THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

Interactions of Radiation with Matter

NUCLREN 5001

Credit Hours:
3.00 - 3.00

Course Levels:
Undergraduate (1000-5000 level)
Graduate (5000-8000 level)

Course Components:
Lecture

Course Description:
This is the core course in Nuclear Engineering that will be focused on teaching ionization interactions with matter, including topics on radiation sources, the interaction of charged particles, x-ray, gamma-rays, and neutrons with matter, nuclear structure, cross-section, nuclear reaction, radiation dose, shielding, radiation damage, space radiation, interactions with electronics, MC simulations.

Prerequisites and Co-requisites:
Prereq: 4505, or Grad standing in Nuclear Engineering, or permission of instructor.

Course Goals / Objectives:
- Understand the type of radiations, sources
- Understand the type of radiations interaction with matter
- Understand the biological effects of radiation and its shielding
- Understand the concept of nuclear reaction, cross-section, collision, and damage to materials
- Understand the simulation tools that are used to simulate the interaction process

Course Topics:

- Atoms and Energy (Structure of Atoms, Nuclide Chart, Atom Measures, Avogadro Number, Energy Concepts for Atoms, Relativistic Energy, Mass-Energy Relationships, Binding Energy and Q-Value Calculations)
- Major Discoveries in Radiation Physics (General Discoveries from Simple Tools, Discovery of X-rays, Radioactivity and Electron, The Electron's Charge, First concept of Atom, Theory of Electromagnetic radiation, Quantum Theory of Radiation, etc.)
- Radioactive Transformation (Processes, Modes, Rate, Units, Mathematics, Radioactive Decay Calculations, Bateman Equation, Radioactive Equilibrium)
- Interactions of Charged Participle with Matter (stopping power, Bragg peak, radiation damage, atom displacement, range, electron range, SRIM simulation)
- Interactions of X-rays and Gamma-rays Interaction with Matter (PE, CS, PP interactions, attenuation coefficient, mass attenuation coefficient, Monte Carlo simulation)
- Interactions of Neutrons with Matter (Cross-Sections, Mass-Energy conversion, Q-values, Reactions channels, Activation Product Calculations by Photon and Neutrons, Fission and Fusion)
- Nuclear Fission and its Products (Fission Energy, Physics of Nuclear Fission, Neutron Economy and Reactivity, Radioactive products of Fission)
- Naturally Occurring Radiation and Radioactivity (Discovery, Background and Cosmic radiation, Cosmogenic radionuclides, Naturally Occurring Radioactive Series, Artificially Occurring Radioactive Series, Carbon Dating, Radon and its Measurements)
- Radiation Shielding (Shielding of Alpha/Beta-Emitting Sources, Attenuation of Beta Particle, Bremsstrahlung Effects for Beta Shielding, Shielding of Photon Sources, Effect of Buildup on Shield Thickness, Line, Ring, Disc and Planar Sources, etc.)
- Concepts of External, Internal and Micro Radiation Dosimetry (External Dosimetry – Review of Basic Concepts, Dosimetry from Neutron and Photon Sources, Real-time Calculations, Internal Dosimetry - Factors In The Internal Dose Equation, etc.)
- Space Radiation and Rad-hardness (single event upset, rad-hard design, radiation effects on electronics)
- Chemical and Biological Effects of Radiation (Physical and Chemical Process, Time Frame for Radiation Effects, Biological Effects, Radiation Syndromes, Radiation Biology – RBE, OER and LET)
- Applied Computational Techniques in Radiation Transport (Monte Carlo Methods, Applications of MCNP, GEANT and brief review of other radiation transport programs)

Designation:

Elective
Required