

ENU 4605-Radiation Interactions and Sources 1 (3 cr), Required Course, Fall, 2006

Description: Study of the interaction of ionizing radiations with matter; cross-sections and radiation fields with emphasis on neutrons and photons (gamma-rays and X-rays); attenuation, energy transfer and energy absorption in matter.

Co-requisites: ENU 4001

Course Objectives: Develop an understanding of ionizing radiation, atomic and nuclear structure, radioactive decay, and radiation interaction with matter, with emphasis on neutrons and photons.

ABET Program Educational Objectives / Professional Components Supported by Course:

1. Graduates will have successful careers in Nuclear Engineering and related disciplines.
2. Graduates will pursue advanced degrees or continuing education.
4. Graduates will use the knowledge and skills obtained in their undergraduate education to practice high ethical and professional standards in Nuclear Engineering and related disciplines.

ABET Program Outcomes Supported by Course:

Outcome a: an ability to apply knowledge of mathematics, science and engineering for problem solving in engineering.

Outcome e: an ability to identify, formulate and solve engineering problems.

Outcome l: an ability to apply advanced mathematics, science, atomic and nuclear physics and engineering to nuclear and radiological systems and processes.

Outcome n: an ability to work professionally in on or more of the areas of: nuclear power reactors, nuclear instrumentation and measurement, radiation protection and shielding and radiation sources and applications

Text: *Atoms, Radiation, and Radiation Protection*, 2nd Edition, James E. Turner, John Wiley & Sons, New York, 1995. [Referred to as **(T)** in Syllabus]

References: *Fundamentals of Nuclear Science and Engineering*, J. Kenneth Shultis and Richard E. Faw, Marcel Dekker, Inc, New York, ISBN 0-8247-0834-2, 2002 [Referred To as **(S&F)** in Syllabus]

Introduction to Radiological Physics and Radiation Dosimetry, Frank H. Attix, Wiley & Sons, Inc., 1986. [Referred to as **(A)** in Syllabus]

Physics for Radiation Protection, James E. Martin, John Wiley & Sons, Inc., 2000. [Referred to as **(M)** in Syllabus]

Nuclear Reactor Physics, Chapters 1 and 2, Weston M. Stacey, John Wiley & Sons, 2001. [Referred to as **(S)** in Syllabus]

Grading: Homework (15%), Exam #1 (25%), Exam #2 (30%), Final Exam (30%)

ENU4605 Radiation Interactions and Sources 1 – Course Outline (Fall 2006)

- I Introduction: Basic Concepts and Quantities, Atomic Physics and Atomic Radiation (3 classes)
Chapters 1 and 2 of (T); Chapter 1 of (A); Chapter 1 and parts of Chapters 2 and 3 of (M); and Chaps/Sections 1, 2.1 through 2.3 and 3.1 of (S&F)

Classification or types of radiation; ionizing versus non-ionizing radiation; atomic structure, x-rays; concepts of flux and fluence
- II Nuclear Physics and Nuclear Radiation (5 classes)
Chapter 3 of (T); Chapter 5 of (A); parts of Chapters 2, 3 and 5 of (M); and Chaps/Sections 3.2, 4, and 5.1 through 5.3 of (S&F)

Nuclear structure; nuclear binding energy; nuclear radiation; α , β and γ decay
- III Characterization of Radiation Fields (8 classes)
Class handouts; Chapters 2 and 3 of (A); parts of Chapters 7 and 8 of (M); and Chaps/Sections 7.1 through 7.2 and 9.1 through 9.3 of (S&F)

Cross sections, interaction rates, flux, current, angular (differential) distributions, activity, dose, exposure, exponential attenuation and buildup factors
- IV Radioactive Decay (7 classes)
Chapter 4 of (T), Chapter 6 of (A); Chapter 5 of (M); and Chaps/Sections 5.4 through 5.7 of (S&F)

Radioactive decay, nuclear activation and radioisotope production
- V Neutron Interactions (9 classes)
Class handouts; Chapters 1 and 2 of (S); Chapter 9 of (T); Chapter 16 of (A); parts of Chapters 4 and 14 of (M); and Chaps/Sections 6 and 7.4 of (S&F)

Nuclear reactions, compound nucleus, magic numbers, kinematics of neutron scattering, thermally averaged cross sections, resonance behavior and fissioning
- VI Photon Interactions (10 classes)
Chapter 8 of (T); Chapter 7 of (A); class handouts; parts of Chapters 4 and 7 of (M); and Chap/Sections 10.1 through 10.6 of (S&F)

Compton effect, photoelectric effect, pair production, Rayleigh scattering, photonuclear interactions, energy transfer and energy absorption