Nuclear Engineering

About the Nuclear Engineering Program

The Nuclear Engineering Program at University of Missouri was established in 1964 and conferred its first Master of Science degree in that same year. Undergraduate students may pursue an academic minor in nuclear engineering (a baccalaureate degree is not offered at this time).

The master's program is designed for those entering students with a B.S. degree in engineering or in chemistry or physics. Students from other fields will be considered on an individual basis. Those students who have attained a B.S. degree in nuclear engineering may be given revised curricula depending on their backgrounds and the requirements of the specific program in which they are enrolled.

The Ph.D. program is typically tailored to fit the academic needs and research goals of our students. The graduate certificates provide students and working professionals with the opportunity to develop unique skills and expertise for jobs in the areas of nuclear material protection, control and accountability.

Faculty


**Associate Professor** S. Kovaleski, J. Kwon, K. Trauth*, R. Winholz

**Assistant Professor** M. Bernards

**Associate Teaching Professor** G. Solbrekken

**Assistant Teaching Professor** S. Naz

- Graduate Faculty Member - membership is required to teach graduate-level courses, chair master's thesis committees, and serve on doctoral examination and dissertation committees.
- **Doctoral Faculty Member** - membership is required to serve on doctoral examination or dissertation committees. Graduate faculty membership is a prerequisite for Doctoral faculty membership.

Undergraduate

- Minor in Nuclear Engineering (http://catalog.missouri.edu/undergraduategraduate/collegeofengineering/nuclearengineering/minor-nuclear-engineering)

While MU does not offer undergraduate degrees specifically in nuclear engineering, the University does offer baccalaureate opportunities in a number of related areas, both within the College of Engineering, and in the other Schools and Colleges that make up the University. The catalog provides a complete list of these degree options (http://catalog.missouri.edu/degreesanddegreeprograms).

Graduate

- MS in Nuclear Engineering (http://catalog.missouri.edu/undergraduategraduate/collegeofengineering/nuclearengineering/ms-nuclear-engineering)

  - with emphasis in Environmental and Regulatory Compliance (http://catalog.missouri.edu/undergraduategraduate/collegeofengineering/nuclearengineering/ms-nuclear-engineering-emphasis-env-reg-compl)

- PhD in Nuclear Engineering (http://catalog.missouri.edu/undergraduategraduate/collegeofengineering/nuclearengineering/phd-nuclear-engineering)

  - with emphasis in Environmental and Regulatory Compliance (http://catalog.missouri.edu/undergraduategraduate/collegeofengineering/nuclearengineering/phd-nuclear-engineering-emphasis-env-reg-compl)

  - with emphasis in Materials (http://catalog.missouri.edu/undergraduategraduate/collegeofengineering/nuclearengineering/phd-nuclear-engineering-emphasis-materials)

  - with emphasis in Medical Physics (http://catalog.missouri.edu/undergraduategraduate/collegeofengineering/nuclearengineering/phd-nuclear-engineering-emphasis-medical-physics)

  - with emphasis in Thermal Hydraulics (http://catalog.missouri.edu/undergraduategraduate/collegeofengineering/nuclearengineering/phd-nuclear-engineering-emphasis-thermal-hydr)

  - Graduate Certificate in Nuclear Engineering (http://catalog.missouri.edu/undergraduategraduate/collegeofengineering/nuclearengineering/graduate-certificate-nuclear-engineering)

  - Graduate Certificate in Nuclear Safeguards Science and Technology (http://catalog.missouri.edu/undergraduategraduate/collegeofengineering/nuclearengineering/graduate-certificate-nuclear-safeguards-science-technology)

Contact for prospective students (those intending to apply):

Dr. Naz Islam, Director of Graduate Studies
319 Naka Hall
Columbia, MO 65211
(573) 882-7570 or islamm@missouri.edu

Nuclear Engineering Program

Dr. John M. Gahl, Director
207 Naka Hall
Columbia, MO 65211
(573) 882-5345 or gahlj@missouri.edu

