NUCLEAR ENGINEERING (NUC ENG)

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.

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 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 Nuclear Reactor Engineering (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 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 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 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 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 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 or Nuc Eng 5312, Nuc Eng 3205.

NUC ENG 4438 Nuclear Engineering Laboratory (LAB 1.0 and LEC 1.0)
A continuation of NUC ENG 4428 that introduces students to the research process through hands-on laboratory activities. Prerequisite: Nuc Eng 4312 or Nuc Eng 5312 and Nuc Eng 4428 or Nuc Eng 5428.

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 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 5002 Cooperative Training (IND 1.0-6.0)
On the job training gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisor's evaluation.

NUC ENG 5010 Nuclear Engineering Seminar (RSD 0.50)
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 5229 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 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, or graduate standing. (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 5253 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 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: Preceded or accompanied by NUC ENG 3223, or MECH ENG 3525, or equivalent, or Graduate standing.

NUC ENG 5259 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 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 5338 Innovation and Value Generation (LEC 3.0)
This course introduces a structured framework for understanding and executing the innovation process, from ideation to implementation. It emphasizes a systematic approach to identifying real-world needs, crafting solutions, and transforming them into impactful outcomes, providing strategies for identifying customer needs and determining innovative solutions. (Co-listed with Econ 5338, Chem Eng 5338, and Min Eng 5338).

NUC ENG 5345 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 or Nuc Eng 5203 or Graduate Standing.

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 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 5312.

NUC ENG 5360 Data Driven Strategic Insights (LEC 3.0)
This course designates a corporate executive to teach identifying the appropriate data analytics for corporate decision-making using modeling frameworks such as regression analysis, forecasting, Monte Carlo simulation, and optimization. The course utilizes Python and cloud-based software platforms to work with large databases in financial contexts. Prerequisites: Econ 1100, Econ 1200, and Econ 3300, or instructor approval. (Co-listed with Econ 5360).

NUC ENG 5361 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, or Graduate Standing.

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, or Graduate Standing.

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 or 5312, Nuc Eng 3205.

NUC ENG 5438 Advanced Nuclear Engineering Laboratory (LAB 1.0 and LEC 1.0)
A continuation of NUC ENG 5428 that emphasizes the research process through development of hands-on laboratory activities. 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 5543 Innovation Economics and Finance (LEC 3.0)
This course teaches rapid project development and financing, from an idea to a revenue-generating asset. It covers process ideation, technology/vendor selection, financial modeling, contract structuring, non-recourse financing, and project execution, such as engineering, procurement, construction, and start-up, resulting in a cash-flowing, tradeable annuity. (Co-listed with Econ 5543, Chem Eng 5543, and Min Eng 5543).

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.

NUC ENG 5648 Innovation to Market (LEC 3.0)
This course provides the tools needed to transform innovative solutions into market-ready products and services, focusing on business model development, value generation, and product management. Students will learn to identify product-market fit, maximize value to customers and users, and launch successful innovations. Prerequisites: Econ 5338 and Econ 5543. (Co-listed with Econ 5648, Chem Eng 5648, and Min Eng 5648).

NUC ENG 5658 Building Sustainability and Environmental, Social and Governance (ESG) (LEC 3.0)
Across the globe, businesses are increasingly recognizing the importance of sustainability and ESG principles. This course equips students with the knowledge, tool set, and skills needed to understand, implement, and integrate sustainability and ESG practices in various organizational contexts. Prerequisites: Junior or above standing. (Co-listed with Econ 5658, Chem Eng 5658, and Min Eng 5658).

NUC ENG 6000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

NUC ENG 6001 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 6010 Nuclear Engineering Seminar (RSD 0.50)
Discussion of current topics.

NUC ENG 6020 Contemporary Issues in Technology and Innovation (LEC 3.0)
This course explores contemporary trends, challenges, and opportunities in technology and innovation, featuring lectures by various industrial experts. Topics include disruptive technologies, innovation strategies, regulatory and policy impacts, and emerging markets. Students will learn the forces driving change in today's global technology landscape. Prerequisites: Graduate standing. (Co-listed with Econ 6020, Chem Eng 6020, and Min Eng 6020).

