



# UNIVERSITY OF MARYLAND

**Department of Materials Science and Engineering  
University of Maryland  
College Park, Maryland  
ENMA 422**

## **Radiation Effects of Materials Radiation Engineering**

Course Description: Ionizing radiation, radiation dosimetry and sensors, radiation processing, radiation effects on; polymers, metals, semiconductors, liquid, and gas, radiation in advance manufacturing, radiation-physical technology

Prerequisites: ENNU 440, and ENNU 310, or ENMA 230, or permission from the instructor.

### Text Books:

1. Robert J. Woods and Alexei K. Pikaev, "Applied Radiation chemistry Radiation Processing", John Wiley and Sons, Inc., 1994
2. Frank Herbert Attix, "Introduction to Radiological Physics and Radiation dosimetry", Willey-VCH

Course Objectives: This course provides an in-depth knowledge on the use of ionizing radiation in advanced manufacturing of polymeric materials and composites, lithography, environmental remediation of toxic materials, sterilization, medicine, and radiation effects on materials and electronics

### Topics Covered:

- I. Interactions of high energy electrons with matter
  - Calculation of stopping power and mass stopping power
  - Dose depth plot
  - Absorbed dose at the interfaces

- II. High-dose dosimetry:
  - Bragg-cavity theory,
  - Calculation of absorbed dose at complicated geometry at the interfaces
  - Neutron dosimetry
  
- III. Bremsstrahlung,
  - Theory
  - Applications
  
- IV. Radiation processing:
  - Radiation yields
  - G-values calculations
  - Radiation sources power and energy
  - Production through-put calculation, processing cost calculation, and radiation
  - Processing efficiency.
  
- V. Radiation in advanced manufacturing:
  - Radiation-induced polymerization
  - Composite materials and polymer
  - Degradation methods and calculations
  
- VI. Chemical dosimetry systems:
  - Fricke dosimeter
  - Dichromate dosimeter system
  - Radiochromic dosimeters,
  - ESR-alanine dosimetry systems
  
- VII. Radiation sterilization of medical products
  - Design of electron beam and gamma radiation processing facilities, and x-rays facilities , types of electron beam machines and sources
  
- VIII. Environmental applications of ionizing radiation in the remediation of toxic materials, Radiation processing of flue gasses: Radiolysis of gases, purification of flue gases, containing SO<sub>2</sub> and NO<sub>x</sub>
  
- IX. Radiation-physical technology (Part 1): Ion implantation, doping of semiconductors, Radiation-physical technology (Part 2): lithography and polymers in micro-electronic
  
- X. Radiation effect on solid-state devices: Single-event phenomena, transient Photocurrent in p-n junction, degradation
  
- X. Radiation-induced corrosion: Mechanisms of radiation-induced corrosion and prevention

**Problem Solving Session:** the last 30 minutes of Thursday class

Grading

1. Midterm exam:.....30%
2. Final exam:.....30%
3. Home work.....20%
4. Project.....20%

Homework record applies to deciding whether, if a final grade based on exams is halfway between B and A, the reported grade is A (excellent homework record) or B (mediocre homework record). Poor homework record results in automatic lowering of one letter grade.

Contribution of course meeting the professional component:

This course is for senior students in materials, nuclear, and reliability programs. It provides the students with the knowledge of the use of ionizing radiation for advanced manufacturing, radiation effect on electronics, and environmental and medical applications. These information are essentials for materials, nuclear and reliability engineers.

Relationship of course to program objectives:

This course is an essential component of nuclear and materials undergraduate in this department since it provides the links between materials, nuclear, and reliability programs.

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