

ME 756 Monte Carlo Methods in Nuclear Engineering

UNLV Department of Mechanical Engineering

Course Description

Theory and application of the Monte Carlo method for neutron transport calculations from introductory concepts to advanced simulations of criticality in fissile materials. Computer applications in nuclear engineering; verification and validation (V&V), nuclear data files, examples of Monte Carlo calculations, case studies and applied problems.

Course Learning Outcomes

By the end of this course, students will be able to:

1. Describe the theory and principles of the Monte Carlo Method.
2. Develop MCNP input files to calculate nuclear criticality safety parameters.
3. Implement variance reduction techniques
4. Write their own Monte Carlo program or subroutine.

Prerequisites

ME 455, [ME 655](#) or equivalent or consent of instructor.

Required Text

Dunn, W. and K. Shultis (2011). Exploring Monte Carlo Methods. Amsterdam: Academic Press. ISBN 978-0444515759

Course Schedule

Important: This schedule is subject to change. The instructor will inform you whenever this is the case.

Week	Topics	Tasks
1	<ul style="list-style-type: none">• Course Introduction	Read Chapter 1
2	<ul style="list-style-type: none">• Introduction to Monte Carlo Methods• Review Topics• Overview of Applied Nuclear Engineering Codes	Read Chapter 9 NCS Review
3	<ul style="list-style-type: none">• Computer Code Development• Verification and Validation	Read Appendix D
4	<ul style="list-style-type: none">• Nuclear Data Files and Cross section Libraries	ENDF Data Assignment
5	<ul style="list-style-type: none">• Probability• Probability Distribution Functions	Read Chapter 2 Read Appendix C Quiz 1
6	<ul style="list-style-type: none">• Random Number Generators	Read Chapter 3 Read Appendix E Random Number Assignment

7	<ul style="list-style-type: none"> • Sampling 	Read Chapter 4 Self-test Assignment
8	<ul style="list-style-type: none"> • Review • Midterm Exam Week 	Midterm Exam
9	<ul style="list-style-type: none"> • Spring Break 	
10	<ul style="list-style-type: none"> • Analog Monte Carlo Method • Error Estimates 	Nuclear Criticality: Four equation assignment
11	<ul style="list-style-type: none"> • Non Analog Monte Carlo Method • Tracking in Phase Space 	Discussion
12	<ul style="list-style-type: none"> • Monte Carlo Criticality Eigenvalue Calculations 	Read Chapter 10 S-Curve Assignment
13	<ul style="list-style-type: none"> • Variance Reduction 	Read Chapter 5 Discussion
14	<ul style="list-style-type: none"> • Markov Chain Monte Carlo 	Read Chapter 6 Variance Reduction Assigment
15	<ul style="list-style-type: none"> • Review 	Quiz 2
16	<ul style="list-style-type: none"> • Study Week 	Self-test Assignment
17	<ul style="list-style-type: none"> • Finals Week 	Final Exam

Course Tasks

Video Lectures & Lecture Notes [also see Learning Modules]

Lecture(s)	Topics
Introduction	Introduction to the Course
Lecture-01-A to Lecture-01-G	Review and Probability Central Limit Theorem
Lecture-02-A to Lecture-02-B	Probability and Sampling Sampling Techniques
Lecture-03-A to Lecture-03-B Tutorial-03-A to Tutorial-03-B	Analog Monte Carlo Method Error Estimates - Variance
Tutorial-03-C to Tutorial-03-E	Non-Analog Monte Carlo Method, and Overview of Variance Reducaion Techniques
Tutorial-05-F to Tutorial-05-H-Segment 2	How certain are Monte Carlo calculations?
Lecture-06-A to Lecture-06-B	

Policies and Resources

Course Policies

Grading: 35% Discussions, quizzes, midterm exam
35% Assignments and problem sets
30% Class project (report and presentation)

Grading Scale:

93-100 A
90-92 A-
88-89 B+
83-87 B
80-82 B-
78-79 C+
75-77 C
70-74 C-
68-69 D+
63-67 D
60-62 D-
59- below F

A grade of **B** or better is required for graduate school credit.

Late Work:

If you are going to be late submitting an assignment, I require previous notice. Without notice, 5% will be deducted up to one week following the due date. Thereafter, 20% will be deducted.

Quizzes & Tests:

Open book and calculator only. You may not refer to any other material, cellphones, or people. All information you need is contained within the quiz or exam.

UNLV Policies

The following UNLV policies can be accessed at <https://online.unlv.edu/content/resources/unlv-policies> (opens into a new tab)

- Academic Misconduct
- Copyright
- Disability Resource Center (DRC)
- Religious Holidays
- Incomplete Grades
- Tutoring
- UNLV Writing Center
- Rebelmail

Library Resources

- Students may consult with a librarian on research needs. For this class, the subject librarian is Sue Wainscott. (https://www.library.unlv.edu/contact/librarians_by_subject). UNLV Libraries

provides resources to support students' access to information. Discovery, access, and use of information are vital skills for academic work and for successful post-college life. Access library resources and ask questions at <https://www.library.unlv.edu>.

