ENU4103 Reactor Analysis & Computations 1 – Statics (Required Course) Spring, 2014

1. Catalog Description (4 credit hours): Neutron reactions, neutron diffusion and neutron multiplication factors for reactors. Reactor physics static analysis; characterization of neutron interactions as a function of properties of various media and neutron energy. Analysis of non-multiplying and multiplying media in slab, spherical and cylindrical geometries using neutron diffusion theory.

2. Pre-requisites: ENU4001 and ENU4605.

3. Course Objectives: To be able to determine neutron reaction rates in various media; to be able to characterize the fission process; to able to understand neutron diffusion theory and its limitations; to be able to solve the diffusion theory equation for non-multiplying and multiplying media using boundary conditions; and to be able to understand chain reactions and criticality.

4. Contribution of course to meeting the professional component: NA

5. Relationship of course to program outcomes:
   Outcome a: an ability to apply knowledge of mathematics, science and engineering for problem solving in engineering.
   Outcome e: an ability to identify, formulate and solve engineering problems.
   Outcome k: an ability to use the techniques, skills and modern engineering tools, including modern computational skills and tools, necessary for nuclear and radiological engineering practice.
   Outcome l: an ability to apply advanced mathematics, science, atomic and nuclear physics and engineering to nuclear and radiological systems and processes.
   Outcome n: an ability to work professionally in on or more of the areas of: nuclear power reactors, nuclear instrumentation and measurement, radiation protection and shielding and radiation sources and applications

6. Instructor: Edward T. Dugan, Ph.D.
   a. Office location: Room 164 Rhines Hall
   b. Telephone: 352 273-2129
   c. E-mail address: edugan@mse.ufl.edu
   d. Class Web site: NA
   e. Office hours: MWF: 1:00 pm to 3:00 pm

7. Teaching Assistant: none
   a. Office location
   b. Telephone
   c. E-mail address
   d. Office hours

8. Meeting Times: MWRF, 3rd Period, 9:35 to 10:25
9. Class/laboratory schedule: NA
10. Meeting Location: CSE E122
11. Material and Supply Fees: NA

12. Textbook:
    a. Title: *Introduction to Nuclear Engineering*
    b. Author: J. Lamarsh and T. Baretta
    c. Publication date and edition: 2001, 3rd Edition
    d. ISBN number: 978-0201824988 (Prentice Hall)

    Code Package Needed: MCNP6/MCNP5/MCNPX (Procured from RSICC)

13. Recommended Reading:

    Fundamentals of Nuclear Reactor Physics, E.E. Lewis, 1st Edition, Elsevier, 2008.
    Nuclear Reactor Analysis, Duderstadt and Hamilton, John Wiley & Sons, 1976.
    Nuclear Reactor Physics, Weston M. Stacey, 2nd Edition, John Wiley & Sons, 2007.
    Nuclear Reactor Engineering, 4th Edition, Glasstone and Sesonske, Chapman and Hall Inc., 1994.
    Introduction to Nuclear Engineering, 2nd Ed, J.R. Lamarsh, Addison-Wesley Publishing Company, Inc., 1983.
    Course Handouts

14. Course Outline

A. **Review of Atomic and Nuclear Physics Concepts**: atomic structure; nuclear forces, binding energy and mass defect; nuclear stability; excited states; magic numbers; nuclear decay. (4 classes)

B. **Interaction of Neutrons with Matter**: neutron cross sections and interaction rates; compound nucleus, resonances and excited states; absorption and scattering cross sections; calculation of atom densities; scattering kinematics. (5 classes)

C. **Neutron Distributions in Energy:** fast, slowing down and thermal energy distributions; Maxwell-Boltzmann distribution and spectrum hardening; energy-averaged reaction rates, infinite medium multiplication factor. (6 classes)

D. **Nuclear Fission Process**: fission energetic including critical energy; fertile versus fissile nuclides; odd-even phenomenon; fission products and fission parameters (ν, α and η); prompt and delayed neutrons; fission rate and power production. (5 classes)

E. **Introduction to Neutron Diffusion Theory**: neutron balance and equation of continuity; comments on neutron transport theory; neutron diffusion theory approximation; Fick's Law; neutron current and neutron leakage; boundary conditions. (6 classes)

F. **Introduction to MCNP** (4 classes)

G. **Neutron Diffusion Theory in Non-Multiplying Media**: point, plane and line sources in infinite media; point, plane and line sources in finite media. (6 classes)

H. **MCNP Non-Multiplying Medium Problems** (4 classes)

I. **Neutron Diffusion Theory in Homogeneous Multiplying Media**: fission chain reaction and neutron multiplication factor; infinite multiplying media; finite multiplying media; four and six factor formulas; material and geometric buckling; slab, spherical and cylindrical reactors; one group, modified one-group and two group calculations; reflected reactors. (10 classes)

J. **MCNP Multiplying Medium Problems** (4 classes)

15. Attendance and Expectations: Attendance is not considered in the grade. However, there will be material covered in class, including example problems, that is not in the text or the course handouts. It is your responsibility to make sure that you have complete class notes for any missed class. Missing class without a good reason is strongly discouraged.

16. Grading: Homework: 20%, Quizes: 10%, Midterm Exam: 35%, Final Exam: 35%
    Final Exam: Thursday, May1 12:30 to 2:30 pm

17. Grading Scale: Grades are to be curved. (No minus grades.)

18. Requirements for class attendance and make-up exams, assignments, and other work are consistent with university policies that can be found at:
    https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx

19. Honesty Policy – All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

    Note that failure to comply with this commitment will result in disciplinary action compliant with the UF Student Honor Code Procedures.
    See http://www.dso.ufl.edu/sccr/procedures/honorcode.php

20. Accommodation for Students with Disabilities – Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

21. UF Counseling Services –Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:
    UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
    Career Resource Center, Reitz Union, 392-1601, career and job search services.

22. Software Use – All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.