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

N E 231 — SURVEY OF NUCLEAR ENGINEERING
1 credit.

Consideration of work done by nuclear engineers; relevance of nuclear energy to society; environmental and other problems. Open to all students. Offered on a pass-fail basis only.

Requisites: None

Repeatable for Credit: No

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

This course presents the theoretical and practical information required to understand operation of nuclear reactors. The course 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: None

Repeatable for Credit: No

Last Taught: Fall 2017

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, 249 or declared in a Civil and Environmental Engineering, Nuclear Engineering and Engineering Physics, Electrical Engineering, Mechanical Engineering, or Physics graduate program

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 2017

N E 373 — NUCLEAR ENERGY AND THE ENVIRONMENT
3 credits.

Fission and fusion processes, nuclear reactors, power plants, radioactivity, biological effects, radiation and thermal releases, governmental regulations' impact on society.

Requisites: HS physics or chem; knowledge of basic biology or consent of instructor; not open to NEEP stdts

Course Designation: Breadth - Natural Science

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2009

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, MATH 319 and MATH 320 or declared in a Civil and Environmental Engineering, Nuclear Engineering and Engineering Physics, Electrical Engineering, Mechanical Engineering or Physics graduate program

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 2017

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: NEEP 405

Repeatable for Credit: No

Last Taught: Fall 2017

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 or declared in a Civil and Environmental Engineering, Nuclear Engineering and Engineering Physics, Electrical Engineering, Mechanical Engineering or Physics graduate program

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
**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, B M E/CBE/B M E 320 or M E 364 or declared in a Civil and Environmental Engineering, Nuclear Engineering and Engineering Physics, Electrical Engineering, Mechanical Engineering or Physics graduate program
**Repeatable for Credit:** No
**Last Taught:** Fall 2017

**N E 412 — NUCLEAR REACTOR DESIGN**
3-5 credits.
Reactor design projects, reactor hazards, economics.
**Requisites:** NEEP 405, 411, Comp Sci 302 or NEEP 271
**Repeatable for Credit:** No

**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:** MSE 350 or 351
**Repeatable for Credit:** No
**Last Taught:** Fall 2016

**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, N E/M S & E 423 and/or N E 541 recommended
**Repeatable for Credit:** No
**Last Taught:** Spring 2017

**N E 427 — NUCLEAR INSTRUMENTATION LABORATORY**
2 credits.
Experiments on nuclear instrumentation, counting, data analysis. One three-hour lab, one lecture per week.
**Requisites:** N E 305 or declared in a Civil and Environmental Engineering, Nuclear Engineering and Engineering Physics, Electrical Engineering, Mechanical Engineering or Physics graduate program
**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

**N E 428 — NUCLEAR REACTOR LABORATORY**
2 credits.
Experiments on reactor operation, flux measurement, measurements of reactor parameters, using pool type reactor. One three-hour lab per week.
**Requisites:** N E 405 and N E 427 or declared in a Civil and Environmental Engineering, Nuclear Engineering and Engineering Physics, Electrical Engineering, Mechanical Engineering or Physics graduate program
**Repeatable for Credit:** No

**N E/M S & E 433 — PRINCIPLES OF CORROSION**
3 credits.
**Requisites:** MSE 330 or equiv
**Repeatable for Credit:** No
**Last Taught:** Spring 2016

**N E/CIV ENGR/I SYE 460 — UNCERTAINTY ANALYSIS FOR ENGINEERS**
3 credits.
This course introduces undergraduates to approaches for quantifying uncertainty in engineering analyses. Both analytical and computational methods are demonstrated.
**Requisites:** Statistics 311, MATH/STAT 431, or consent of instructor
**Repeatable for Credit:** No

**N E 489 — HONORS IN RESEARCH**
1-3 credits.
Undergraduate research and senior honors thesis in nuclear engineering.
**Requisites:** Honors candidacy in nuclear engineering
**Course Designation:** Honors - Honors Only Courses (H)
**Repeatable for Credit:** Yes, unlimited number of completions

