NC STATE UNIVERSITY

NE 520 Course Syllabus

Radiation and Reactor Fundamentals

Fall 2025

Instructor Information

Name	Office Phone	Mobile Phone	Email	Office Location
Elizabeth Kautz (Assistant Professor)	--	--	ekautz@ncsu.edu	Burlington Laboratory, 2152
Nusrat Karim (Nuclear Engineering Ph.D. student)	--	--	nkarim@ncsu.edu	Burlington Laboratory, graduate office suit 1222

Office Hours

In-person office hours: Immediately after class (approx. 1130 AM to 1230 PM on Thursdays).

In addition, the instructor is available for in-person or virtual office hours upon appointment (please email to find a time).

Location: Instructor office (Burlington 2152)

Office hours for distance education students: held online, 'on demand' *(please email to find a time).* A zoom or Microsoft teams link will be provided for the meeting.

Preferred Method of Communication & Response Time

- **Preferred method of communication:** If you need to contact the instructor directly, please use the provided email. You can expect to receive a response within two business days (i.e., not over the weekend). If I email you directly, please strive to respond within two business days. It is recommended that you check your NC State email at least once a day to stay on top of course communications.
- **Asking questions about the course:** If you have a question about the course or its content, you can email the instructor or post your question on the Student Help Forum in Moodle. You can expect to receive a response within two business days (i.e. not over the weekend). For direct in-person questions, feel free to ask questions at the end of each class period or schedule an appointment.
- **Email guidelines:** Always include a descriptive, specific but concise subject. Include your course number in your email, and provide adequate context for your question in order to ensure full understanding of your email. Be sure to use your NC State email account, and sign with your name and Student ID number.

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Course Information

Course Website (moodle): https://moodle-courses2527.wolfware.ncsu.edu/course/view.php?id=904&bp=s

Meeting Time: 10:15 – 11:30 am Tuesday/Thursday

Location: Lampe 327

Please refer to our course moodle page for the most up-to-date information on meeting times, locations, office hours, etc. If there are any changes to class or office hour meetings times/locations/schedule, they will be communicated to all course participants via moodle. Typically, an announcement will be sent, and if any regular changes are implemented, the course information section of moodle will also be updated.

Course Credit Hours: **3**

Catalog Description

Basics of nuclear physics and reactor physics that are needed for graduate studies in nuclear engineering. Concepts covered include atomic and nuclear models, nuclear reactions, nuclear fission, radioactive decay, neutron interactions, nuclear reactors, neutron diffusion in non-multiplying and multiplying systems, and basic nuclear reactor kinetics.

Structure

- ☐ This course is completely **asynchronous**, which means that students have no real-time class meeting requirements. Learning materials, activities, assignments, and assessments are delivered through **Moodle**, a secure and easy-to-use online learning platform.
- ☑ This course is delivered in a **hybrid** format, meaning it has asynchronous and synchronous components. Asynchronous components are delivered through **Moodle**, a secure and easy-to-use online learning platform.
- ☐ The majority of this course is **synchronous**, delivered through real-time, face-to-face class sessions. Additional materials and activities delivered through **Moodle**, a secure and easy-to-use online learning platform.

Meeting Time and Tool Used

The course will be conducted through in-person meetings at the day and time indicated by the course schedule. This course will also be available to distance education students with live and recorded lectures.

All course material will be posted/available on our moodle webpage. The course moodle page will be where all lecture notes, resources, and assignments will be posted. Grades will also be recorded/posted on moodle. Exams will be administered in-class, or through a proctoring arrangement for distance education students.

Prerequisites

MA341 and PY208 (or equivalent)

Minimum Technical and Digital Information Literacy Skills

Required technical Skills

- Navigate and use Moodle, NC State's Learning Management System.
- Use Gmail, including attaching files to email messages
- Create and submit files in commonly used word processing program formats (MS Word, text editors, Google Docs, LaTex) including typing mathematical expressions and equations.
- Download and upload attachments
- Use spreadsheet, presentation, graphics programs and other applications in digital environments
- Use web conferencing tools including Zoom and Google Meet.
- Post to discussion boards and forums Required digital information literacy skills
- Perform online research using various search engines and library databases. Visit Distance Learning Services at NC State Libraries for more information.
- Use computer networks to locate and store files or data.
- Use online search tools for specific academic purposes, including the use of search criteria, keywords and filters
- Analyze digital information for credibility, currency, and bias (e.b. disinformation, misinformation)
- Properly cite information sources

