NUCLEAR ENGINEERING

The nuclear engineering program is offered under the department of nuclear engineering and radiation science.

The nuclear engineering program has a primary mission to provide an outstanding and comprehensive undergraduate and graduate education to tomorrow's leaders in nuclear engineering and radiation science. The bachelor of science program provides each student with fundamental knowledge of nuclear engineering and related technologies, analytical and problem solving ability, ability for technical communications, professional ethics, leadership and interpersonal skills, capability to conduct research, and the ability to recognize the value of life-long learning. It is the only nuclear engineering degree program accredited in the state of Missouri. The nuclear engineering faculty, interact with professional societies, national laboratories, and the nuclear industry to promote continuing education, research opportunities, and public dissemination of information about issues and advances in the field.

Nuclear engineers develop and promote the utilization of energy released from nuclear fission, fusion, and the decay of radioisotopes. Currently, there are nearly 100 nuclear power plants operating in the United States producing about 20 percent of our nation's electricity and about 50% of our low carbon energy. These plants use nuclear fission to produce energy and are cooled by ordinary (light) water, hence the name, Light Water Reactors. This technology reduces the emission of greenhouse gases like carbon dioxide significantly, thus contributing to a better environment. In addition, nuclear reactors are used for the propulsion of submarines and aircraft carriers.

In fusion power plants, under development, strong magnetic fields contain a plasma fuel of hydrogen isotopes, such as deuterium, at temperatures hotter than the sun. The deuterium extracted from one gallon of water could produce as much energy as burning several hundred gallons of gasoline.

Radioisotopes are used in industry and research, and in medicine for diagnostic and therapeutic purposes. The medical use of radioisotopes and X-rays saves hundreds of thousands of lives every year throughout the world. Radioisotopes are also used in small power generators for space flights.

If you choose nuclear engineering, you could work in the areas of nuclear reactor design, plant licensing, plant operation, fuel management and development, radioactive waste disposal, health physics, instrumentation and control, fusion research, space nuclear power, and applications of radioisotopes in industry, medicine, and research. As a nuclear engineer, you might be employed by utilities, reactor vendors, architect-engineering firms, consulting firms, industrial research centers, national laboratories, hospitals, government agencies or universities.

The nuclear engineering curriculum consists of three components: general education, mathematics and basic sciences, and engineering topics. The students apply the principles of physics, chemistry and mathematics to the study of engineering topics which include statics, mechanics of materials, electronic circuits and machines, thermodynamics, and metallurgy. The knowledge gained in these areas is applied to the understanding of nuclear engineering topics including reactor fluid mechanics and heat transfer, reactor physics, nuclear radiation measurements, radioactive waste management, reactor operation, and nuclear materials.

Engineering design and hands-on laboratory experiences are an integral part of a significant number of required courses in the nuclear engineering program. Design topics include but are not limited to reactor cooling systems, radiation protection, structural components, waste disposal and transportation systems, nuclear reactor cores and the design of experiments for radiation detection and measurement. While obtaining experience in these areas the students are prepared for designing a complete nuclear system such as a nuclear plant for electric power generation, space propulsion, desalination, district heating or radioisotope production for industrial, medical or research applications.

Laboratory facilities available to nuclear engineering students include a radiation measurements laboratory, a 200 kW pool-type nuclear reactor, a materials analysis laboratory, a radiochemistry lab, and a neutron generator. The students have access to state-of-the-art computing facilities including personal computers, and a high-performance cluster. The department offices and laboratories are primarily housed in Fulton Hall. The nuclear reactor is housed in its own building.

Mission Statement

The primary mission of the nuclear engineering program is to provide well-educated nuclear engineering professionals and leaders to Missouri and the nation in the commercial nuclear industry, national laboratories, graduate schools, and the nation's defense and federal agencies.

