Nuclear Engineering (NE)

NE 201 Introduction to Nuclear Engineering (2 credit hours)
An introduction to the concepts, systems and application of nuclear processes. Topics include radioactivity, fission, fusion, reactor concepts, biological effects of radiation, nuclear propulsion, and radioactive waste disposal. Designed to give students a broad perspective of nuclear engineering and an introduction to fundamentals and applications of nuclear energy.

Prerequisite: Grade of C or better in MA 241, PY 205
Typically offered in Fall only

NE 202 Radiation Sources, Interaction and Detection (4 credit hours)
Introduction to nuclear energy. Topics include radioactivity, radiation detection, interaction of radiation with matter, nuclear reactions, fission, fusion, nuclear reactors, radiation safety and protection, and laboratory measurement of nuclear radiation.

Prerequisites: C- or better in MA 242 and PY 208
Typically offered in Spring only

NE 235 Nuclear Reactor Operations Training (2 credit hours)
Principles of nuclear reactor operations. Lectures to cover basic nuclear engineering theory pertaining to fission reactor operations; laboratory sessions to provide hands on training with the PULSTAR nuclear reactor including facility pre-startup checks, approach to criticality, steady state operations, and measurement of various operating parameters. Qualified students may opt to enter training and study for the U.S. Nuclear Regulatory Commission exam to become federally licensed nuclear Reactor Operators. Does not count towards NE graduation requirements

Typically offered in Fall only

NE 290 Introduction to Health Physics (3 credit hours)
Fundamentals of ionizing radiation safety. The course will review basic physical principles, radiation sources, introductory radiation dosimetry, radiation safety guidelines, evaluation of safety measures, and basic radiation control principles for contamination and radioactive material safety to include measurement physics, counting statistics and basic radiobiology principles.

Prerequisite: MA 242 and PY 208
Typically offered in Fall only

NE 301 Fundamentals of Nuclear Engineering (3 credit hours)
Introductory course in nuclear engineering. Neutron physics, reactor operation, and reactor dynamics. Basic principles underlying the design and operation of nuclear systems, facilities and applications.

Prerequisite: MA 341 and (CSC 112 or CSC 113) and C- or better in NE 202
Typically offered in Fall only

NE 400 Nuclear Reactor Energy Conversion (4 credit hours)
Introduction to the concepts and principles of heat generation and removal in reactor systems. Power cycles, reactor heat sources, analytic and numerical solutions to conduction problems in reactor components and fuel elements, heat transfer in reactor fuel bundles and heat exchangers. Problem sets emphasize design principles. Heat transfer lab included. Credit will not be given for both NE 400 and NE 500.

Prerequisite: MAE 201 and a C- or better in NE 301
Typically offered in Spring only

NE 401/NE 501 Reactor Analysis and Design (3 credit hours)
Elements of nuclear reactor theory for reactor core design and operation. Includes one-group neutron transport and mutigroup diffusion models, analytical and numerical criticality search, and flux distribution and calculations for homogeneous and heterogeneous reactors, slowing down models, introduction to perturbation theory.

Prerequisites: MA 401 and C- or better in NE 301
Typically offered in Spring only

NE 402 Reactor Engineering (4 credit hours)
A course in thermal-hydraulic design and analysis of nuclear systems. Single and two-phase flow, boiling heat transfer, modeling of fluid systems. Design constraints imposed by thermal-hydraulic considerations are discussed. A thermal-hydraulics laboratory included. Credit will not be given for both NE 402 and NE 502.

Prerequisite: MAE 308 and either NE 400 or MAE 310
Typically offered in Fall only

NE 403 Nuclear Reactor Laboratory (2 credit hours)
Nuclear reactor laboratory. A laboratory course performed on the NCSU PULSTAR reactor. Topics include reactor startup and approach to critical. Neutron flux distributions. Reactivity balances. Control rod worth and power coefficients of reactivity.

Prerequisite: C- or better in NE 301 Co-requisite: NE 401
Typically offered in Spring only

NE 404 Radiation Safety and Shielding (3 credit hours)
Radiation safety and environmental aspects of nuclear power generation. Radiation interaction, photon attenuation, shielding theory and design project, external and internal dose evaluation, reactor effluents and release of radioactivity into the environment, transportation and disposal of radioactive waste; and environmental impact of nuclear power plants.