Policies:

Academic Misconduct—Academic integrity is a legitimate concern for every member of the campus community; all share in upholding the fundamental values of honesty, trust, respect, fairness, responsibility and professionalism. By choosing to join the UNLV community, students accept the expectations of the Student Academic Misconduct Policy and are encouraged when faced with choices to always take the ethical path. Students enrolling in UNLV assume the obligation to conduct themselves in a manner compatible with UNLV's function as an educational institution.

An example of academic misconduct is plagiarism. Plagiarism is using the words or ideas of another, from the Internet or any source, without proper citation of the sources. See the *Student Academic Misconduct Policy* (approved December 9, 2005) located at: <https://www.unlv.edu/studentconduct/student-conduct>.

Copyright—The University requires all members of the University Community to familiarize themselves with and to follow copyright and fair use requirements. **You are individually and solely responsible for violations of copyright and fair use laws. The university will neither protect nor defend you nor assume any responsibility for employee or student violations of fair use laws.** Violations of copyright laws could subject you to federal and state civil penalties and criminal liability, as well as disciplinary action under University policies. Additional information can be found at: <http://www.unlv.edu/provost/copyright>.

Disability Resource Center (DRC)—The UNLV Disability Resource Center (SSC-A 143, <http://drc.unlv.edu>, 702-895-0866) provides resources for students with disabilities. If you feel that you have a disability, please make an appointment with a Disabilities Specialist at the DRC to discuss what options may be available to you. If you are registered with the UNLV Disability Resource Center, bring your Academic Accommodation Plan from the DRC to the instructor during office hours so that you may work together to develop strategies for implementing the accommodations to meet both your needs and the requirements of the course. Any information you provide is private and will be treated as such. To maintain the confidentiality of your request, please do not approach the instructor in front of others to discuss your accommodation needs.

Religious Holidays Policy—Any student missing class quizzes, examinations, or any other class or lab work because of observance of religious holidays shall be given an opportunity during that semester to make up missed work. The make-up will apply to the religious holiday absence only. It shall be the responsibility of the student to notify the instructor within the first 14 calendar days of the course for fall and spring courses (excepting modular courses), or within the first 7 calendar days of the course for summer and modular courses, of his or her intention to participate in religious holidays which do not fall on state holidays or periods of class recess. For additional information, please visit: <http://catalog.unlv.edu/content.php?catoid=6&navoid=531>.

Transparency in Learning and Teaching—The University encourages application of the transparency method of constructing assignments for student success. Please see these two links for further information:

<https://www.unlv.edu/provost/teachingandlearning>

<https://www.unlv.edu/provost/transparency>

Incomplete Grades—The grade of I—Incomplete—can be granted when a student has satisfactorily completed three-fourths of course work for that semester/session but for reason(s) beyond the student’s control, and acceptable to the instructor, cannot complete the last part of the course, and the instructor believes that the student can finish the course without repeating it. The incomplete work must be made up before the end of the following regular semester for undergraduate courses. Graduate students receiving “I” grades in 500-, 600-, or 700-level courses have up to one calendar year to complete the work, at the discretion of the instructor. If course requirements are not completed within the time indicated, a grade of F will be recorded and the GPA will be adjusted accordingly. Students who are fulfilling an Incomplete do not register for the course but make individual arrangements with the instructor who assigned the I grade.

Tutoring and Coaching—The Academic Success Center (ASC) provides tutoring, academic success coaching and other academic assistance for all UNLV undergraduate students. For information regarding tutoring subjects, tutoring times, and other ASC programs and services, visit <http://www.unlv.edu/asc> or call 702-895-3177. The ASC building is located across from the Student Services Complex (SSC). Academic success coaching is located on the second floor of the SSC (ASC Coaching Spot). Drop-in tutoring is located on the second floor of the Lied Library and College of Engineering TEB second floor.

UNLV Writing Center—One-on-one or small group assistance with writing is available free of charge to UNLV students at the Writing Center, located in CDC-3-301. Although walk-in consultations are sometimes available, students with appointments will receive priority assistance. Appointments may be made in person or by calling 702-895-3908. The student’s Rebel ID Card, a copy of the assignment (if possible), and two copies of any writing to be reviewed are requested for the consultation. More information can be found at: <http://writingcenter.unlv.edu/>.

Rebelmail—By policy, faculty and staff should e-mail students’ Rebelmail accounts only. Rebelmail is UNLV’s official e-mail system for students. It is one of the primary ways students receive official university communication such as information about deadlines, major campus events, and announcements. All UNLV students receive a Rebelmail account after they have been admitted to the university. Students’ e-mail prefixes are listed on class rosters. The suffix is always @unlv.nevada.edu.

Emailing within WebCampus is acceptable.

Final Examinations—The University requires that final exams given at the end of a course occur at the time and on the day specified in the final exam schedule. See the schedule at: <http://www.unlv.edu/registrar/calendars>.