

ENU 4641 – APPLIED RADIATION PROTECTION

Catalog Description: Introduction to practical radiation protection techniques and practices including laboratory experiences. Examination of pertinent regulations, current practice, ethics, and instrumentation/measurement practices. Design of facilities and controls to optimize benefits of radiation applications and minimize exposure risks

Course Pre-requisites: ENU 4606 – Radiation Interactions & Sources 2
 ENU 4630 – Fundamentals of Radiation Shielding

Course Objectives: This course is designed to introduce nuclear engineering and nuclear engineering sciences students to the basic principles, concepts, and methodology of radiation protection and radiological hazard evaluation.

Program Educational Objectives / Professional Components Supported by Course:

1. Provide students with the ability to apply advanced mathematics, computational skills, science and engineering science, including atomic and nuclear physics, to identify, formulate, analyze and solve nuclear and radiological engineering problems.
2. Provide students with a knowledge of the fundamentals of radiation transport, interactions and detection and with the principles required for the analysis, design and safe operation of radiation producing and using equipment and systems.
4. Provide students with the skills needed to communicate effectively, work collaboratively, and understand their professional and ethical responsibilities and the impact of engineering solutions in a societal and economic context so they can pursue successful, productive careers in nuclear and radiological engineering.

Program Outcomes Supported by Course:

- a. an ability to apply knowledge of mathematics, science and engineering;
- e. an ability to identify, formulate and solve engineering problems;
- g. an ability to communicate effectively;
- j. a knowledge of contemporary issues;
- l. an ability to apply advanced mathematics, science, and engineering sciences, including atomic and nuclear physics, to nuclear and radiological systems and processes;
- n. an ability to work professionally in one or more of the areas of: nuclear power systems, nuclear instrumentation and measurement, radiation protection and shielding, and radiation sources and applications.

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Textbooks and Other Resources:

Richard E. Faw and J. Kenneth Shultis
Radiological Assessment: Sources and Exposures
American Nuclear Society (1999)
ISBN 0-89448-455-9 (Order at www.ans.org)

Various Handouts from NCRP, ICRP, and ICRU Reports

Course Schedule by Topic

1. Biological Effects of Ionizing Radiation

- Molecular effects
- Cellular effects
- Organ and organ system-level effects
- Acute radiation syndromes
- Radiation risk coefficients (1990 National Academy of Sciences BEIR V Report)

2. Exposure to Natural and Man-Made Radiation Sources

- Cosmic, solar, and geomagnetically trapped radiation
- Cosmogenic radionuclides
- Primordial radionuclides
- Decay series of primordial radionuclides
- Medical sources
- Nuclear power
- Miscellaneous sources

3. Internal Dose Evaluation

- ICRP 30 methodology
- Retention equations – ICRP 30
- Excretion equations – ICRP 30
- ICRP 30 Lung Model
- ICRP 30 GI Tract Model
- ICRP 30 Bone Model
- Annual Limits on Intake and Derived Air Concentrations
- ICRP 60 Respiratory Tract Model
- Recycling biokinetic models – ICRP 30+

4. Atmospheric Dispersion of Radionuclides

- Atmospheric stability
- Diffusion of radionuclides in the atmosphere
- Results obtained from the diffusion model
- Refinements to the Gaussian Plume Model
- Estimation of diffusion parameters
- Averaging times
- Limitations of the Gaussian Plume Model

5. Dispersion of Radionuclides in Surface and Ground Water

- Near-field mixing in surface water
- Discharge to small lakes and reservoirs
- Discharge to rivers and estuaries
- Discharge to large lakes and oceans
- Sedimentation effects in surface waters
- Radionuclide migration in groundwater

6. Environmental Pathway Modeling

- General description of exposure pathways
- Terrestrial exposure pathways
- Aquatic and marine exposure pathways
- Treatment of special radionuclides
- Usage factors