

NUCLEAR, PLASMA, & RADIOLOGICAL ENGINEERING, BS

for the degree of Bachelor of Science in Nuclear, Plasma, & Radiological Engineering

department website: <https://npri.illinois.edu/>
department faculty: Nuclear, Plasma, & Radiological Engineering Faculty (<https://npri.illinois.edu/directory/faculty/>)
overview of college admissions & requirements: The Grainger College of Engineering (<https://grainger.illinois.edu/admissions/>)
college website: <https://grainger.illinois.edu/>
Current Program Educational Objectives: <https://npri.illinois.edu/academics/undergraduate/program-educational-objectives> (<https://npri.illinois.edu/academics/undergraduate/program-educational-objectives/>)

Nuclear, plasma, and radiological engineering is a branch of engineering that is concerned with the development and use of nuclear energy and radiation sources for a wide variety of applications in energy production, in materials processing and science, and for biomedical and industrial uses. Areas of interest include the continued safe and reliable application of fission reactors as central electric power plant thermal sources; plasma processing applications and the longer term development of fusion reactors for electric power generation; and the use of radiation sources in such areas as materials, biological systems, medical treatment, radiation instrumentation, environmental systems, and activation analysis.

The first two years of the curriculum provide a strong foundation in basic sciences (physics, mathematics, and chemistry), engineering sciences (analytical mechanics and thermodynamics), an introduction to computer use, and introduction to nuclear energy systems. Most technical concentration takes place in the third and fourth years of the curriculum according to the educational and career interest of the students. The curriculum provides three professional concentration areas: power, safety and the environment; plasma and fusion science and engineering; and radiological, medical, and instrumentation applications. Each concentration area allows flexibility in developing advanced technical expertise but also requires depth of understanding in the area. The third path meets pre-med requirements and facilitates the minor in bioengineering. To complete this concentration area, students should take certain chemistry and biology courses in the first two years of the curriculum.

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Graduation Requirements

Minimum Overall GPA: 2.0

Minimum hours required for graduation: 128 hours

General education: Students must complete the Campus General Education (<https://courses.illinois.edu/gened/DEFAULT/DEFAULT/>) **requirements including the campus general education language requirement. One of the SBS courses must be an introductory economics course (ECON 102 or ECON 103).**

Orientation and Professional Development

| Code | Title | Hours |
|-------------|--------------------------------------|-------|
| ENG 100 | Engineering Orientation ¹ | 0 |
| NPRE 100 | Orientation to NPRE | 1 |
| Total Hours | | 1 |

Foundational Mathematics and Science

| Code | Title | Hours |
|-------------|--------------------------------|-------|
| CHEM 102 | General Chemistry I | 3 |
| CHEM 103 | General Chemistry Lab I | 1 |
| MATH 221 | Calculus I ² | 4 |
| MATH 231 | Calculus II | 3 |
| MATH 241 | Calculus III | 4 |
| MATH 285 | Intro Differential Equations | 3 |
| PHYS 211 | University Physics: Mechanics | 4 |
| PHYS 212 | University Physics: Elec & Mag | 4 |
| PHYS 214 | Univ Physics: Quantum Physics | 2 |
| Total Hours | | 28 |

Nuclear, Plasma, and Radiological Engineering Technical Core

| Code | Title | Hours |
|-------------|---|-------|
| CS 101 | Intro Computing: Engrg & Sci ³ | 3 |
| ECE 205 | Electrical and Electronic Circuits | 3 |
| ECE 206 | Electrical and Electronic Circuits Lab | 1 |
| ME 200 | Thermodynamics | 3 |
| NPRE 247 | Modeling Nuclear Energy System | 3 |
| NPRE 431 | Materials in Nuclear Engrg | 3 |
| NPRE 441 | Radiation Protection | 4 |
| NPRE 446 | Radiation Interact w/Matter I | 3 |
| NPRE 447 | Radiation Interact w/Matter II | 3 |
| NPRE 448 | Nuclear Syst Engrg & Design | 4 |
| NPRE 451 | NPRE Laboratory | 3 |
| NPRE 455 | Neutron Diffusion & Transport | 4 |
| NPRE 458 | Design in NPRE | 4 |
| TAM 210 | Introduction to Statics ^{3,4} | 2 |
| TAM 212 | Introductory Dynamics ⁴ | 3 |
| Total Hours | | 46 |

