

Introduction to Nuclear Engineering

ENU 6937 Section TN1

Class Periods: M/W, periods 6-7 (12:50 – 2:45 pm) (4 credits)

Location: 316 Chemical Engineering Building

Academic Term: Fall 2022

Instructor:

Justin Watson

justin.watson@ufl.edu

(352) 273-0241

Office Hours: 178 Rhines Hall, Wednesday 3:00 pm-5:00 pm

No Teaching Assistant

Course Description

In this course, students will learn basic concepts of Atomic and Nuclear Physics, Interaction of Radiation with Matter, Detecting Nuclear Radiations, Neutron Diffusion and Moderation, Nuclear Reactor Theory, Time Dependent Reactor, and Two-Phase Flow and Heat Transfer.

Course Pre-Requisites / Co-Requisites

None

Course Objectives

1. Students will develop a familiarity with basic topics in atomic and nuclear physics (HW 1, Exam 1).
2. Students will develop a familiarity with basic topics in interaction of radiation with matter (HW 2, Exam 1).
3. Students will develop a familiarity with basic topics in detecting nuclear radiations (HW 3, Exam 2).
4. Students will develop a familiarity with basic topics in neutron diffusion and moderation (HW 4, Exam 2).
5. Students will develop a familiarity with basic topics in nuclear reactor theory (HW 5, Exam 3).
6. Students will develop a familiarity with basic topics in time dependent reactor theory (HW 6, Exam 3).
7. Students will develop a familiarity with basic topics in two-phase flow and heat transfer (HW 7, Exam 4).

Materials and Supply Fees

None

Required Textbooks and Software

None

Recommended Materials

None

Optional Materials

- Atoms, Radiation and Radiation Protection, James E. Turner, 2007, Third Edition, ISBN 978-3-527-40606-7
- Fundamentals of Nuclear Engineering, J. Kenneth Shultis and Richard E. Faw, 2016, Third Edition, ISBN 978-1-498-76929-7
- Radiation Detection and Measurement, Glenn Knoll, 2010, Fourth Edition, ISBN 978-0-470-13148-0
- Introduction to Nuclear Engineering, John R. Lamarsh and Anthony J. Baratta, 2018, Fourth Edition, 0134570057
- Nuclear Systems I: Thermal Hydraulic Fundamentals, N.E. Todreas and M.S. Kazimi, 2011 (2nd edition). (ISBN: 9781439808870).

Course Schedule

Week 1:	Introduction: Course Overview, Syllabus, Scope of Nuclear Engineering (1 Lecture) Atomic and Nuclear Physics: Mass and Abundance of Nuclides, Atomic and Nuclear Structure, (3 Lectures)
Week 2:	Atomic and Nuclear Physics: Radiation and Cross-Sections, Radioactive Decay and Kinetics, Units of Measuring Radioactivity (3 Lectures) Interaction of Radiation with Matter: Photon Interactions (1 Lectures) Homework 1 Due
Week 3:	Interaction of Radiation with Matter: Heavy Charged Particle Interactions, Electron Interactions(4 Lectures)
Week 4:	Interaction of Radiation with Matter: Neutron Interactions, Radiation Dose & KERMA, (4 Lectures) Homework 2 Due
Week 5:	Interaction of Radiation with Matter: Fission (1 Lectures) Exam 1 (Atomic and Nuclear Physics & Interaction of Radiation with Matter) Detecting Nuclear Radiations: Counting Statistics and Error Analysis, General Detector Properties, Pulse Shaping and Processing (3 Lectures)
Week 6:	Detecting Nuclear Radiations: Detection Electronics, Gas Detectors (Ionization Chambers, G-M Tubes, Proportional Counters), Scintillation Detectors (Organic & Inorganic), Semiconductor Detectors (Silicon & Germanium) (4 Lectures) Homework 3 Due
Week 7:	Detecting Nuclear Radiations: Neutron Detection (Thermal & Fast) (1 Lectures) Neutron Diffusion and Moderation: Neutrons diffusion and Moderation, Energy Loss in Scattering Reactions, The Equation of Continuity, The diffusion Equation, Boundary Conditions (3 Lectures)
Week 8:	Neutron Diffusion and Moderation: Solutions of the Diffusion Equation, Diffusion Length, The Group Diffusion Method, Thermal Neutron Diffusion, Two-Group Calculation of Neutron Moderation (3 Lectures) Exam 2 (Detecting Nuclear Radiations & Neutron Diffusion and Moderation) Nuclear Reactor Theory: One-Group Reactor Equation, Slab Reactor and Other Reactor Shape, One-Group Critical Equation, Thermal Reactors, Applications to Practical Problems, Reflected Reactors, Multi-Group Calculations, Heterogeneous Reactors (1 Lectures) Homework 4 Due
Week 9:	Nuclear Reactor Theory: One-Group Reactor Equation, Slab Reactor and Other Reactor Shape, One-Group Critical Equation, Thermal Reactors (4 Lectures)
Week 10:	Nuclear Reactor Theory: Applications to Practical Problems, Reflected Reactors, Multi-Group Calculations, Heterogeneous Reactors (4 Lectures) Homework 5 Due