Prerequisite: NE 301 with a grade of C- or better or NE 419
Typically offered in Fall only

NE 405 Reactor Systems (3 credit hours)
Nuclear power plant systems: design criteria, design parameters, and economics. Topics covered include: PWR, BWR, core design, primary loops, auxiliary and emergency systems; containment, reactor control and protection systems, accident and transient behaviors.

Prerequisite: NE 401, NE 402
Typically offered in Spring only

NE 406 Nuclear Engineering Senior Design Preparation (1 credit hours)
Preliminary design phase in nuclear engineering systems to prepare for the final phase design. Preliminary designs developed by teams with advice of faculty, with reports presented in oral and written form. Current and future systems emphasized, and use of computers encouraged.

Prerequisite: NE 401, Corequisite: NE 402
Typically offered in Fall only

NE 408 Nuclear Engineering Design Project (3 credit hours)
Projects in design of practical nuclear engineering systems. Preliminary designs developed by teams with advice by faculty as needed, with reports presented in oral and written form. Current and future systems emphasized, and use of computers encouraged.

Prerequisite: NE 406
Typically offered in Spring only

NE 409/MSE 409/NE 509/MSE 509 Nuclear Materials (3 credit hours)
Introduces students to properties and selection of materials for nuclear steam supply systems and to radiation effects on materials. Implications of radiation damage to reactor materials and materials problems in nuclear engineering are discussed. Topics include an overview of nuclear steam supply systems, crystal structure and defects, dislocation theory, mechanical properties, radiation damage, hardening and embrittlement due to radiation exposure and problems concerned with fission and fusion materials. Students cannot receive credit for both 409 and 509.

Prerequisite: MSE 201
Typically offered in Fall only

NE 412 Nuclear Fuel Cycles (3 credit hours)
Processing of nuclear fuel with descriptions of mining, milling, conversion, enrichment, fabrication, irradiation, reprocessing, and waste disposal. In-core and out-of-core nuclear fuel management design, including objectives, constraints, decisionsand methodologies. Nuclear power plant and fuel cycle economics.

Prerequisite: NE 401
Typically offered in Fall only

NE 418 Nuclear Power Plant Instrumentation (3 credit hours)
Instrumentation and supporting systems required for control and protection of a nuclear power plant. Radiation measurement, process measurement, and reactor operating principles used to develop instrumentation requirements and characteristics. Requirements and implementations of instrumentation, control and protection systems for pressurized and boiling water reactors. Design and implementation issues include power supplies, signal transmission, redundancy and diversity, response time, and reliability.

Prerequisite: ECE 221 or ECE 331
Typically offered in Spring only

NE 419 Introduction to Nuclear Energy (3 credit hours)
Electrical power generation from nuclear fission, fundamental aspects of fission chain reaction, and reactor design. Reactor types, their static and dynamic characteristics and instrumentation. Reactor operation and safety. Nuclear fusion and fusionreactor development.Not open to majors in Nuclear Engineering

Prerequisite: PY 202 or PY 208
Typically offered in Fall and Spring

NE 431/NE 531 Nuclear Waste Management (3 credit hours)
Scientific and engineering aspects of nuclear waste management. Management of spent fuel, high-level waste, uranium mill tailings, low-level waste and decommissioning wastes. Fundamental processes for the evaluation of waste management systems with emphasis on the safety assessment of waste disposal facilities to include nuclear criticality safety, free release and transportation. There is also a required research project for the graduate version of the course.

Prerequisite: MA 341 and PY208 (or any equivalent)
Typically offered in Fall only

NE 490/NE 590 Health Physics and Radiological Emergency Response (3 credit hours)
This is an advanced health physics course encompassing internal and external radiological dosimetry along with control of radiation fields including airborne radioactivity. Students will learn basic interactions and response functions, biological effects as well as natural and manmade sources allowing emphasis on the final coverage of nuclear emergency response.

Prerequisite: MA 341 and PY 208 (or equivalent)
Typically offered in Fall only

NE 491 Special Topics in Nuclear Engineering (1-4 credit hours)
Detailed coverage of special topics.

NE 500 Advanced Energy Conversion in Nuclear Reactors (3 credit hours)
A course which introduces concepts and principles of heat generation and removal in reactor systems. Power cycles, reactor heat sources, analytic and numerical solutions to conduction problems in reactor components and fuel elements, heat transfer in reactor fuel bundles and heat exchangers. Design principles are emphasized in homework and in-class problems. Course project is required. Credit will not be given for both NE 400 and NE 500.