Professional Concentration Area Electives

| Code | Title | Hours |
|---|------------------------------|-----------|
| Students choose one of the Professional Concentration Areas below. | | 25 |
| Power, Safety, and the Environment | | |
| TAM 335 | Introductory Fluid Mechanics | 4 |

| | | |
|---|---|--------|
| or ME 310 | Fundamentals of Fluid Dynamics | |
| NPRE 421 | Plasma and Fusion Science | 3 |
| NPRE 432 | Nuclear Engrg Materials Lab | 2 |
| Technical electives broken down as follows: | | 16 |
| Minimum of 6 hours from the list below: | | |
| NPRE 201 | Energy Systems | 2 or 3 |
| NPRE 398 | Special Topics | 1 to 4 |
| NPRE 412 | Nuclear Power Econ & Fuel Mgmt | 3 or 4 |
| NPRE 442 | Radioactive Waste Management | 3 |
| NPRE 457 | Safety Anlys Nucl Reactor Syst | 3 or 4 |
| NPRE 461 | Probabilistic Risk Assessment | 3 or 4 |
| NPRE 480 | Energy and Security | 3 |
| NPRE 481 | Writing on Technol & Security | 3 or 4 |
| NPRE 483 | Seminar on Security | 1 |
| NPRE 498 | Special Topics | 1 to 4 |
| Remaining 10 credit hours of technical electives from list below. Technical electives selected from departmentally approved Power, Safety, and the Environment elective course work in Common Engineering and Technical Electives or one of the following subfields: Thermal Sciences; Power and Control Systems; Solid, Fluid and Continuum Mechanics; Computational Sciences and Engineering; Environmental Engineering and Science. The student's academic advisor must approve the chosen course set to insure that a strong program is achieved. | | |
| Common Engineering and Technical Electives | | |
| MATH 415 | Applied Linear Algebra | 3 or 4 |
| NPRE 199 | Undergraduate Open Seminar (May be taken up to 2 times in separate seminars for credit towards concentration) | 1 |
| NPRE 470 | Fuel Cells & Hydrogen Sources | 3 |
| NPRE 475 | Wind Power Systems | 3 or 4 |
| STAT 400 | Statistics and Probability I | 4 |
| Thermal Sciences | | |
| ME 320 | Heat Transfer | 4 |
| ME 400 | Energy Conversion Systems | 3 or 4 |
| ME 402 | Design of Thermal Systems | 3 or 4 |
| ME 404 | Intermediate Thermodynamics | 4 |
| ME 410 | Intermediate Gas Dynamics | 3 or 4 |
| ME 411 | Viscous Flow & Heat Transfer | 4 |
| ME 420 | Intermediate Heat Transfer | 4 |
| Power and Control Systems | | |
| ECE 329 | Fields and Waves I | 3 |
| ECE 310 | Digital Signal Processing | 3 |
| ECE 330 | Power Ckts & Electromechanics | 3 |
| ECE 476 | Power System Analysis | 3 |
| ECE 486 | Control Systems | 4 |
| Solid, Fluid and Continuum Mechanics | | |
| TAM 251 | Introductory Solid Mechanics | 3 |
| TAM 252 | Solid Mechanics Design | 1 |
| TAM 424 | Mechanics of Structural Metals | 3 or 4 |
| TAM 435 | Intermediate Fluid Mechanics | 4 |
| TAM 445 | Continuum Mechanics | 4 |
| TAM 451 | Intermediate Solid Mechanics | 4 |

| | | |
|--|--------------------------------|--------|
| TAM 456 | Experimental Stress Analysis | 3 |
| Computational Sciences and Engineering | | |
| CS 357 | Numerical Methods I | 3 |
| CS 450 | Numerical Analysis | 3 or 4 |
| ME 471 | Finite Element Analysis | 3 or 4 |
| Environmental Engineering and Science | | |
| CEE 201 | Systems Engrg & Economics | 3 |
| CEE 330 | Environmental Engineering | 3 |
| CEE 437 | Water Quality Engineering | 3 |
| CEE 443 | Env Eng Principles, Chemical | 4 |
| CEE 444 | Env Eng Principles, Biological | 4 |
| CEE 445 | | |
| CEE 446 | Air Quality Engineering | 4 |
| CEE 447 | Atmospheric Chemistry | 4 |
| Plasma and Fusion Science and Engineering | | |
| TAM 335 | Introductory Fluid Mechanics | 4 |
| or ME 310 | Fundamentals of Fluid Dynamics | |
| NPRE 421 | Plasma and Fusion Science | 3 |
| NPRE 423 | Plasma Laboratory | 2 |
| NPRE 429 | Plasma Engineering | 3 |
| Remaining 13 credit hours of technical electives selected from departmentally approved Plasma and Fusion Science and Engineering elective course work in Common Engineering and Technical Electives or one of the following subfields: Physical Science, Electrical Engineering, or Electronic Materials. The student's academic advisor must approve the chosen course set to ensure that a strong program is achieved. | | |
| Common Engineering and Technical Electives | | |
| MATH 415 | Applied Linear Algebra | 3 or 4 |
| NPRE 199 | Undergraduate Open Seminar | 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 |
| MSE 462 | | |