Educational Objectives

- Fundamental knowledge of nuclear engineering and related technologies. Our graduates will continue to demonstrate a sound fundamental knowledge of nuclear engineering and related technologies as members of their professional community.
- Analytical and problem solving ability. Our graduates will continue to use logical, creative, collaborative, analytical and problem solving abilities to address emerging multidisciplinary endeavors.
- Technical communication and interpersonal skills. Our graduates will continue to demonstrate technical communication and interpersonal skills, enabling them to excel in their profession.
- Leadership and professional ethics. Our graduates will continue to demonstrate leadership with an understanding of, and a commitment to, professional ethics.
- Capability to conduct research. Our graduates will continue to demonstrate the capability to conduct research enabling them to contribute to meeting the needs of their profession.
- Pursuit of life-long learning. Our graduates will continue to demonstrate a recognition of, and a desire for, the pursuit of life long learning that will foster their ability to adapt to change.

Student Outcomes

1. The ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. An ability to apply engineering design to produce solutions that meets specified needs with consideration of public health, safety and welfare as well as global, cultural, social, environmental, and economic factors
3. An ability to communicate effectively with a range of audiences

4. 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
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Bachelor of Science Nuclear Engineering

The nuclear engineering program at Missouri S&T is characterized by its focus on the scientific basics of engineering and its innovative application. The necessary interrelations among the various topics, the engineering disciplines, and the other professions as they naturally come together in the solution of real world problems are emphasized as research, analysis, synthesis, and design are presented and discussed through classroom and laboratory instruction.

For the bachelor of science degree in nuclear engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. A student must maintain an average of at least two grade points overall and for all courses taken in nuclear engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work from the humanities and the social sciences areas and should be chosen according to the following rules:

1. All students are required to take one American history course and one economics course. The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310,or POL SCI 1200. The economics course may be either ECON 1100 or ECON 1200.
2. Students must take ENGLISH 1120. Students must also take one communications elective, selected from ENGLISH 1160, ENGLISH 3560, or SP&M S 1185.
3. The remaining nine hours must be taken in humanities or social sciences at the 1000 level or above. Foreign language courses numbered 1180 can be considered to be one of these courses. (Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 4000 level.)
4. Skill courses are not allowed to meet humanities and social sciences requirements except in foreign languages. Students who select the foreign language option are urged to take more than one course.
5. Special topics, special problems courses and honors seminars are allowed only by petition to and approval by the student's department chair.

Freshman Year			
First Semester	**Credits**	**Second Semester**	**Credits**
ENGLISH 1120	3	HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3
FR ENG 1100	1	MATH 1215	4
MATH 1214 or 1211	4	MECH ENG 1720	3
NUC ENG 1105[1]	1	PHYSICS 1135	4
CHEM 1100	1	Elective-Hum or Soc Sci[2]	3
CHEM 1310	4		
CHEM 1319	1		
	15		17
Sophomore Year			
First Semester	**Credits**	**Second Semester**	**Credits**
CIV ENG 2200	3	CIV ENG 2210	3
COMP SCI 1972, or 1970, or 1971	2	ECON 1100 or 1200	3
COMP SCI 1982, or 1980, or 1981	1	MATH 3304	3
MATH 2222	4	MECH ENG 2519	3
NUC ENG 2105	2	NUC ENG 2406	1
PHYSICS 2135	4	NUC ENG 3103, or PHYSICS 2305, or PHYSICS 2311	3
	16		16
Junior Year			
First Semester	**Credits**	**Second Semester**	**Credits**
ELEC ENG 2800	3	ENGLISH 1160, or 3560, or SPM S 1185	3
MET ENG 2110	3	NUC ENG 4312 or 5312	3
NUC ENG 3205	3	NUC ENG 3223	3
NUC ENG 3221	3	NUC ENG 4203 or 5203	3
COMP SCI 3200 (OR 3000 Level MATH, 5000 Level STAT)	3	STAT 3115, or 3111, or 3113, or 3117	3
		Nuclear Engineering Elective[3]	3
	15		18
Senior Year			
First Semester	**Credits**	**Second Semester**	**Credits**
NUC ENG 4207 or 5207	3	NUC ENG 4438 or 5438	2
NUC ENG 4241 or 5241	3	NUC ENG 4497	3
NUC ENG 4428 or 5428	3	Technical Elective - 3000 or 4000 level[4]	3
NUC ENG 4496	2	Technical Elective - 4000 Level	3
Nuclear Engineering Elective	3	Elective - Hum or Soc Sc	3
Elective-Hum or Soc Sc	3		
	17		14

Total Credits: 128

Note: Minimum credit hours for graduation is 128.