Prerequisite: MAE 201
Typically offered in Spring only

NE 501/NE 401 Reactor Analysis and Design (3 credit hours)
Elements of nuclear reactor theory for reactor core design and operation. Includes one-group neutron transport and mutigroup diffusion models, analytical and numerical criticality search, and flux distribution and calculations for homogeneous and heterogeneous reactors, slowing down models, introduction to perturbation theory.

Prerequisites: MA 401 and C- or better in NE 301
Typically offered in Spring only

NE 502 Reactor Engineering (3 credit hours)
Thermal-hydraulic design and analysis of nuclear systems. Single and two-phase flow, boiling heat transfer, modeling of fluid systems. Design constraints imposed by thermal-hydraulic considerations are discussed. Credit will not be given for bothNE 402 and NE 502.

Prerequisite: MAE 308
Typically offered in Fall only

NE 504 Radiation Safety and Shielding (3 credit hours)
A basic course in radiation safety and environmental aspects of nuclear power generation. Topics include radiation interaction, photon attenuation, shielding, internal and external dose evaluation, reactor effluents and release of radioactivity into the environment, transportation and disposal of radioactive waste; and environmental impact of nuclear power plants. Term-long project.

Prerequisite: NE 401 or NE 520
Typically offered in Fall only

NE 505 Reactor Systems (3 credit hours)
Nuclear power plant systems: PWR, BWR and advanced concepts. Design criteria, design parameters, economics, primary and secondary loops, safety systems, reactor control and protection systems, containment, accident and transient behaviors, core design, and reactivity control mechanisms. Term-long project. Credit for both NE 405 and NE 505 is not allowed

Prerequisite: NE 401, NE 402
Typically offered in Spring only

NE 509/MSE 509/NE 409/MSE 409 Nuclear Materials (3 credit hours)
Introduces students to properties and selection of materials for nuclear steam supply systems and to radiation effects on materials. Implications of radiation damage to reactor materials and materials problems in nuclear engineering are discussed. Topics include an overview of nuclear steam supply systems, crystal structure and defects, dislocation theory, mechanical properties, radiation damage, hardening and embrittlement due to radiation exposure and problems concerned with fission and fusion materials. Students cannot receive credit for both 409 and 509.

Prerequisite: MSE 201
Typically offered in Fall only

NE 512 Nuclear Fuel Cycles (3 credit hours)
Processing of nuclear fuel with description of mining, milling, conversion, enrichment, fabrication, irradiation, shipping, reprocessing and waste disposal. Fuel cycle economics and fuel cost calculation. In-core and out-of-core nuclear fuel management, engineering concepts and methodology. Term-long project. Credit for both NE 412 and NE 512 is not allowed

Prerequisite: NE 401
Typically offered in Fall only

NE 520 Radiation and Reactor Fundamentals (3 credit hours)
Basics of nuclear physics and reactor physics that are needed for graduate studies in nuclear engineering. Concepts covered include, atomic and nuclear models, nuclear reactions, nuclear fission, radioactive decay, neutron interactions, nuclear reactors, neutron diffusion in non-multiplying and multiplying systems, and basic nuclear reactor kinetics.

Prerequisite: MA 341 and PY 208
Typically offered in Fall only

NE 521 Principles of Radiation Measurement (3 credit hours)
Radiation detection measurement methods employed in nuclear engineering. Topics include: physics of nuclear decay and nuclear reactions, interaction of charged particles, photons, and neutrons with matter, fundamental properties of radiation measurement systems, statistical analysis of radiation measurements, common radiation detectors (gas-filled detectors, scintillators, and semiconductor detectors), data acquisition and processing methods, and radiation measurement applications.

Prerequisites: Graduate standing in Nuclear Engineering or instructor permission
Typically offered in Fall only

NE 523 Computational Transport Theory (3 credit hours)
Derivation of the nonlinear Boltzmann equation for a rarefied gas and linearization to the equation of transport of neutral particles. Deterministic methods for solving the neutron transport equation: Multigroup energy discretization; Discrete Ordinates angular discretization; various spatial discretization methods. Convergence of numerical solutions with discretization refinement. Iterative solution algorithms: inner, outer, and power iterations. Spectral analysis of inner iterations convergence and acceleration. Selection of advanced topics.

