



NUCL 6030: Radiation Interactions

Fall 2019 (3 credits)

Class Schedule: Monday and Wednesday, 11:50 – 13:10

Location: WEB 2460

Instructor: Dr. Edward Cazalas

Email: edward.cazalas@utah.edu

Phone Number: 801.581.7397

Office Hours: Wednesdays, 13:10 – 15:00, and by appointment

Office Location: MEB 3274

Course Description

This course will provide students with a fundamental understanding of basic principles covering the modern theory of the atomic and nucleus structure, quantum description of nuclear processes, interactions of radiation with matter, and radioactive decay. Special emphasis will be placed on understanding the scattering and attenuation of neutrons, photons, and charge particles.

Prerequisites: Instructor's consent.

Textbook and Materials

REQUIRED TEXTBOOK: James E. Turner, *Atoms, Radiation and Radiation Protection*, 3rd Ed., WILEY-VCH, 2007. (ISBN: 978-3527406067)

Online Resources:

- **National Nuclear Data Center** - <https://www.nndc.bnl.gov/>
- **Chart of Nuclides** - <https://www.nndc.bnl.gov/chart/>
- **Evaluated Nuclear Data File (ENDF)** – <https://www.nndc.bnl.gov/exfor/endl00.jsp>
- **X-Ray and Gamma-Ray Data** – <https://www.nist.gov/pml/x-ray-and-gamma-ray-data>
- **X-Ray Data Booklet** - <http://xdb.lbl.gov/>

Supplemental Materials:

- Krane, K.S., *Modern Physics*, 3rd Ed. Wiley, 2012 (ISBN: 978-1118061145)
- Lamarsh, J.R., Baratta, A.J., *Introduction to Nuclear Engineering*, 3rd Ed. Prentice Hall, 2001 (ISBN: 0-201-82498-1)

Course Objectives and Outcomes

Course Objectives:

1. Convey knowledge of basic atomic and nuclear structure, and radioactive decay.
2. Introduce students to radiation sources, radiation types, and their properties.
3. Develop detailed understanding of the physics of ionizing radiation, including their production, transport, and interaction with matter.

Course Outcomes: *Students should have mastery over...*

1. Atomic and nuclear structure, and radioactive decay.
2. Photon, charged particle, and neutron sources, transport, and interactions.
3. Quantitative and qualitative ability to solve problems related to fundamental radiation interactions.

Attendance and Drop Policy

- Attendance and participation, in full, is expected in each class. This includes punctual arrival and attention to presented lectures.
- In the event of an absence, it is the student's responsibility to obtain and review the material that was covered during the absence.
- The drop policy for this course is in accordance with University rules and regulations. It is the student's responsibility to be familiar with these policies.

Assignments and Course Evaluation

Homework: 40%

In-Class Quizzes: 10%

Exams (3): 30%

Final Exam: 20%

Homework: Homework must be handed in by 17:00 of the date due. Late homework assignments will be subject to a 10% penalty per day late (17:01 = 1 day late). Homework must be typed up and should be electronically submitted.

In-Class Quizzes: Quizzes will be conducted at the beginning of randomly selected classes. No makeups for missed quizzes (exception – see makeup exams). Tardiness to a quiz constitutes 0% for that quiz.

Makeup Exams: Makeup exams and quizzes may be allowed only when arrangements are made with the instructor *prior* to the scheduled exam or quiz, or if there is a *documented* medical emergency or *significant* life-altering circumstance. In all these cases, see instructor ASAP for possibility of makeup.

Tentative In-Class Exam Schedule:

Exam 1: September 18th

Exam 2: October 28th

Exam 3: November 20th

Final Exam: Friday, December 13. 10:30 – 12:30

University Policies

1. **Academic Misconduct.** Academic misconduct (e.g. cheating) of any kind will not be tolerated. Please understand the difference between discussing with and helping one another, and academic misconduct. If you are having difficulty in understanding the material, please let us know and we will be happy to help. If you have any questions about what constitutes academic misconduct, please ask the instructor, or see the University of Utah Student Code (Sections III and V in particular)... <https://regulations.utah.edu/academics/6-400.php>
2. **Safety on Campus.** The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit <https://safeu.utah.edu>
3. **College of Engineering (COE) Guidelines.** Please be aware of the COE guidelines. The COE guidelines provide describe the procedures and information on the appeals process, withdrawal process, ADA, repeat requirements, and adding courses. For more information, go to <https://www.coe.utah.edu/students/current/semester-guidelines/>
4. **The Americans with Disabilities Act.** The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, (801) 581-5020. CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in an alternative format with prior notification to the Center for Disability Services.
5. **Addressing Sexual Misconduct.** Title IX makes it clear that violence and harassment based on sex and gender (which Includes sexual orientation and gender identity/expression) is a civil rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran's status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to the police, contact the Department of Public Safety, 801-585-2677(COPS).
6. **Wellness Statement.** Personal concerns such as stress, anxiety, relationship difficulties, depression, cross-cultural differences, etc., can interfere with a student's ability to succeed and thrive at the University of Utah. For helpful resources contact the Center for Student Wellness - www.wellness.utah.edu; 801-581-7776.
7. **Learners of English as an Additional/Second Language.** If you are an English language learner, please be aware of several resources on campus that will support you with your language development and writing. These resources include: the Department of Linguistics ESL Program (<http://linguistics.utah.edu/esl-program/>); the Writing Center (<http://writingcenter.utah.edu/>); the Writing Program (<http://writing-program.utah.edu/>); the English Language Institute (<http://continue.utah.edu/eli/>). Please let me know if there is any additional support you would like to discuss for this class.

Course Schedule (FA19)

Week	Class	Date	Topic
1	1	M 8/19	Course Intro, Radiation (Ch1)
	2	W 8/21	Atomic Structure (Ch2)
2	3	M 8/26	Nuclear Radiation (Ch3)
	4	W 8/28	Radioactive Decay (Ch4)
3	5	M 9/2	LABOR DAY – NO CLASS
	6	W 9/4	Flux and Fluence, Interaction Rates
4	7	M 9/9	Heavy Charged Particles – Sources, Energy Transfer (Ch5)
	8	W 9/11	Heavy Charged Particles – Stopping Power (Ch5)
5	9	M 9/16	Heavy Charged Particles – Range, Relativistic Corrections (Ch5)
	10	W 9/18	===== EXAM 1 =====
6	11	M 9/23	Electrons – Sources, Stopping Power (Ch6)
	12	W 9/25	Electrons – Bremsstrahlung, Range, Tracks (Ch6)
7	13	M 9/30	Charged Particle Tracks – LET, Straggling, Bragg Peak (Ch7)
	14	W 10/2	Photons – Electromagnetic Radiation, Sources, (Ch8)
8	15	M 10/7	FALL BREAK – NO CLASS
	16	W 10/9	FALL BREAK – NO CLASS
9	17	M 10/14	Photons – Photoelectric Effect, Scattering (Ch8)
	18	W 10/16	Photons – Pair Production, Photonuclear (Ch8)
10	19	M 10/21	Photons – Cross Sections and Attenuation (Ch8)
	20	W 10/23	Photons – Non-Ionizing Radiation
11	21	M 10/28	===== EXAM 2 ===== (Dr. Cazalas away)
	22	W 10/30	TBD (Dr. Cazalas away)
12	23	M 11/4	Neutron Sources (Ch9)
	24	W 11/6	Neutron Scattering (Ch9)
13	25	M 11/11	Neutron Resonances, Thermalization, Absorption (Ch9)
	26	W 11/13	Neutron Fissioning (Ch9)
14	27	M 11/18	Neutron Cross Sections (Ch9)
	28	W 11/20	===== EXAM 3 =====
15	29	M 11/25	Special Topics – Introduction to Detectors (Ch10)
	30	W 11/27	Special Topics – Introduction to Dosimetry (Ch12)
16	31	M 12/2	Special Topics – Introduction to Shielding (Ch15)
	32	W 12/4	Preparation for Final Exam
17	33	Th 12/13	===== FINAL EXAM 10:30 – 12:30 =====

Note: This syllabus is meant to serve as an outline and guide for our course. Please note that I may modify it with reasonable notice to you. I may also modify the Course Schedule to accommodate the needs of our class. Any changes will be announced in class and posted on Canvas under Announcements.