NUC ENG 6030 Contemporary Issues in Energy Economics (LEC 3.0)
This course explores the key challenges, trends, and opportunities shaping the future of energy, featuring insights from industry experts. It delves into the complexities of energy transition, decarbonization, policy regulation, and technological innovations, highlighting the forces driving change in the global energy economy. Prerequisites: Graduate standing. (Co-listed with Chem Eng 6030 and Econ 6030 and Min Eng 6030).

NUC ENG 6040 Oral Examination (IND 0.0)
After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/ comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

NUC ENG 6050 Continuous Registration (IND 1.0)
Doctoral candidates who have completed all requirements for the degree except the dissertation, and are away from the campus must continue to enroll for at least one hour of credit each registration period until the degree is completed. Failure to do so may invalidate the candidacy. Billing will be automatic as will registration upon payment.

NUC ENG 6085 Internship (IND 0.0-15)
Students working toward a doctor of engineering degree will select with the advice of their committees, appropriate problems for preparation of a dissertation. The problem selected and internship plan must conform to the purpose of providing a high level engineering experience consistent with the intent of the doctor of engineering degree.

NUC ENG 6099 Research (IND 0.0-15)
Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

NUC ENG 6203 Advanced Reactor Physics (LEC 3.0)
Transport and diffusion theory; multigroup approximation; criticality calculations; cross-section processing; buildup and depletion calculations; delayed neutrons and reactor kinetics; lattice physics calculations; full core calculations; analysis and measurement of reactivity coefficients. Prerequisite: Math 5325.

NUC ENG 6205 Linear Transport Theory (LEC 3.0)
Monoenergetic Boltzmann equation for neutral particles by the method of singular eigen-functions and polynomial expansions. Prerequisites: Nuc Eng 4203, Math 5358.

NUC ENG 6223 Nuclear Reactor Safety (LEC 3.0)
Study of safety criteria; reactor characteristics pertinent to safety; reactor transient behavior; loss of coolant accident analysis; emergency core cooling; fuel behavior during accident conditions; reactor risk analysis; current reactor safety issues. Prerequisites: Nuc Eng 4203 or 5203, and 5257.

NUC ENG 6241 Effects Of Radiation On Solids (LEC 3.0)
The theories of the interaction of nuclear radiation with matter. Experimental approaches to radiation studies, including the sources and dosimetry. Nature and properties of crystal imperfections. The influence of radiation on physical, mechanical and surface properties of metals and alloys. Radiation effects on materials other than those incorporated in nuclear reactors. The annealing of defects. Prerequisite: Met Eng 5170 or Nuc Eng 5241.

NUC ENG 6257 Advanced Nuclear Thermal Hydraulics (LEC 3.0)
Treatment of advanced topics in nuclear reactor thermal-hydraulics including analysis of fuel elements and fuel melting, multiphase flow dynamics and two-fluid models, interfacial transfer of mass, momentum, and energy, multiphase flow scaling, and numerical applications. Prerequisite: Math 5325 and Nuc Eng 5257.

NUC ENG 6301 Microeconomics: Managerial and Project Economics (LEC 3.0)
This course equips students with microeconomic tools to optimize business outcomes, focusing on pricing strategies and production efficiency across different market structures. Students will learn financial feasibility modeling and incorporate uncertainty to assess the economic viability of engineering and infrastructure projects using key financial metrics. Prerequisites: Graduate standing. (Co-listed with Econ 6301).

NUC ENG 6331 Radiation Shielding (LEC 3.0)
Radiation sources; interactions of radiation with matter; dosimetry and radiation protection guidelines. The particle transport equation and methods of solving it; the Monte Carlo Method; special computational methods for neutron and gamma attentuation. Computer codes used in shielding. Shielding materials, shield design. Prerequisite: Nuc Eng 4203 or 5203.

NUC ENG 6638 Energy Policy and Economic Analysis (LEC 3.0)
This course focuses on the economic and policy aspects of energy. Topics include energy prices, electricity market mechanisms, renewables, nuclear, alternative fuels, climate change, and the environmental consequences of energy consumption and production. The efficiency of various energy options is compared and discussed for future energy policies. Prerequisites: Graduate standing. (Co-listed with Econ 6638, Chem Eng 6638, and Min Eng 6638).