NE 401/501: Reactor Analysis and Design Advanced math & moderate programming skills are necessary. Permissible programming languages: Fortran or C++
Typically offered in Spring only

NE 528/PY 528 Introduction to Plasma Physics and Fusion Energy (3 credit hours)
Concepts in plasma physics, basics of thermonuclear reactions; charged particle collisions, single particle motions and drifts, radiation from plasmas and plasma waves, fluid theory of plasmas, formation and heating of plasmas, plasma confinement, fusion devices and other plasma applications.

Prerequisite: MA 401 and PY 208
Typically offered in Fall only

NE 529/PY 529 Plasma Physics and Fusion Energy II (3 credit hours)
This course expands on the treatment of plasmas as a system of coupled fluids and introduces the foundations of plasma kinetic theory. Derivation of the plasma kinetic equation and the Vlasov equation serve as the starting point to introduce the kinetic study of plasma systems. From this introduction of the governing equations for full kinetic treatment, methods for analyzing plasma response to electromagnetic and electrostatic perturbations using the linearized Vlasov model for uncorrelated plasmas are introduced. Kinetic stability of Vlasov plasmas is introduced and the Nyquist method is used to determine conditions for kinetic stability. The concept of correlated plasmas is then introduced through the introduction of reduced distribution functions and the BBGKY heirarchy. Finally, simple correlated systems and the Liouville model for two-system correlation is covered to look at the impact of particle correlation due to collisions and coulomb interaction.

Prerequisite: NE 528
Typically offered in Spring only

NE 531/NE 431 Nuclear Waste Management (3 credit hours)
Scientific and engineering aspects of nuclear waste management. Management of spent fuel, high-level waste, uranium mill tailings, low-level waste and decommissioning wastes. Fundamental processes for the evaluation of waste management systems with emphasis on the safety assessment of waste disposal facilities to include nuclear criticality safety, free release and transportation. There is also a required research project for the graduate version of the course.

Prerequisite: MA 341 and PY208 (or any equivalent)
Typically offered in Fall only

NE 533 Nuclear Fuel Performance (3 credit hours)
In this course we will study the basic role of fuel in reactor operation and understand how the fuel impacts heat generation and transport to the coolant. The course will begin with an overview of different fuels and the fabrication processes required to construct nuclear fuel. This will include various fuel types and geometries, with a focus on light water reactor fuel and cladding. Thermal transport, mechanics, and thermomechanics affecting fuel behavior will be introduced, and methods to solve the governing equations numerically and analytically will be developed. Subsequently, changes in the fuel and cladding material that degrade the performance of the fuel will be examined. Finally, the knowledge gained throughout the course will be utilized to conduct fuel performance simulations with MOOSE.

Prerequisite: NE 409 or equivalent
Typically offered in Spring only

NE 541 Nuclear Nonproliferation Technology and Policy (3 credit hours)
Technology and policy challenges and solutions to prevent the spread of nuclear weapons. Topics include: issues of nuclear proliferation inherent to civilian nuclear power development; technologies, processes, and policies for safeguarding nuclear materials and technology; integrating the preceding subjects to strengthen the global nuclear nonproliferation regime. Includes a field trip to Oak Ridge National Laboratory during Spring Break to gain hands-on experience with safeguards measurements of nuclear material. The field trip is required; there is no cost to the student.

Graduate standing in Nuclear Engineering or instructor consent.
Typically offered in Spring only

NE 550 Introduction to Atomistic Simulations (3 credit hours)
NE 550 is an introductory course on molecular dynamics simulations. The course covers the principles of classical and statistical mechanics that underpin the simulation methods. Emphasis is placed on writing computer programs for determining thermodynamic, structural and transport properties of different types of materials.

Prerequisite: PY 208 or equivalent and MA 341
Typically offered in Spring only

NE 577/MAE 577 Multiscale Two-phase Flow Simulations (3 credit hours)
Modeling and simulation of two-phase flows using interface tracking approach and ensemble averaging approaches. Model validation and verification based on interface-tracking data, boiling models. Nuclear reactor applications. The course focuses on interface tracking methods understanding as applied to bubbly flow simulations. Students will develop a simplified solver to track 2D bubbles/droplets throughout the course homework assignments and will learn how to apply this approach for better understanding of multi-phase flow as part of the course project.