About the Nuclear Science Engineering Program

The Nuclear Engineering Program at University of Missouri was established in 1964 and conferred its first Master of Science degree in that same year. Educational programs are closely connected with the research foci of participating faculty members. The master's program is designed for those entering students with a B.S. degree in engineering or in chemistry or physics. Students from other fields will be considered on an individual basis. Those students who have attained a B.S. degree in nuclear engineering may be given revised curricula depending on their backgrounds and the requirements of the specific program in which they are enrolled. The Ph.D. program is typically tailored to fit the academic needs and research goals of our students. The graduate certificates...
provide students and working professionals with the opportunity to develop unique skills and expertise for jobs in the areas of nuclear material protection, control and accountability.

**Illustrative Areas of Study**

Course topics include nuclear materials management, aerosol mechanics, reactor safety analysis, nuclear energy conversion, reactor physics, reactor design, nondestructive testing and measurement, radiative heat transfer, neutron spectrometry, neutron and gamma ray transport, neutron activation analysis, nuclear waste management, nuclear plasma research, health physics, magnetic resonance imaging, radiation therapy and alternative and renewable energy concepts.

**Students Admitted in 2012 and Earlier**

For nuclear engineering students admitted in 2012 and earlier (i.e., to the Nuclear Science Engineering Institute), the contact is Dr. Tushar Ghosh

NSEI Director of Graduate Studies

E2433 Lafferre Hall

(573) 882-9736

ghosht@missouri.edu

**NU_ENG 2201: Topics in Nuclear Engineering**

Current and new developments in nuclear engineering.

Credit Hours: 3

Prerequisites: sophomore standing; PHYSCS 1210 and PHYSCS 1220 and MATH 1100 or MATH 1120 or instructor's consent

**NU_ENG 2303: Harnessing the Atoms in Everyday Life: Fulfill M Curie's Dream**

Introduction to applications of nuclear science and technology, utilizing web-based learning scenarios.

Credit Hours: 3

**NU_ENG 4001: Topics in Nuclear Engineering**

Current and new developments in nuclear engineering. May be repeated for credit.

Credit Hour: 2-5

Prerequisites: instructor's consent

**NU_ENG 4302: Safe Handling of Radioisotopes**

Introduction of methods and procedures for safe handling of radioisotopes in the research laboratory. Intensive lecture and laboratory training sessions designed for persons planning to use radioisotopes at the University.

Credit Hour: 1

Prerequisites: instructor's consent

**NU_ENG 4305: Survey of Nuclear Engineering**

Introductory topics in nuclear engineering. Atomic and nuclear physics; nuclear reactor principles under steady-state and transient conditions; heat removal; shielding; instrumentation; power generation; fusion.

Credit Hours: 3

Prerequisites: concurrent with MATH 4100

**NU_ENG 4306: Advanced Engineering Math**

(same as CH_ENG 4306; cross-leveled with NU_ENG 7306). Applies ordinary and partial differential equations to engineering problems; Fourier's series; determinants and matrices; Laplace transforms; analog computer techniques.

Credit Hours: 3

Prerequisites: MATH 4100

**NU_ENG 4315: Energy Systems and Resources**

(same as ECE 4020). Analysis of present energy usage in Missouri, USA and the world, evaluation of emerging energy technologies and trends for the future. Economics and environmental impact of the developed technologies.

Credit Hours: 3

Prerequisites: ENGINR 2300 or equivalent

**NU_ENG 4315W: Energy Systems and Resources - Writing Intensive**

(same as ECE 4020). Analysis of present energy usage in Missouri, USA and the world, evaluation of emerging energy technologies and trends for the future. Economics and environmental impact of the developed technologies.

Credit Hours: 3

Prerequisites: ENGINR 2300 or equivalent

**NU_ENG 4319: Physics and Chemistry of Materials**

(same as PHYSCS 4190, BIOL_EN 4480 and CHEM 4490). Undergraduate/graduate level course offered every winter semester for students from Physics, Chemistry, Engineering and Medical Departments and consists of lectures, laboratory demonstrations, two mid term and one final exam. Graduate students will submit a term paper.

