NE 100/200M - Introduction to Nuclear Energy and Technology

Fall 2020, TuTh 9:30 - 11:00 am PT, on the Interwebs

Course Location

Zoom Meeting:
https://berkeley.zoom.us/j/91812736470?pwd=bFRsalVQRUlyQk5pRFdaWmV5N2Y3QT09

Meeting ID: 918 1273 6470

Passcode: 154979

One tap mobile

+12133388477,,91812736470#,,,,,,0#,,154979# US (Los Angeles)

+16692192599,,91812736470#,,,,,,0#,,154979# US (San Jose)

Find your local number: https://berkeley.zoom.us/u/ac4CHEkwGV

Lectures will be recorded and posted on bcourses:
https://bcourses.berkeley.edu/courses/1497069

Course Objectives

The objective of this class is to provide students with an overview of the fundamental technical and societal aspects of nuclear energy. Emphasis is on nuclear fission as an energy source, with a study of the basic physics of the nuclear fission process followed by detailed discussions of issues related to the control, radioactivity management, thermal energy management, fuel production, and spent fuel management. A discussion of the various reactor types in use around the world will include analysis of safety and nuclear proliferation issues surrounding the various technologies. Case studies of some reactor accidents and other nuclear-related incidents will be included. This class is intended for Sophomore Nuclear Engineering students, but it is also suitable for Community College transfer students and students from other majors that want to gain a basic understanding of nuclear technology.

The 200M session is intended for Master of Engineering students that do not have a background in nuclear engineering.

Learning Outcomes

At the end of the course, students should be able to:

- understand basic theoretical concepts of nuclear physics, reactor physics, and energy removal
- describe radiation damage mechanisms in materials and biological tissue, estimate radiation dose, understand radiation shielding
- understand the concepts of chain reaction, neutron balance, criticality, reactivity, and reactivity control

- describe the main nuclear power reactor designs and identify their major components
- describe core components and understand their function
- calculate cost of electricity based on simple economic principles
- describe the differences between PWRs and BWRs in terms of core design, steam cycle, and operation
- understand the concept of design-basis accidents, their causes, and their consequences
- identify the main steps and related facilities of the nuclear fuel cycle
- understand the fundamental aspects of used fuel reprocessing and disposal

This class meets the following ABET outcomes:

(a) an ability to apply knowledge of mathematics, science, and engineering

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(i) a recognition of the need for and an ability to engage in life-long learning

Teaching Philosophy

The class will be based on **active learning** rather than traditional lectures. To try to facilitate this in covid times, we will have the following structure:

- the first 50 minutes of class is lecture and discussion. You are encouraged to engage in discussions, Q&A, and problem-solving. This will be recorded and posted later that same day.
- the last 30 minutes of class will be breakout group discussions. Your breakout group will have a chance to talk about the lecture material, work on problems, and ask questions.
- At the end of each class, each student must turn in an **exit email** with a question, comment, suggestion, etc. related to the lecture that just ended.

Every week we will cover a topic (or cluster of topics).

Before Tuesday's class students will have to complete a **reading assignment**. This will be the basis for the class discussion.

The following Thursday, students will work in class on numerical exercises.

A **homework** on the topic of the week will have to be completed by 5 pm Friday. Students will be able to work on the homework through the week and to ask questions in class.

Instructor

Rachel Slaybaugh (slaybaugh@berkeley.edu), office hours: W 11:00 am - noon or by appointment

Reader

Samuel Varghese (samueltv9923@berkeley.edu), office hours: T 11:00 am - noon

Textbook

R. L. Murray, K. E. Holbert, *Nuclear Energy An Introduction to the Concepts, Systems, and Applications of Nuclear Processes*, Seventh Edition, 2014, Butterworth-Heinemann, ISBN 978-0124166547 (UC LIBRARY ONLINE ACCESS IS AVAILABLE)--for off-campus access, a proxy or a VPN is required, read more here)

Additional reference: R. A. Knief, Nuclear Engineering: *Theory and Technology of Commercial Nuclear Power*, Second Edition, 2008, ISBN 978-0-89448-458-2.