1 Nuclear Engineering students are expected to take Nuclear Technology Applications (NUC ENG 1105) during their Freshman year. However, transfer students are exempt. Students who attend the Nuclear Engineering Summer Camp as high school students may have this requirement waived.
2 Humanities and Social Science to be taken in accordance with the policy described above.
3 Any Nuclear Engineering course 4000 level or higher.
4 Any Math, Science, or Engineering courses at the appropriate level.

Fundamentals of Engineering Exam: All nuclear engineering students must take the Fundamentals of Engineering Examination prior to graduation. A passing grade on this examination is not required to earn a B.S. degree, however, it is the first step toward becoming a registered professional engineer. This requirement is part of the Missouri S&T assessment process as described in assessment requirements found elsewhere in this catalog.

Nuclear Engineering Minor Curriculum

A nuclear engineering minor enhances the academic credentials of a student and broadens his/her employment choices. A minimum of 15 hours is required for a minor in nuclear engineering.

Before the courses listed below can be taken, the student should have completed MATH 3304 (or equivalent) and PHYSICS 2305 (or NUC ENG 3103 or equivalent). Required courses are:

NUC ENG 3205	Fundamentals of Nuclear Engineering	3
NUC ENG 3223	Reactor Heat Transfer	3
NUC ENG 4312	Nuclear Radiation Measurements and Spectroscopy	3

The other 6 hours should be selected from nuclear engineering 3000 or 4000 level courses.

Muthanna Hikmat Al Dahhan, Curators' Distinguished Professor
DSc Washington University

Ayodeji Babatunde Alajo, Associtate Professor
PHD Texas A&M University

Syed Bahauddin Alam, Assistant Professor
PHD University of Cambridge

Carlos Henry Castano Giraldo, Associate Professor
PHD University of Illinois Urbana-Champaign

Joseph Graham, Associate Professor
PHD University of Texas at Austin

Joseph W Newkirk, Professor and Department Chair of Nuclear Engineering and Radiation Science
PHD University of Virginia

Joshua P Schlegel, Associate Professor
PHD Purdue University

Joseph D Smith, Professor and Laufer Endowed Chair in Energy
PHD Brigham Young University

Shoaib Usman, Associate Professor
PHD University of Cincinnati

Haiming Wen, Assistant Professor
PHD University of California-Davis

NUC ENG 1105 Nuclear Technology Applications (LEC 1.0)
It is a project oriented course that examines various aspects of nuclear technology, such as radiation detection, radiation protection, food irradiation, medical and industrial applications. The students will work in small groups on stimulating projects.

NUC ENG 2001 Special Topics (LEC 0.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

NUC ENG 2105 Introduction To Nuclear Engineering (LEC 2.0)
Atoms and nuclei; nuclear reactions; radioactivity; interactions of radiation with matter; fission and fusion reactors; nuclear fuels; radiation effects on materials and man; radioactive waste disposal; reactor safety; radiation protection. Prerequisite: Math 1215 or Math 1221.

NUC ENG 2406 Reactor Operations I (LAB 1.0)
A first course in reactor operations training and practical approach to nuclear reactor concepts. Students will receive hands-on training and are encouraged to take the NRC Reactor Operator's Exam. Prerequisites: Math 1214 or Math 1208 or Math 1211.

NUC ENG 3000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

NUC ENG 3001 Special Topics (LAB 0.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

NUC ENG 3103 Interactions Of Radiation With Matter (LEC 3.0)
Atoms and nuclei; relativistic kinematics; quantum theory; nuclear decay; cross sections; neutron, gamma, and charged particle interactions; production of radioisotopes; electrical, thermal and magnetic properties of solids. Prerequisites: Math 2222, Physics 2135.

