NUCLEAR ENGINEERING (N E)

N E 1 – COOPERATIVE EDUCATION PROGRAM
1 credit.

Work experience which combines classroom theory with practical knowledge of operations to provide students with a background upon which to base a professional career.
Requisites: Sophomore standing
Course Designation: Workplace - Workplace Experience Course
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2026
Learning Outcomes: 1. Identify and respond appropriately to real-life engineering ethics cases relevant to co-op work
Audience: Undergraduate

2. Synthesize and apply appropriate technical education to real world technical work
Audience: Undergraduate

3. Communicate effectively in writing and speaking with a range of audiences in the workplace, including those without disciplinary expertise
Audience: Undergraduate

4. Develop professional and transferable habits like time management skills, collaborative problem-solving skills, and research skills for learning new information
Audience: Undergraduate

N E 231 – INTRODUCTION TO NUCLEAR ENGINEERING
3 credits.

Nuclear fission/fusion, medical applications of radiation, radiation safety. Socio-economic topics including environmental justice, community engagement, nuclear policy. Brief history of and controversies in nuclear engineering. Career paths and ethics in engineering, and introduction to professional communication.
Requisites: None
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Describe how nuclear science and technology are used in our world today
Audience: Undergraduate

2. Identify different career paths in nuclear engineering
Audience: Undergraduate

3. Distinguish the technological and socio-economic context and challenges of nuclear engineering
Audience: Undergraduate

4. Analyze problems in nuclear engineering ethics and arrive at defensible actions
Audience: Undergraduate

5. Produce a deliverable relevant to the class curriculum, designed by a team
Audience: Undergraduate

N E 234 – PRINCIPLES AND PRACTICE OF NUCLEAR REACTOR OPERATIONS
4 credits.

Presents the theoretical and practical information required to understand operation of nuclear reactors. Content includes all subjects which must be known by a person seeking an operating license for the university reactor. Instructors integrate information on similar operations and systems in a nuclear power plant.
Requisites: Declared in Nuclear Engineering
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Solve problems involving radioactive decay, radiation attenuation, neutron activation and the time dependent behavior of reactors
Audience: Undergraduate

2. Describe the units and methods of detecting ionizing radiation, the principles of radiation protection and applicable federal regulations
Audience: Undergraduate

3. Describe reactor components and systems and their relevance to reactor operations
Audience: Undergraduate

4. Manipulate the reactivity controls of a reactor
Audience: Undergraduate

N E 305 – FUNDAMENTALS OF NUCLEAR ENGINEERING
3 credits.

Properties of nuclei, nuclear structure, radioactivity, nuclear reactions, fission, resonance reactions, moderation of neutrons.
Requisites: PHYSICS 205, 241, 244, or 249, or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Solve steady wave mechanics problems beginning from the appropriate form of Schrodinger's equation
Audience: Undergraduate

2. Describe the Semi Empirical Mass Formula as well as the features of the "binding energy/nucleon" curve
Audience: Undergraduate

3. Explain why the "magic numbers" of nuclear physics differ from those of atomic physics
Audience: Undergraduate

4. Explain the correlation between the half-lives for alpha-decay and the Q-value
Audience: Undergraduate

5. Describe the energy spectrum of beta-decay
Audience: Undergraduate

6. List the different absorption mechanism of gamma-rays
Audience: Undergraduate

7. Compare the kinematics of elastic scattering with that of charged particle scattering
Audience: Undergraduate

N E 405 – NUCLEAR REACTOR THEORY
3 credits.

The neutronics behavior of fission reactors, primarily from a theoretical, one-speed perspective. Criticality, fission product poisoning, reactivity control, reactor stability and introductory concepts in fuel management, followed by slowing down and one-speed diffusion theory.
Requisites: N E 305 and (MATH 319, 320, 321, or 375), or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Write neutron balance conditions describing the temporal, spectral and spatial behavior of (neutron) multiplying systems
Audience: Undergraduate

2. Explain how stability issues manifest themselves in choices of reactor design and operation in light water reactors
Audience: Undergraduate

3. Assess whether or not a system containing fissile material is critical
Audience: Undergraduate

4. Estimate the lifetime of a core based on the initial excess reactivity; prescribe control materials for maintaining criticality over the core lifetime
Audience: Undergraduate

5. Solve simple temporal reactor kinetics problems and explain the shape of the reactor power curve
Audience: Undergraduate

6. Solve simple spectral problems and explain the shape of the neutron spectrum in a light water reactor
Audience: Undergraduate

7. Find the spatial neutron distribution and associated power distribution for a given combination of constituent materials using one-group and two-group diffusion theory
Audience: Undergraduate

N E 408 – IONIZING RADIATION
3 credits.

