COURSE #: NERS 312 **CREDITS:** 3/ Required	**COURSE TITLE:** Elements of Nuclear Engineering and Radiological Scie
TERMS OFFERED: Winter	**For each prerequisite below, "E" denotes Enforced and "A" denotes Ad**
TEXTBOOKS/REQUIRED MATERIAL: Krane, *Introductory Nuclear Physic, Wiley 1988*	**PREREQUISITES:** NERS 311 (A)
INSTRUCTOR(S): Alex Bielajew	**COGNIZANT FACULTY:** Alex Bielajew
CoE BULLETIN DESCRIPTION: Nuclear properties. Nuclear properties. Radioactive decay. Alpha-, beta-, and gamma- decays of nuclei. Nuclear fission and fusion. Radiation interactions and reaction cross-sections.	**COURSE TOPICS:** Nuclear properties, force between nucleons, nuclear m radioactive decay , alpha, beta and gamma decays, nuclear reactions and cross-sections, fission and fusion.
COURSE STRUCTURE/SCHEDULE Lecture: 3 per week @ 50 minutes each	
COURSE OBJECTIVI For each Course Objective, links to the Program Educational Objectives are shown	1. Students will know key nuclear properties (radius, spin, binding energy, separation energies, decay energetics, Q values). [1,2] 2. Students will understand decay systematics (decay laws, decay chains). [1,2] 3. Students will learn the fundamentals of alpha, beta and gamma decays (nuclear decays and physics). [1,2] 4. Students will understand the fundamentals of nuclear reactions, including fission and fusion [1,2] 5. Students will acquire knowledge for higher level courses involving the applications of radiation. [1,2]
COURSE OUTCOME For each Course Outcome, links to the Program/ABET Student Outcomes are identified. [#,a-k]	1. Demonstrate knowledge of introductory terminology for nuclei, nuclear properties, units and dimensions. [1,2,3|ABET a,k,e] 2. Know the magnitude of nuclear radius & it A-dependence, find data on mass/abundance of nuclides, describe nuclear binding energy, describe nuclear angular momentum and parity, nuclear electromagnetic moments, and excited states. Read energy level diagrams. [1,2,3|ABET a,k,e] 3. Describe the shell model, significance of even-even nuclei, collective structure, rotations/vibrations, and realistic nuclear models. [1,2,3|ABET a,k,e] 4. Solve the decay law, list of the types of decay, describe the quantum theory of radioactive decay, solve decay problems with production, solve for growth of daughter activities, and describe the natural radioactivity chains. Describe the physical mechanisms of alpha, beta and gamma decay, and the properties that strongly impact the decay constant. [1,2,3|ABET a,k,e] 5. Explain why alpha decay occurs, alpha decay processes, alpha decay systematics, solve problems in the theory of alpha emission, qualitatively, describe the influence of angular momentum and parity in alpha decay. [2,3,5](1,2,3,12) 6. Describe the energy release in beta decay, and the Fermi theory of beta decay. Describe the classical experimental tests of Fermi theory. Describe the angular momentum and parity selection rules, comparative half-lives and "forbidden" decays. [1,2,3|ABET a,k,e] 7. Describe the energetics of gamma decay, read energy level diagrams, describe classical electromagnetic radiation and transition to quantum mechanics, and the influence of angular momentum and parity selection rules. Describe angular distribution and polarization measurements. Describe internal

	emissions and lifetimes for gamma emission. [1,2,3|ABET a,k,e] 8. Enumerate types of reactions and relevant conservation laws, describe the energetics of nuclear reactions. Describe the concept of Isospin. Define the concept of reaction and scattering cross-sections and compute kinematic relationships based on conservation of energy and mass. Describe fission and fusion. Describe why nuclei fission. [1,2,3|ABET a,k,e]
ASSESSMENT TOOL For each assessment tool, links to the Course Outcomes are identified	1. Exams measure all outcomes for individual students under time constraint. 2. Assigned problem sets measure all outcomes under less time pressure and with collaboration between stud and assistance from instructor. 3. Course evaluation by each student at the end of the course assesses all outcomes. 4. Faculty self-assessment provides self-assessment data on all outcomes.

Revision History: **September, 1998; March, 2002; April, 2006; March, 2007; May 2010; September 2010**