NUC ENG 3205 Fundamentals of Nuclear Engineering (LEC 3.0)
An introduction to the principles and equations used in nuclear fission reactor technology including: reactor types; neutron physics and reactor theory; reactor kinetics and control; radiation protection; reactor safety and licensing; and environmental aspects of nuclear power. Prerequisites: Math 3304; Preceded or accompanied by Physics 2305 or 2311, or Nuc Eng 3103.

NUC ENG 3221 Reactor Fluid Mechanics (LEC 3.0)
A study of the fundamental principles of incompressible viscous and inviscid flows in ducts, nozzles, tube bundles and applications to nuclear engineering; fluid statics; dimensional analysis and similitude; boundary layer theory. Prerequisites: Mech Eng 2519 or Mech Eng 2527, Math 3304, Junior standing.

NUC ENG 3223 Reactor Heat Transfer (LEC 3.0)
A study of the fundamental principles of conduction, convection and thermal radiation with volumetric source terms for nuclear engineering applications; empirical correlations; finite difference methods; analysis of nuclear reactor cores. Prerequisite: Nuc Eng 3221.

NUC ENG 4000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

NUC ENG 4001 Special Topics (LEC 0.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

NUC ENG 4099 Undergraduate Research (IND 0.0-6.0)
Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

NUC ENG 4203 Reactor Physics I (LEC 3.0)
Study of neutron interactions, fission, chain reactions, neutron diffusion and neutron slowing down; criticality of a bare thermal homogeneous reactor. Prerequisite: Nuc Eng 3205.

NUC ENG 4207 Nuclear Fuel Cycle (LEC 3.0)
Nuclear fuel reserves and resources; milling, conversion, and enrichment; fuel fabrication; in-and-out-of core fuel management; transportation, storage, and disposal of nuclear fuel; low level and high level waste management; economics of the nuclear fuel cycle. Prerequisite: Nuc Eng 3205.

NUC ENG 4229 Nuclear Power Plant Systems (LEC 3.0)
A study of current nuclear power plant concepts and the environmental, economics and safety considerations affecting their design. Includes such topics as: thermodynamics, thermal hydraulics, and mechanical and electrical aspects of nuclear power facilities. Prerequisites: Nuc Eng 3205 and accompanied or preceded by Nuc Eng 3223.

NUC ENG 4241 Nuclear Materials I (LEC 3.0)
Fundamentals of materials selection for components in nuclear applications; design and fabrication of UO2 fuel; reactor fuel element performance; mechanical properties of UO2; radiation damage and effects, including computer modeling; corrosion of materials in nuclear reactor systems. Prerequisites: Civ Eng 2210; Nuc Eng 3205; Nuc Eng 3223; Met Eng 2110. (Co-listed with Met Eng 5170).

NUC ENG 4253 Monte Carlo Approach to Reactor Analysis (LEC 3.0)
An introduction to a stochastic method for solving particle transport problems with a view to utilize the method in reactor design and analysis, shielding problems, flux calculations, reaction rates determination and general steady state reactor physics analysis. Prerequisites: Accompanied by NUC ENG 3205.

NUC ENG 4257 Two-phase Flow in Energy Systems - I (LEC 3.0)
It is an introductory course for both undergraduate or graduate students who are interested in the application of two-phase flow in energy systems. It will acquaint students with governing equations for both single-phase and two-phase fluid flow, state-of-the-art analytical methods and various two-phase flow phenomena related to energy systems. Prerequisite: Nuc Eng 3221 or Chem Eng 3101 or Mech Eng 3131.

NUC ENG 4259 Licensing Of Nuclear Power Plants (LAB 1.0 and LEC 2.0)
The pertinent sections of the Code of Federal Regulations, the Nuclear Regulatory Commission's Regulatory Guides and Staff Position Papers, and other regulatory requirements are reviewed. Safety analysis reports and environmental reports for specific plants are studied. Operational aspects of the nuclear power plant will be covered by including field trips. Prerequisite: Nuc Eng 3205.

