

ME 754 Introduction to Nuclear Criticality Safety

UNLV Department of Mechanical Engineering

Course Description

This course provides an overview of the physics of criticality, factors that affect reactivity, hand calculation techniques, experiments and the development of subcritical limits, criticality accidents, standards and regulations, evaluations, etc. It is the first of four required courses for the Nuclear Criticality Safety Certification. It can also be taken as a stand-alone course.

Course Learning Outcomes

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

1. Identify factors that affect criticality safety.
2. Determine suitable standard and regulations for criticality safety.
3. Specify safety practices.
4. Document incidents and recommend recovery procedures.
5. Identify fuel cycle criticality issues.

Prerequisites

ME455/ME655 Fundamentals of Nuclear Engineering or similar course, or practical experience, based on instructor approval. Basic knowledge of atom physics and the nuclear fission process are required (a brief review will be provided in the course introduction).

Required Text

R. A. Knief, Nuclear Criticality Safety Theory and Practice, American Nuclear Society, ISBN 0-89448-028-6 (1993).

Course Schedule

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

Module	Begins	Topics	Tasks
1	8/29	Course Introduction Introductory Topics I: Atom physics, cross sections, nuclear data, nuclear fuel cycle	View lecture 1A-E Self Introductions (Discussion 1) Review Topics
2	8/29	Introductory Topics II: Six-factor formula, neutron balance controls, etc.	Continue Review Topics Text Ch. 1 and 2 Assignment 1
3	9/5	Parameters: Factors that affect criticality safety, MAGIC MERV	View lectures 2A-E MAGIC MERV Activity
4	9/12	Criticality Accidents: Review, Tokai Mura accident	View lecture 3A-D View Lecture 4A-D Text Ch. 3 LA-13638 (Reference)

5	9/19	Standards and Definitions: Regulations, procedures, standards, orders, guides	Self-Study: Read PDF Standards & Regulations Text Ch. 9 Assignment 2
6	9/26	Hand Calculation Methods: Buckling, shape conversion, surface density method, etc.	Read Ch. 8, Appxs. B, C, D View Lectures 5A-F and Examples 1-3 Assignment 3
7	10/3	Experiments and Sub-Critical Limits: Experiments, simulations, parameter limits, operating limits	View lecture 7 Chapters 5 & 7 Self-Test
8	10/10	Midterm Exam Week	Start thinking about your class project Read Class Project instructions
9	10/17	Nuclear Criticality Safety Practices & Incident Reporting and Recovery: Administrative practice, design and operation, geometry control, poisons, mass and volume limits, moderation and concentration control, etc.	Self Study: Read PDF Read Ch. 10 and Appx. G (Recovery Section) Discussion 2
10	10/24	Introduction to Monte Carlo Methods	Self Study: Read PDF Excel problem demo Read Ch. 6 and Appx. A Assignment 4
11	10/31	Criticality Safety Practices: An overview	Self Study: Read PDF Discussion 3
12	11/7	Criticality Safety Evaluations	View lecture 6A-D Read Apx F Read PDF - sample eval Discussion 4
13	11/14	Fuel cycle criticality issues	Read Ch. 11 Self Study: Read PDF Discussion 5 Quiz
14	11/21	Preparation for Final Report/Presentation	
15	11/28	Study Week	
16	12/5	Finals Week. Presentations: Class project (via Skype)	Live Presentations

Course Tasks

Video Lectures & Lecture Notes [also see Learning Modules]

Lecture(s)	Topics	Week of
1A-E	Introduction to the course and instructor	8/29
2A-E	Factors That Affect Criticality	8/29
3A-D	Criticality Accidents Summary	9/5
4A-C	Case Study: Tokai-Mura	9/12
5A-F	Hand Calculation Methods and Examples	9/19
6A-D	Criticality Safety Evaluations	9/26
7A-E	Critical Experiments and Subcritical Limits	10/3

Discussions

Discussions	Discussion Topic
1	Introductions. Please post an introduction in Discussion 1. We are interested in hearing about your knowledge and experience in the nuclear energy field, nuclear criticality, plus your purpose in taking the course. Read the introductions of others and respond to at least two.
2	Administrative Practices for NCS
3	Criticality Safety Practices
4	Criticality Safety Evaluations
5	Fuel Cycle Criticality Issues

Assignments

Assignment	Assignment Description
Review Topics	Review and self-test of prerequisite knowledge
1	Knief, Problems 2-1, 2-2, 2-3, 2-4, and 2-9
2	Knief, Problems 9-1 and 9-2
3	Knief, Problems 8-3 and 8-12
4	Knief, Problems 6-1 and 6-4
5	Course Project - live presentation

Resources

Resources (open into new tabs/windows)
U.S. Nuclear Regulatory Commission website
A Review of Criticality Accidents 2000 Revision (LA-13638)
American National Standard for NCS in Operations with Fissionable Materials Outside Reactors (ANS-8.1)
Anomalies of Nuclear Criticality (PNNL-19176)
Guide for Validation of Nuclear Criticality Safety Computational Methodology (NUREG-6698)
Critical Dimensions of Systems Containing 235U, 239Pu, and 233U (LA-10860-MS)
Nuclear Safety Guide TID-7016 Revision 2

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](tel: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>.