Radiological, Medical and Instrumentation Applications

| | | |
|----------|----------------------|---|
| NPRE 435 | Radiological Imaging | 3 |
|----------|----------------------|---|

Select one from:

| | | |
|----------|--------------------------------|--------|
| MCB 403 | Cell & Membrane Physiology Lab | 1 or 2 |
| BIOE 415 | Biomedical Instrumentation Lab | 2 |
| NPRE 444 | Nuclear Analytical Methods Lab | 2 or 3 |

Remaining 20 credit hours from the Technical electives on the departmentally approved Radiological, Medical and Instrumentation Applications elective course work in Common Engineering and Technical Electives or one of the following subfields: Biomolecular Engineering, Biomedical Engineering, and Radiation Detection and Analysis. The student's academic advisor must approve the chosen course set to ensure that a strong program is achieved.

Common Engineering and Technical Electives

| | | |
|----------|---|--------|
| BIOE 120 | Introduction to Bioengineering | 1 |
| CHEM 104 | General Chemistry II | 3 |
| CHEM 105 | General Chemistry Lab II | 1 |
| CHEM 232 | Elementary Organic Chemistry I | 3 or 4 |
| CHEM 233 | Elementary Organic Chem Lab I | 2 |
| IB 150 | Organismal & Evolutionary Biol | 4 |
| IB 151 | Organismal & Evol Biol Lab | 1 |
| MATH 415 | Applied Linear Algebra | 3 or 4 |
| ME 310 | Fundamentals of Fluid Dynamics | 4 |
| MCB 150 | Molec & Cellular Basis of Life | 4 |
| MCB 151 | Molec & Cellular Laboratory | 1 |
| NPRE 199 | Undergraduate Open Seminar ((May be taken up to 2 times in separate seminars for credit towards concentration)) | 1 |
| NPRE 201 | Energy Systems | 2 or 3 |
| NPRE 398 | Special Topics | 1 to 4 |
| NPRE 421 | Plasma and Fusion Science | 3 |
| NPRE 461 | Probabilistic Risk Assessment | 3 or 4 |
| NPRE 481 | Writing on Technol & Security | 3 or 4 |
| NPRE 498 | Special Topics | 1 to 4 |
| STAT 400 | Statistics and Probability I | 4 |
| TAM 335 | Introductory Fluid Mechanics | 4 |

Biomolecular Engineering Electives

| | | |
|-------------|--------------------------------|--------|
| BIOE 120 | Introduction to Bioengineering | 1 |
| BIOE 414 | Biomedical Instrumentation | 3-4 |
| or CHBE 472 | Techniques in Biomolecular Eng | |
| CHEM 232 | Elementary Organic Chemistry I | 3 or 4 |
| MCB 450 | Introductory Biochemistry | 3 |
| MCB 401 | Cellular Physiology | 3 |
| or BIOP 401 | Introduction to Biophysics | |
| MCB 403 | Cell & Membrane Physiology Lab | 1 or 2 |