NUC ENG 4281 Probabilistic Risk Assessment (LEC 3.0)
A discussion of the techniques for assessment of reliability, safety and risk associated with complex systems such as those encountered in nuclear power. Classification of accidents, fault tree analysis, consequences, figures of merit, and use of probabilistic risk analysis in regulation are discussed. (Co-listed with Eng Mgt 4281).

NUC ENG 4312 Nuclear Radiation Measurements and Spectroscopy (LAB 1.0 and LEC 2.0)
Contemporary radiation detection theory and experiments with high resolution gamma-ray spectroscopy, solid state detectors, neutron detection and conventional gas filled detectors. Neutron activation analysis of unknown material, statistical aspects of nuclear measurements. Prerequisite: Nuc Eng 3205, Elec Eng 2800.

NUC ENG 4345 Nuclear Engineering Mathematical Methods (LEC 3.0)
Application of mathematical methods used in the solution of nuclear engineering problems, particularly with the neutron kinetics equations, the Navier-Stokes equations, and the heat conduction equation with nuclear heat generation terms. Prerequisites: Nuc Eng 4203.

NUC ENG 4347 Radiological Engineering (LEC 3.0)
Radiation exposure pathways analysis. Modeling of radionuclides transport through atmosphere, surface and ground water. Human health impact. Transportation of nuclear waste. Nuclear Waste characterization. Regulatory structure and requirements. Scenario case studies and computer simulation of transport. Prerequisite: Nuc Eng 3205.

NUC ENG 4350 Introduction to Nuclear Medical Science (LEC 3.0)
Introduction to physics and technologies involved in various radiological imaging and treatment systems in the medical field, such as digital radiography, digital mammography, computed tomography and nuclear medicine instruments will be covered. Prerequisites: Nuc Eng 4312 or equivalent. (Co-listed with Nuc Eng 5350).

NUC ENG 4361 Fusion Fundamentals (LEC 3.0)
Introduction to the plasma state, single particle motion, kinetic theory, plasma waves, fusion, power generation, radiation mechanisms, inertial confinement and fusion devices, including conceptual fusion power plant designs. Prerequisite: Preceded or accompanied by Math 3304.

NUC ENG 4363 Applied Health Physics (LEC 3.0)
Radiation sources; external and internal dosimetry; biological effects of radiation; radiation protection principles; regulatory guides; radioactive and nuclear materials management. Prerequisite: Nuc Eng 3103 or Physics 2305.

NUC ENG 4367 Radioactive Waste Management And Remediation (LEC 3.0)
Sources and classes of radioactive waste, long-term decay, spent fuel storage, transport, disposal options, regulatory control, materials issues, site selection and geologic characterization, containment, design and monitoring requirements, domestic and foreign waste disposal programs, economic and environmental issues, history of disposal actions, and conduct of remedial actions and clean up. Prerequisite: Math 3304. (Co-listed with Geology 4421).

NUC ENG 4370 Plasma Physics I (LEC 3.0)
Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices. Introduction to plasma kinetic theory. Prerequisite: Aero Eng 3131 or Mech Eng 3131 or Physics 3211 or Nuc Eng 3221 or Elec Eng 3600. (Co-listed with Aero Eng 5570, Mech Eng 5570, Physics 4543).

NUC ENG 4428 Reactor Laboratory I (LAB 1.0 and LEC 2.0)
Acquaints the student with neutron flux measurement, reactor operation, control rod calibration, reactor power measurement and neutron activation experiments. Experiments with the thermal column and neutron beam port are also demonstrated. Prerequisites: Nuc Eng 4312, Nuc Eng 3205.

NUC ENG 4438 Reactor Laboratory II (LAB 1.0 and LEC 1.0)
A continuation of Nuclear Engineering 4428 with experiments of a more advanced nature. Prerequisite: Nuc Eng 4428.

NUC ENG 4456 Reactor Operation II (LAB 1.0)
The operation of the training reactor. The program is similar to that required for the NRC Reactor Operator's license. Students from other disciplines will also benefit from the course. Prerequisite: Nuc Eng 2105, 2406.