Sources, interactions, and detection of ionizing radiation. Biological effects, shielding, standards of radiation protection.
Requisites: N E 305, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Explain the modes by which uncharged radiation (photons and neutrons) interacts with matter
Audience: Undergraduate

2. Describe how heavy and light charged particles interact with matter
Audience: Undergraduate

3. Determine radiological quantities associated with radiation protection (e.g., exposure, absorbed dose, and dose equivalent) for external sources of radiation (unshielded and shielded)
Audience: Undergraduate

4. Determine committed doses for internal sources of radiation
Audience: Undergraduate

5. Design a shield to protect occupational workers from radiation exposure due to simple photon and neutron sources
Audience: Undergraduate

N E 411 – NUCLEAR REACTOR ENGINEERING
3 credits.

Reactor heat generation and removal; steady- and unsteady-state conduction in reactor elements; single phase, two-phase, and liquid metal cooling, core thermal design.
Requisites: N E 305, M E 361, and (M E 363 and M E 364 or CBE 320) or graduate/professional standing, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Solve steady-state, coupled conduction and convection heat transfer problems in geometric configurations relevant to nuclear reactors
Audience: Undergraduate

2. Describe the temperature excursion experienced by the fuel during an uncontrolled accident sequence using relevant approximations
Audience: Undergraduate

3. Perform mass, momentum, and energy balances on different reactor components
Audience: Undergraduate

4. Assess the safety margin of different reactor components during normal and off-normal conditions, with reference to the concept of “defense-in-depth"
Audience: Undergraduate

N E 412 – NUCLEAR REACTOR DESIGN
5 credits.

Reactor design projects, reactor hazards, economics.
Requisites: N E 405 and (E P 271 or COMP SCI 300, 302, or 310), or graduate/professional standing
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Apply nuclear engineering technical skills in the context of design
Audience: Undergraduate

2. Apply design thinking methodology within engineering design
Audience: Undergraduate

3. Practice quality assurance and documentation
Audience: Undergraduate

4. Build and work within a team, practicing leadership and project management
Audience: Undergraduate

5. Practice managing uncertainty in decision-making. "How do you take risks?"
Audience: Undergraduate

N E/M S & E 423 – NUCLEAR ENGINEERING MATERIALS
3 credits.

Fundamentals of fuel and cladding behavior in terms of thermal properties, chemical behavior and radiation damage.
Requisites: M S & E 350 or 351, graduate/professional standing, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Apply material science and engineering principles to analyze mass transport, heat transport, corrosion, and mechanical behavior in nuclear fuels and materials
Audience: Undergraduate

2. Assess irradiation induced microstructural change and mechanical property degradation in nuclear materials
Audience: Undergraduate

3. Apply material science and engineering principles to identify material challenges in current and advanced nuclear reactors
Audience: Undergraduate

4. Identify mechanisms and mitigation strategies for critical materials issues in current and advanced nuclear reactors
Audience: Undergraduate

N E 424 – NUCLEAR MATERIALS LABORATORY
1 credit.

Practical application of materials issues for nuclear systems including welding, non-destructive examination, optical microscopy, electron microscopy, to understand radiation damage and corrosion.
Requisites: M S & E 350 or 351, graduate/professional standing, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Conduct metallographic sample preparation and follow it up with optical and scanning electron microscopy for microstructural characterization and analysis
Audience: Undergraduate

2. Perform hardness and tensile and impact toughness testing of materials to assess their mechanical behavior
Audience: Undergraduate

3. Use the x-ray diffraction technique to determine the crystal structure of materials, identify the phases present, and measure residual stresses
Audience: Undergraduate

4. Perform simulations of ion-material interaction to determine the penetration depth of ions as a function of ion energy, type, and substrate material
Audience: Undergraduate

5. Comprehend the various components and work of the ion beam accelerator
Audience: Undergraduate

6. Describe the operational issues of a nuclear reactor and some of its inner workings
Audience: Undergraduate

7. Identify and address the challenges of radioactive sample handling and characterization
Audience: Undergraduate

N E 427 – NUCLEAR INSTRUMENTATION LABORATORY
2 credits.

