ENU 4606-Radiation Interactions and Sources 2 (3 credits), Required Course, Spring, 2007

Description: Continuation of ENU 4605. Study of photon, charged particle and electron interactions with matter; attenuation, energy transfer and energy absorption in matter. X-ray production, accelerators and neutron sources; applications in nuclear & radiological engineering.

Pre-requisite: ENU 4605

Course Objectives: Development of understanding of photon and charged particle interactions; x-ray production; accelerators and neutron sources and applications in nuclear and radiological engineering.

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.

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 k: an ability to use the techniques, skills and modern engineering tools, including modern computational skills and tools, necessary for nuclear and radiological engineering practice.
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.

References: *Introduction to Radiological Physics and Radiation Dosimetry*, Frank H. Attix, Wiley & Sons, Inc., 1986.
Physics for Radiation Protection, James E. Martin, John Wiley & Sons, Inc., 2000.

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

ENU 4606 Radiation Interactions and Sources 2 – Course Outline (Spring, 2005)

I Photon Interactions – Part I (8 classes)
Chapter 7 of Attix, Chapter 8 of Turner and class handouts

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

II Photon Interactions – Part 2 (6 classes)
Chapter 7 of Attix, Chapter 8 of Turner and extensive class handouts

Coherent and incoherent scattering of photons, atomic form factors and incoherent scattering functions

III. Electron and Charged Particle Interactions (10 classes)
Chapter 8 of Attix, Chapters 5, 6 and 7 of Turner and class handouts

Coulamb force interactions, stopping power, CSDA, range, radiation yield, linear energy transfer (LET) and straggling

IV. X-Ray Production (4 classes)
Chapter 9 of Attix and class handouts

Fluorescence x-rays, bremsstrahlung x-rays, beam filtration and beam quality

V. Dose – Part 2 (3 classes)
Chapters 8 of Attix, Chapter 9 of Lamarsh and class handouts

Dose, dose rate, quality factor, dose equivalent for heavy particles and electrons

VI. Accelerators and Neutron Sources (5 classes)
Chapter 8 of Murray and class handouts

High-voltage machines, linear accelerators, cyclotron, betatron, synchotron, collider, spallation and neutron generators

VII MCNP Monte Carlo Calculations (7 classes)
Class handouts

A few selected simple, basic problems will be studied using MCNP. The instructor will provide color particle track plots from the MCNP solutions using the auxiliary SABRINA module. The goal here will be to help provide the students with a better understanding of the physics of particle transport/particle interactions and introduce the concept of Monte Carlo simulations.

Prepared by E. T. Dugan Spring, 2007