NUEN - NUCLEAR ENGINEERING (NUEN)

NUEN 101 Principles of Nuclear Engineering

Credit 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. O 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:** Grade of C or better in MATH 251 and PHYS 207, or concurrent enrollment.

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:** Grade of C or better in CHEM 107 or CHEM 120; grade of C or better in PHYS 206.

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:** Grade of C or better in NUEN 302 and MATH 308; grade of C or better in MATH 309 or concurrent enrollment.

NUEN 302 Introduction to Nuclear Engineering II

Credits 3. 3 Lecture Hours. Basic radioactivity, nuclear and neutron physics as applied to nuclear engineering. **Prerequisites:** Grade of C or better in NUEN 201; grade of C or better in MATH 308 or concurrent enrollment.

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. **Prerequisites:** Grade of C or better in NUEN 301 and 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. **Prerequisites:** Grade of C or better in 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:** Grade of C or better in 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:** Grade of C or better in NUEN 303 and NUEN 304.

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:** Grade of C or better in NUEN 304 and 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:** Grade of C or better in NUEN 304, NUEN 406 and MEEN 461.

NUEN 416 Small Modular Reactors and Microreactors

Credits 3. 3 Lecture Hours. Advanced topics in small modular reactors (SMR) and microreactors (MR); unique applications in the field of nuclear energy; SMR and MR systems and applications for non-carbon emitting sources of electricity; issues for emerging countries with small electrical grids; utilization of modularity for construction and staging of plants; analysis of SMR and MR designs, technologies, economics, financing approaches and regulatory processes. **Prerequisites:** Grade of C or better in NUEN 302 or approval of instructor.

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 207 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 engineeringgrade 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 437 Fundamentals of Fusion Engineering

Credits 3. 3 Lecture Hours. Broad introduction to the engineering of fusion energy systems; fundamental knowledge regarding fusion physics and approaches to achieve fusion; engineering challenges such as energy conversion, tritium fuel cycle, fusion neutronics and wastes. **Prerequisites:** Grade of C or better in MEEN 344 or equivalent; grade of C or better in NUEN 301.

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:** Grade of C or better in 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 467 Deep Learning for Engineering Applications

Credits 3. 3 Lecture Hours. Fundamentals of deep learning along with its advanced applications in addressing engineering problems, emphasizing modeling and simulation, as well as complex system analysis; combination of theoretical knowledge with practical applications; hands-on coding practice to foster a robust understanding of deep learning techniques and learn how to leverage them to solve complex engineering challenges. **Prerequisites:** Grade of a C or better in MATH 309 or MATH 311.

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 484 Internship

Credits 0-1. 0 Lecture Hours. 0 Lab Hours. 0-1 Other Hours. Directed internship in an organization or a research or teaching laboratory within or outside Texas A&M University; under the supervision of a professional expert aligned with the student's professional objectives; consists of on-the-job training, research, teaching, management, or a combination of these. **Prerequisites:** Junior or senior classification or approval of instructor.

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.