Experiments on nuclear instrumentation, counting, data analysis.
Requisites: N E 305 or graduate/professional standing
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Explain the operational principles of nuclear radiation detectors in the context of how radiation interacts with matter
Audience: Undergraduate

2. Identify the best choice of detector for a given type of radiation and its limitations
Audience: Undergraduate

3. Operate basic nuclear counting instrumentation: gas-ionized and solid-state detectors, nuclear instrumentation module, power supplies, signal amplifiers, oscilloscopes, and single- and multi-channel analyzers
Audience: Undergraduate

4. Estimate experimental uncertainties in counting measurements and calculate errors associated with quantities derived from such measurements
Audience: Undergraduate

5. Take laboratory notes and prepare clearly written experimental reports
Audience: Undergraduate

N E 428 – NUCLEAR REACTOR LABORATORY
2 credits.

Experiments on reactor operation, flux measurement, measurements of reactor parameters, using pool type reactor.
Requisites: N E 405 and 427, or graduate/professional standing
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Analyze, through experiment, the time-dependent behavior of reactors in the subcritical state, the critical state and the supercritical state
Audience: Undergraduate

2. Analyze, through experiment, the spatial shape and energy spectrum of neutron fluxes
Audience: Undergraduate

3. Measure neutron and reactor parameters
Audience: Undergraduate

4. Describe the extent to which theory and experiment agree, and what approximations or uncertainty result in deviations between the two
Audience: Undergraduate

N E/M S & E 433 – PRINCIPLES OF CORROSION
3 credits.

Thermodynamics and kinetics of metallic corrosion. The common forms of corrosion and corrosion susceptibility tests. Electrochemical measurement of corrosion rates. Corrosion prevention, economic considerations. High temperature oxidation and sulphidation. Corrosion case histories.
Requisites: M S & E 330, or graduate/professional standing, or member of Engineering Guest Students
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Characterize various modes of corrosion
Audience: Undergraduate

2. Investigate the societal impact of corrosion
Audience: Undergraduate

3. Explore methods of corrosion prevention
Audience: Undergraduate

4. Interpret the thermodynamic and electrochemical basis of corrosion
Audience: Undergraduate

5. Analyze corrosion kinetics using Tafel equations
Audience: Undergraduate

6. Explain principles of high temperature corrosion
Audience: Undergraduate

7. Apply concepts of corrosion to specific technology sectors
Audience: Undergraduate

N E 489 – HONORS IN RESEARCH
1-3 credits.

Undergraduate research and senior honors thesis in nuclear engineering.
Requisites: Declared in Nuclear Engineering Honors in Undergraduate Research program
Course Designation: Honors - Honors Only Courses (H)
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2014

N E 505 – NUCLEAR REACTOR ANALYSIS
3 credits.

The neutronics behavior of fission reactors, both from a theoretical and computational multi-group perspective. Multi-group diffusion theory, finite-difference and nodal methods, core heterogeneous effects, pin power reconstruction, thermal neutron spectra, fine group whole spectrum calculations and coarse group constant generation.
Requisites: N E 405, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Analyze the performance of a nuclear fuel assembly throughout its lifetime
Audience: Both Grad & Undergrad

2. Explain and demonstrate the changes in nuclear fuel assembly performance as operational parameters vary
Audience: Both Grad & Undergrad

3. Use an industry-relevant software package to perform lattice calculations for analysis and design of a nuclear fuel assembly
Audience: Both Grad & Undergrad

4. Explain and demonstrate the changes in nuclear fuel assembly performance as design parameters vary
Audience: Both Grad & Undergrad

5. Compare different forms of analysis for the same application
Audience: Graduate

N E/MED PHYS 506 – MONTE CARLO RADIATION TRANSPORT
3 credits.

