

# NUCLEAR AND RADIOLOGICAL ENGINEERING

## EGN 6913 Engineering Graduate Research 0-3 Credits, Max 12 Credits

**Grading Scheme:** S/U

Course will provide the student with supervised research in a laboratory setting.

## ENU 5005 Introduction to Nuclear Engineering 4 Credits

**Grading Scheme:** Letter Grade

Students will learn Atomic and Nuclear Physics, Interaction of Radiation with Matter, Detecting Nuclear Radiations, Neutron Diffusion and Moderation, Nuclear Reactor Theory, Time Dependent Reactor, and Two-Phase Flow and Heat Transfer at a level appropriate to begin graduate-level coursework in nuclear engineering sciences.

**Prerequisite:** NES\_PHD or NES\_MS.

## ENU 5142 Risk Assessment and Economic Analysis of Nuclear Systems. 3 Credits

**Grading Scheme:** Letter Grade

Probabilistic risk assessment, including fault trees, event trees, reliability block diagrams, component reliability modeling; and economic analysis, including sensitivity studies, capital cost, levelized cost of electricity, of nuclear systems. .

**Prerequisite:** STA 3032 or ENU 5005 or (ENU 4104 & ENU 4134).

## ENU 5176L Principles of Nuclear Reactor Operations Laboratory 1 Credit

**Grading Scheme:** Letter Grade

Principles of reactor operations applied to startup, operation, and control of the training reactor to include performing reactor physics measurements and instrumentation and control calibrations.

**Prerequisite:** ENU 4144 or equivalent and consent of instructor.

## ENU 5186 Nuclear Fuel Cycles 3 Credits

**Grading Scheme:** Letter Grade

Fuel cycle from uranium mining through waste management. Reactor fuel cycle including economics and advanced fuel management. Nodal code evaluation of criticality, power peaking and power sharing through operating cycle, use of burnable poisons and reshuffle and reload for uranium and plutonium cycles.

**Prerequisite:** ENU 4104.

## ENU 5516L Nuclear Engineering Laboratory II 2 Credits

**Grading Scheme:** Letter Grade

Laboratory practice in neutron and gamma detection and analysis. Determination of basic neutron parameters in nonmultiplying and multiplying media.

**Prerequisite:** ENU 4612L or ENU 5615L and 4104 or ENU 6106.

## ENU 5615C Nuclear Radiation Detection and Instrumentation 4 Credits

**Grading Scheme:** Letter Grade

Interaction of radiation with matter, radiation-detection systems, pulse shaping, amplification, amplitude and time-analyzing circuitry; counting and measuring devices and control systems for nuclear reactors.

**Prerequisite:** ENU 3003 and EEL 3303L or equivalent. ;

**Corequisite:** ENU 6051 ; or prereq of ENU 4605 or equivalent.

## ENU 6051 Radiation Interaction Basics and Applications I 3 Credits

**Grading Scheme:** Letter Grade

Interaction of X-rays, gamma rays, neutrons, and charged particles with matter; radioactive decay, nuclear moments, and nuclear transitions. Application to basic problems in nuclear engineering sciences.

## ENU 6106 Nuclear Reactor Analysis I 3 Credits

**Grading Scheme:** Letter Grade

Nuclear criticality, neutron transport equation, multigroup neutron diffusion theory, and perturbation theory. Reactor kinetics: point model, reactivity feedback, and space-time models.

**Prerequisite:** ENU 6051.

## ENU 6115 Power Plant Simulation 3 Credits

**Grading Scheme:** Letter Grade

Instruction and practical experience in the operation and interpretation of results from major nuclear reactor simulation codes such as TRACE, RELAP5, RETRAN, CATHARE, and SAM.

**Prerequisite:** EML 4140 or ENU 4133 or ENU 4134 or ENU 6135 or ENU 6136 or ENU 5005.

## ENU 6126 Fundamentals of Reactor Kinetics 3 Credits

**Grading Scheme:** Letter Grade

Nuclear reactor kinetics, including mathematics, transport and diffusion considerations, steady state and time dependent reactor physics, delayed neutron properties, photoneutrons, and neutron reactions, approximations and solutions to the kinetics equations, numerical solution methods using explicit, implicit, integral, marching, and finite difference solution methods.

**Prerequisite:** ENU 4001, ENU 4605, ENU 4103.

## ENU 6135 Nuclear Thermal Hydraulics 4 Credits

**Grading Scheme:** Letter Grade

Treatment of nuclear thermal sciences: thermodynamics, fluid mechanics, heat transfer, two-phase flow, boiling; sub-channel thermal hydraulics, steam generator design, balance of plant analysis.

**Prerequisite:** EML 4140 and (ENU 4133 or EGN 3353C)

## ENU 6136 Advanced Nuclear Thermal Hydraulics 3 Credits

**Grading Scheme:** Letter Grade

Topics in advanced nuclear thermal hydraulics, fluid mechanics, and heat transfer including areas of ongoing research and applications to current and future nuclear fission reactors.