Credit Hours: 3

Prerequisites: PHYSCS 2760 and CHEM 1320 or equivalent and instructor's consent

**NU_ENG 4320: Natural Resources and Nuclear Energy**

Not for engineering students. Lecture, demonstration; describes physical environment, energy, power plants, nuclear reactors; radioactivity, its biological effects; health physics measures, rad-waste disposal; nuclear safeguards, nuclear explosives, societal implications.

Credit Hours: 3

Prerequisites: high school algebra

**NU_ENG 4328: Introductory Radiation Biology**

(same as BIO_SC 4328, RADIOL 4328, V_M_S 7328). Concepts of ionizing radiations, their actions on matter through effects on simple chemical systems, biological molecules, cell, organisms, man.
NU_ENG 4330: Science and Technology of Terrorism and Counter Terrorism
(same as PEA_ST 4330). Terrorism has been a familiar tool of political conflict, and it has assumed greater importance during the past twenty years. This subject has been treated by political scientists in various forms, but the scientific and technological aspects of different forms of terrorism cannot be found in a single place. It is important for persons who propose counter measures to understand the basics of different types of terrorism such as for instance the nature of chemical agents, their properties such as toxicity, etc. in order to build better defense systems.

Credit Hours: 3
Prerequisites: junior standing, Sciences/Engineering; one course in Biological Sciences and Physics/Chemistry; or instructor's consent

 NU_ENG 4331: Nonproliferation Issues for Weapons of Mass Destruction
Nonproliferation and impact on technology and world events.

Credit Hours: 3
Prerequisites: junior/senior standing or instructor's consent. May be repeated for credit

 NU_ENG 4331W: Nonproliferation Issues for Weapons of Mass Destruction - Writing Intensive
Nonproliferation and impact on technology and world events.

Credit Hours: 3
Prerequisites: junior/senior standing or instructor's consent. May be repeated for credit

 NU_ENG 4341: Nuclear Chemical Engineering
Principles and processes of importance in the field of nuclear technology.

Credit Hours: 3

 NU_ENG 4346: Introduction to Nuclear Reactor Engineering I
(same as ECE 4030). Engineering principles of nuclear power systems, primarily for the production of electrical energy.

Credit Hours: 3
Prerequisites: ENGINR 1200, ENGINR 2300 or equivalent

 NU_ENG 4349: Nuclear Engineering Materials
Properties of materials for reactor components; radiation damage and corrosion; metallurgy of reactor materials.

Credit Hours: 3
Prerequisites: upper division or graduate standing in Physical Sciences or Engineering, or instructor's consent

 NU_ENG 4350: Nuclear Forensic Analysis

Credit Hours: 3

 NU_ENG 4353: Introduction to Fusion
Basic plasma physics, principles of thermonuclear fusion, plasma confinement and heating, and devices.

Credit Hours: 3
Prerequisites: senior standing or instructor's consent

 NU_ENG 4357: Nuclear Heat Transport

Credit Hours: 2
Prerequisites: NU_ENG 4305, NU_ENG 4346 or instructor's consent

 NU_ENG 4359: Principles of Direct Energy Conversion
Principles and utilization of thermoelectric, thermonic, photovoltaic, magnetohydrodynamic generators and fuel cells.

Credit Hours: 3
Prerequisites: ENGINR 2300, MAE 3400, or equivalent

 NU_ENG 4365: Nuclear Power Engineering
Nuclear reactor heat generation and removal; nuclear reactor coolants; analysis of nuclear reactor power plants.

Credit Hours: 3
Prerequisites: ENGINR 2300

 NU_ENG 4369: Introduction to Plasmas
(same as ECE 4550; cross-leveled with NU_ENG 7375, ECE 7550). Equations of plasma physics, interaction of waves and plasmas; plasma sheaths and oscillations; measurements and applications.

Credit Hours: 3
Prerequisites: ECE 4930 or instructor's consent

 NU_ENG 4375: Introduction to Particulate Systems Engineering
An introduction to natural and engineered particulate systems.