Use of Monte Carlo technique for applications in nuclear engineering and medical physics. Major theory of Monte Carlo neutral particle transport is discussed. Standard Monte Carlo transport software is used for exercises and projects. Major emphasis is on analysis of real-world problems.
Requisites: N E 305 and (N E 405, N E 408, PHYSICS/B M E/H ONCOL/MED PHYS 501 or N E/MED PHYS 569) or graduate/professional standing
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Use an industry-relevant software package to perform Monte Carlo radiation transport simulations for analysis of fixed source and/or multiplying systems
Audience: Both Grad & Undergrad

2. Explain how random processes are used to simulate a single particle transport history through an engineering system, including source, streaming and collisions
Audience: Both Grad & Undergrad

3. Explain how the paths of many particle transport histories are combined to provide estimates of engineering results
Audience: Both Grad & Undergrad

4. Analyze the statistical performance of a simulation and suggest ways to improve that performance
Audience: Both Grad & Undergrad

5. Apply Monte Carlo radiation transport to a problem related to your research
Audience: Graduate

N E/M E 520 – TWO-PHASE FLOW AND HEAT TRANSFER
3 credits.

Two-phase flow and heat transfer in engineering systems. Pool boiling and flow boiling. Phenomenological modeling.
Requisites: M E 361 and (M E 364 or CBE 320), or graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Apply physical principles to model two-phase flows, boiling heat transfer, and condensation using analytic and computational techniques
Audience: Both Grad & Undergrad

2. Calculate the critical heat flux on heated surfaces
Audience: Both Grad & Undergrad

3. Calculate the two phase flow pressure drop in pipes
Audience: Both Grad & Undergrad

4. Critically review scientific literature in multiphase flow and heat transfer
Audience: Graduate

N E/E C E/PHYSICS 525 – INTRODUCTION TO PLASMAS
3 credits.

Basic description of plasmas: collective phenomena and sheaths, collisional processes, single particle motions, fluid models, equilibria, waves, electromagnetic properties, instabilities, and introduction to kinetic theory and nonlinear processes. Examples from fusion, astrophysical and materials processing processing plasmas.
Requisites: (E C E 320 or PHYSICS 322), graduate/professional standing, or member of Engineering Guest Students
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Define the fundamental properties of a plasma and analyze single-particle dynamics.
Audience: Both Grad & Undergrad

2. Formulate and distinguish between fluid models (e.g., two-fluid, Magnetohydrodynamics - MHD) to describe collective plasma behavior.
Audience: Both Grad & Undergrad

3. Analyze plasma waves, equilibria, and instabilities using fluid models.
Audience: Both Grad & Undergrad

4. Apply the kinetic equation for a plasma and explain its relationship to the hierarchy of fluid models.
Audience: Both Grad & Undergrad

5. Select an appropriate physical model to analyze and solve problems in plasma applications.
Audience: Graduate

N E 526 – LABORATORY COURSE IN PLASMAS
3 credits.

Provides a background in the techniques for creating, exciting, and measuring the properties of lab plasmas and using the associated apparatus.
Requisites: PHYSICS/E C E/N E 525 or graduate/professional standing
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. List the necessary hardware to generate and measure ultra-high vacuum conditions
Audience: Both Grad & Undergrad

2. Describe the plasma formation process when using a biased electrode or wave-heating
Audience: Both Grad & Undergrad

3. Explain the working principle of Langmuir plasma diagnostics
Audience: Both Grad & Undergrad

4. Perform data analysis in the framework of self-driven and independent research
Audience: Both Grad & Undergrad

5. Prepare a clearly written experimental report
Audience: Both Grad & Undergrad

6. Interpret experimental data based on comparisons with theory and modelling results
Audience: Graduate

N E/E C E/PHYSICS 527 – PLASMA CONFINEMENT AND HEATING
3 credits.

Principles of magnetic confinement and heating of plasmas for controlled thermonuclear fusion: magnetic field structures, single particle orbits, equilibrium, stability, collisions, transport, heating, modeling and diagnostics. Discussion of current leading confinement concepts: tokamaks, tandem mirrors, stellarators, reversed field pinches, etc.
Requisites: E C E/N E/PHYSICS 525, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2026

N E/E C E 528 – PLASMA PROCESSING AND TECHNOLOGY
3 credits.

Introduction to basic understanding and techniques. Plasma processing of materials for semiconductors, polymers, plasma spray coatings, ion implantation, etching, arcs, extractive metallurgy and welding. Plasma and materials diagnostics.
Requisites: PHYSICS 322 or E C E 320, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2021

N E 536 – FEASIBILITY OF FUSION POWER PLANTS BASED ON CONTROLLED NUCLEAR FUSION
3 credits.

