

NUEN - NUCLEAR ENGINEERING (NUEN)

NUEN 101 Principles of Nuclear Engineering

Credits 1. 1 Lecture Hour. Introduction to nuclear engineering including global and national energy requirements, radioactivity, radiation protection, and fission and fusion reactor concepts.

NUEN 102 Nuclear Engineering Practice

Credits 0. 0 Other Hours. Participation in an approved high-impact learning practice; reflection on professional outcomes from engineering body of knowledge; documentation and self-assessment of learning experience at mid-curriculum point. **Prerequisite:** NUEN 101.

NUEN 201 Introduction to Nuclear Engineering I

Credits 3. 3 Lecture Hours. Atomic and nuclear physics discoveries that have led to the development of nuclear engineering, atomic models, relativity, x-rays, types of nuclear reactors; problem solving techniques. **Prerequisites:** MATH 251 or registration therein; PHYS 208.

NUEN 265 Materials Science for Nuclear Energy Applications

Credits 3. 3 Lecture Hours. Materials science fundamentals with an emphasis on nuclear applications; topics will include bonding, crystal structures crystalline defects, mechanical properties and radiation effects in metal, ceramic and polymer materials. **Prerequisites:** CHEM 102, or CHEM 104 and CHEM 114, or CHEM 107; PHYS 218.

NUEN 289 Special Topics in...

Credits 1 to 4. 1 to 4 Lecture Hours. Selected topics in an identified area of nuclear engineering. May be repeated for credit. **Prerequisite:** Approval of department head.

NUEN 301 Nuclear Reactor Theory

Credits 3. 3 Lecture Hours. An introduction to neutron diffusion theory, neutron moderation, conditions for criticality of nuclear reactors. **Prerequisites:** NUEN 302.

NUEN 302 Introduction to Nuclear Engineering II

Credits 3. 3 Lecture Hours. Basic radioactivity, nuclear and neutron physics as applied to nuclear engineering. **Prerequisites:** NUEN 201; MATH 308 or registration therein.

NUEN 303 Radiation Detection and Isotope Technology Laboratory

Credits 3. 2 Lecture Hours. 3 Lab Hours. Interaction of radiation with matter; behavior of various nuclear radiation detectors studied both theoretically and experimentally in laboratory; properties of radionuclides useful to industry considered and evaluated from engineering point of view; writing intensive course. **Prerequisite:** Grade of C or better in NUEN 309.

NUEN 304 Nuclear Reactor Analysis

Credits 3. 3 Lecture Hours. The group diffusion method, multi-region reactors, heterogeneous reactors, reactor kinetics, changes in reactivity. **Prerequisite:** NUEN 301; MATH 309.

NUEN 309 Radiological Safety

Credits 3. 3 Lecture Hours. Interactions of nuclear radiations with matter and biological systems; theory and practice of radiation dosimetry as applied to radiation protection; design and application of radiation dosimetry systems for personnel monitoring, area radiation monitoring and accident situation; includes external and internal dosimetry as well as long-term risk analysis. **Prerequisite:** NUEN 302.

NUEN 315 Thermodynamics in Nuclear Systems

Credits 3. 3 Lecture Hours. Introduction of thermodynamic theory and application; thermodynamic properties and conservation of mass and energy; first and second laws of thermodynamics; energy transfer by heat, work and mass; analysis of open and closed systems; key thermodynamic components in nuclear systems including BWR, PWR and other types of reactors; application of thermodynamic cycles to nuclear power systems; and heat and mass balances throughout nuclear systems. **Prerequisites:** MEEN 221; MATH 251 or MATH 253.

NUEN 329 Analytical and Numerical Methods

Credits 3. 3 Lecture Hours. Introduction to use of numerical analysis and advanced analytical techniques for obtaining nuclear reactor flux distributions, temperatures and transients; use of digital computer in obtaining nuclear reactor design information. **Prerequisites:** MATH 309 and NUEN 301.

