NE 690: Radiation Protection and Shielding – Spring 2004

Proposed Catalog Description: (3) II. 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. Pr: NE 495.

Class Schedule: Lectures MWF 9:30–10:20

Instructor: J. K. Shultis, Office WD-137b or RA-312, (913) 532-5626; e-mail `jks@ksu.edu`
Office hours: Open office or by appointment.

Textbook:

(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`.
(2) J.K. Shultis and R.E. Faw *Fundamentals of Nuclear Science and Engineering*, Marcel Dekker, New York, 2002. This is the text you used in NE 495.

Prerequisites: 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.

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:**
   Difference between neutron and photon calculations
   Fission neutrons in hydrogenous media and removal theory
   Fast neutrons in non-hydrogenous media

Capture gamma attenuation
Neutron shielding with concrete
Neutron duct streaming and skyshine

7. **Radiation Hazards:**
   Stochastic vs deterministic effects
   High vs low dose risks
   Hereditary effects
   Radiogenic carcenomas for low doses
   Radon risks

8. **Transport calculations:**
   Deterministic versus Monte Carlo approaches
   The MCNP code

Course Objectives: After completing this course, you should be to:

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

Student Evaluations: 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 objectives and the assignment of individual grades.

Examination Dates: (to be annouced)

Honor System:

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