General Education Program (GEP) Information

Not Applicable

Learning Outcomes

Upon completion of this course, students will be able to:

1. Explain the core principles of modern physics as they apply to nuclear systems, and compare major atomic and nuclear models.
2. Quantitatively analyze radioactive decay processes (calculate activities, half-lives, growth and decay chains), and describe their implications for reactor operation and waste management.
3. Apply conservation laws and cross-section formalism to binary nuclear reactions, and compute reaction Q-values and energy release in fission and fusion processes.
4. Characterize how different types of radiation interact with matter and use this to estimate shielding requirements.
5. Select and evaluate appropriate radiation detection and measurement techniques.
6. Describe the basic principles of nuclear reactor operation, including neutron life cycle, criticality, and both fission and fusion power concepts.

Course Materials

Required textbook

J. Kenneth Shultis and Richard E. Faw; Fundamentals of Nuclear Science and Engineering Third Edition; CRC Press; ISBN 9781498769297, Suggested Retail Price $159.95

Other required materials

N/A

Optional materials

- Kenneth Krane; Introductory Nuclear Physics; John Wiley and Sons; ISBN 978-0471805533, Suggested Retail Price $123
- J. Lamarsh, "Introduction to Nuclear Engineering", 4th edition, Pearson; 9780134570327, Suggested Retail Price $55 (digital)
- Chart of the Nuclides, Nuclides and Isotopes, 17th Edition. Knolls Atomic Power Laboratory (KAPL), estimated cost $30 plus S&H

Technology Requirements

NC State University Libraries offers Technology Lending, where many devices are available to borrow for a 7-day period. Computer labs are available in various locations around campus for student use.

Computer

A laptop computer is recommended for students taking this course. NC State's Online and Distance Education provides technology requirements and recommendations for computer hardware, and NC State's Office of Information Technology provides recommendations for your computer at NC State.

Other devices

No other devices or peripheral tools will be needed for this course.

Software and digitally-hosted course components

There are no specific softwares required for this course.

Other Student Expenses

N/A

Communication Guidelines

Respecting our learning community

The NC State Code of Student Conduct outlines expectations for behavior in the classroom (whether virtual or physical) and the consequences for students who violate these expectations. Any behavior that impacts other students' ability to learn and success will be addressed, but expressing diverse viewpoints and interpretations of course content is welcome.

Community guidelines for this course include:

- Use a respectful tone in all forms of communication (email, written, oral, visual)
- Maintain professionalism (avoid slang, poor grammar, etc.) in your written communication.
- Respect regional dialects and culturally embedded ways of oral communication.
- Stay home or in your dorm room if you are exhibiting symptoms of a contagious illness (fever, chills, etc.).
- Enter our classroom community respectfully by refraining from lewd or indecent speech or behavior, helping to maintain a safe physical environment, not using your cell phone for voice or text communication except when explicitly given leave to do so, and not attending class under the influence of any substance.
- Treat each community member with respect by not recording others without their consent or engaging in any form of hazing or harassment or intimidation or abuse.
- Respect cultural differences that may influence communication styles and needs.

Plan for interaction between instructors and students

Students are encouraged to interact with the instructors for brief questions/issues directly after the end of the in-person courses. For more detailed questions or issues students are encouraged to schedule appointments with the instructors as discussed above. For any change/update of the course schedule and for approaching deadlines for homeworks, midterm exams and final exams, the instructors will contact the students via emails.

Expectations for learner participation and interaction

Collaboration on homeworks are encouraged amongst students. However, copying work or plagiarism will not be tolerated.

Grading and Feedback

Grading criteria, details, and timing of feedback

Percentage of grade	Component	Details and timing of feedback
30 %	Homework	• 10 homeworks will be assigned. Each having equal weighting. • *You will receive a grade / feedback within two weeks of the homework submission deadline.** • *Homework is due at times specified on moodle.* • *Late homeworks are allowed, but are only eligible for up to 50% of the homework grade.*
20 %	Exam 1	• *You will receive a grade / feedback within one two weeks of the exam date.** • *If you miss an exam, you will only be allowed to take the exam if you provide an excused absence.*
20 %	Exam 2	• *You will receive a grade / feedback within two weeks of the exam date.** • *If you miss an exam, you will only be allowed to take the exam if you provide an excused absence.*
30 %	Final exam	• Final exam is cumulative. • *You will receive a grade / feedback within two weeks of the exam date.** • *The final exam will only be rescheduled for individuals with an excused absence, similar to previous exams. If there are extenuating circumstances making it such that you cannot take the final exam at the scheduled time, contact the instructor.*

*modifications to the timing of grades/feedback, if required, will be announced.

