



KANSAS STATE UNIVERSITY

Radiation Protection and Shielding

UEA 601/601G

KSU – NE690

Prerequisites: NE495 Elements of Nuclear Engineering

Students are expected to have an understanding of mathematics through ordinary differential equations, including Laplace transforms; elementary atomic and nuclear physics, including theories of alpha-particle and beta-particle decay; and mechanics of particle interactions.

Description: Basic principles and concepts of radiation protection and shield design: dosimetric units and response functions, hazards of radiation doses, radiation sources, basic methods for dose evaluation, and shielding design techniques for photons and neutrons. Three hours lec. a week.

Instructor

Dr. J.K. Shultis

Kansas State University

Office (785) 532-5626

Email jks@ksu.edu

Required Text

(1) J.K. Shultis and R.E. Faw, Radiation Shielding, American Nuclear Society, La Grange Park, IL, 2000. If book is not locally available, it may be ordered from the American Nuclear Society through the web <http://www.ans.org>. Errata available at K-State Online in the course Handouts module.

(2) J.K. Shultis and R.E. Faw Fundamentals of Nuclear Science and Engineering, 2nd edition, CRC Press, Boca Raton, FL, 2008. This is a secondary reference and is not required.

Course Objectives:

1. Quantify the interaction rate of various radiation types in matter, the penetration of various radiations, and the physical and biological doses imparted by radiation.
2. Assess the appropriateness of different dosimetry indices to quantify radiation hazards.
3. Quantify types and strengths of radiation sources from both natural and artificial origins.
4. Evaluate the biological consequences of various radiation doses and quantify the resulting health risks.
5. Design radiation shields for photon and neutron radiations.
6. Assess when simple point-kernel with buildup factor analyses and detailed transport analyses are needed for a shield design.
7. Perform simple MCNP calculations

Topics:

1. Introduction to radiation protection:

Overview of radiological assessment
Evolution of radiation protection standards
Foundations of radiation protection engineering

2. Interaction of radiation with matter:

Photon and neutron interaction coefficients
Penetration of charged particles through matter
Dosimetric units and response functions

3. Sources ionizing radiation:

Neutron sources
Gamma photon sources
X-ray sources

4. Basic methods for radiation dose evaluation:

Uncollided radiation
Uncollided doses from distributed sources
Point-kernel concept for total dose

5. Special Techniques for photons:

Photon buildup-factor concept
Broad-beam attenuation of photons
Photon albedo concept
Photon streaming through ducts
Photon skyshine

6. Special Techniques for Neutrons:

Hydrogenous media
Removal Theory
Secondary radiations

7. Use of the MCNP Monte Carlo Code:

Preparing the input file
Special Project

8. Radiation Hazards:

Stochastic vs deterministic effects
High vs low dose risks
Hereditary effects
Radiogenic carcinomas for low doses
Radon risks

Course Policies and Administration

Homework: There will be bi-weekly homework assignments, a one-hour midterm examination, and a comprehensive two-hour final examination. Performance on exams and homework assignments as well as in-class participation and responses will all be used to assess the success of the course

Class Attendance: Attending class lectures is NOT voluntary! Attendance will be randomly

taken and anyone found to have more than 4 unexcused class absences will be dropped from the course

Statement Regarding Academic Honesty:

Kansas State University has an Undergraduate Honor System based on personal integrity which is presumed to be sufficient assurance in academic matters one's work is performed honestly and without unauthorized assistance. Undergraduate students, by registration, acknowledge the jurisdiction of the Undergraduate Honor System. The policies and procedures of the Undergraduate Honor System apply to all full and part-time students enrolled in undergraduate courses on-campus, off-campus, and via distance learning. A component vital to the Honor System is the inclusion of the Honor Pledge <http://www.ksu.edu/honor/pledge.htm> which applies to all assignments, examinations, or other course work undertaken by undergraduate students. The Honor Pledge is implied, whether or not it is stated: "On my honor, as a student, I have neither given nor received unauthorized aid on this academic work." A grade of XF can result from a breach of academic honesty.

An XF would be failure of the course with the X on the transcript indicating failure as a result of a breach of academic honesty. For more information, visit the Honor System home web page at: <http://www.ksu.edu/honor>

Statements for Academic Accommodations for Students with Disabilities:

Any student with a disability that needs a classroom accommodation, access to technology or other assistance in this course should contact Disability Support Services and/or their instructor