Introduction to the main aspects of fusion power plants and the underlying plasma physics. Key design considerations will be summarized related to fusion fuels, resources, plasma physics, plasma-facing materials, magnets, neutronics, shielding, tritium breeding blankets, structural materials, activation, radiation damage, neutral beams, wave heating current drive, safety, and environmental concerns. Focus on magnetic confinement fusion and its near-term and longer-term prospects.
Requisites: N E 305, M S & E 331, E C E 330, M E 364, CBE 320, PHYSICS 322, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Evaluate and compare important characteristics of magnetic fusion energy systems under different configurations
Audience: Both Grad & Undergrad

2. Evaluate the technological performance challenges to the key components of a magnetic fusion energy system
Audience: Both Grad & Undergrad

3. Describe the challenges to the feasibility of magnetic fusion energy
Audience: Both Grad & Undergrad

4. Discuss the role of fusion energy as part of future energy systems, including its economic viability
Audience: Both Grad & Undergrad

5. Evaluate and compare the important characteristics of inertial fusion energy and aneutronic fusion
Audience: Graduate

N E 541 – RADIATION DAMAGE IN METALS
3 credits.

A survey of the nature of point defects, how these defects are produced, how the defects migrate and cluster, and what effects point defects and defect clusters have on the physical and mechanical properties of metals.
Requisites: M S & E 350 or 351, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025

N E 545 – MATERIALS DEGRADATION IN ADVANCED NUCLEAR REACTOR ENVIRONMENTS
3 credits.

Overview of materials (cladding and structural materials) used in advanced reactor systems and the associated degradation. Interactions between the advanced nuclear reactor environment and materials. Surface degradation, corrosion, oxidation, dissolution, vaporization, mass transfer, diffusion, and hands-on examples related to advanced reactors.
Requisites: M S & E 350, 351, or 352, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Describe the effects of environmental degradation on structural integrity of material used in advanced nuclear reactors
Audience: Both Grad & Undergrad

2. Identify and describe the mitigation strategies to prevent such degradation
Audience: Both Grad & Undergrad

3. Solve complex problems related to materials degradation using analytical and numerical techniques
Audience: Graduate

N E 550 – ADVANCED NUCLEAR POWER ENGINEERING
3 credits.

Analysis of nuclear systems for the production of useful power. Emphasis: thermodynamic cycles, reactor types, coupling of reactor and power plant, design synthesis, and plant economics.
Requisites: N E 405 and (N E 411 or concurrent enrollment), graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Identify the key features of a range of advanced reactor technologies
Audience: Undergraduate

2. Analyze advanced reactors using theory applicable to multiple technologies
Audience: Undergraduate

3. Describe the design philosophy of advanced reactor technologies and be able to discuss the extent to which each of the reactor design types embodies those principles
Audience: Undergraduate

4. Identify the drivers and goals for advanced reactors and assess critically whether they meet these goals
Audience: Undergraduate

5. Synthesize information from multiple sources to make informed judgements about the relative merits and challenges of the various advanced reactor technologies
Audience: Graduate

N E 555 – NUCLEAR REACTOR DYNAMICS
3 credits.

Basic equations and physical parameters of point reactor kinetics without feedback effects; the nuclear reactor as a total system; reactor excursions, Fuchs-Nordheim and Bethe-Tait models; space-time reactor dynamics; synthesis methods.
Requisites: N E 405, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2020
Learning Outcomes: 1. Determine the behavior of the reactor power due to control element movement in the PRKE 1 group and 6 group models
Audience: Both Grad & Undergrad

2. Examine the behavior of the reactor in the presence of reactivity feedback effects (Resonance behavior, Doppler Broadening, density effects)
Audience: Both Grad & Undergrad

3. Analyze the power and temperature level behaviors due to the rapid injection and sinusoidal inputs of reactivity using the Nordheim-Fuchs models
Audience: Both Grad & Undergrad

4. Analyze the stability of a reactor using the Routh and Nyquist stability criterion and the singe and two temperature models
Audience: Both Grad & Undergrad

5. Examine numerical methods for the solution of the PRKEs and the reactor dynamics equations with feedback
Audience: Both Grad & Undergrad

6. Apply the reactor dynamics equations with feedback to a reactor design
Audience: Graduate

N E/M E 565 – POWER PLANT TECHNOLOGY
3 credits.

