Reactor Analysis and Computation I

ENU 4103, Section 2B30
Class Periods: Mondays and Wednesdays, Periods 3&4, 9:35-11:30 AM
Location: Mondays: PSY 0129; Wednesdays: MAEA 0327
Academic Term: Spring 2022

Instructor:
James E Baciak
jebaciak@mse.ufl.edu
352-273-2131
Office Hours: Monday, Period 6 :12:40 – 1 40 PM,
Tuesday, Period 3: 9:35 – 10:25 AM
Wednesday, Period 8: 3:00 – 3:50 PM
Thursday, Period 4: 10:40 – 11:30 AM

109 Nuclear Annex Building

Note: These times are subject to change during the first week of class to better accommodate your schedules. In addition, some of these office hours will be designated as Zoom hours to better assist students that may be prefer asking questions virtually.

Teaching Assistant/Peer Mentor/Supervised Teaching Student:

None

Course Description

Lectures discussing neutron reactions, fission chain and criticality and neutron transport/diffusion for nuclear reactors. Neutron thermalization and thermal scattering kernals. 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 ENU 4605, with minimum grades of C

Course Objectives

The focus of this course is an understanding of the modern practice of reactor physics. This entails both an understanding of classic deterministic reactor theory and concepts and governing equations that goes into computational 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 (C++, FORTRAN, Matlab, Python, etc) to solve problems related to radiation transport and to apply concepts learned into applied problems and evaluations (often as self-study or homework, the benefit of such exercises is thus highly dependent on the effort exerted by each student). You are responsible for familiarizing yourself with these topics.

Classical Reactor Physics

- Introduction: Scope of Nuclear Engineering
- Atomic and Nuclear Physics
- Interaction of Radiation with Matter

- Neutron Energy Distributions
- The Fission Process
- Nuclear Reactors and Nuclear Power
- Neutron Diffusion and Moderation
- Nuclear Reactor Theory
- Numerical Solution to Neutron Diffusion
- The Time Dependent Reactor (Reactor Kinetics)

Materials and Supply Fees

None.

Relation to Program Outcomes (ABET):

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Medium
3. An ability to communicate effectively with a range of audiences	Low
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Low
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Required Textbooks and Software

- Introduction to Nuclear Engineering, Fourth Edition
- John R. Lamarsh and Anthony J. Baratta
- 2018
- 0134570057

Recommended Materials

- James J. Duderstadt and Louis J. Hamilton, "Nuclear Reactor Analysis," 1976, 0-471-22363-8
- Weston M. Stacey, "Nuclear Reactor Physics," 2018, Third Revised Edition, 978-527-41366-9

Course Schedule

Date		**Course Topic**
January	5	Introduction, Course Goals and Objectives, Atomic and Nuclear Physics
	10	Atomic and Nuclear Physics
	12	Neutron Interactions with Matter
	17	**No Class – MLK Day**
	19	Neutron Interactions with Matter
	24	Neutron Interactions with Matter
	26	Neutron Energy Distributions
February	2	Neutron Energy Distributions
	7	Nuclear Power and Power Reactors
	9	**In-Class Test #1**
	14	Nuclear Fission Process
	16	Introduction to Neutron Transport and Diffusion Theory
	21	Introduction to the Neutron Transport Equation
	23	Introduction to the Neutron Transport Equation
	28	Multigroup Neutron Diffusion Theory
March	2	Multigroup Neutron Diffusion Theory
	7	**No Class – Spring Break**
	9	**No Class – Spring Break**
	14	Introduction to Monte Carlo Theory and Finite Difference Methods
	16	Introduction to Monte Carlo Theory and Finite Difference Methods
	21	Criticality Calculations and Problems
	23	**In-Class Test #2**
	28	Neutron Diffusion Theory in Homogeneous Multiplying Media
	30	Neutron Diffusion Theory in Homogeneous Multiplying Media
April	4	Heterogeneous Reactors
	6	Heterogeneous Reactors and Homogenization
	11	Time Dependent Reactor Kinetics

13	Time Dependent Reactor Kinetics	Project Report Due
18	Time Dependent Reactor Kinetics	
20	Time Dependent Reactor Kinetics; Class Review	
25		
26	**FINAL EXAM (12:30-2:30 PM)**	

Attendance Policy, Class Expectations, and Make-Up Policy

Students are expected to attend all class lectures, 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 the 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. Attendance will be taken at the beginning of each class and will be included as part of the course grading. In addition material will be covered during the lectures not covered in the text, it is the responsibility of the student to take notes during lecture.

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies:
https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/

Class distractions such as cell phones are unacceptable and the use of such devices are are prohibited during the lectures. Students will ensure that any such device into the classroom will be turned off or put on silent mode. Such disruptions (including texting) will lead to the student being told to leave the room for the duration of the class period, including during examinations periods. NOTE: if a pop quiz is given after the student is asked to leave, they will receive a zero as a grade for that pop quiz. Laptops, tablets, iPads, etc are only allowed for note taking purposes. All other use is prohibited. If a student arrives late or leaves early, they are 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, they will receive a zero for that pop quiz (no make-up).

Evaluation of Grades

Assignment	**Total Points**	**Percentage of Final Grade**
Homework Sets (8-10)	Varies	40%
Quizzes	10	5%
Tests	100	20%
Final Exam	100	15%
Project Report	100	20%
Total		**100%**

Grading Policy

Percent	**Grade**	**Grade Points**
92.0 - 100	A	4.00
88.0 - 91.9	A-	3.67
84.0 - 87.9	B+	3.33
81.0 – 83.9	B	3.00
78.0 - 80.9	B-	2.67
75.0 - 77.9	C+	2.33
71.0 - 74.9	C	2.00
68.0 - 73.3	C-	1.67
65.0 - 67.9	D+	1.33

61.0 - 64.9	D	1.00
58.0 - 60.9	D-	0.67
0 - 57.9	E	0.00

Since I do not curve the grading scale, all students can receive an A (or an E)! Note: this scale may be adjusted from semester-to-semester by a couple of points depending on topics covered and difficulty of exams.

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 who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation
Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

In-Class Recording
Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

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 Conduct Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

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: https://registrar.ufl.edu/ferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: https://counseling.ufl.edu, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

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/.

COVID-19

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email covid@shcc.ufl.edu) to be evaluated for testing and to receive further instructions about returning to campus.
- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the UF Health Screen, Test & Protect website for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

Academic Resources

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

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling; https://career.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://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/;https://care.dso.ufl.edu.

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