Credit Hours: 3
Prerequisites: CH_ENG 3234 or MAE 4300 or equivalent

 NU_ENG 4382: Lasers and Their Applications
(same as ECE 4570; cross-leveled with NU_ENG 7382, ECE 7570). Introduction to lasers, from both a conceptual viewpoint and from the application of Maxwell's equation, to develop the optical theory for lasers.

Credit Hours: 3
Prerequisites: PHYSCS 2760, and MATH 4110

 NU_ENG 4391: Nuclear Radiation Detection
(same as CHEM 4600). Principles and application of radiation detectors and analyzers: ionization, Geiger-Muller, proportional, liquid and solid scintillation, semiconductor, pulse height analyzers, coincidence circuits, data reduction, tracer applications, activation analysis. Lectures, laboratory.
Credit Hours: 3  
Prerequisites: senior standing or instructor's consent  

**NU_ENG 7001: Topics in Nuclear Science and Engineering**  
Current and new developments in nuclear engineering.  
Credit Hour: 2-5  
Prerequisites: instructor's consent  

**NU_ENG 7080: Medical Ethics for Medical Physics**  
This course will start with an introduction into medical ethics then transitions into research procedures with humans and animals. This course will cover research ethics, professional conduct, authorship, publishing, and plagiarism.  
Credit Hour: 1  
Prerequisites: instructor's consent  

**NU_ENG 7085: Special Problems in Nuclear Science and Engineering**  
Special Problems in Nuclear Science and Engineering.  
Credit Hour: 1-5  

**NU_ENG 7087: Seminar in Nuclear Science and Engineering**  
Reviews of investigations and projects of importance in nuclear engineering.  
Credit Hour: 1  

**NU_ENG 7302: Safe Handling of Radioisotopes**  
Introduction of methods and procedures for safe handling of radioisotopes in the research laboratory. Intensive lecture and laboratory training sessions designed for persons planning to use radioisotopes at the University.  
Credit Hour: 1  
Prerequisites: instructor's consent  

**NU_ENG 7303: Radiation Safety**  
(same as RA_SCI 7303). Types and origins of radiation; radiation detection and measurement; radiation interactions; shielding; dose calculations; federal, state and local regulations; and procedures for safe uses of radiation. Laboratory experiments in radiation measurements and protection.  
Credit Hours: 3  
Prerequisites: college physics, calculus based  

**NU_ENG 7305: Survey of Nuclear Engineering**  
Introductory topics in nuclear engineering. Atomic and nuclear physics; nuclear reactor principles under steady-state and transient conditions; heat removal; shielding; instrumentation; power generation; fusion.  
Credit Hours: 3  
Prerequisites: concurrent with MATH 4100  

**NU_ENG 7306: Advanced Engineering Math**  
(cross-leveled with NU_ENG 7306). Applies ordinary and partial differential equations to engineering problems; Fourier's series; determinants and matrices; Laplace transforms; analog computer techniques.  

**NU_ENG 7313: Nuclear Science for Engineering for Secondary Science Teachers**  
This one-week course is for high school science and math teachers, and provides basic of nuclear scheme concepts and their applications, types of radiation (including radiation detection and protection), and industrial, medical and nuclear power generation application.  
Credit Hours: 3  
Prerequisites: instructor's consent; actively engaged in STEM teaching at the secondary level  

**NU_ENG 7315: Energy Systems and Resources**  
(same as ECE 7020). Analysis of present energy usage in Missouri, USA and the world, evaluation of emerging energy technologies and trends for the future. Economics and environmental impact of the developed technologies.  
Credit Hours: 3  
Prerequisites: ENGINR 2300 or equivalent  

**NU_ENG 7319: Physics and Chemistry of Materials**  
(same as PHYSCS 7190, BIOL_EN 7480 and CHEM 7490). Undergraduate/graduate level course offered every winter semester for students from Physics, Chemistry, Engineering and Medical Departments and consists of lectures or laboratory demonstrations, two midterm and one final exam. Graduate students will submit a term paper.  
Credit Hours: 3  
Prerequisites: PHYSCS 2760 and CHEM 1320 or equivalent and instructor's consent  