Week 11:	Time Dependent Reactor: Classification of Time Problems, Reactor Kinetics, Control Rods and Chemical Shim, Temperature Effects of Reactivity (4 lectures)
Week 12:	Time Dependent Reactor: Fission Product poisoning, Core Properties During Lifetime (1 lectures) Exam 4 (Nuclear Reactor Theory & Time Dependent Reactor) Two-Phase Flow and Heat Transfer: Averaging, Parameters, Transport in Two-Phase (1.5 - M2/M3), Modeling Two-Phase Flow - HEM, SFM (1.5 - M4/M5) (3 lectures) Homework 6 Due
Week 13:	Two-Phase Flow and Heat Transfer: Pressure Loss in Two-Phase Flow (1 - M6), Flow Regimes (1 - M7), Boiling (2 - M8/M9/M10 - roughly one hour on each of fundamentals, correlations, CHF) (4 lectures)
Week 14	Two-Phase Flow and Heat Transfer: Boiling (1 - M8/M9/M10 - roughly one hour on each of fundamentals, correlations, CHF) Nuclear-Specific Applications, Heat Transport in nuclear fuel - pellets, gap, clad (1.5 - M11), Fluid Mechanics and Heat Transfer in Assemblies/SCA (1.5 - M1/M12), (4 lectures) Homework 7 Due
Week 15:	Two-Phase Flow and Heat Transfer: Thermal Design (1 - M15) (1 lectures)
	12/15/2022 @ 12:30 PM - 2:30 PM Final Exam (Two-Phase Flow and Heat Transfer)

HW Topic Listing:

1. Atomic and Nuclear Physics
2. Interaction of Radiation with Matter
3. Detecting Nuclear Radiations
4. Neutron Diffusion and Moderation
5. Nuclear Reactor Theory
6. Time Dependent Reactors
7. Two-Phase Flow and Heat Transfer

Exams:

1. Atomic and Nuclear Physics & Interaction of Radiation with Matter Nuclear Reactor Kinetics, Multigroup Diffusion Theory
2. Detecting Nuclear Radiations & Neutron Diffusion and Moderation
3. Nuclear Reactor Theory & Time Dependent Reactors
4. Two-Phase Flow and Heat Transfer

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance during all scheduled class times is required. Excused absences must be consistent with university policies in the Graduate Catalog (<https://catalog.ufl.edu/graduate/regulations>) and require appropriate documentation. Additional information can be found here: <https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>

Evaluation of Grades

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework Sets (7)	15 each	20%
Exams (4)	100 each	80%
		100%

Grading Policy

The following is given as an example only.

Percent	Grade	Grade Points
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

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 support, 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>.