

Department of Materials Science and Engineering

**University of Maryland**

**College Park, Maryland**

**Radiation Effects of Materials ENMA 422**

# Fall, 2019

Course Objectives: This course provides an in-depth the fundamentals of the interactions of ionizing radiation with matter. The course concentrates on the interactions of charged particles (such as proton alpha particles, and electrons), high energy photons (such as gamma rays and X-rays), and neutrons with aqueous solutions, organic solvents, solids, and gas. It also discusses in details the dosimetry concept and various dosimetry systems. The course also provides knowledge on radiation processing and 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 semiconductors and electronics for space applications.

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

**Text Books:**

**Manual for Radiation Engineering:** It is provided through Canvas

References:

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

**THE USE OF CELL PHONE AND INTERNET ARE NOT ALLOWED IN THE CLASS**

Topics Covered:

## Interactions of high energy photons and electrons with matter

Calculation of stopping power and mass stopping power

Dose depth plot

Absorbed dose at the interfaces

## High-dose dosimetry:

## Bragg-cavity theory,

## Calculation of absorbed dose at complicated geometry at the interfaces

## Neutron dosimetry

## Bremmstrahlung,

### Theory

Applications

## Radiation processing:

## Radiation yields

## G-values calculations

## Radiation sources power and energy

## Production through-put calculation, processing cost calculation, and radiation Processing efficiency.

## 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,

## EPR-alanine dosimetry systems

## 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

## Environmental applications of ionizing radiation in the remediation of toxic materials, Radiation processing of flue gasses: Radiolysis of gases, purification of flue gases, containing SO2 and NOx

## 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

## Radiation-induced corrosion: Mechanisms of radiation-induced corrosion and prevention

**Problem Solving Session**: The last 30 minutes of Thursday class.

#### Grading

1. Midterm exa-1: Tuesday, October 22, 2019…….15%
2. Midterm Exam-2: Tuesday, November 19, 2019….15%
3. Final exam: December, 2019.………………. 30%

The exact date to be determined.

1. Homework………………………….........................20%
2. 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:

The course provides the students with the knowledge of the use of ionizing radiation for advanced manufacturing, radiation effect on electronics, and environmental and medical applications. This information is essentials for materials, nuclear, chemical, mechanical, electrical, bioengineering, aerospace, civil, and reliability engineers.

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##### Office Hours: Monday, 3-4 PM

**Wednesday, 3-4 PM**