

ENU 4104 Reactor Anal. & Computations 2 - Dynamics (3 cr), Elective Course, Fall, 2014

- 1. Description:** Continuation of ENU 4103. Neutron thermalization and thermal scattering kernels. Treatment of resonances and Doppler broadening. Dynamic analysis of reactors including point model and space-time models. Feedback and reactor dynamics and control. Short-term transient analysis and long-term time-dependence.
- 2. Pre-requisite:** ENU4103
- 3. Course Objectives:** Complete steady state analysis of reactors. Study of dynamic behavior of reactors including feedback from thermal neutron spectrum and resonance effects; methods of analysis; reactor control; analysis of both short-term and long-term transients.
- 4. ABET Program Educational Objectives/Professional Components Supported by Course:**
 - a. Graduates will have successful careers in Nuclear Engineering and related disciplines.
 - b. Graduates will pursue advanced degrees or continuing education.
- 5. ABET Program Outcomes Supported by Course:**
 - 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.
Room 235 NSC, edugan@mse.ufl.edu Phone: 846-1376
Office Hours: Generally, I should be available MWThF from 9:30AM to 12:30PM and WTh from 3PM to 5PM. If you email me questions, I will try to respond as soon as possible.
- 7. Grader:** none
- 8. Class Meeting Times:** MWF, 7th Period, 1:55 to 2:45, 227 NSC
Final Exam: Thur, Dec 18, 7:30AM – 9:30AM (Exam Group 18A)
- 9. Laboratory Meeting Time:** none
- 10. Meeting Location:** 227 NSC
- 11. Material and Supply Fees:** NA
- 12. Text:** *Introduction to Nuclear Engineering*
 - a. Title: *Introduction to Nuclear Engineering*
 - b. Author: J. Lamarsh and T. Baretta [Referred to as **B&L** in the Syllabus]
 - c. Publication date and edition: 2001, 3rd Edition
 - d. ISBN number: 978-0201824988 (Prentice Hall)

Code Packages Needed: MCNP6/MCNP5/MCNPX and SCALE6.1 (Procured from RSICC)

13. References:

- a. *Fundamentals of Nuclear Reactor Physics*, E.E. Lewis, Elsevier, 2008, ISBN 978-0-12-370631-7 [Referred to as **EL** in the Syllabus]
- b. *Nuclear Reactor Analysis*, Duderstadt and Hamilton, John Wiley & Sons, 1976 [Referred to as **D&H** in the Syllabus]
- c. *Nuclear Reactor Physics*, Chapters 1 and 2, Weston M. Stacey, John Wiley & Sons, 2001. [Referred to as **WS** in syllabus]
- d. *Nuclear Reactor Engineering*, 4th Edition, Glasstone and Sesonske, Chapman and Hall Inc., 1994. [Referred to as **G&S** in the Syllabus]
- e. *Nuclear Reactor Theory*, Chapter 9, Bell and Glasstone, VanNostrand Reinhold Company, New York, 1970.
- f. *Introduction to Nuclear Engineering*, 2nd Ed, J.R. Lamarsh, Addison-Wesley Publishing Company, Inc., 1983. [Referred to as **L** in the Syllabus]
- g. **Extensive Course Handouts:** Handouts in the form of PDFs of PPT presentations will be provided. These handouts and HW Problems should provide most of what you will need to learn the course material. The text and the above references are supplemental which can provide additional insight/understanding where needed.