NUC ENG 4496 Nuclear System Design I (LAB 1.0 and LEC 1.0)
A preliminary design of a nuclear system (e.g. a fission or fusion nuclear reactor plant, a space power system, a radioactive waste disposal system). Prerequisites: Nuc Eng 3223, Nuc Eng 4203 or Nuc Eng 5203; preceded or accompanied by Nuc Eng 4241 or Nuc Eng 5241.

NUC ENG 4497 Nuclear System Design II (LEC 3.0)
A complete design of a nuclear system (e.g.a fission or fusion nuclear reactor plant, a space power system, a radioactive waste disposal system). Prerequisite: Nuc Eng 4496.

NUC ENG 4577 Nuclear Forensics and Radiochemistry (LEC 3.0)
Learn the fundamentals of radiochemistry and its application to the broad field of Nuclear Forensics. Includes a review of nuclear science and cosmochemistry (the origin of the chemical elements), a historical review of spent fuel reprocessing techniques including solvent extraction. A broad review of the modern nuclear forensics field and its importance. Prerequisites: Nuc Eng 2105 recommended.

NUC ENG 5000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in he department. Consent of instructor required.

NUC ENG 5001 Special Topics (IND 0.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

NUC ENG 5010 Seminar (RSD 0.0-6.0)
Discussion of current topics.

NUC ENG 5203 Reactor Physics I (LEC 3.0)
Study of neutron interactions, fission, chain reactions, neutron diffusion and neutron slowing down; criticality of a bare thermal homogeneous reactor. Prerequisite: Nuc Eng 3205.

NUC ENG 5207 Nuclear Fuel Cycle (LEC 3.0)
Nuclear fuel reserves and resources; milling, conversion, and enrichment; fuel fabrication; in-and-out-of core fuel management; transportation, storage, and disposal of nuclear fuel; low level and high level waste management; economics of the nuclear fuel cycle. Prerequisite: Nuc Eng 3205.

NUC ENG 5241 Nuclear Materials I (LEC 3.0)
Fundamentals of materials selection for components in nuclear applications; design and fabrication of UO2 fuel; reactor fuel element performance; mechanical properties of UO2; radiation damage and effects, including computer modeling; corrosion of materials in nuclear reactor systems. Prerequisites: Civ Eng 2210; Nuc Eng 3205: Nuc Eng 3223; Met Eng 2110. (Co-listed with Met Eng 5170).

NUC ENG 5251 Reactor Kinetics (LEC 3.0)
Derivation and solutions to elementary kinetics models. Application of the point kinetics model in fast and thermal reactor dynamics, internal and external feedback mechanisms, rigorous derivation and solutions of the space dependent kinetics model fission product and fuel isotope changes during reactor operation. Prerequisite: Nuc Eng 3205.

NUC ENG 5257 Introduction to Nuclear Thermal Hydraulics (LEC 3.0)
An introductory course in the application of thermal-hydraulic principles to energy systems, with emphasis on nuclear energy issues. Will include the development of constitutive models and applications to power systems, fluid mechanics, and heat transfer problems (including multiphase flows). Prerequisite: Graduate standing.

NUC ENG 5281 Introduction to Probabilistic Risk Assessment (LEC 3.0)
An introduction to advanced techniques for assessing reliability, safety and risk in complex systems. Classification of initiating events, fault tree analysis, consequences, figures of merit, and use of probabilistic risk analysis in regulation are discussed using examples and applied through a simple case study. (Co-listed with Sys Eng 5281).

NUC ENG 5312 Nuclear Radiation Measurements and Spectroscopy (LAB 1.0 and LEC 2.0)
Contemporary radiation detection theory and experiments with high resolution gamma-ray spectroscopy, solid state detectors, neutron detection and conventional gas filled detectors. Neutron activation analysis of unknown material, statistical aspects of nuclear measurements. Prerequisite: Nuc Eng 3205.

NUC ENG 5347 Radiological Engineering (LEC 3.0)
Radiation exposure pathways analysis. Modeling of radionuclides transport through atmosphere, surface and ground water. Human health impact. Transportation of nuclear waste. Nuclear Waste characterization. Regulatory structure and requirements. Scenario case studies and computer simulation of transport. Prerequisite: Nuc Eng 3205.

