

Probabilistic Risk Assessment and Management of Nuclear Systems

COURSE INFORMATION

1. **Instructor:** Dr. Mihai A. Diaconeasa
1110D Burlington Engineering Labs (BU), (919) 515-3768
e-mail (typical response within 12 hours): madiacon@ncsu.edu
Office hours: Wednesday 5:00pm-7:00pm, BU 1110D
and <https://ncsu.zoom.us/j/8292985327> or appointment arranged by email.
2. **Teaching Assistant:** Kirill Shumilov (kshumil@ncsu.edu)
Office hours: Friday 5:00pm-7:00pm, BR 2333
and <https://ncsu.zoom.us/j/97789330771> or appointment arranged by email.
3. **Schedule:**
 - Captured lectures are available at:
<https://ncsu.hosted.panopto.com/Panopto/Pages/Sessions/List.aspx#folderID=c0f2e7b1-7bc4-49f0-adb5-b32e0049cd65>.
 - Online **class evaluations** will be available for students to complete during the last 2 weeks of the semester then become unavailable at 8am on the first day of finals:
Due 8am August 3
Students will receive an email message directing them to a website where they can login using their Unity ID and complete evaluations. All evaluations are confidential; instructors **will not know how any one student** responded to any question, and students will not know the ratings for any instructors. Results of the evaluation is revealed to the instructor **after** the grades are assigned.
Evaluation website: <http://go.ncsu.edu/cesurvey>
4. **Description:** A course which introduces principles of probabilistic risk assessment and management of complex engineering systems, with a particular focus on nuclear power applications. Fundamental safety and risk concepts, accidents and risk management, a review of major probabilistic risk assessment studies, hazard analysis, qualitative and quantitative systems analysis, human and software reliability, uncertainty quantification, and risk-informed and performance-based design and licensing of advanced nuclear reactors under development. Risk and safety principles are emphasized in homework and in-class problems. Course project is required.
5. **Recommended Prerequisites:**
 - ST 370 “Probability and Statistics for Engineers”, or
 - MA 421: “Introduction to Probability” or equivalent.Contact the instructor if you don’t have the exact pre-requisite course to discuss your background.
6. **Learning Outcomes:**

The students completing this course will be able to:

 - **Explain** the general safety and risk concepts.
 - **Judge** the importance of the nuclear plant regulation and licensing key rules.
 - **Implement** the principles of risk and reliability analysis for simple engineered systems.

- **Explain** deterministic and probabilistic safety analyses of nuclear systems.
- **Interpret** the critical events and lessons learnt of the major accidents and incidents for nuclear systems.
- **Contrast** the major probabilistic risk assessment studies of nuclear systems.
- **Explain** advanced simulation-based methods for risk assessment.
- **Apply** basic risk and reliability models for predicting the safety of nuclear systems.
- **Apply** appropriate risk management strategies for ensuring the safety of nuclear systems.

Additionally, the graduate students completing this course will be able to:

- **Develop** basic risk and reliability models for predicting the safety of nuclear systems.
- **Select** appropriate risk management strategies for ensuring the safety of nuclear systems.

7. Test Schedule

Exam:	Date/Time/Location:
Midterm	Friday, October 3 (take-home, any time of the day)
Final:	Friday, December 5 (take-home, any time of the day)

<https://studentservices.ncsu.edu/calendars/exam/#fall>

8. **Homework:** Homework will be assigned periodically throughout the semester. The last homework assignment may be due during the last week of classes. **Moodle** is used to post lecture notes, homework and other materials:

Late Assignments: Unless stated otherwise, assignments are due at the end of the day on the designated due date. Assignments turned in within 24 hours of this time are considered LATE and will be assessed a 25% penalty unless the student requested an exemption from the instructor. Assignments turned in after 48 hours will be marked and returned to the student, but no credit will be assigned unless the student requested an exemption from the instructor. Overall, to allow for unforeseen circumstances, exceptions to this policy may be granted by contacting the instructor.

9. **Makeup Work Policy:** We understand that sometimes life makes it difficult to focus on schoolwork. If you are having a personal problem that affects your participation in this course, please talk to us as early as possible to create a plan.
10. **Attendance:** Required; Active class participation is strongly encouraged and it will be rewarded at the instructor's discretion. University policy on definition of excused absences: <https://policies.ncsu.edu/regulation/reg-02-20-03-attendance-regulations/>.

Personal Problems: We understand that sometimes life makes it difficult to focus on schoolwork. If you are having a personal problem that affects your participation in this course, please talk to us to create a plan. Please do not wait until the end of the semester to share any challenges that have negatively impacted your engagement and academic performance. The sooner we connect, the more options we will have available to us to support your overall academic success. If you are not comfortable speaking with us directly, please utilize the other student resources provided below in order to understand how to best approach success in this course given your personal needs as soon as possible.