Typically offered in Spring only

NE 590/NE 490 Health Physics and Radiological Emergency Response (3 credit hours)
This is an advanced health physics course encompassing internal and external radiological dosimetry along with control of radiation fields including airborne radioactivity. Students will learn basic interactions and response functions, biological effects as well as natural and manmade sources allowing emphasis on the final coverage of nuclear emergency response.

Prerequisite: MA 341 and PY 208 (or equivalent)
Typically offered in Fall only

NE 591 Special Topics In Nuclear Engineering I (1-6 credit hours)
Credits Arranged

Typically offered in Fall and Spring

NE 592 Special Topics In Nuclear Engineering II (1-6 credit hours)
Credits Arranged

Typically offered in Fall and Spring

NE 601 Seminar (1 credit hours)
Discussion of selected topics in nuclear engineering.

Typically offered in Fall and Spring

NE 685 Master's Supervised Teaching (1-3 credit hours)
Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

Prerequisite: Master's student
Typically offered in Fall, Spring, and Summer

NE 690 Master's Examination (1-9 credit hours)
For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

Prerequisite: Master's student
Typically offered in Fall only

NE 693 Master's Supervised Research (1-9 credit hours)
Instruction in research and research under the mentorship of a member of the Graduate Faculty.

Prerequisite: Master's student
Typically offered in Fall, Spring, and Summer

NE 695 Master's Thesis Research (1-9 credit hours)
Thesis research.

Prerequisite: Master's student
Typically offered in Fall, Spring, and Summer

NE 696 Summer Thesis Research (1 credit hours)
For graduate students whose programs of work specify no formal course work during a summer session and who will be devoting full time to thesis research.

Prerequisite: Master's student
Typically offered in Summer only

NE 699 Master's Thesis Preparation (1-9 credit hours)
For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

Prerequisite: Master's student
Typically offered in Fall, Spring, and Summer

NE 721 Nuclear Laboratory Fundamentals (3 credit hours)
Labratory experiments and techniques that are useful and instructive to a Nuclear Engineer. The labs include experiments on radiation detectors and detection techniques, Gamma-and X-ray spectroscopy, and use of the thermal neutron beam of the nuclear reactor for neutron imaging. All state-of-the art radiation detectors are taught and used. Restricted to Nuclear Engineering Graduate Students.

Prerequisite: MA 401 and NE 401
Typically offered in Spring only

NE 722 Reactor Dynamics and Control (3 credit hours)
Methods of describing and analyzing dynamic behavior of systems. These methods applied to reactor systems and the effects of feedbacks studies. Methods of measuring the behavior of reactor systems and development of logic systems for control and safety.

Prerequisite: NE 401 or NE 520
Typically offered in Fall only

NE 723 Neutron Transport Theory (3 credit hours)
Advanced theory of neutron transport and computational methods of solving particle transport (linear Boltzmann) equation for reactor physics problems. Principle topics: models of neutron transport; analytic methods for solving transport equation; asymptotic diffusion limit; PN and SPN methods, homogenization methodology; numerical methods for multidimensional problems; computational methods for multiphysics problems. Objective is to enable students to read literature and perform relevant analysis of neutron transport and reactor-physics problems.

P:NE 520 or NE 401/501
Typically offered in Fall only

NE 724 Reactor Heat Transfer (3 credit hours)
Consideration of heat generation and transfer in nuclear power reactors. Topics include reactor heat generation, steady-state and transient heat combustion in reactor fuel elements, boiling heat transfer and single and two-phase flow.

Prerequisite: NE 402 and NE 401 or NE 520
Typically offered in Spring only

NE 726 Radioisotopes Measurement Applications (3 credit hours)
Introduction the student to measurement applications using radioisotopes and radiation. Discussion of all major tracing, gauging and analyzer principles and treatment of several specific applications in detail. Objective is to familiarize student with design and analysis of industrial measurement systems using radioisotopes and/or radiation.

Prerequisite: NE 401 or NE 520
Typically offered in Spring only

NE 727 Nuclear Engineering Analysis (3 credit hours)
Fundamental material on: (1) numerical methods for solving the partial differential equations pertinent to nuclear engineering problems, (2) Monte Carlo simulation of radiation transport and (3) data and error analysis techniques including estimation of linear and nonlinear model parameters from experimental data.