Grading scale

This course uses this grading scale:

Low	Letter	High
97 ≤	A+	≤ 100
93 ≤	A	< 97
90 ≤	A-	< 93
87 ≤	B+	< 90
83 ≤	B	< 87
80 ≤	B-	< 83
77 ≤	C+	< 80
73 ≤	C	< 77
70 ≤	C-	< 73
67 ≤	D+	< 70
63 ≤	D	< 67
60 ≤	D-	< 63
0 ≤	F	< 60

Requirements for earning a grade of “Satisfactory”

If you are taking this course for credit only (S/U), your grade will be reported as S (Satisfactory) when course work is equivalent to C- or better or U (Unsatisfactory) when course work is equivalent to less than a C-. For more information, see the Credit Only Courses regulation.

Requirements and procedures for auditing this course

Auditing this course is approved on a case-by-case basis. Please contact the course instructor to attain approval. Refer to the Audit regulation for more information and links to required forms.

Course Schedule

Please note: Course schedule is subject to change. Timing of HW assignments will be communicated via moodle.
*Callister unless otherwise noted

Date	Week #	Class #	Topics	Reading Assignment*
08/19/25	1	1	Course overview, Introduction Fundamental Concepts	Chapter 1
08/21/25		2	Modern Physics Concepts	Chapter 2
08/26/25	2	3	Modern Physics Concepts	Chapter 2
08/28/25		4	Atomic/Nuclear Models	Chapter 3
09/02/25	3	5	Atomic/Nuclear Models	Chapter 3
09/04/25		6	Nuclear Energetics	Chapter 4
09/09/25	4	7	Nuclear Energetics	Chapter 4
09/11/25		8	Radioactivity	Chapter 5
09/16/25	5	Wellness Day. No Class		
09/18/25		9	*Open/Instructor Discretion*	
09/23/25	6	10	**Exam 1**	
09/25/25		11	Binary Nuclear Reactions	Chapter 6
09/30/25	7	12	Binary Nuclear Reactions	Chapter 6
10/02/25		13	Radiation Interactions with Matter	Chapter 7
10/07/25	8	14	Radiation Interactions with Matter	Chapter 7
10/09/25		15	Radiation Interactions with Matter	Chapter 7
10/14/25	9	Fall Break. No Class		

10/16/25		16	Detection and Measurement of Radiation	Chapter 8
10/21/25	10	17	Detection and Measurement of Radiation	Chapter 8
10/23/25		18	*Open/Instructor Discretion*	
10/28/25	11	19	**Exam 2**	
10/30/25		20	Principles of Nuclear Reactors	Chapter 10
11/04/25	12	21	Principles of Nuclear Reactors	Chapter 10
11/06/25		22	Nuclear Power	Chapter 11
11/11/25	13	23	Nuclear Power	Chapter 11
11/13/25		24	Nuclear Power	Chapter 11
11/18/25	14	25	Fusion Reactors and Other Conversion Devices	Chapter 12
11/20/25		26	Fusion Reactors and Other Conversion Devices	Chapter 12
11/25/25	15	27	*Open/Instructor Discretion*	
11/27/25		Thanksgiving - No Class		
12/02/24	16	Review		
12/04/25		Final Exam		

Course Policies

Proctored exams

Three midterm exams will be conducted. One final exam will be conducted covering all course material (cumulative) and will be administered during the university scheduled day and time for this course's Final Exam.

Late assignments

Late assignments will be accepted at the discretion of the instructor, and **students can earn up to 50 % of the total assignment grade**. Delays due to excused reasons must be approved by the instructors at the earliest time the excused reason is identified.

Incomplete grades, withdrawals

Information on incomplete grades can be found at REG 02.50.03 – Grades and Grade Point Average. If you encounter a serious disruption to your work not caused by you and you would have otherwise successfully completed the course, contact your instructor as soon as you can to discuss the possibility of earning an incomplete in the course for the semester, including an agreement on when the remaining work must be done in order to change the grade to the appropriate letter grade.

If a student must withdraw from a course or from the University due to hardship beyond their control, see Withdrawal Process and Timeline | Student Services Center for information and instructions.

Attendance

Per university policy, full participation in classes and examinations is expected of all students. Instructors may use reasonable academic penalties commensurate with the importance of the work missed because of unexcused absences. Please refer to the University Policy on Attendance Regulations REG 02.20.3 for details on university policy regarding attendance and excused absences.

