COURSE # : NERS 320 **CREDITS:** 4 / Required	**COURSE TITLE :** Problems in Nuclear Engineering and Radiological Sciences
TERMS OFFERED: Fall `	**PREREQUISITES:** Concurrent enrollment in NERS 311
TEXTBOOKS/REQUIRED MATERIAL: Typed class notes (almost 400 pages)	**COGNIZANT FACULTY:** Edward Larsen
INSTRUCTOR: Edward Larsen	**FACULTY APPROVAL:**
CoE BULLETIN DESCRIPTION: This course introduces junior-level NERS students to several different standard physical problems in nuclear engineering and radiological sciences, together with basic mathematical and numerical methods for solving the problems. In the course each different physical problem will be introduced, mathematical equations for the problem will be derived, and solution techniques will be presented to solve the equations. The course is meant to prepare students for more advanced senior-level NERS courses.	**COURSE TOPICS:** (approximate number of hours in parentheses) 1. Basics of Deterministic and Monte Carlo Numerical Methods. (1 week) 2. Radioactive Decay and Simplified Rate Problems – Coupled systems of first-order ODE's solved by analytic and numerical methods. (4 weeks) 3. Elements of Neutron & Photon Transport – Cross sections, Boltzmann Equation, Monte Carlo methods, & Method of Characteristics. (4 weeks) 4. Point Kinetics Equations & Prompt Jump Approximation – Coupled systems of first-order ordinary differential equations. (1.5 weeks) 5. Neutron Diffusion Equation – 1D and 2D Second-order partial differential equations, 2D solved by separation of variables. (2.5 weeks)
COURSE STRUCTURE/SCHEDULE: Lectures: 3 per week, 2 @ 80 minutes and 1 @ 50 minutes	

COURSE OBJECTIVES (Links to Program Educational Objective Outcomes are shown.)	1. Students will understand the basic physics that underlie important physical processes in nuclear engineering. [1,2] 2. Students will learn how to formulate mathematical equations that model these physical processes. [1,2] 3. Students will learn how to analytically solve some of these mathematical equations. [1,2] 4. Students will learn how to numerically "simulate" some of these mathematical equations. [1,2] 5. Students will learn methods for solving first- and second-order partial differential equations. [1,2]
COURSE OUTCOMES (Links to Program /ABET Student Outcomes are shown.)	1. Students will review certain topics from advanced calculus and learn the basic principles of deterministic and Monte Carlo methods. [1,2,3|ABET a,k,e] 2. Students will (i) understand the process of radioactive decay, (ii) learn how to formulate systems of ordinary differential equations that model this process, and (iii) solve these equations using analytic, deterministic, and Monte Carlo methods. [1,2,3|ABET a,k,e] 3. Students will learn how to formulate and solve "simplified rate" equations that model complex problems in radiological health engineering. [1,2,3|ABET a,k,e] 4. Students will understand (i) the physical elements of neutron and proton transport, (ii) how to formulate a mathematical equation that describes this process, and (iii) how to solve some basic problems using Monte Carlo and analytic techniques. [1,2,3|ABET a,k,e] 5. Students will learn the "Method of Characteristics" for solving first-order partial differential equations. [1,2,3|ABET a,k,e] 6. Students will understand (i) the basic physics of "Point Reactor Kinetics," (ii) how to formulate systems of first-order differential equations to model this process, and (iii) how to solve these equations using the Prompt Jump Approximation. [1,2,3|ABET a,k,e] 7. Students will (i) understand the derivation of the neutron diffusion equation, (ii) learn how to solve 1-D diffusion problems analytically and numerically, and (iii) learn how to solve certain 2-D problems analytically. [1,2,3|ABET a,k,e] 8. Students will learn the "Separation of Variables" method for solving second-order partial differential equations. [1,2,3|ABET a,k,e]
ASSESSMENT TOOLS (Links to Course Out-comes are identified.)	1. 1 or 2 mid-term exams, and a final exam assess outcomes for individual students under time constraints. [1-8] 2. 10 - 12 weekly problem sets measure outcomes under less time pressure, with possible collaboration between students and assistance from instructor or GSI. [1-8] 3. Course evaluations by students assess all outcomes at the end of the course. 4. Faculty self-assessment provides self-assessment data on all outcomes.