Prerequisite: NE 401 or NE 520
Typically offered in Fall only

NE 729 Reactor Theory and Analysis (3 credit hours)
Theoretical aspects of neutron diffusion and transport related to the design computation and performance analysis of nuclear reactors. Principal topics: a unified view of the neutron cycle including slowing down, resonance capture and thermalization; reactor dynamics and control; fuel cycle studies; and neutron transport methods. Background provided for research in power and test reactor analysis.

Prerequisite: NE 723, NE 727
Typically offered in Spring only

NE 732 Principles of Industrial Plasmas (3 credit hours)
Theory and fundamental physical principles of industrial plasmas. Applications in plasma processing, plasma manufacturing technology, arcs and torches, plasma sprayers, high-voltage high-current switching devices, plasma-driven devices and plasma-aided technology. Emphasis on particle transport and plasma flow.

Prerequisite: NE/PY 528
Typically offered in Spring only

NE 740 Laboratory Projects In Nuclear Engineering (3 credit hours)
Enhancement of laboratory skills pertinent to nuclear engineering research through projects that requiring student to design the experiment, assemble equipment, carry out the measurements and analyze and interpret data. Students work in groups of two and perform to completion two laboratory projects.

Prerequisite: NE 721
Typically offered in Spring only

NE 745 Plasma Laboratory (3 credit hours)
Experimental plasma generation and plasma diagnostic techniques. Lecture topics include high vacuum techniques, perturbing and non-perturbing probe techniques, and laser and emission spectroscopy. Laboratories utilize various methods of measuring plasma parameters discussed in lectures.

Prerequisite: NE 528 or PY 508 or PY 509
Typically offered in Spring only

NE 746 Fusion Energy Engineering (3 credit hours)
Description and analysis of the technologies of devices necessary to produce fusion energy including vacuum technology, plasma heating and fueling, magnetics, special energy conversion, neutronics, materials, environment and safety. Stress upon design integration and ensuing technological constraints.

Prerequisite: NE 528
Typically offered in Fall only

NE 751 Nuclear Reactor Design Calculations (3 credit hours)
Application of digital computer to problems in reactor core nuclear design. Study and exercise of available reactor core physics computer modules. Description of systems and programs used by industry for power reactor core design and core follow. A review of relevant analytic and numerical methods facilitates computer program development by students.

Prerequisite: NE 723
Typically offered in Spring only

NE 752 Thermal Hydraulic Design Calculations (3 credit hours)
Advanced presentation of thermal-hydraulic analysis of nuclear power systems. Topics including development of single phase and two-phase fluid flow equations, subchannel analysis, interphase phenomena and numerical solution methods relevant to design and safety analysis codes.

Prerequisite: NE 724
Typically offered in Fall only

NE 753 Reactor Kinetics and Control (3 credit hours)
The control of nuclear reactor systems. Development of basic control theory including the use of Bode, Nyquist and S-plane diagrams and state-variable methods. Analysis of reactor and reactor systems by these methods and development of control methods and optimum-control methods. Discussion of models of reactors and reactor-associated units, such as heat exchangers. Presentation of effects of nonlinearities.

Prerequisite: NE 722
Typically offered in Spring only

NE 755 Reactor Theory and Analysis (3 credit hours)
Theoretical aspects of neutron diffusion and transport related to the design computation and performance analysis of nuclear reactors. Principal topics: a unified view of the neutron cycle including slowing down, resonance capture and thermalization; reactor dynamics and control; fuel cycle studies; and neutron transport methods. Background provided for research in power and test reactor analysis.

Prerequisite: NE 723, NE 727
Typically offered in Spring only

NE 757 Radiation Effects On Materials (3 credit hours)
Interaction of radiation with matter with emphasis on microstructural modification, physical and mechanical effects. Defects generation and annealing, void swelling, irradiation growth and creep, and irradiation induced effects in reactor materialsare discussed. Current theories and experimental techniques are discussed.

Typically offered in Spring only

NE 761 Radiation Detection (3 credit hours)
Advanced aspects of radiation detection such as computer methods applied to gamma-ray spectroscopy, absolute detector efficiencies by experimental and Monte Carlo techniques, the use and theory of solid state detectors, time-of-flight detection experiments and MÂ¿ssbauer and other resonance phenomena.

Prerequisite: NE 726
Typically offered in Spring only

NE 762 Radioisotope Applications (3 credit hours)
Presentation of advanced principles and techniques of radioisotope applications. Topics include radiotracer principles; radiotracer applications to engineering processes; radioisotope gauging principles; charged particle, gamma ray and neutron radioisotope gauges.