**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:** NEEP 305 or equiv and one of NEEP 405, 408, Med Phys 501 or 569, or consent of instructor
**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

**N E/M E 520 — TWO-PHASE FLOW AND HEAT TRANSFER**
3 credits.
**Requisites:** ME 361 or Ch E 310 or equiv, Ch E 320 or ME 364 or equiv
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement
**Repeatable for Credit:** No
**Last Taught:** Spring 2014
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: One crse in electromagnetic fields beyond elem physics

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

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: NEEP, Physics or ECE 525 or consent of instructor

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

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: N E/E C/E/PHYSICS/E C/E/N E 525 or graduate or 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

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 ECE 320 or equiv or cons inst

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

Repeatable for Credit: No

Last Taught: Fall 2017

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: NEEP 405, 411

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

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: MSE 350 or 351

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 2017

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: NEEP 405 and 411

Repeatable for Credit: No

Last Taught: Fall 2016

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: NEEP 405

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

Repeatable for Credit: No

Last Taught: Fall 2016
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: ME 361 or consent of instructor
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2017

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: None
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

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: NEEP 405 NEEP 411
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

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 224
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

N E 602 — SPECIAL TOPICS IN REACTOR ENGINEERING
3 credits.
Requisites: None
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2017

N E 699 — ADVANCED INDEPENDENT STUDY
3 credits.
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

N E 705 — ADVANCED REACTOR THEORY
3 credits.
Requisites: NEEP 405
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

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: STAT 311 or MATH/STAT 431 or SOC/C&E SOC 360, IE 516, Grad st; or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2015

N 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.
Requisites: NEEP/ECE/PHYSICS/E C E/N E 525 PHYSICS 721 or ECE 740 or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

N 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.
Requisites: Physics, ECE, NEEP 525 PHYSICS 721 or ECE 740 or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Nuclear Engineering (N E)

**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.

**Requisites:** NEEP/ECE/PHYSICS/E C/E/N E 525 PHYSICS 721 or ECE 740 or cons inst

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

**Repeatable for Credit:** No

**Last Taught:** Spring 2017

**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.

**Requisites:** Engr Mech 202 or Phys 311; Phys 322

**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, wigglers, wave-particle dynamics, Cerenkov masers, gyrotrons, coherent gain and efficiency, spontaneous emission, beam sources and quality, related accelerator concepts experimental results and applications.

**Requisites:** ECE 740 or PHYSICS 721, or equiv, or cons inst

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

**Repeatable for Credit:** No

**Last Taught:** Fall 2014

**N E 790 — MASTER’S RESEARCH AND THESIS**
1-9 credits.

Enroll Info: Master’s candidates only

**Requisites:** Graduate standing

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

**Repeatable for Credit:** Yes, unlimited number of completions

**N E 890 — PRE-DISSERTRATOR’S RESEARCH**
1-9 credits.

Research by the Ph.D. students prior to becoming dissertators.

**Requisites:** Graduate or professional standing

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

**Repeatable for Credit:** Yes, unlimited number of completions

**N E 903 — SPECIAL TOPICS-PLASMA PHYSICS**
3 credits.

**Requisites:** NEEP or ECE or PHYSICS/E C/E/N E 724 or cons inst

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

**Repeatable for Credit:** Yes, unlimited number of completions

**Last Taught:** Spring 2018

**N E/E C/E/PHYSICS 922 — SEMINAR IN PLASMA PHYSICS**
1 credit.

**Requisites:** Graduate or professional standing

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

**Repeatable for Credit:** Yes, unlimited number of completions

**N E 990 — RESEARCH AND THESIS**
1-6 credits.

Enroll Info: For students with dissertator status only

**Requisites:** Graduate or professional standing

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

**Repeatable for Credit:** Yes, unlimited number of completions

**N E 999 — ADVANCED INDEPENDENT STUDY**
1-3 credits.

**Requisites:** Consent of instructor

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

**Repeatable for Credit:** Yes, unlimited number of completions