**NU_ENG 7320: Natural Resources and Nuclear Energy**  
Not for engineering students. Lecture, demonstration; describes physical environment, energy, power plants, nuclear reactors; radioactive, its biological effects; health physics measures, rad-waste disposal; nuclear safeguards, nuclear explosives, societal implications.  
Credit Hours: 3  
Prerequisites: high school algebra  

**NU_ENG 7328: Introductory Radiation Biology**  
(same as BIO.SC 7328, RADIOL 7328, and V_M_S 7328). Concepts of ionizing radiations, their actions on matter through effects on simple chemical systems, biological molecules, cell, organisms, man.  
Credit Hours: 3  
Prerequisites: Sciences/Engineering; one course in Biological Sciences and Physics/Chemistry; or instructor's consent  

**NU_ENG 7330: Science and Technology of Terrorism and Counter Terrorism**  
Terrorism has been a familiar tool of political conflict, and it has assumed greater importance during the past twenty years. This subject has been treated by political scientists in various forms, but the scientific and technological aspects of different forms of terrorism cannot be found in a single place. It is important for persons who propose counter measures to understand the basics of different types of terrorism such as for instance...
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<td>NU_ENG 7335</td>
<td>Nuclear Safeguards Science and Technology (same as ECE 7335)</td>
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<td>Nuclear materials management and safeguards, including physical protection systems, material accounting and control, monitoring, and regulatory issues.</td>
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<td>Equations of plasma physics, interaction of waves and plasmas; plasma sheaths and oscillations; measurements and applications.</td>
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<td>Particulate Systems Engineering</td>
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<td>Lasers and Their Applications</td>
<td>3</td>
<td>An introductory course in lasers. The course treats the subject from both a conceptual viewpoint and from the application of Maxwell's equations, to develop the optical theory for lasers. The course includes approximately 10 class-room hours of laboratory work with lasers.</td>
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<td>NU_ENG 7391</td>
<td>Nuclear Radiation Detection</td>
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<td>Principles and application of radiation detectors and analyzers: ionization, Geiger-Muller, proportional, liquid and solid scintillation, semiconductor, pulse height analyzers, coincidence circuits, data reduction, tracer applications, activation analysis. Lectures, laboratory.</td>
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<td>Radiation Shielding</td>
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<td>Fundamentals of radiation interactions stressing neutron and gamma radiation transport; ray theory, removal theory, multi-group transport shield design principles.</td>
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<td>NU_ENG 8409</td>
<td>Radiation Shielding</td>
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<td>Fundamentals of radiation interactions stressing neutron and gamma radiation transport; ray theory, removal theory, multi-group transport shield design principles.</td>
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NU_ENG 7470: Fast Reactor Analysis
Analytical methods for designing fast breeder reactor systems. Graded on a S/U basis only.

Credit Hours: 3
Prerequisites: NU_ENG 8412, NU_ENG 8432, NU_ENG 8451 or instructor's consent

NU_ENG 8001: Advanced Topics in Nuclear Science and Engineering
Advanced developments in nuclear engineering.

Credit Hours: 3
Prerequisites: instructor's consent

NU_ENG 8085: Problems in Nuclear Science and Engineering
Supervised investigation in nuclear engineering to be presented in the form of a report.

Credit Hour: 1-6

NU_ENG 8090: Research in Nuclear Science and Engineering
Independent investigation in nuclear engineering to be presented as a thesis. Graded on an S/U basis only.

Credit Hour: 1-99

NU_ENG 8402: Nuclear Fuel Cycle
Covers the nuclear fuel cycle from mine through enrichment, fuel element burn-up reactor physics, chemical reprocessing, waste disposal, with special emphasis on the newer proliferation-resistant fuel cycles.

Credit Hours: 3
Prerequisites: NU_ENG 4386 or NU_ENG 4305 and instructor's consent

NU_ENG 8403: Applied Topics in Medical Physics and Health Physics
Directed observations and experience in scientific aspects of daily operations in nuclear medicine, diagnostic radiology, radiotherapy and health physics.

