ENU 6106 – Reactor Analysis 1
3 credits, Graduate Level, Fall 2016

Course Description

(Official catalog version) Credits: 3; three 1-hour lectures. Neutron reactions, fission and criticality for nuclear reactors. Analytical and numerical calculations for reactor design and analysis.

Prerequisites

None.

Instructors and Course Meetings

Kelly A. Jordan, Florida Power and Light Professor of Nuclear Engineering
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352-294-2106
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Lecture: NSC 227, MW 6-7 (1250-1445)

Office hours: TBD / by appointment.

Texts

Required Text: *Nuclear Reactor Analysis*, Duderstadt and Hamilton.

The following references will be useful for students needing additional background to the material presented in this class:

1. *Introductory Nuclear Physics*, Krane, 1987 (3th edition). (ISBN: 047180553X). What it says on the tin: a book on nuclear physics.
2. *Advanced Engineering Mathematics*, Kreyszig, 2011 (10th edition). (ISBN: 0470458364). Reactor physics and radiation transport are heavily mathematical subjects, this book gives an excellent engineer's guide to using the math, without overemphasizing the theory; an solid reference for when you don't remember what a Bessel function is.

Course Outline

The focus of this course is an understanding of the modern *practice* of reactor physics. This entails an both an understanding of classic deterministic reactor theory and computational Monte Carlo techniques, and how they are applied to the analysis of real reactors.

This course will require some facility with programming in a high level language (Python is preferred), and the use of MCNP for radiation transport calculations. We will do some in-class overviews of these topics, but you are responsible for familiarizing yourself with these topics.

Unit 1 Classical Reactor Physics

- Overview of Reactor Physics 1
- Overview of Reactor Physics 2
- Basic Neutronics
- Transport Theory Derivation
- Diffusion Theory and Thermal Diffusion Length
- Reactor Eq. as Diffusion w/ Fission Source & Time Coupled Modes
- Solutions of Reactor Eq. in Different Geometries & 1.5 Gp Theory
- Reflected Reactors, Self-Shielding, Homogenization
- Perturbation Theory and Intro to Adjoints
- Adjoint Operators and Derivation of Adjoint Transport Eq.
- Feedback and Reactivity Coefficients
- Reactor Kinetics Crash Course
- Further Reactor Kinetics

Project 1: TBD (Potentially a collection of homework problems)

Unit 2 Monte Carlo

- The Monte Carlo Method
- Intro to Monte Carlo 2
- Intro to Monte Carlo 3
- Intro to MCNP
- Reactor Calculations in MCNP KCODE

- Kinetics Calculations in MCNP Pseudoadjoints
- Programming in Python
- More Programming in Python

Project 2: Build your own Monte Carlo code

Unit 3 Advanced Topics

- Enqvist Reactor Noise 1
- Enqvist Reactor Noise 2
- Zhu Uncertainty Quantification 1
- Zhu Uncertainty Quantification 2
- Nimmagadda Nuclear Data 1
- Nimmagadda Nuclear Data 2
- Integral Benchmark Experiments
- Experimental Reactor Physics 1 PROTEUS
- Experimental Reactor Physics 2 Approach to Critical, Flux Calibration

Project 3: UFTR Safety Analysis

Attendance and Class Conduct

You're a graduate student: attendance is not considered in the grade. However, many materials in the course will not be covered in the textbook or in the notes – only in class. Some example problems and complex figures fall into this category. Students are responsible for these materials.

Class Projects

Projects turned in between the due date and the release of solutions will be worth 50% of their score had they been on time. Submissions will not be accepted after solutions are released. Solutions are typically released within a week after the class period following the due date. There may be assignments for which no "late homework, half-credit" period will exist.

Grading

There will be homework assignments and three projects. Weights towards the final grade are as follows:

33% Project 1 TBD 33% Project 2 Build your own Monte Carlo code 34% Project 3 UFTR Safety Analysis

Grades will be assigned according to the following scale and will be curved at the discretion of the instructor:
93.0%+: A
90.0-92.9%: A-
87.0-89.9%: B+
83.0-86.9%: B
80.0-82.9%: B-
77.0-79.9%: C+
73.0-76.9%: C
70.0-72.0%: C-
67.0-69.9%: D+
63.0-66.9%: D
60.0-62.9%: D-
59.9% and lower: E

Requests for re-grading of any course document should be submitted as a written request within one week of the graded document being returned. After one week, re-grading requests will no longer be considered.

In order to graduate, graduate students must have an overall GPA and an upper-division GPA of 3.0 or better (B or better). Note: a B- average is equivalent to a GPA of 2.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit: http://gradschool.ufl.edu/catalog/current-catalog/catalog-general-regulations.html

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.

Addenum: Any academic dishonesty, including unauthorized collaborations on projects or copying of homework, and/or cheating on exams will be reported through appropriate official channels. If this is your first documented offense at UF, you should expect to receive, at minimum, a failing grade in this course. If you have prior offenses, I will recommend suspension or expulsion from UF, as appropriate.

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.

UF Counseling Services

Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

- University Counseling Center, 301 Peabody Hall, 392-1575, Personal and Career Counseling.
- SHCC mental Health, Student Health Care Center, 392-1171, Personal and Counseling.
- Center for Sexual Assault/Abuse Recovery and Education (CARE), Student Health Care Center, 392-1161, sexual assault counseling.
- Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling.

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.