NUCLEAR, PLASMA, AND RADIOLOGICAL ENGINEERING: RADIOLOGICAL, MEDICAL & INSTRUMENTATION APPLICATIONS, BS

for the degree of Bachelor of Science in Nuclear, Plasma, & Radiological Engineering with a concentration in Radiological, Medical & Instrumentation Applications

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 radiological, medical and instrumentation applications concentration encompasses the intersection of radiation technologies, medicine, and security. This area focuses on developing science and engineering techniques that utilize ionizing radiation for biomedical research and healthcare as well as nuclear safeguards and radiation detection for homeland security. Areas of scholarship and research in which students are involved include but are not limited to: biomedical imaging, radiation detection and measurement systems, emerging x-ray imaging techniques, image processing, instrumentation for emission tomography (PET and SPECT), spectroscopy, dosimetry, homeland security, nuclear safeguards, nonproliferation, radiation protection during radiation therapy, big data analytics for radiation sensor networks, health physics, advanced thermal neutron detectors, and isotope identification algorithms. Students confer with their academic advisor on a chosen course set to ensure that a strong program is achieved. Students may select technical electives in the life sciences (chemistry, biology) to apply towards pre-med requirements. Technical electives are chosen from among NPRE courses and courses outside the department in the subfields of biomolecular and biomedical engineering. The program prepares graduates for positions in industry, research laboratories, federal and regulatory agencies, as well for medical programs and further graduate study.

Current Program Educational Objectives

for the degree of Bachelor of Science in Nuclear, Plasma, & Radiological Engineering with a concentration in Radiological, Medical & Instrumentation Applications

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 Sciiences	
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
Total Hours		**2**

Introductory Economics Elective

Code	Title	Hours
ECON 102	Microeconomic Principles	3
or ECON 103	Macroeconomic Principles	
Total Hours		**3**

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
Total Hours		**29**

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	Fundamentals of Fluid Dynamics	4
or TAM 335	Introductory Fluid Mechanics	
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
Total Hours		**53**

Professional Concentration Area

Code	Title	Hours
Required Courses		**5**
NPRE 435	Radiological Imaging	3
NPRE 452	Advanced Radiological Science Lab	2
Technical Electives		**12**
From Departmentally Approved List of Technical Electives - students are to take at least 12 hours. This includes technical electives from NPRE or from other departments in the subfields Biomolecular Engineering and Biomedical Engineering. The student is to confer with their academic adviser on a chosen course set to ensure that a strong program is achieved.		
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
MCB 150	Molec & Cellular Basis of Life	4
MCB 151	Molec & Cellular Laboratory	1
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 481	Writing on Technol & Security	3 or 4
NPRE 498	Special Topics	1 to 4
STAT 400	Statistics and Probability I	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	
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
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. (https://go.grainger.illinois.edu/FreeElectives/)		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-radiological-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
Composition I or Language Other Than English (3rd level) course	4	Language Other Than English (3rd level) or Composition I course	4
CHEM 102	3	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		
	17		**17**

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		
	17		**15**

Third Year

First Semester	Hours	Second Semester	Hours
NPRE 321 (or NPRE 330)	3	NPRE 349	2
MATH 257	3	NPRE 451	3
NPRE 445	4	NPRE 455	4
TAM 335 (ME 310 may be substituted)	4	ECE 205	3
General Education course (choose a Humanities or Social/Behavioral Science course with Cultural Studies designation)	3	Technical elective course	3
	17		**15**

Fourth Year			
First Semester	**Hours**	**Second Semester**	**Hours**
NPRE 330 (or NPRE 321)	3	NPRE 441	4
NPRE 435	3	NPRE 458	4
NPRE 449	3	Technical elective course	3
NPRE 452	2	Technical elective course	3
Technical elective course	3		
Free elective course	2		
	16		**14**

Total Hours 128

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The student outcomes are:

1. An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.
   a. Identify, formulate, and solve engineering problems.
   b. Advanced mathematics applied to nuclear engineering concepts.
   c. Transport and interaction of radiation with matter.
   d. Atomic and nuclear physics, quantum mechanics.
   e. Computational solutions.
2. An ability to apply the engineering design process to produce solutions that meet specified needs with consideration for public health and safety, and global, cultural, social, environmental, economic, and other factors as appropriate to the discipline.
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
   a. Develop and conduct experiments, analyze and interpret data, and use engineering judgment to draw conclusions.
   b. Measure nuclear and radiation processes specifically.
   c. Analyze and interpret data, using engineering judgement to draw conclusions from experimental data.
4. An ability to communicate effectively with a range of audiences.
5. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
   a. Recognize ethical and professional responsibilities.
   b. Make informed judgements.
6. An ability to recognize the ongoing need to acquire new knowledge, to choose appropriate learning strategies, and to apply this knowledge.
7. An ability to function effectively as a member or leader of a team that establishes goals, plans tasks, meets deadlines, and creates a collaborative and inclusive environment.

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

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