NUCLEAR ENGINEERING (NUGN)

NUGN505. NUCLEAR SCIENCE AND ENGINEERING SEMINAR. 1.0 Semester Hr.
(I, II) The Nuclear Science and Engineering Seminar provides a forum for Nuclear Engineering graduate students to present their research projects, participate in seminars given by Nuclear Science and Engineering professionals, and develop an enhanced understanding of the breadth of the nuclear engineering discipline. Prerequisite: graduate standing. 1 hour seminar; 1 semester hour. Repeatable; maximum 2 hours granted towards M.S./M.E. Degree Requirements and 4 hours maximum granted towards Ph.D. Requirements.

NUGN506. NUCLEAR FUEL CYCLE. 3.0 Semester Hrs.
(I) An introduction to nuclear energy emphasizing the science, engineering, and policies underlying the systems and processes involved in energy production by nuclear fission. Students will acquire a broad understanding of nuclear energy systems framed in the context of the fuel used to power nuclear reactors. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- Use Segré chart to determine properties of various nuclides
- Describe the components of various nuclear fuel cycles and their interrelation
- Determine the cost of nuclear fuel under a variety of economic and technical conditions
- Distinguish between various fissile nuclides and their importance as reactor fuel or nuclear explosives
- Perform and apply basic power reactor calculations such as isotope production rates, average flux, reactor power, capacity factor, fuel burnup, efficiency of multibatch cores.
- . Recount the basic chemical and engineering considerations in the milling of uranium bearing ores and the reprocessing of used nuclear fuel
- Describe major regulations affecting nuclear waste disposal in the US and their impact on disposal strategies
- Describe the major features of a waste repository and consider how they intersect with the requirements imposed by the composition of used nuclear fuel.

NUGN510. INTRODUCTION TO NUCLEAR REACTOR PHYSICS. 3.0 Semester Hrs.
Bridges the gap between courses in fundamental nuclear physics and the neutronic design and analysis of nuclear reactors. Review of neutron energetics and reactions; nuclear cross sections; neutron induced fission; neutron life cycle, multiplication, and criticality; nuclear reactor kinetics and control; the diffusion approximation for neutron transport; simple reactor geometries and compositions; modeling and simulation of reactors. Prerequisite: ENGY475, MEGN475 or equivalent.

NUGN520. INTRODUCTION TO NUCLEAR REACTOR THERMAL-HYDRAULICS. 3.0 Semester Hrs.
Bridges the gap between fundamental courses in thermodynamics, fluid flow, and heat transer and the thermal-hydraulic design and analysis of nuclear reactors. Provides a comprehensive introduction to the thermal-hydraulics of each of the major classes of nuclear reactors. Introduces the major thermal-hydraulic computational tools, passively safe reactor design, thermal-hydraulic transient analysis, and severe nuclear reactor accident analysis. Prerequisite: ENGY475, MEGN475 or equivalent.

NUGN535. INTRODUCTION TO HEALTH PHYSICS. 3.0 Semester Hrs.
(I) Health physics evaluates effects of ionizing radiation on biological systems for the safe use of radiation and control of potential health hazards. The core concept is dosimetry, which relates the radiation absorbed externally and internally to a quantitative estimate of health effects. Other areas in health physics such as protection standards, regulations, and radiation diagnosis and therapy are all constructed on dosimetric methods.