Credit Hour: 1-6
Prerequisites: departmental consent

NU_ENG 8404: Nuclear Reactor Laboratory I
Application of reactor physics principals to operation of and experiments with the University of Missouri Research Reactor. Neutron activation analysis, instrumentation, reactivity evaluation.

Credit Hours: 3
Prerequisites: NU_ENG 4346 or NU_ENG 8411

NU_ENG 8405: Nuclear Reactor Laboratory II
Advanced experiments to measure diffusion length, Fermi age, material buckling, transfer function, neutron spectrum and other reactor characteristics. Reactor simulation with an analog computer.

Credit Hours: 3
Prerequisites: NU_ENG 8411 or instructor's consent

NU_ENG 8406: Clinical and Research Application in Medical and Health Physics
To give students an understanding of the range of clinical practice and medical research involving the practice and nuclear physics/engineering.

Credit Hour: 1
Prerequisites: NU_ENG 8409 and NU_ENG 4303, college calculus or equivalent and calculus based physics

NU_ENG 8408: State Variable Methods in Automatic Control
(same as CH_ENG 8780, ECE 8780, and MAE 8780). State variables for continuous and discrete-time dynamic control systems; controllability and observability; optimal control of linear systems.

Credit Hours: 3
Prerequisites: CH_ENG 4370, ECE 4310, MAE 4730 or instructor's consent

NU_ENG 8409: Interaction of Radiation with Matter
Theory/applications of radiation interaction processes. Reviews nuclear physics concepts; radioactive decay; sources/ spectra of ionizing radiation; collision mechanisms for charged particles, electromagnetic radiation, neutrons for interaction with matter.

Credit Hours: Entrance requirements

NU_ENG 8411: Nuclear Reactor Theory I
Nuclear reactions; nuclear fission; introduces neutron transport; diffusion and slowing down of neutrons; steady-state homogeneous and heterogeneous reactor theory.

Credit Hours: 3
Prerequisites: instructor's consent

NU_ENG 8412: Nuclear Reactor Theory II
Linear and non-linear reactor kinetics; perturbation theory; temperature and fission product effects; control rod theory; transport theory.

Credit Hours: 3
Prerequisites: NU_ENG 8411 or NU_ENG 4346

NU_ENG 8421: Advanced Radiation Detection Electronics
Principles of radiation pulse analysis with emphasis on applications. Radiation detection devices; amplifying, shaping and discrimination circuits; nuclear pulse analysis; automated data analysis systems. Lectures and lab.

Credit Hours: 3
Prerequisites: NU_ENG 4346, NU_ENG 4391 or instructor's consent

NU_ENG 8422: Radiation Shielding
Fundamentals of radiation interactions stressing neutron and gamma radiation transport; ray theory, removal theory, multi-group transport shield design principles.

Credit Hours: 3
Prerequisites: NU_ENG 8409 or instructor's consent
NU_ENG 8429: Radiation Dosimetry
Basis and applications of conventional and microscopic radiation dosimetry. Dose concepts and quantities; biological dose-response models; dose measurement principles; photon, charged particle, and neutron dosimetry.

Credit Hours: 3
Prerequisites: NU_ENG 8409
Recommended: NU_ENG 4328

NU_ENG 8432: Nuclear Thermal Hydraulics and Safety
Engineering topics from reactor heat transfer and thermal stresses, fuel cycle analysis, power plant thermodynamics, shielding, and reactor safety analysis.

Credit Hours: 3
Prerequisites: NU_ENG 8411 or NU_ENG 4346, or instructor's consent

NU_ENG 8434: Fracture Mechanics I
(same as MAE 8220). Mechanics of flawed structure. Concepts include Griffith theory, Barenblatt's theory, Irwin analysis, energy analysis of cracked bodies, fracture toughness testing, plane strain, plane stress, transition temperature concepts, subcritical flaw growth.

Credit Hours: 3
Prerequisites: MAE 3200 or instructor's consent

NU_ENG 8435: Physics of Diagnostic Radiology
Principles and applications of X-ray production and interactions. Images production concepts including X-ray film, intensifying screens, grids, fluoroscopy, image intensification and television monitors. Image quality analysis and assessment.