**Prerequisite:** ENU 4134 or EGM 6812 or EML 6155 or ENU 6135

## ENU 6143 Advanced Nuclear Reactor Concepts 3 Credits

**Grading Scheme:** Letter Grade

Covers modern concepts for nuclear fission reactor systems, including advanced light-water reactors, gas-cooled reactors, and liquid-metal reactors. Topics covered for each type of reactor system will include thermal modeling, reactor safety, licensing, reactor physics, materials selection, and fuel cycles.

**Prerequisite:** (ENU 4134 or ENU 6135) & (ENU 4103 or ENU 6106).

## ENU 6305 Radiochemistry 3 Credits

**Grading Scheme:** Letter Grade

Fundamental behavior of radionuclides, use and application of radioanalytical techniques, and applications to nuclear fuel cycle.

**Prerequisite:** A course or two course sequence in introductory undergraduate chemistry, such as CHM 2045/2046 or CHM 2095/2096.

## ENU 6375 Nuclear Security Science 3 Credits

**Grading Scheme:** Letter Grade

The nuclear fuel cycle from the perspective of nuclear forensics, security, nonproliferation, and safeguards and in the context of international nuclear policies. Nuclear threats are balanced with the past history of nuclear weapons use, current nonproliferation technology, and the growth of the international nuclear industry. Signatures including radiological and morphological characteristics of nuclear material is introduced as well as the techniques for the detection of special nuclear mater.

**Prerequisite:** ENU 6051.

**ENU 6616C Advanced Radiation Measurement Laboratory 3 Credits**

**Grading Scheme:** Letter Grade

Advanced radiation detection methods and applications in the fields of nuclear safeguards, dosimetry, and nuclear medicine. Coverage of radiological non destructive assay methods for materials control and accountability. Hands-on experience on state-of-the-art radiation detection instrumentation.

**Prerequisite:** ENU 6051.

**ENU 6715 Plasma and Fusion 3 Credits**

**Grading Scheme:** Letter Grade

Introduction to the concepts underlying plasma confinement in fusion devices.

**Prerequisite:** PHY 2049.

**ENU 6835 Nuclear Fuels 3 Credits**

**Grading Scheme:** Letter Grade

Survey of the nuclear fuels from ore to waste, including mining, pin design, fabrication, in-core performance, storage, disposal and fuel economics.

**ENU 6845L Nuclear Fuels and Materials Laboratory 3 Credits**

**Grading Scheme:** Letter Grade

Design of irradiation experiments and post-irradiation examinations (PIE) needed to understand the behavior of nuclear fuels and materials. Hands-on experience on state-of-the-art characterization instrumentation, sample preparation and handling, and safe radiological work practices.

**Prerequisite:** ENU 6805 or ENU 4800.

**ENU 6905 Individual Work 1-6 Credits, Max 12 Credits**

**Grading Scheme:** Letter Grade

Supervised study or research in areas not covered by other graduate courses.

**ENU 6910 Supervised Research 1-5 Credits, Max 5 Credits**

**Grading Scheme:** S/U

Supervised Research

**ENU 6935 Nuclear and Radiological Engineering Seminar 1 Credit, Max 8 Credits**

**Grading Scheme:** S/U

Discussion of research, current trends in the nuclear related industry, government, and research establishments.

**ENU 6936 Special Projects in Nuclear and Radiological Engineering Sciences 1-9 Credits, Max 12 Credits**

**Grading Scheme:** Letter Grade

Nonthesis research projects.

**ENU 6937 Special Topics in Nuclear and Radiological Engineering Sciences 1-9 Credits, Max 12 Credits**

**Grading Scheme:** Letter Grade

Special Topics in Nuclear and Radiological Engineering Sciences

**ENU 6940 Supervised Teaching 2 Credits, Max 5 Credits**

**Grading Scheme:** S/U

This is a practicum course to provide students with supervised teaching experience on developing effective instructional methods and materials in engineering education as well as effective mentoring skills in a professional setting.

**Prerequisite:** NES\_PHD.

**Corequisite:** EGS 6056.

**ENU 6941 Professional Development for Nuclear Engineering Sciences 1 Credit**

**Grading Scheme:** S/U

Students will learn strategies and sound practices in proposal research, creation, and defense.

**Prerequisite:** NES\_PHD.

**ENU 6971 Research for Master's Thesis 1-15 Credits**

**Grading Scheme:** S/U

Research for Master's Thesis

**ENU 6972 Research for Engineer's Thesis 1-15 Credits**

**Grading Scheme:** S/U

Research for Engineer's Thesis

**ENU 7979 Advanced Research 1-12 Credits**

**Grading Scheme:** S/U

Research for doctoral students before admission to candidacy. Designed for students with a master's degree in the field of study or for students who have been accepted for a doctoral program. Not appropriate for students who have been admitted to candidacy.

**ENU 7980 Research for Doctoral Dissertation 1-15 Credits**

**Grading Scheme:** S/U

Research for Doctoral Dissertation