Providing feedback to us: We encourage your feedback at any time throughout the semester about things that are helping you learn, or things that aren't helping. Please let us know if there are ways that we can improve the course to better support your learning.

11. Text and Selected References: Lecture notes will be provided for each class.

Required text:

- J. C. Lee and N. J. McCormick, Risk and Safety Analysis of Nuclear Systems. John Wiley & Sons, 2011 ISBN-13: 978-0470907566. <https://catalog.lib.ncsu.edu/catalog/NCSU2504608>.

Recommended texts:

- H. Kumamoto and E. J. Henley, Probabilistic Risk Assessment and Management for Engineers and Scientists. Wiley, 2000 ISBN-13: 978-0780360174.

Additional guidance:

- J.W. Hickman. PRA Procedures Guide: A Guide to the Performance of Probabilistic Risk Assessments for Nuclear Power Plants; NUREG/CR-2300; Nuclear Regulatory Commission, Washington, D.C. (USA), 1983. <https://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr2300/index.html>.

12. Letter Grading:

Discussion	3%
Midterm	20%
Homework	22%
Project	35%
Final	20%

A+ ≥ 96%*	A 92 – 95%	A- 89 – 91%
B+ 86 – 88%	B 82 – 85%	B- 79 – 81%
C+ 76 – 78%	C 72 – 75%	C- 69 – 71%
D+ 65 – 68%	D 61 – 64%	D- 56 – 60%
	F < 56%	

*Must be top 5% student in the class as well to earn the "A+".

13. Credit-Only (S/U) Grading: In order to receive a grade of S, students are required to take all exams and quizzes, complete all assignments, and earn a grade of C- or better. Conversion from letter grading to credit only (S/U) grading is subject to university deadlines. Refer to the Registration and Records calendar for deadlines related to grading. For more details refer to <https://policies.ncsu.edu/regulation/reg-02-20-15/>.

14. Auditors (AU): Information about and requirements for auditing a course can be found at <https://policies.ncsu.edu/regulation/reg-02-20-04/>.

15. Academic Integrity

- University policy on academic integrity: **Code of Student Conduct Policy** <https://policies.ncsu.edu/policy/pol-11-35-01/>
- By signing your name on either test or homework for this course every student implies the following statement: "I have neither given nor received unauthorized aid on this test or assignment."

- Absolutely no collaboration is permitted during the tests. All the tests are closed book unless otherwise specified.
 - Collaboration on homework assignments is allowed, but the submitted work must be your own individual work. Homework assignments must not be treated as group assignments. Zero grade will be assigned for particular homework for the first offence. Second offense will be reported to the *Office of Student Conduct*.
 - Alternatives to Academic Dishonesty:
 - i. Seek out help – connect with your instructor and teaching assistant, ask if there is special tutoring available.
 - ii. Drop the course – can you take it next semester it is offered when you might feel more prepared and less pressured?
 - iii. Ask for an extension – if you explain your situation to your instructor, an extended deadline may be granted.
 - iv. See a counselor at the Counseling Center, and/or your school, college or department – NC State has many resources for students who are feeling the stresses of academic and personal pressures.
16. **Wellness Support:** As a student you may experience a range of personal issues that can impede learning, such as strained relationships, increased anxiety, alcohol/drug concerns, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may impact your ability to participate in daily activities. It is very important that you have a support system and that you ask for help when you are struggling. The **Counseling Center** at NC State offers confidential mental health services for full time NC State students, including same-day emergency services. Please visit <https://counseling.dasa.ncsu.edu/> to get connected. The full list of resources available to you are found at: <https://wellness.ncsu.edu/resources/>.
17. **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 safe environment for learning. Occasionally, you may come across a fellow classmate whose personal behavior concerns or worries you. When this is the case, I would encourage you to report this behavior by making a referral on the **NC State Cares** website: <https://prevention.dasa.ncsu.edu/nc-state-cares/about/>. Although you can report anonymously, it is preferred that you share your contact information so they can follow-up with you personally.
18. **Accommodations for Disabilities:** Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 515-7653. For more information on NC State's policy on working with students with disabilities, please see the **Academic Accommodations for Students with Disabilities Regulation** (<https://policies.ncsu.edu/regulation/reg-02-20-01/>).
19. **Digital Course Components:** Students may be required to disclose personally identifiable information to other students in the course, via digital tools, such as 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. All Moodle deliverables will have their originality automatically evaluated with the Turnitin software. You are not allowed to share any course materials with anyone or upload to any websites without instructor's written approval.

20. Use of electronic devices in class: Communication devices are to be turned on silent prior to entering the classroom. No exceptions. Use of electronic devices during class for purposes other than taking notes is prohibited. Tablets are encouraged for following the posted lecture materials or taking electronic notes.