NUEN 330 Monte Carlo Radiation Transport and MCNP Code

Credits 3. 2 Lecture Hours. 2 Lab Hours. Principles of Monte Carlo method; statistical methods in Monte Carlo; random number generation; sampling methods for physical processes represented by Boltzmann transport equation; particle tracking in combinatorial geometry; ACE format cross-sections; introduction to MCNP code; MCNP applied to radiation shielding, criticality safety, reactor physics and detector modeling problems; MCNP output analysis; MCNP statistical tests; MCNP tallying procedures; Variance reduction techniques; introduction to develop Monte Carlo algorithms. **Prerequisite:** Grade of C or better in NUEN 302; grade of C or better or concurrent enrollment in NUEN 301; MCNP code single user license from RSICC, ORNL, USA; junior or senior classification.

NUEN 405 Nuclear Engineering Experiments

Credits 3. 2 Lecture Hours. 3 Lab Hours. Experimental measurements of basic nuclear reactor parameters; reactor operation and reactor safety. **Prerequisites:** NUEN 303; NUEN 304 or senior classification.

NUEN 406 Nuclear Engineering Systems and Design

Credits 3. 3 Lecture Hours. Nuclear plant systems; conventional and advanced generation power reactors, nuclear simulators, transient analysis using available software for reactor simulators; nuclear engineering design methodology; problem formulation, criteria, trade-off decisions and design optimization; case studies. **Prerequisite:** NUEN 304; MEEN 461 or approval of instructor.

NUEN 410 The Design of Nuclear Reactors

Credits 4. 4 Lecture Hours. Application of reactor theory and other engineering disciplines in fundamental and practical design of nuclear reactor systems for power applications; use of computer in design operations. **Prerequisites:** NUEN 304 and NUEN 406; MEEN 461.

NUEN 417/MEEN 417 Basics of Plasma Engineering and Applications

Credits 3. 3 Lecture Hours. Basic plasma properties and confinement techniques; single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory; wave phenomena in plasmas and introduction to plasma kinetic theory; analysis of laboratory plasmas and plasma applications including fusion, electric propulsion, materials processing and plasmas enhanced chemistry. **Prerequisites:** Grade of C or better in PHYS 208 or equivalent; senior classification in nuclear, mechanical or aerospace engineering, or physics. **Cross Listing:** MEEN 417/NUEN 417.

NUEN 418 Fuel Assembly and 3-D Reactor Core Design and Modeling

Credits 3. 3 Lecture Hours. Application of state-of-the-art engineering-grade codes in the neutronic design, analysis and modeling of nuclear fuel assembly and core. **Prerequisites:** NUEN 304 and junior or senior classification.

NUEN 428 Computational Fluid Dynamics in Nuclear Thermal Hydraulics

Credits 3. 3 Lecture Hours. Computational fluid dynamics (CFD) as it relates to thermal hydraulics in nuclear power generation; computational model of important flow scenarios using appropriate mesh generation techniques; assessment of result validity through standard verification and validation practices. **Prerequisite:** Grade C or better in NUEN 329, MEEN 344, or equivalent.

NUEN 430 Computer Applications in Nuclear Engineering

Credits 3. 3 Lecture Hours. Applications of digital computers to solve nuclear engineering problems; nuclear data and cross-section libraries; deterministic methods for linear and non-linear nuclear systems, and Monte Carlo methods for linear nuclear systems. **Prerequisites:** NUEN 304, NUEN 329.

NUEN 431 Technical Communications Issues in the Nuclear Industries

Credit 1. 1 Lecture Hour. Introduction to a variety of topics that present communication challenges; opportunities to learn from a variety of visiting experts concerning the nuances and challenges of, as well as successful methods for, communicating with concerned audiences about technically challenging topics. **Prerequisite:** Junior or senior classification or approval of instructor.