Prerequisite: NE 726
Typically offered in Fall only

NE 765 Verification and Validation in Scientific Computing (3 credit hours)
Advances in scientific computing have made modeling and simulation an important part of engineering and science. This course provides students with understanding and knowledge of comprehensive and systematic development of concepts, principles and procedures for verification, and validation of models and simulations. The methods discussed in class will be applied to wide range of technical fields of engineering (including nuclear and mechanical engineering) and technology. The theory lectures and assignments will be complemented with demonstration computer exercises, examples, and a computer project on uncertainty propagation in modeling.

Restriction: Graduate Standing in College of Engineering or College of Science
Typically offered in Fall only

NE 770 Nuclear Radiation Attenuation (3 credit hours)
Advanced course in computational methods for neutron and photon transport. Methods include Monte Carlo and deterministic solutions to the transport equation for both fixed source and eigenvalue problems. Digital computers employed in the solution of practical problems.

Prerequisite: NE 723 or equivalent
Typically offered in Fall only

NE 772/CE 772 Environmental Exposure and Risk Analysis (3 credit hours)
Course covers the identification, transport, and fate of hazardous substances in the environment; quantification of human exposures to such substances; dose-response analysis; and uncertainty and variability analysis. The general risk assessment framework, study design aspects for exposure assessment, and quantitative methods for estimating the consequences and probablity of adverse health outcomes are emphasized.

Prerequisite: ST 511 or 515
Typically offered in Spring only

NE 777 Radiological Assessment (3 credit hours)
Principles of analyzing environmental radiation transport and resulting human exposure and dose and dose management. Source terms of radiation exposure, the radon problem, transport or radionuclides in the atmosphere, effluent pathways modeling, radiation dosimetry, probabilistic models for environmental assessment, uncertainty analysis, and radiation risk management. A laboratory research project report will be developed as an outcome of this course.

Prerequisite: NE520 & NE504 or NE590 and a semester long statistics course or permission by instructor
Typically offered in Spring only

NE 780 Magnetohydrodynamics & Transport in Plasmas (3 credit hours)
Advanced fluid description of plasmas for magnetic fusion, space and industrial plasmas, and other applications. Emphasis on a first principles approach to transport, equilibria, and stability.

Prerequisite: NE 528, NE/PY 414 and 415
Typically offered in Fall only

NE 781 Kinetic Theory, Waves, & Non-Linear Effects in Plasmas (3 credit hours)
Kinetic theory, waves, and non-linear phenomena in magnetized plasmas. First principles approach to the treatment of instabilities and other collective effects.

Prerequisite: NE 528, NE/PY 414 and 415, Corequisite: MA 775
Typically offered in Fall only

NE 795 Advanced Topics In Nuclear Engineering I (1-3 credit hours)
A study of recent developments in nuclear engineering theory and practice.

Typically offered in Fall and Spring

NE 796 Advanced Topics In Nuclear Engineering II (3 credit hours)
A study of recent developments in nuclear engineering theory and practice.

Typically offered in Fall and Spring

NE 801 Seminar (1 credit hours)
Discussion of selected topics in nuclear engineering.

Typically offered in Fall and Spring

NE 885 Doctoral Supervised Teaching (1-3 credit hours)
Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

Prerequisite: Doctoral student
Typically offered in Fall, Spring, and Summer

NE 890 Doctoral Preliminary Examination (1-9 credit hours)
For students who are preparing for and taking written and/or oral preliminary exams.

Prerequisite: Doctoral student
Typically offered in Fall and Spring

NE 893 Doctoral Supervised Research (1-9 credit hours)
Instruction in research and research under the mentorship of a member of the Graduate Faculty.

Prerequisite: Doctoral student
Typically offered in Fall and Spring

NE 895 Doctoral Dissertation Research (1-9 credit hours)
Dissertation research.

Prerequisite: Doctoral student
Typically offered in Fall, Spring, and Summer

NE 896 Summer Dissertation Research (1 credit hours)
For graduate students whose programs of work specify no formal course work during a summer session and who will be devoting full time to thesis research.

Prerequisite: Doctoral student
Typically offered in Summer only

NE 899 Doctoral Dissertation Preparation (1-9 credit hours)
For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

Prerequisite: Doctoral student
Typically offered in Fall and Spring