Nuclear Engineering	3
NPRE 349	Introduction to NPRE Heat Transfer	2
NPRE 441	Radiation Protection	4
NPRE 445	Interaction of Radiation with Matter	4
NPRE 449	Nuclear Systems Engineering and Design	3
NPRE 451	NPRE Laboratory	3
NPRE 455	Neutron Diffusion & Transport	4
NPRE 458	Design in NPRE	4
TAM 210	Introduction to Statics (TAM 211 may be taken instead of TAM 210. The extra hour may be applied towards the Professional Concentration Area electives.)	2
TAM 212	Introductory Dynamics (PHYS 325 may be taken instead of TAM 212 for students pursuing the PHYS minor.)	3
<b>Total Hours</b>		<b>53</b>

**Professional Concentration Area**

Code	Title	Hours
<b>Required Courses</b>		<b>8</b>
NPRE 421	Plasma and Fusion Science	3
NPRE 423	Plasma Laboratory	2
NPRE 429	Plasma Engineering	3
<b>Technical Electives</b>		<b>9</b>

From Departmentally Approved List of Technical Electives - students are to take at least 9 hours. This includes technical electives from NPRE or from other departments in the subfields Physical Science, Electrical Engineering, or Electronic Materials. The student is to confer with their academic adviser on a chosen course set to ensure that a strong program is achieved.

NPRE 199	Undergraduate Open Seminar (May be repeated in separate terms to a maximum of 2 times.)	1
NPRE 201	Energy Systems	2 or 3
NPRE 398	Special Topics	1 to 4
NPRE 461	Probabilistic Risk Assessment	3 or 4
NPRE 470	Fuel Cells & Hydrogen Sources	3
NPRE 481	Writing on Technol & Security	3 or 4
NPRE 498	Special Topics	1 to 4
STAT 400	Statistics and Probability I	4

**Physical Science Electives**

CHEM 104	General Chemistry II	3
CHEM 105	General Chemistry Lab II	1
PHYS 435	Electromagnetic Fields I	3
PHYS 436	Electromagnetic Fields II	3
PHYS 460	Condensed Matter Physics	4

**Electrical Engineering Electives**

ECE 329	Fields and Waves I	3
ECE 340	Semiconductor Electronics	3
ECE 441	Physcs & Modeling Semicond Dev	3
ECE 444	IC Device Theory & Fabrication	4

**Electronic Materials Electives**

MSE 304	Electronic Properties of Matls	3
MSE 403	Synthesis of Materials	3
MSE 460	Electronic Materials I	3
MSE 461	Electronic Materials II	3

**Total Hours** 17

**Free Electives**

Code	Title	Hours
Additional course work, subject to the Grainger College of Engineering restrictions to Free Electives, so that there are at least 128 credit hours earned toward the degree. ( <a href="https://go.grainger.illinois.edu/FreeElectives/">https://go.grainger.illinois.edu/FreeElectives/</a> )		11

**Total Hours of Curriculum to Graduate** 128

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**Sample Sequence**

This sample sequence is intended to be used only as a guide for degree completion. All students should work individually with their academic advisors to decide the actual course selection and sequence that works best for them based on their academic preparation and goals. Enrichment programming such as study abroad, minors, internships, and so on may impact the structure of this four-year plan. Course availability is not guaranteed during the semester indicated in the sample sequence. The curriculum sequence can also be viewed via dynamic and static curricular

maps (<https://grainger.illinois.edu/academics/undergraduate/majors-and-minors/npre-plasma-map/>), which include prerequisite sequencing.

Students must fulfill their Language Other Than English requirement by successfully completing a third level of a language other than English. See the corresponding section on the Degree and General Education Requirements (<http://catalog.illinois.edu/general-information/degree-general-education-requirements/>). One of the SBS courses must be an introductory economics course (ECON 102 or ECON 103). NPRE 481 will satisfy a technical elective requirement in the Professional Concentration Area and the Campus General Education Advanced Composition requirement. If NPRE 481 is not selected, a separate Advanced Composition course must be taken.

Free Electives: Additional course work, subject to the Grainger College of Engineering restrictions to Free Electives (<https://go.grainger.illinois.edu/FreeElectives/>), so that there are at least 128 credit hours earned toward the degree.

**First Year**

First Semester	Hours	Second Semester	Hours
NPRE 100		1 CS 101 (CS 124 may be substituted)	3
MATH 221 (MATH 220 may be substituted)		4 MATH 231	3
ENG 100		1 PHYS 211	4
CHEM 102		3 Language Other Than English (3rd level) or Composition I course	4
Composition I or Language Other Than English (3rd level) course		4 ECON 102 or ECON 103 (counts as General Education course)	3
CHEM 103	1		
General Education course (choose a Humanities or Social/Behavioral Science course with Cultural Studies designation)	3		
		<b>17</b>	<b>17</b>

**Second Year**

First Semester	Hours	Second Semester	Hours
NPRE 200		2 NPRE 247	3
MATH 241		4 MATH 285	3
PHYS 212		4 ME 200	3
TAM 210 (TAM 211 may be substituted)		2 TAM 212 (PHYS 325 may be substituted)	3

General Education course (choose a Humanities or Social/Behavioral Science course with Cultural Studies designation)	3 Free elective course	3
Free elective course	2	
		<b>17</b>
		<b>15</b>

**Third Year**

First Semester	Hours	Second Semester	Hours
NPRE 321		3 NPRE 349	2
MATH 257		3 NPRE 421	3
NPRE 445		4 NPRE 451	3
TAM 335 (ME 310 may be substituted)		4 NPRE 455	4
General Education course (choose a Humanities or Social/Behavioral Science course with Cultural Studies designation)	3 ECE 205		3
		<b>17</b>	<b>15</b>

**Fourth Year**

First Semester	Hours	Second Semester	Hours
NPRE 330		3 NPRE 429	3
NPRE 423		2 NPRE 441	4
NPRE 449		3 NPRE 458	4
Technical elective course		3 Technical elective course	3
Technical elective course		3	
Free elective course	2		
		<b>16</b>	<b>14</b>

**Total Hours 128**

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**Nuclear, Plasma, & Radiological Website**

Nuclear, Plasma, & Radiological Engineering Faculty (<https://npre.illinois.edu/directory/faculty/>)

The Grainger College of Engineering Admissions (<https://grainger.illinois.edu/admissions/>)

**The Grainger College of Engineering**