NUEN 432 Nuclear Power Plant Fundamentals

Credits 3. 3 Lecture Hours. Understanding the operation of a nuclear electric general station; includes reactor water chemistry, material science, electrical science; mechanical science, civil engineering for nuclear power plant engineers, and digital process control systems. **Prerequisite:** Junior or senior classification in the college of engineering; non-NUEN majors.

NUEN 436 Human Performance for Nuclear Power Plant Engineers

Credits 2. 2 Lecture Hours. Six modules: human performance fundamentals, the organization and the processes, the individual worker, the engineer, corrective action programs and root cause analysis, and case studies including TMI-2, Chernobyl, Davis-Besse, and Fukushima Daiichi. **Prerequisites:** NUEN 432; junior or senior classification in the college of engineering.

NUEN 451 Nuclear Security System Design

Credits 3. 3 Lecture Hours. The science and engineering associated with the design, evaluation and implementation of systems to secure nuclear and radiological materials; adversary characterization, categorization of nuclear and radiological targets, calculation of consequences associated with failure to protect targets, detection and delay technologies, and mathematical methods for evaluation and managing risk. **Prerequisites:** NUEN 303 and NUEN 309 or equivalent, or approval of instructor.

NUEN 460 Nuclear Plant Systems and Transients

Credits 3. 3 Lecture Hours. Use of engineering principles to elucidate the nuclear, mechanical, electrical and functional interactions among nuclear plant components and systems; reactor protection systems, alarm and trip setpoints, normal and accident transients; components studied in detail include core, control rod drive mechanism, neutron source, neutron detectors, primary coolant system, and emergency core cooling system. **Prerequisites:** NUEN 301, NUEN 302, NUEN 304, NUEN 406, NUEN 430 or equivalents; MEEN 315, MEEN 344, MEEN 461 or equivalents; junior or senior classification.

NUEN 465 Nuclear Materials Engineering

Credits 3. 3 Lecture Hours. Explore applications of materials science principles in nuclear energy systems; includes crystal structures and defects, metallurgy, and materials thermochemistry; emphasis on nuclear fuel performance, structural material changes, and waste materials; laboratory demonstrations on materials behavior. **Prerequisites:** NUEN 265, MEEN 222/MSEN 222 or equivalent and NUEN 302.

NUEN 475 Environmental Nuclear Engineering

Credits 3. 3 Lecture Hours. Environmental aspects of nuclear power; natural radiation environment and the distribution of radioactivity added to the environment by human activities; evaluation of effects of radiation and radioactivity on the environment and on humans. **Prerequisite:** Grade of C or better in NUEN 309.

NUEN 479 Radiation Protection Engineering

Credits 3. 2 Lecture Hours. 3 Lab Hours. Analysis of radiation hazard situations and design of nuclear facilities from a safety standpoint. **Prerequisite:** NUEN 475.

NUEN 481 Seminar

Credit 1. 1 Lecture Hour. Designed to broaden the student's capability, performance and perspective in nuclear engineering through faculty, student and guest presentations. **Prerequisite:** NUEN 410 or registration therein or NUEN 479 or registration therein.

NUEN 485 Directed Studies

Credits 1 to 6. 1 to 6 Other Hours. Problems of limited scope approved on an individual basis intended to promote independent study; program enrichment for capable students; results presented in writing to staff. **Prerequisites:** Junior or senior classification and approval of department head.

NUEN 489 Special Topics in...

Credits 1 to 4. 1 to 4 Lecture Hours. 0 to 4 Lab Hours. Selected topics in an identified area of nuclear engineering. May be repeated for credit. **Prerequisite:** Approval of instructor.

NUEN 491 Research

Credits 1 to 4. 1 to 4 Other Hours. Research conducted under the direction of a faculty member in Nuclear Engineering. May be repeated 2 times for credit. Registration in multiple sections of this course is possible within a given semester provided that the per semester credit hour limit is not exceeded. **Prerequisites:** Junior or senior classification and approval of instructor.