14. Course Outline:

- a. Review of Neutron Diffusion Theory in Multiplying Media (**5 classes**)
One group and two group approximations; reflected reactors/reflector savings
(Section 7.5 of **EL** Sections 6.4-6.6 of **L** and **B&L** and Sections 3.130-3.160 of **G&S**, 3rd Ed)
- b. Special Considerations for Fast and Thermal Group Constants (**10 classes**)
Thermal spectrum effects; resonance energy and spatial shielding effects
Thermal and fast spectra and generation of fast and thermal group constants
(Chapter 3 of **EL**; Sections 3.114-3.116 and 4.13-4.45 of **G&S**; Ch 9 pp 375-394, Ch 8 pp 315-332 & pp 358-369, Ch 10 pp 398- 439 of **D&H**; Section 6.8 of **B&L**; class handouts; and sections from code manuals)
Impact of heterogeneous lattice effects (Chapter 10 in **D&H**: pp 398-439)
Use of group constants in criticality calculations
(Sections 4.46-4.69 in **G&S**; Ch 7 pp 285-311 and Ch 13 pp 515-525 of **D&H**; Section 6.7 of **B&L**; class handouts; and sections from code manuals)
- c. Time Dependent Reactor/Reactor Kinetics – Short Term Time Dependence (**6 classes**)
Time dependent diffusion equation, prompt neutron lifetime, delayed neutrons, units of reactivity, point reactor kinetics (PRK) equations
(Chapter 5 of **EL**; Section 7.1 and 7.2 of **L** and **B&L**; Sections 5.1-5.55 of **G&S**; Ch 6, pp 233-246 & pp 255-268 of **D&H**; class handouts)
- d. Reactivity Control and Feedback Effects (**6 classes**)
Reactivity control; fuel temperature (Doppler), moderator temperature and void reactivity feedback; xenon and samarium poisoning.
(Chapter 9 of **EL**; Sections 7.3-7.4 of **L** and Sections 7.3-7.5 **B&L**; Sections 5.56-5.124 of **G&S**; Ch 15 pp 567-577 of **D&H**; and class handouts)

- e. Introduction to Fuel Depletion Calculations – Long Term Time Dependence (**5 classes**)
Core properties during burnup; fuel depletion calculations
(Chapter 10 of **EL**; Section 7.5 of **L** and Section 7.6 **B&L**; Sections 4.70-4.85 and 8.172-8.192 and Sections 4.73-4.93 and 10.13-10.62 in **G&S**; Ch 15 pp 580-600 of **D&H**; and class handouts)
- f. MCNP criticality or k-code calculations (9 classes)
MCNP geometries, MCNP materials and cross section libraries, MCNP tallies and MCNP criticality (MCNP manual and class handouts)
 - fuel pin/unit cell calculations (comparison with SCALE results)
 - fuel assembly calculations (comparison with SCALE results)
 - reactor (core + reflector) calculations (comparison with SCALE results)

15. Attendance and Expectations:

Class attendance is expected. You should not miss a class except for valid reasons such as illness. If you do miss a class, it is your responsibility to make sure you obtain missed information.

Class distractions such as **cell phones and pagers are unacceptable !** Students should ensure that any such devices that are brought into the classroom are turned off or operated in a silent mode during the class period

16. Grading: Homework/code reports: 30%; Midterm Exam: 30%; Final Exam: 30%;
Pop quizzes (in class): 10%

17. Grading Scale: A (92-100%), B⁺ (88-91), B (80-87%), C⁺ (76-79), C (70-76%),
D⁺ (66-69), D (60-65%), E (<60%)

As a general reminder, a grade of C- is not a qualifying grade for critical tracking courses. Currently, ENU 4104 is *not* a critical tracking course. As a reminder, in order to graduate, students must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). Note: a C- average is equivalent to a GPA of 1.67 and, therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit: <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

18. Requirements for Class Attendance: 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. Academic Honesty

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<http://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

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>

Cheating - the improper taking or tendering of any information or material which shall be used to determine academic credit. Taking of information includes, but is not limited to, copying graded homework assignments from another student; working together with another individual(s) on a take-home test or homework when not specifically permitted by the teacher; looking or attempting to look at another student's paper during an examination; looking or attempting to look at text or notes during an examination when not permitted. Tendering of information includes, but is not limited to, giving your work to another student to be used or copied; giving someone answers to exam questions either when the exam is being given or after having taken an exam; giving or selling a term paper or other written materials to another student; sharing information on a graded assignment.

20. Students with Disabilities

Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the 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, <http://www.counseling.ufl.edu/cwc/Default.aspx>, counseling services and mental health services.
- Career Resource Center, Reitz Union, 392-1601, career and job search services.
University Police Department 392-1111.

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.

23. Students are expected to provide feedback on the quality of instruction in this course based on 10 criteria.

These evaluations are conducted online at <https://evaluations.ufl.edu>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results>.