Biomedical Engineering Electives

| | | |
|-------------|--------------------------------|--------|
| BIOE 120 | Introduction to Bioengineering | 1 |
| CHEM 232 | Elementary Organic Chemistry I | 3 or 4 |
| ECE 380 | Biomedical Imaging | 3 |
| BIOE 414 | Biomedical Instrumentation | 3-4 |
| or CHBE 472 | Techniques in Biomolecular Eng | |

| | | |
|-------------|--------------------------------|--------|
| BIOE 415 | Biomedical Instrumentation Lab | 2 |
| ECE 480 | Magnetic Resonance Imaging | 3 or 4 |
| MCB 250 | Molecular Genetics | 3 |
| MCB 252 | Cells, Tissues & Development | 3 |
| MCB 401 | Cellular Physiology | 3 |
| or BIOP 401 | Introduction to Biophysics | |
| MCB 402 | Sys & Integrative Physiology | 3 |
| MCB 403 | Cell & Membrane Physiology Lab | 1 or 2 |
| MCB 404 | Sys & Integrative Physiol Lab | 1 to 2 |

Electives

| Code | Title | Hours |
|------|---|-------|
| | The Grainger College of Engineering Liberal Education course list, or additional courses from the campus General Education lists for Social and Behavioral Sciences or Humanities and the Arts ⁵ | 6 |

| | |
|--|---|
| Free electives. Additional unrestricted course work, subject to certain exceptions as noted by the College, so that there are at least 128 credit hours earned toward the degree. ⁶ | 6 |
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| | |
|--|------------|
| Total Hours of Curriculum to Graduate | 128 |
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- ¹ External transfer students take ENG 300 instead.
- ² MATH 220 may be substituted, with four of the five credit hours applying toward the degree. MATH 220 is appropriate for students with no background in calculus.
- ³ Students may elect to take CS 125 in place of CS 101, and TAM 211 in place of TAM 210. The extra hour will be applied toward the Professional Concentration Area electives.
- ⁴ Students in the Plasma and Fusion Science Engineering Professional Concentration Area may elect to take PHYS 325 in place of TAM 212. Further, students in this concentration may elect to take both PHYS 325 and PHYS 326 in place of TAM 210 and TAM 212. The extra hour from PHYS 325 and PHYS 326 will be applied toward the Professional Concentration Area electives.
- ⁵ The Grainger College of Engineering approved liberal education course list can be found here (<https://wiki.illinois.edu/wiki/display/ugadvise/Degree+Requirements/#DegreeRequirements-GeneralEducationElectives>). Note that these credit hours could carry the required cultural studies designation required for campus general education requirements.
- ⁶ The Grainger College of Engineering restrictions to free electives can be found here (<https://wiki.illinois.edu/wiki/display/ugadvise/Degree+Requirements/#DegreeRequirements-FreeElectives>).

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Suggested Sequence

The curriculum sequence below is a suggested sequence, as all Grainger Engineering students work with a department academic advisor to achieve their educational goals, specific to their needs and preparation. Dynamic and Static curricular maps, which include prerequisite sequencing, can be found here (<https://grainger.illinois.edu/academics/undergraduate/majors-and-minors/npre-map/>).

| First Year | | Free elective | 3 |
|---|-------|--|-----|
| First Semester | | Semester Hours | 17 |
| NPRE 100 Orientation to NPRE | 1 | Second Semester | |
| ENG 100 Engineering Orientation | 0 | NPRE 421 Plasma and Fusion Science | 3 |
| MATH 221 ¹ Calculus I | 4 | (or | |
| CHEM 102 General Chemistry I | 3 | Professional | |
| CHEM 103 General Chemistry Lab I | 1 | Concentration | |
| RHET 105 Writing and Research | 4-3 | Area | |
| (or Free | | elective in | |
| elective) ² | | Radiological, | |
| General education elective ³ | 3 | Medical, | |
| | | and | |
| Semester Hours | 16-15 | Instrumentation | |
| Second Semester | | Applications) ⁸ | |
| MATH 231 Calculus II | 3 | NPRE 447 Radiation Interact w/Matter II | 3 |
| PHYS 211 University Physics: Mechanics | 4 | NPRE 451 NPRE Laboratory | 3 |
| CS 101 ⁴ Intro Computing: Engrg Sci | 3 | NPRE 455 Neutron Diffusion Transport | 4 |
| Free elective (or RHET 105) ^{2,5} | 3-4 | Professional Concentration Area elective ⁷ | 3 |
| General education elective ³ | 3 | Semester Hours | 16 |
| Semester Hours | 16-17 | Fourth Year | |
| Second Year | | First Semester | |
| First Semester | | NPRE 431 Materials in Nuclear Engrg | 3 |
| MATH 241 Calculus III | 4 | NPRE 448 Nuclear Syst Engrg Design | 4 |
| PHYS 212 University Physics: Elec Mag | 4 | Professional Concentration Area electives ⁷ | 6 |
| TAM 210 ^{4,6} Introduction to Statics | 2 | General education elective ³ | 3 |
| Professional Concentration Area elective ⁷ | 3 | Semester Hours | 16 |
| General education elective ³ | 3 | Second Semester | |
| Semester Hours | 16 | NPRE 441 Radiation Protection | 4 |
| Second Semester | | NPRE 458 Design in NPRE | 4 |
| MATH 285 Intro Differential Equations | 3 | Professional Concentration Area electives | 6 |
| ME 200 Thermodynamics | 3 | Semester Hours | 14 |
| PHYS 214 Univ Physics: Quantum Physics | 2 | Total Hours: | 128 |
| NPRE 247 Modeling Nuclear Energy System | 3 | | |
| TAM 212 ⁶ Introductory Dynamics | 3 | | |
| General education elective ³ | 3 | | |
| Semester Hours | 17 | | |
| Third Year | | | |
| First Semester | | | |
| ECE 205 Electrical and Electronic Circuits | 3 | | |
| ECE 206 Electrical and Electronic Circuits Lab | 1 | | |
| NPRE 446 Radiation Interact w/Matter I | 3 | | |
| TAM 335 Introductory Fluid Mechanics | 4 | | |
| or ME | | | |
| 310 (or | | | |
| Professional | | | |
| Concentration | | | |
| Area | | | |
| elective in | | | |
| Radiological, | | | |
| Medical, | | | |
| and | | | |
| Instrumentation | | | |
| Applications) ⁸ | | | |
| General education elective ³ | 3 | | |

