

## **Reactor Analysis & Computations I - Statics**

ENU 4103 Section 2B30

**Class Periods:** MWRF, 3rd period, 9:35-10:25

**Location:** WEIM1094

**Academic Term:** Spring 2017

### **Instructor:**

Dr. Sedat Goluoglu

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352-294-1690

Office Hours: MW, 10:45-11:30, Rhines 168

### **Teaching Assistants:**

Please contact through the Canvas website

- Zander Mausolff, Office Hours: TBD

### **Course Description**

Three one-hour lectures discussing neutron reactions, fission chain and criticality and neutron transport/diffusion for nuclear reactors. Neutron thermalization and thermal scattering kernels. Dynamic analysis of reactors including point and space-time models. Feedback and reactor dynamics and control. Short-term transient analysis and long-term time-dependence.

### **Course Pre-Requisites / Co-Requisites**

ENU 4001 and ENU4605 with minimum C.

### **Course Objectives**

1. Graduates will have successful careers in Nuclear Engineering or related disciplines.
2. Graduates will pursue advanced degrees or continuing education.

### **Materials and Supply Fees**

None

### **Professional Component (ABET):**

4 credits engineering

1. Provide students with the ability to identify, formulate and solve engineering problems.
2. Provide students with the ability to use the techniques, skills and modern engineering tools, including modern computational skills and tools, necessary for nuclear and radiological engineering practice.
3. Provide students with the ability to apply advanced mathematics, science, atomic and nuclear physics and engineering to nuclear and radiological systems and processes.
4. Provide students with the ability to work professionally in one or more of the areas of: nuclear power reactors, nuclear instrumentation and measurement, radiation protection and shielding and radiation sources and applications.

### **Relation to Program Outcomes (ABET):**

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.

### **Required Textbooks and Software**

- Title: *Introduction to Nuclear Engineering*
- Author: J. Lamarsh and T. Baretta
- Publication date and edition: 2001, 3rd Edition
- ISBN number: 978-0201824988

**Code Package Required:** MCNP6/MCNP5/MCNPX (Procured from RSICC).

### **Recommended Materials**

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

### **Approximate Course Schedule**

- 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)
- 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)
- 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)
- Review of Nuclear Fission Process:** fission energetic including critical energy; fertile versus fissile nuclides; odd-even phenomenon; fission products and fission parameters ( $\nu$ ,  $\alpha$  and  $\eta$ ); prompt and delayed neutrons; fission rate and power production. (~5 classes)
- 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)
- Introduction to Monte Carlo Theory and MCNP** (~4 classes)
- 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)
- MCNP Non-Multiplying Medium Problems** (~4 classes)
- 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)
- MCNP Multiplying Medium Problems** (~4 classes)

### **Attendance Policy, Class Expectations, and Make-Up Policy**

You are expected to attend all class meetings, barring meritorious professional or University-sanctioned personal reasons. Particularly meritorious reasons are expected for any absence from exams. Whether or not your justification for your absence is acceptable (other than those that are sanctioned by the University) is at sole discretion of the Instructor. Notify the Instructor and check to see if it is acceptable as soon as you know you will be absent. As a hint, "I partied too much and have a hangover" will not pass the muster.

Class distractions such as **cell phones and pagers are unacceptable**. Students will ensure that any such devices that are brought into the classroom will be turned off. There is no tolerance for mobile phones or other electronic disruptions. Such disruptions (including texting) will lead to the student being told to leave the room for the duration of the class period, including during examination periods. Note that if a pop quiz is given after the student is asked to leave, he/she will receive zero as a grade for that pop quiz. Laptops, tablets, iPads, etc. are not allowed

during the lecture period. If a student arrives late or leaves early, he/she is expected to do so with minimum level of disruption to the class in progress. If a pop quiz is given before or after the student is in the classroom, he/she will receive zero for that pop quiz (no make-up). You will notice that there is a strong correlation between number of students absent in a class period and the probability of having a pop quiz!

**All exams are cumulative**, i.e., every topic that is covered prior to the exam day (including the latest class period) may be on the test. This means you should study in advance – those who wait until the last day typically do not do well in this class! Instructor will assume you already know the topics covered in the prerequisite course MAP 2302. Excused absences are consistent with university policies in the undergraduate catalog (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>) and require appropriate documentation.

### ***Evaluation of Grades***

<b>Assignment</b>	<b>Total Points</b>	<b>Percentage of Final Grade</b>
Homework Sets	100 each	10%
(Pop) Quizzes	100 each	20%
Midterm Exams	100	40%
Final Exam	100	30%
		100%

### ***Grading Policy***

<b>Percent</b>	<b>Grade</b>	<b>Grade Points</b>
94.0 - 100	A	4.00
90.0 - 93.9	A-	3.67
87.0 - 89.9	B+	3.33
84.0 - 86.9	B	3.00
80.0 - 83.9	B-	2.67
77.0 - 79.9	C+	2.33
74.0 - 76.9	C	2.00
70.0 - 73.9	C-	1.67
67.0 - 69.9	D+	1.33
64.0 - 66.9	D	1.00
60.0 - 63.9	D-	0.67
0 - 59.9	E	0.00

Instructor reserves the right to curve the grades.

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

### ***Students Requiring Accommodations***

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

### ***Course Evaluation***

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. 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/>.

### ***University Honesty Policy***

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 (<https://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.

### ***Software Use***

All faculty, staff, and students 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.

### ***Student Privacy***

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html>

### ***Campus Resources:***

#### *Health and Wellness*

#### **U Matter, We Care:**

If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) or 352 392-1575 so that a team member can reach out to the student.

**Counseling and Wellness Center:** <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

#### **Sexual Assault Recovery Services (SARS)**

Student Health Care Center, 392-1161.

**University Police Department** at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

#### *Academic Resources*

**E-learning technical support**, 352-392-4357 (select option 2) or e-mail to [Learning-support@ufl.edu](mailto:Learning-support@ufl.edu).  
<https://lss.at.ufl.edu/help.shtml>.

**Career Resource Center**, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

**Library Support**, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

**Teaching Center**, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.  
<https://teachingcenter.ufl.edu/>.

**Writing Studio, 302 Tigert Hall, 846-1138.** Help brainstorming, formatting, and writing papers.  
<https://writing.ufl.edu/writing-studio/>.

**Student Complaints Campus:** [https://www.dso.ufl.edu/documents/UF\\_Complaints\\_policy.pdf](https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf).

**On-Line Students Complaints:** <http://www.distance.ufl.edu/student-complaint-process>.