Excuses for unanticipated excused absences must be presented to the instructor as soon as possible but no later than one week after the return to class. Excused absences must be presented for the cases of exams and late/missed homework assignments.

Related NC State Policy: REG 02.20.03 – Attendance Regulations

University Policies

Academic integrity and honesty

Students are required to comply with the university policy on academic integrity found in the Code of Student Conduct 11.35.01 sections 8 and 9. Therefore, students are required to uphold the Pack Pledge: "I have neither given nor received unauthorized aid on this test or assignment." Violations of academic integrity will be handled in accordance with the Student Discipline Procedures.

Please refer to the Academic Integrity web page for a detailed explanation of the University's policies on academic integrity and some of the common understandings related to those policies.

Student privacy

Originality Checking Software

- ☐ Software is being used in this course to detect the originality of student submissions.
- ☑ Software is not used in this course to detect originality of student submissions.

Class recording statement:

- ☐ In-class sessions are recorded in such a way that might also record students in this course. These recordings will NOT be used beyond the current semester or in any other setting outside of the course.
- ☑ In-class sessions are recorded in such a way that might also record students in this course. These recordings MAY be used beyond the current semester or in any other setting outside of the course. Contact your instructor if you have concerns.
- ☐ Students will not be able to be identified in any course recordings, or the course will not be recorded at all.

Class privacy statement:

- ☑ This course requires online exchanges among students and the instructor, but NOT with persons outside the course. Students may be required to disclose personally identifiable information to other students in the course, via electronic tools like email or web-postings, where relevant to the course. Examples include online discussions of class topics and posting of student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course.
- ☐ Student information in this course may be accessible to persons beyond the instructor and students in the course. This course may involve electronic sharing or posting of personally identifiable student work or other information with persons not taking or administering the course. Students will be asked to sign a consent form allowing disclosure of their personally identifiable work. No student is required to sign the consent form as a condition of taking the course. If a student does not want to sign the consent form, he or she has the right to ask the instructor for an alternative, private means of completing the coursework.

Other policies

Students are responsible for reviewing the NC State University PRR's which pertains to their course rights and responsibilities:

- Equal Opportunity and Non-Discrimination Policy Statement and additional references
- Code of Student Conduct
- Grades and Grade Point Average
- Credit-Only Courses
- Audits

Student Resources

Academic and Student Affairs maintains a website with links for student support on campus, including academic support, community support, health and wellness, financial hardship or insecurity, and more.
Find Help on Campus.

Disability resources

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the Disability Resource Office (DRO). For more information on NC State's policy on working with students with disabilities, please see the Policies, Rules and Regulations page maintained by the DRO and REG 02.20.01 Academic Accommodations for Students with Disabilities.

Safe at NC State

At NC State, we take the health and safety of students, faculty and staff seriously. The Office for Institutional Equity and Diversity supports the university community by providing services and resources to support and guide individuals in obtaining the help they need. See the Safe at NC State webpage for resources.

Supporting Fellow Students in Distress

As members of the NC State Wolfpack community, we each share a personal responsibility to express concern for one another and to ensure that this classroom and the campus as a whole remains a healthy and safe environment for learning. Occasionally, you may come across a fellow classmate whose personal behavior concerns or worries you, either for the classmate's well-being or yours. If you feel this way, I would encourage you to report this behavior to the NC State CARES website. Although you can report anonymously, it is preferred that you share your contact information so they can follow-up with you personally.

Course Evaluations

ClassEval is the end-of-semester survey for students to evaluate instruction of all university classes. The current survey is administered online and includes 12 closed-ended questions and 3 open-ended questions. Deans, department heads, and instructors may add a limited number of their own questions to these 15 common-core questions.

Each semester students' responses are compiled into a ClassEval report for every instructor and class. Instructors use the evaluations to improve instruction and include them in their promotion and tenure dossiers, while department heads use them in annual reviews. The reports are included in instructors' personnel files and are considered confidential.

Online class evaluations will be available for students to complete during the last two weeks of the semester for full semester courses and the last week of shorter sessions. Students will receive an email directing them to a website to complete class evaluations. These become unavailable at 8am on the first day of finals.

- Contact ClassEval Help Desk: classeval@ncsu.edu
- ClassEval website
- More information about ClassEval

Syllabus Modification Statement

Our syllabus represents a flexible agreement. It outlines the topics we will cover and the order we will cover them in. Dates for assignments represent the earliest possible time they would be due. The pace of the class depends on student mastery and interests. Thus minor changes in the syllabus can occur if we need to slow down or speed up the pace of instruction.