NUC ENG 5350 Advanced Nuclear Medical Science (LEC 3.0)
Advanced level of technologies involved in medical modalities, such as digital radiography, digital mammography, modern computed tomography, gamma camera, SPECT and PET will be covered. Prerequisites: Nuc Eng 4312 or equivalent.

NUC ENG 5363 Applied Health Physics (LEC 3.0)
Radiation sources; external and internal dosimetry; biological effects of radiation; radiation protection principles; regulatory guides; radioactive and nuclear materials management. Prerequisite: Nuc Eng 3103 or Physics 2305.

NUC ENG 5365 Radiation Protection Engineering (LEC 3.0)
Radiation fields and sources including nuclear reactors, radioactive wastes, x-ray machines, and accelerators. Stopping of radiation (Charges particles, photons, and neutrons) by matter. Radiation transport methods. Radiation shielding design. Dose rate calculations. Biological effects of radiation. Regulatory guides (10CFR20). Prerequisite: Nuc Eng 3205.

NUC ENG 5367 Radioactive Waste Management And Remediation (LEC 3.0)
Sources and classes of radioactive waste, long-term decay, spent fuel storage, transport, disposal options, regulatory control, materials issues, site selection and geologic characterization, containment, design and monitoring requirements, domestic and foreign waste disposal programs, economic and environmental issues, history of disposal actions, and conduct of remedial actions and clean up. Prerequisite: Math 3304. (Co-listed with Geology 4421).

NUC ENG 5370 Plasma Physics I (LEC 3.0)
Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices. Introduction to plasma kinetic theory. Prerequisite: Aero Eng 3131 or Mech Eng 3131 or Physics 3211 or Nuc Eng 3221 or Elec Eng 3600. (Co-listed with Aero Eng 5570, Mech Eng 5570, Physics 4543).

NUC ENG 5428 Advanced Reactor Laboratory I (LAB 1.0 and LEC 2.0)
Acquaints the student with neutron flux measurement, reactor operation, control rod calibration, reactor power measurement and neutron activation experiments. Experiments with the thermal column and neutron beam port are also demonstrated. Prerequisites: Nuc Eng 4312, Nuc Eng 3205.

NUC ENG 5438 Advanced Reactor Laboratory II (LAB 1.0 and LEC 1.0)
A continuation of Nuclear Engineering 4428 with experiments of a more advanced nature. Prerequisite: Nuc Eng 4428 or Nuc Eng 5428.

NUC ENG 5456 Reactor Operation II (LAB 1.0)
The operation of the training reactor. The program is similar to that required for the NRC Reactor Operator's license. Students from other disciplines will also benefit from the course. Prerequisite: Nuc Eng 2105, 2406.

NUC ENG 5507 Nuclear Policy (LEC 3.0)
This course introduces nuclear security and safeguards policy. It explores the following topics: history of domestic and international nuclear policy, evolution of U.S. nuclear weapons policy, factors influencing policy, the IAEA, nuclear deterrence policy, nuclear safeguards policy, policy in non-proliferation issues, and various international agreements. Prerequisites: Graduate Standing or enrolled in the Nuclear Nonproliferation certificate program.

NUC ENG 5509 Nuclear Nonproliferation (LEC 3.0)
This course will introduce IAEA mission specific to nonproliferation. The class will provide discussion of essential elements of a nuclear weapon, followed by a brief historical over of nonproliferation treaties in place to deter proliferation. Methods of fissile material production will be discussed followed by a survey of tool and techniques available an Prerequisites: Graduate Standing or enrolled in the Nuclear Nonproliferation certificate program.

NUC ENG 5577 Advanced Nuclear Forensics and Radiochemistry (LEC 3.0)
Fundamentals of radiochemistry, including nuclear science, cosmochemistry, spent fuel reprocessing, with details on solvent extraction. We will review case studies in Nuclear Forensics. This advanced section also includes experiments on radiochemistry and demonstrate experimental nuclear forensics techniques. Dual listed with Nuc Eng 4577.
