

NE 495: Elements of Nuclear Engineering

Fall 2005

2000–2002 Catalog Description: (3) I, II. Survey of nuclear engineering concepts and applications. Nuclear reactions, radioactivity, radiation interaction with matter, reactor physics, risk and dose assessment, applications in medicine, industry, agriculture and research. PR.: MATH 221, PHYS 213.

Textbook: J.K. Shultis and R.E. Faw, *Fundamentals of Nuclear Science and Engineering*, ISBN 0-8247-0834-2, Marcel Dekker, New York, 2002.

Errata available from <http://ww2.mne.ksu.edu/~jks/books.htm>

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

Prerequisites: (1) knowledge of calculus-based classical physics, (2) knowledge of integral and differential calculus.

Class Schedule: Lectures MWF 11:30–12:20 in Fiedler Auditorium

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

1. Explain a variety of nuclear phenomena using concepts of modern physics
2. Estimate magnitudes of atomic and nuclear properties from macroscopic data
3. Calculate nuclear reaction energetics from atomic mass data
4. Predict properties of radioactive materials
5. Design and analyze various applications of radioactivity
6. Describe characteristics of charged-particle, photon and neutron interaction with matter
7. Quantify attenuation of and reaction rates for neutral radiation particles
8. Assess efficacy of different radiation protection techniques
9. Calculate doses, infer subsequent health risks to humans, and assess compliance to federal standards
10. Describe and quantify the neutron cycle in a reactor
11. Expound on the many uses of nuclear technology in society
12. Elucidate, in words a liberal-arts graduate could understand, the importance or physical meaning of nuclear jargon terms introduced in the course, such as flux, decay constant, binding energy, thermal utilization, etc.

Topics:

1. Introduction (0.3 week)
2. Basic Atomic and Nuclear Physics (3 weeks)
3. Radioactivity (2 weeks)
4. Radiation Interaction with Matter (2 weeks)
5. Fission and Fusion Reactions (1.5 weeks)
6. Radiation Dosimetry and Risk Assessment (2.3 weeks)
7. Nuclear Reactors (2 weeks)
8. Applications of Nuclear Technology (2 weeks)

Evaluations:

1. **Class Participation:** Throughout the course there will be in-class group activities. You are expected to fully participate in such activities and will be held accountable to present results for your group.
2. **Homework:** You will be randomly assigned to a small group in which you will actively participate to complete the bi-weekly homework assignments. Each group will submit a single report. Every member is expected (1) to assist in solving all problems, (2) understand the solution of each problem (to the level that she or he could answer a similar problem in an examination), and (3) participate in the group homework write-up. Note: Each group member is to write up at least one solution. Indicate next to the problem number who did the writeup. Finally, all members of the group are to sign the homework write-up to indicate they have participated as required. *Your signature indicates you have reviewed all the problem write-ups and understand how each problem is solved.*
3. **Preparation for Class:** You will usually be given reading assignments prior to discussing the topics in class. There will often be a short quiz (5-10 minutes) at the beginning or end of class covering topics in your reading assignments or the lecture.
4. **Examination:** In addition to quizzes, there will be two examinations, a midterm and a final.
5. Grades will be assigned on the basis of a weighted average of scores from group assignments, individual efforts (exams and quizzes), and class participation. Typically 60–70% of your grade will be from your individual scores and the remainder from the greater of your group scores or your individual scores.

Course Web Site:

You will find at <http://www.mne.ksu.edu/~jks/courses.htm> auxiliary material for this course. There is a study guide which gives you a topic by topic outline of things I expect you to be able to do after completing each chapter. Also you will find copies of old midterm and final examinations for this course.

Examination Dates:

Midterm: to be announced

Final: Monday Dec. 12, 4:10–6:00 PM

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>