ENU4103 Reactor Analysis & Computations 1 – Statics (Required Course) Spring, 2016

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 develop an understanding of neutron diffusion theory and its limitations; to be able to solve the diffusion theory equation for non-multiplying and multiplying media using boundary conditions; to develop an understanding of 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: Joseph M. Mack, Ph.D.
   a. Office location: Room 235 Nuclear Sciences Building
   b. Telephone: 352-846-1376
   c. E-mail address: jmack@mse.ufl.edu
   d. Class Web site: NA
   e. Office hours: M,W, Th: 11:00 am to 1:00 pm

7. Teaching Assistant: TBD
   a. Office location
   b. Telephone
   c. E-mail address
   d. Office hours

8. Meeting Times: MWThF, 3rd Period, 9:35 to 10:25
9. Class/laboratory schedule: NA
10. Meeting Location: NSB 227
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 in addition to course handouts:

    Nuclear Reactor Analysis, Duderstadt and Hamilton, John Wiley & Sons, 1976.
    Nuclear Reactor Engineering, 4th Edition, Glasstone and Sesonske, Chapman andHall Inc., 1994.
    Neutron Physics, Beckurtz and Wirtz, Springer-Verlag Berlin, Gottingen, Heidelberg, 1964.
    The Atomic Nucleus, R. D. Evans, McGraw-Hill, 1955.

14. Approximate 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. **Review of 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. **Review of 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. **Review of 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 the Neutron Transport Equation and Diffusion Theory**: connectivity of neutron transport theory to diffusion theory approximation; Fick's Law; neutron current and neutron leakage; boundary conditions. (~6 classes)

F. **Introduction to Monte Carlo Theory and 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)

K. **Fusion Reactor Overview (time permitting)**

15. Attendance is expected but will not be specifically graded. **Regular and active participation is paramount**. If a student anticipates missing a class, they should have someone pick up handouts or take notes, and let the instructor know beforehand. Otherwise, a student should see the instructor afterward to get any handout material and the lecture content for that class period; it is your responsibility. Classmate pick up of handouts is also acceptable.

Operation of all cell phones, ipads, kindles, and similar devices is *verboten* with two exceptions: 1) a note-taking device, in which case the instructor must be able to its use , and 2) a condition whereby a student anticipates a situation that might require communications during class. Coordinate with the instructor before class, as warranted.

Late arrivals are accommodated, provided they do not disturb others and it does not occur frequently. Frequent tardiness will be addressed by an instructor-student conference.

ALL email communication between student and instructor must be facilitated through the University of Florida system: jmack@mse.ufl.edu

16. Grading: Homework: 30%, Midterm Exam: 30%, Final Exam: 40%
Midterm Exam Date: TBD; Final Exam Date: TBD.

Grading Scale
A+….95-100
A…...90-95-
B+.....85-90
B……80-85-
C+.....75-80
C……70-75-
D+.....65-70
D……60-65-
F…..<60

Grades may be adjusted at the end of the course at the discretion of the instructor. Improvement over the course of the semester and classroom effort may be used to clarify close grade boundaries.

17. 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

18. 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

19. 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.

20. **Make-up or Early Exam Policy**: make-up or early exams are only given for exceptional circumstances and in accordance with University policy, and the request must be pre-approved by the lecturer.

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.