¹ MATH 220 may be substituted, with four of the five credit hours applying toward the degree. MATH 220 is appropriate for students with no background in calculus.

² RHET 105 (or an alternative Composition I sequence) is taken either in the first or second semester of the first year, according to the student's UIN (Spring if your UIN is Odd). Free Electives are taken the other semester. Composition I guidelines can be found at <http://catalog.illinois.edu/general-information/degree-general-education-requirements/> under Written Communication Requirement.

³ Students must take 6 hours from the campus General Education Social and Behavioral Sciences list, 6 hours from campus General Education Humanities and the Arts list, and 6 hours from a liberal education list approved by the college or from the campus General Education lists for Social and Behavioral Sciences or Humanities and the Arts. ECON 102 or ECON 103 must be one of the Social and Behavioral Sciences courses. Students must also complete the campus cultural studies requirement by completing (i) one western/comparative culture(s) course, (ii) one non-western culture(s) course, and (iii) one U.S. Minority Culture(s) course from the General Education cultural studies lists. Most students select general education courses that simultaneously satisfy these cultural studies requirements.

⁴ Students may elect to take CS 125 in place of CS 101, and TAM 211 in place of TAM 210. The extra hour will be applied toward the Professional Concentration Area electives.

- ⁵ Consideration should be given to NPRE 101 as a free elective in the spring semester of the freshman or sophomore year. Alternately, free elective hours provide a means to fulfill requirements for campus minors such as Bioengineering, Computer Science, International Minor in Engineering, Mathematics, or Physics, without excessive additional hours beyond the normal degree requirements.
- ⁶ Students in the Plasma and Fusion Science Engineering Professional Concentration Area may elect to take PHYS 325 in place of TAM 212. This facilitates the minor in Physics. Further, students in this concentration may elect to take both PHYS 325 and PHYS 326 in place of TAM 210 and TAM 212. The extra hour from PHYS 325 and PHYS 326 will be applied toward the Professional Concentration Area electives.
- ⁷ A student must fulfill the NPRE Professional Concentration Area requirement (<https://npre.illinois.edu/academics/undergraduate/technical-electives/>) by taking the required technical courses and technical elective courses in one of the three professional concentration areas: Power, Safety, and the Environment; Plasma and Fusion Science Engineering; or Radiological, Medical, and Instrumentation Applications.
- ⁸ Students in the Power, Safety, and the Environment and in the Plasma and Fusion Science Engineering Professional Concentration Areas must take a fluid mechanics course (TAM 335 or ME 310) and NPRE 421. Students in the Radiological, Medical, and Instrumentation Applications Concentration are not required to take these courses. They may instead use the hours otherwise filled with these courses to take electives in the Radiological, Medical and Instrumentation Applications Areas.