

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 2022

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 2023

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 2021

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 2022

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 2023

N E 406 – 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

Repeatable for Credit: No

Last Taught: Fall 2021

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 2023

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 2022

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 2023

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 2022

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 2023

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 2023

N E 428 – NUCLEAR REACTOR LABORATORY

2 credits.

Experiments on reactor operation, flux measurement, measurements of reactor parameters, using pool type reactor.

Requisites: NE 405 and NE 427, or graduate/professional standing

Repeatable for Credit: No

Last Taught: Spring 2023

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 2022

N E/CIV ENGR/ISY E 460 – UNCERTAINTY ANALYSIS FOR ENGINEERS

3 credits.

Introduction to approaches for quantifying uncertainty in engineering analyses. Both analytical and computational methods are demonstrated.

Requisites: (STAT/MATH 309, STAT 311, 224, 324, or STAT/MATH 431), graduate/professional standing, or member of Engineering Guest Students

Repeatable for Credit: No

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/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 2022

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 B M E 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 2022

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 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 2023

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 2023

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 2023

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 ST OF POWER FROM CONTROLLED THERMONUCLEAR FUSION

3 credits.

Introduction to the use and design of possible fusion reactors. Problems of the plasma confinement and energy density, neutronics of blanket design, and radiation damage.

Requisites: N E 405 and 411, 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 2022

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 2022

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 2023

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 (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 2022

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

N E/M E 565 – POWER PLANT TECHNOLOGY

3 credits.

Design and performance of power plants for the generation of electric power; fossil and nuclear fuels, cycle analysis, component design and performance, plant operation, control, economics and environmental impact. Advanced concepts.

Requisites: M E 361, or 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

Repeatable for Credit: No

Last Taught: Fall 2022

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; lecture and lab.

Requisites: MATH 234 and (PHYSICS 241 or 249) or graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2022

N E 571 – ECONOMIC AND ENVIRONMENTAL ASPECTS OF NUCLEAR ENERGY

3 credits.

Economics of the nuclear fuel cycle. Economic and environmental impact 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

Repeatable for Credit: No

Last Taught: Spring 2023

N E/ISY 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 2023

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: Fall 2021

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: Summer 2023

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 2022

N E/C&E SOC/ISY 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 2022

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 2022**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 2023**N E 741 – INTERACTION OF RADIATION WITH MATTER**

3 credits.

Review of topics in electrodynamics and special relativity; ionization and energy loss during scattering of charged particles; radiation from charged particles including Bremsstrahlung, Cerenkov, and Synchrotron radiation; Thomson scattering of electromagnetic waves by charged particles. Knowledge of Dynamics [such as EMA 202 or PHYSICS 311] and Electromagnetics [such as PHYSICS 322] required.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2015**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 2019**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:** Summer 2023**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:** Summer 2023**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 2022**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 2023**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:** Summer 2023**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:** Fall 2021