21. Use of AI Tools: In this course, students are encouraged to explore and utilize generative AI tools, such as chatbots, text generators, paraphrasers, etc., as part of their learning and coursework. These tools can be valuable for brainstorming, drafting, and enhancing your understanding of the material. However, it is important to critically assess and cite any AI-generated content used in your assignments and projects. Students are expected to demonstrate their own understanding and critical thinking in their final submissions. Proper attribution and transparency about your usage of an AI tool are expected. If you have any questions about what constitutes ethical and responsible use of AI tools, please consult with the instructor before submitting your work. We may also integrate AI Tools into some of our assignments. Here are some examples of ethical and responsible generative AI use.

- Use AI tools only for tasks that are appropriate for your level of learning and understanding. Do not use AI tools to replace your own thinking or analysis, or to avoid engaging with the course content.
- Cite any AI tools you use properly, following the citation style specified by the instructor. APA Example: OpenAI. (2025). ChatGPT 5 (Date version) [Large language model]. <https://chat.openai.com/chat>
- Provide evidence of how you used the AI tool and how it contributed to your assignment. Explain what you learned from the AI tool, how you verified its accuracy and reliability, how you integrated its output with your own work, and how you acknowledged its limitations and biases.
- Take full responsibility for any mistakes or errors made by the AI tool. Do not rely on the AI tool to produce flawless or correct results. Always check and edit the output before submitting your work. If you discover any inaccuracies or inconsistencies in the output after submission, notify the instructor immediately and correct them as soon as possible.
- If you are working on a group assignment, discuss the use of AI tools with your group members and agree on how you plan to use them and how you will be transparent with the instructor regarding their use.

22. Health and Well-Being Resources: These are difficult times, and academic and personal stress are natural results. Everyone is encouraged to [take care of themselves](#) and their peers. If you need additional support, there are many resources on campus to help you:

- Student Health Services (Health Services | Student)
- If you or someone you know are experiencing food, housing, or financial insecurity, please see the Pack Essentials Program (Pack Essentials).

23. Non-Discrimination Policy: NC State provides equal opportunity and affirmative action efforts, and prohibits all forms of unlawful discrimination, harassment, and retaliation ("Prohibited Conduct") that are based upon a person's race, color, religion, sex (including pregnancy), national origin, age (40 or older), disability, gender identity,

genetic information, sexual orientation, or veteran status (individually and collectively, "Protected Status"). Additional information as to each Protected Status is included in NCSU REG 04.25.02 (Discrimination, Harassment and Retaliation Complaint Procedure). NC State's policies and regulations covering discrimination, harassment, and retaliation may be accessed at <https://policies.ncsu.edu/policy/pol-04-25-05> or <https://oied.ncsu.edu/divweb/>. Any person who feels that he or she has been the subject of prohibited discrimination, harassment, or retaliation should contact the Office for Equal Opportunity (OEO) at 919-515-3148.

COURSE TOPICS

1. Risk and Safety of Engineered Systems (2 lectures)
2. Probabilities of Events (3 lectures)
3. Reliability Data (2 lectures)
4. Reliability of Multiple-Component Systems (1 lecture)
5. Availability and Reliability of Systems with Repair (2 lectures)
6. Probabilistic Risk Assessment (3 lectures)
7. Computer Programs for Probabilistic Risk Assessment (1 lecture)
8. Nuclear Power Plant Safety Analysis (2 lectures)
9. Major Nuclear Power Plant Accidents and Incidents (2 lectures)
10. PRA Studies of Nuclear Power Plants (3 lectures)
11. Passive Safety and Advanced Nuclear Energy Systems (3 lectures)
12. Risk-Informed Regulations, Maintenance, and Management (2 lectures)
13. Simulation-Based Probabilistic Risk Assessment (2 lectures)

COURSE PROJECT

Project deliverables (Subscribe to your Moodle calendar for due dates, all deliverables to be submitted **via Moodle Turnitin**):

1. Choose between the project option or propose a suitable alternative with a short description of the project goals. Include any progress made so far in your draft report.
2. Specific plan (2-5 pages) on executing the project, including theoretical framework report (proposed model types to be used) and possible issues with the project formulation. Include any progress made so far in your draft report.
3. Proposal on models and specific set of values to be used with the software application and justification. Include any progress made so far in your draft report.
4. Working model and demonstration for specific set of parameters accompanied by analytical proof (when possible) that the results are trustworthy. Include any progress made so far in your draft report.

5. Final report, which includes the electronic version of the model, and the detailed results section and conclusions on what are the recommended decisions based on the risk results.

Please keep this syllabus easily accessible so that you can refer to it throughout the semester. Contact us with any clarifying questions in advance of the semester or within the first week. We look forward to supporting your learning in this course.