Design and performance of power plants for the generation of electric power; fossil, solar, wind, hydro and nuclear fuels, cycle analysis, component design and performance, plant operation, control, economics and environmental impact.
Requisites: M E 361, CBE 310, 320, or CIV ENGR 324, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Describe how electricity is produced in a power plant
Audience: Both Grad & Undergrad

2. Apply physical principles to model power plants including power output and efficiency
Audience: Both Grad & Undergrad

3. Observe and collect data on current issues and designs associated to power generation
Audience: Both Grad & Undergrad

4. Describe codes and regulations associated with power production, and how power is sold on the market and transmitted to the customer
Audience: Both Grad & Undergrad

5. Critically review scientific literature pertaining to power plant design
Audience: Both Grad & Undergrad

6. Effectively present detailed information regarding operation and maintenance of power plant components
Audience: Graduate

N E/MED PHYS 569 – HEALTH PHYSICS AND BIOLOGICAL EFFECTS
3-4 credits.

Physical and biological aspects of the use of ionizing radiation in industrial and academic institutions; physical principles underlying shielding instrumentation, waste disposal; biological effects of low levels of ionizing radiation.
Requisites: MATH 234 and (PHYSICS 241 or 249), graduate/professional standing, or declared in Medical Physics VISP
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Investigate theoretical concepts that are used in radiation safety practice.
Audience: Both Grad & Undergrad

2. Evaluate the effectiveness of radiation safety practice considering theoretical, economic, political, and societal perspectives.
Audience: Both Grad & Undergrad

3. Consider the ethical consequences of radiation safety regulations.
Audience: Both Grad & Undergrad

4. Integrate knowledge into research and/or clinical work
Audience: Graduate

N E 571 – ECONOMIC AND ENVIRONMENTAL ASPECTS OF NUCLEAR ENERGY
3 credits.

Economics of the nuclear fuel cycle. Economic and environmental impact of the nuclear fuel cycle. Impact on design, plant siting and regulation.
Requisites: N E 405, graduate/professional standing, or member of Engineering Guest Students
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Recognize and describe the relationships between different sectors of the nuclear energy industry and nuclear fuel cycle
Audience: Both Grad & Undergrad

2. Perform economic and/or environmental analysis of energy systems
Audience: Both Grad & Undergrad

3. Communicate the results of economic and/or environmental analyses to an audience of peers
Audience: Both Grad & Undergrad

4. Describe the social, economic, and environmental dimensions of nuclear energy
Audience: Both Grad & Undergrad

5. Analyze potential tradeoffs and interrelationships among the social, economic, and environmental dimensions of nuclear energy
Audience: Both Grad & Undergrad

6. Communicate the results of economic and/or environmental analyses to policy-makers
Audience: Graduate

N E/I SY E 574 – METHODS FOR PROBABILISTIC RISK ANALYSIS OF NUCLEAR POWER PLANTS
3 credits.

Methods for risk and reliability analysis of engineered systems, particularly as applied in the nuclear power industry. Fault trees and event trees, Bayesian data analysis, probabilistic risk management. Some familiarity with nuclear plant safety systems is helpful, but not required.
Requisites: (STAT/MATH 309, STAT 311, 224, 324, or STAT/MATH 431), graduate/professional standing, or member of Engineering Guest Students
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Correctly apply methods of fault tree, event-tree, data, and uncertainty analysis to evaluate potential risks of engineering systems
Audience: Both Grad & Undergrad

2. Recognize, formulate, and analyze risks of engineered systems
Audience: Both Grad & Undergrad

3. Explain the results of risk analysis to managers and other non-specialist decision-makers
Audience: Graduate

N E 602 – SPECIAL TOPICS IN REACTOR ENGINEERING
0-3 credits.

Special Topics in Reactor Engineering.
Requisites: None
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2026

N E 699 – ADVANCED INDEPENDENT STUDY
0-3 credits.

Directed study projects as arranged with instructor.
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2026

N E 705 – ADVANCED REACTOR THEORY
3 credits.