NUGN570. MATHEMATICAL METHODS IN NUCLEAR SCIENCE AND ENGINEERING. 1.0 Semester Hr.
This is a 1 credit course in the applied mathematics of nuclear engineering. Students will be instructed in how to solve systems of coupled ODEs and PDEs describing neutron transport and burnup. Students will also learn how to use adjoint perturbation theory to investigate stability in nuclear reactors, and how to use Python to formulate numerical solutions to neutron transport and burnup equations. Examples will be drawn specifically from nuclear reactor physics and nuclear thermal hydraulics.
Course Learning Outcomes

- Use matrix exponentials and Laplace transforms to solve linear modified burnup equations
- Identify linear PDEs and ODEs that come up in modeling nuclear reactors
- Use Python for numerical solutions of the neutron diffusion equation
- Use Python for the coupled solution of neutron diffusion and burnup equations in a 1-D reactor
- Understand the derivation of the modified Bateman equations used to model burnup in a nuclear reactor
- Solve the time dependent neutron diffusion equation in 1-3 dimensions
- Use perturbation theory to understand stability in the non-linear neutron diffusion equation
- Define and solve adjoint equations

NUGN580. NUCLEAR REACTOR LABORATORY. 3.0 Semester Hrs.
Provides hands-on experience with a number of nuclear reactor operations topics. Reactor power calibration; gamma spectroscopy; neutron activation analysis; reactor flux and power profiles; reactor criticality; control rod worth; xenon transients and burnout; reactor pulsing. Taught at the USGS TRIGA reactor. Prerequisite: NUGN510. 3 hours laboratory; 3 semester hours.

NUGN585. NUCLEAR REACTOR DESIGN I. 2.0 Semester Hrs.
Provides a basic understanding of the nuclear reactor design process, including: key features of nuclear reactors; nuclear reactor design principles; identification of design drivers; neutronic and thermal-hydraulic design of nuclear reactors; reactor safety considerations; relevant nuclear engineering computer codes. Prerequisite: NUGN510, NUGN520.

NUGN586. NUCLEAR REACTOR DESIGN II. 2.0 Semester Hrs.
Builds on the design experience obtained in NUGN586 to provide an in-depth understanding of the nuclear reactor design process. Prerequisites: NUGN585 (taken in the same academic year). 2 hours lecture; 2 semester hours.

NUGN590. COMPUTATIONAL REACTOR PHYSICS. 3.0 Semester Hrs.
(I) This course will provide an introduction to computational nuclear reactor physics. Students will understand the physics driving neutron cross sections and how they determined, and how neutron transport calculations are completed using Monte Carlo and finite difference

methods. Students will learn how to write modular code using professional software engineering practices, and will have an introduction to the Serpent and MCNP family of transport codes. 3 hours lecture; 3 semester hours.

Course Learning Outcomes

- Students should understand the physics driving reactor operation and implement this understanding to address nuclear engineering challenges.

NUGN598. SPECIAL TOPICS. 6.0 Semester Hrs.
(I, II, S) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once, but no more than twice for the same course content. Prerequisite: none. Variable credit: 0 to 6 credit hours. Repeatable for credit under different titles.

NUGN599. INDEPENDENT STUDY IN NUCLEAR ENGINEERING. 0.5-6 Semester Hr.
(I, II, S) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: ?Independent Study? form must be completed and submitted to the Registrar. Variable credit: 0.5 to 6 credit hours. Repeatable for credit under different topics/ experience and maximums vary by department. Contact the Department for credit limits toward the degree.

NUGN698. SPECIAL TOPICS. 6.0 Semester Hrs.
(I, II, S) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once, but no more than twice for the same course content. Prerequisite: none. Variable credit: 0 to 6 credit hours. Repeatable for credit under different titles.

NUGN699. INDEPENDENT STUDY IN NUCLEAR ENGINEERING. 0.5-6 Semester Hr.
(I, II, S) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: ?Independent Study? form must be completed and submitted to the Registrar. Variable credit: 0.5 to 6 credit hours. Repeatable for credit under different topics/ experience and maximums vary by department. Contact the Department for credit limits toward the degree.

NUGN707. GRADUATE THESIS / DISSERTATION RESEARCH CREDIT. 1-15 Semester Hr.
(I, II, S) Research credit hours required for completion of a Masters-level thesis or Doctoral dissertation. Research must be carried out under the direct supervision of the student's faculty advisor. Variable class and semester hours. Repeatable for credit.