Credit Hours: 3
Prerequisites: NU_ENG 8409 or equivalent or instructor's consent

NU_ENG 8439: Clinical Physics in Radiotherapy
Principles and applications of radiation producing units, exposure and dose measurements, and calibration. External beam physics parameters and application to fixed field and rotational field treatment planning.

Credit Hours: 3
Prerequisites: NU_ENG 8409 or equivalent or instructor's consent

NU_ENG 8444: Fracture and Fatigue Prevention in Engineering Practice
Practical design problems. Introduction to retrofit design, maintenance, product improvement and new design from a fatigue and fracture prevention philosophy. Fail safe and safe life designs are presented.

Credit Hours: 3
Prerequisites: NU_ENG 8434

NU_ENG 8450: Superconductivity and Its Applications
(same as ECE 8020). Phenomenology and theory of superconductivity; cryogenic practice; metallurgy of superconducting elements, alloys and compounds. Applications, present and prospective. Graded on an S/U basis only.

Credit Hours: 3
Prerequisites: NU_ENG 8412, NU_ENG 8432, NU_ENG 8451 or instructor's consent

NU_ENG 8451: Computational Methods of Reactor Analysis
Applies numerical analysis and digital computation to topics from multi-group diffusion theory, transport theory, reactor kinetics, reactor thermal hydraulics, radiation shielding, reactor safety.

Credit Hours: 3
Prerequisites: NU_ENG 8411 and MATH 4300

NU_ENG 8452: Ultrasound and Magnetic Resonance Imaging
The physical principles of MRI and ultrasound including clinical instrumentation, artifacts in images, biological effects and quality control. Images obtained with both techniques will be presented.

Credit Hours: 3
Prerequisites: NU_ENG 4391, NU_ENG 8409, NU_ENG 4306 or equivalent

NU_ENG 8453: Advanced Fusion Theory
Plasma stability theory, charged particle diffusion, slowing down of charged particles, interaction of radiation with matter, direct energy conversion using charged particles, and engineering considerations.

Credit Hours: 3
Prerequisites: NU_ENG 4353 and NU_ENG 4375 or PHYSCS 8450 or instructor's consent

NU_ENG 8454: Clinical Physics of Nuclear Medicine
Physical principles, statistics of radionuclide decay and highlights into the most current instrumentation to utilize in vivo radionuclides for both diagnostic imaging and therapy. Also includes brachy therapy.

Credit Hours: 3
Prerequisites: NU_ENG 4306, NU_ENG 8409 or equivalent

NU_ENG 8455: Growth, Characterization and Appl. of Diamond and Related Materials
This course explores the development of diamond films. Discussion of other wide band-gap materials are covered. Topics include Chemistry of Diamond Growth, Thermodynamics, Nucleation, Methods of Growth, Methods of Impurity Control, Characterization and Modification, Doping, and Applications.

Credit Hours: 3
Prerequisites: MAE 3200 or equivalent

NU_ENG 8461: Neutron Transport Theory
The Boltzmann equation; general properties and solution; numerical methods of solving the transport equation; neutron thermalization and neutron spectra.

Credit Hours: 3
Prerequisites: NU_ENG 8412; MATH 4940, MATH 4300, or instructor's consent

NU_ENG 8470: Fast Reactor Analysis
Analytical methods for designing fast breeder reactor systems. Graded on a S/U basis only.

Credit Hours: 3
Prerequisites: NU_ENG 8412, NU_ENG 8432, NU_ENG 8451 or instructor's consent
NU_ENG 8471: Radiation Protection
Theory and applications of radiation protection and health physics. Radiation dosimetry methods and calculations, shielding evaluations, equipment surveys and inspection, environmental monitoring, radiation standards and regulations and administration presented.

Credit Hours: 3
Prerequisites: NU_ENG 4303 and NU_ENG 4328

NU_ENG 9090: Research in Nuclear Science and Engineering
Independent investigation in nuclear engineering to be presented as a thesis. Graded on an S/U basis only.

Credit Hour: 1-99