The neutron transport equation and its application to the analysis of nuclear reactors. Numerical solution methods, including the multi-group model, one-group equations, energy-averaged constants, discrete ordinates, and Monte Carlo methods. Perturbation theory and variational techniques for practical problems. Knowledge of Nuclear Reactor Theory [such as N E 405] required.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Derive and examine the Neutral Particle Transport Equation in the one- group and multi-group approximations
Audience: Graduate

2. Apply the Spherical Harmonics expansion and explain how it leads to the Legendre Polynomial expansion in one-dimension. Examine the P1 approximation and it leads to Diffusion theory. Program the P1 and P3 approximations
Audience: Graduate

3. Derive the Discrete Ordinates numerical approximation in one-dimensional slab coordinates, incorporate the boundary conditions and program the S2 and S8 discrete ordinates approximations. Work through the curvilinear Coordinates
Audience: Graduate

4. Derive the Integral Neutral Particle Transport Equation. Examine the numerical methods for the solution of the discrete integral transport (IT) method and the collision probability (IT) method. Program an IT method
Audience: Graduate

5. Derive and interpret the Adjoint Equation to the Transport Equation
Audience: Graduate

6. Discuss and examine the direct integration method
Audience: Graduate

7. Present a numerical IT method or write a multi-dimensional code based on a method examined and discussed in the course
Audience: Graduate

N E/C&E SOC/I SY E/SOC 708 – SOCIETAL RISK MANAGEMENT OF TECHNOLOGICAL HAZARDS
3 credits.

Issues involved in decision-making regarding technological risks and risk management in areas such as nuclear power, hazardous waste disposal, and pollution control. Risk perception and cognitive biases; risk analysis and decision analysis; political issues in risk management; regulatory mechanisms; and risk communication. Selected case studies.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2020

N E/E C E/PHYSICS 724 – WAVES AND INSTABILITIES IN PLASMAS
3 credits.

Waves in a cold plasma, wave-plasma interactions, waves in a hot plasma, Landau damping, cyclotron damping, magneto-hydrodynamic equilibria and instabilities, microinstabilities, introduction to nonlinear processes, and experimental applications. Basic knowledge of plasmas [such as PHYSICS/E C E/N E 525] and advanced electromagnetics [such as PHYSICS 721 or E C E 740] strongly encouraged.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025

N E/E C E/PHYSICS 725 – PLASMA KINETIC THEORY AND RADIATION PROCESSES
3 credits.

Coulomb Collisions, Boltzmann equation, Fokker-Planck methods, dynamical friction, neoclassical diffusion, collision operators radiation processes and experimental applications. Basic knowledge of plasmas [such as PHYSICS/E C E/N E 525] and advanced electromagnetics [such as PHYSICS 721 or E C E 740] strongly encouraged.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025

N E/E C E/PHYSICS 726 – PLASMA MAGNETOHYDRODYNAMICS
3 credits.

MHD equations and validity in hot plasmas; magnetic structure and magnetic flux coordinates; equilibrium in various configurations; stability formulation, energy principle, classification of instabilities; ideal and resistive instability in various configurations, evolution of nonlinear tearing modes; force-free equilibria, helicity, MHD dynamo; experimental applications. Basic knowledge of plasmas [such as PHYSICS/E C E/N E 525] and advanced electromagnetics [such as PHYSICS 721 or E C E 740] strongly encouraged.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2026

N E/E C E/PHYSICS 749 – COHERENT GENERATION AND PARTICLE BEAMS
3 credits.

Fundamental theory and recent advances in coherent radiation charged particle beam sources (microwave to X-ray wavelengths) including free electron lasers, wiggler/wave-particle dynamics, Cerenkov masers, gyrotrons, coherent gain and efficiency, spontaneous emission, beam sources and quality, related accelerator concepts experimental results and applications.
Requisites: E C E 740
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024

N E 790 – MASTER'S RESEARCH AND THESIS
1-9 credits.

Directed study projects as arranged with instructor.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2026

N E 890 – PRE-DISSERTATOR'S RESEARCH
1-9 credits.

Research by the Ph.D. students prior to becoming dissertators.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2026

N E 903 – SPECIAL TOPICS-PLASMA PHYSICS
0-3 credits.

Special Topics in Plasma Physics. Knowledge of Plasma Physics [such as PHYSICS/E C E/N E 525] required
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2025

N E/E C E/PHYSICS 922 – SEMINAR IN PLASMA PHYSICS
0-1 credits.

Current topics in plasma physics.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2026

N E 990 – RESEARCH AND THESIS
1-6 credits.

Directed study projects as arranged with instructor.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2026

N E 999 – ADVANCED INDEPENDENT STUDY
1-3 credits.

Directed study projects as arranged with instructor.
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2024