ENU 4612-Nuclear Radiation Detection and Instrumentation (3 credits), Required Course, Fall, 2005

Description: Physics and electronics of radiation detection and instrumentation systems for application to nuclear energy, radiological sciences, radiation protection, medical physics and imaging, and industrial safety and control systems.

Prequisites: EEL 3003, EEL 3303L, and ENU 4605

Course Objectives: Provide students with the opportunity to learn the principals of radiation interactions with matter, radiation detection techniques and characteristics of different radiation detectors; Development of communication skills including technical writing and oral presentations; Prepare students for independent research and/or design projects.

Program Educational Objectives / Professional Components Supported by Course:

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

Program Outcomes Supported by Course:

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

b. b1. An ability to design and conduct experiments
b2. An ability to interpret data

c. An ability to develop an engineering design to meet specific technical requirements within realistic constraints such as economic, environmental, heath and safety and reliability

e. An ability to identify, formulate, and solve engineering problems

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

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

m. An ability to measure and interpret measurements of nuclear and radiological processes

n. An ability to work professionally in one or more areas of: nuclear power reactors, nuclear instrumentation and measurement, radiation protection and shielding, and radiation sources and applications

Text: Glenn F. Knoll, *Radiation Detection and Measurement*, 3rd Ed., John Wiley & Sons, Inc., 1999. (ISBN: 0-471-07338-5)

References: Nicholas Tsoulfanidis, *Measurement and Detection of Radiation*, 2nd Ed., Taylor and Francis, 1995.
Sheldon Jeter and Jeffery Donnell, "*Writing Style and Standards in Undergraduate Reports*," College Publishing, 2004.

Grading: Homework (25%), Quizzes (25%), Midterm Exam (20%), Final Exam (30%)

ENU4612 Course Outline (Fall 2005)

I Review of Radiation Sources and Interactions (3 classes)
Chapters 1 and 2 of Knoll

Review different types of ionizing radiation (charged particles, neutrons, and photons), typical radiation sources, and basic radiation interactions with materials

II Statistics and Error Analysis (4 classes)
Chapter 3 of Knoll

Statistics of random events, binomial, poisson, and gaussian distributions, Chi-squared testing, background radiation, and error propagation

III Electronics and Basic Detector Properties (9 classes)
Chapters 4, 16-18, and 20 of Knoll

Circuit analysis, RC and CR pulse shaping, linear and logic pulse functions, introduction to NIM equipment, single vs. multi-channel analysis, timing and coincidence measurements, general detector properties, efficiencies, solid angle, and energy resolution, background and shielding

IV Gas Detectors (4 classes)
Chapters 5-7 of Knoll

General gas detector properties, ionization chambers, proportional counters, and Geiger-Mueller counters

V Spectroscopy and Scintillator Detectors (6 classes)
Chapters 8-10 and 19 of Knoll

Charged-particle spectroscopy, gamma-ray spectroscopy, importance of detector size, organic vs. inorganic scintillators, photomultiplier tubes, photodiodes, and thermoluminescent dosimeters

VI Semiconductor Detectors (7 classes)
Chapters 11, 12, and 19 of Knoll

Basics of semiconductor materials, p-n junctions, diodes, Si(Li), Ge(Li) and HPGe detectors, neutron activation analysis, and other semiconductor materials

VII Neutron Detection (3 classes)
Chapters 14 and 15 of Knoll

Neutron interactions, capture vs. scattering, thermal vs. fast neutrons, detectors suitable for neutron detection, neutron spectroscopy

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