Prerequisites

Students taking the class should have completed Math 53, and Physics 7A and B. Physics 7C and Math 54 can help but are not required.

Course Policies

- **Participation is mandatory.** Because this course is virtual and there are all kinds of extenuating circumstances, I understand if you cannot attend every class. However, I expect you to read the material and participate with your discussion group.
- Each **homework is due on Friday at 5 pm** (see the schedule for details). No late homework will be accepted and $(n-1)!$ points will be subtracted from the total grade, where n is the number of missing assignments—no, "!" is not an exclamation mark.
- Grade Proportion
  - Homework (12): 60% (regrades available for 0-2 scores)
  - Final: 25%
  - Project: 15%
  - Grading scale; we'll be trying a 5-point grading scale this semester
    4: A, demonstrates mastery of topics (shows work illustrating the correct solution was achieved with correct steps)
    3: B, demonstrates knowledge about topics (answer may be incorrect, but many steps are correct / pointing in the right direction)
    2: C, demonstrates some understanding of topics (some key steps may be missing or incorrect, but work is headed in a valid direction)
    1: D, demonstrates very limited understanding of topics (some steps are correct, and some correct approaches are included)
    0: F, does not demonstrate understanding of topics (most steps are incorrect, or the approach taken is not valid for the problem)

Project

NE100: students (in a group of 2) are expected to create a video (3-5 minutes) where the explain to a layperson a concept of choice related to nuclear energy or radiation applications.

NE200M: each student is expected to write a review paper (3-5 pages, single spaced, 12pt font) on a concept of choice related to nuclear energy or radiation applications; the target audience in this case is someone with technical knowledge of the field, although not a subject matter expert.

The project is due at 5 pm on Friday, December 11th.

Homework guidelines

- Homework must be completed in a Jupyter Notebook (http://jupyter.org or https://colab.research.google.com)
- Learning jupyter:
- State clearly the process used to solve each exercise, list the assumptions, and show the work through each step (unless obvious)
- List the source of your information
- Submit the notebook on bCourses

Jupyter notebook tutorials:

- https://github.com/rachelslaybaugh/ucb-ipython-intro
- https://www.youtube.com/watch?v=3C9E2yPBw7s (You need the anaconda navigator parts, but anaconda is likely a good choice, https://www.anaconda.com/products/individual)
- https://github.com/Reproducible-Science-Curriculum/introduction-RR-Jupyter

Everyone is welcome

Diversity is a defining feature of the University of California and we embrace it as a source of strength. Our differences of race, ethnicity, gender, religion, sexual orientation, gender identity, age, socioeconomic status, abilities, experience and more, enhance our ability to achieve the university's core missions of public service, teaching, and research. In this class we embrace diversity and welcome students from all backgrounds and want everyone in the room to feel respected and valued.

Code of Conduct

We'll abide by this code of conduct: https://www.goodenergycollective.org/code-of-conduct

Academic Integrity

The student community at UC Berkeley has adopted the following Honor Code:

> *As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others."*

The expectation is that you will adhere to this code. The University provides some basic guidance about academic integrity: http://sa.berkeley. edu/conduct/integrity. Lack of knowledge of the academic honesty policy is not a reasonable explanation for a violation. Questions related to course assignments and the academic honesty policy should be directed to me.

Collaboration and Independence: Reviewing lecture and reading materials and studying for exams can be enjoyable and enriching things to do with fellow students. This is recommended. However, unless otherwise instructed, homework assignments are to be completed independently and materials submitted as homework should be the result of one's own independent work.

Cheating: A good lifetime strategy is always to act in such a way that no one would ever imagine that you would even consider cheating. Anyone caught cheating on a quiz or exam in this course will receive a failing grade in the course and will also be reported to the University Center for Student Conduct. In order to guarantee that you are not suspected of cheating, please keep your eyes on your own materials and do not converse with others during the quizzes and exams.

Plagiarism: To copy text or ideas from another source without appropriate reference is plagiarism and will result in a failing grade for your assignment and usually further disciplinary action. For additional information on plagiarism and how to avoid it, see, for example:

http://www.lib.berkeley.edu/instruct/guides/citations.html#PlagiarismLinks to an external site.
http://gsi.berkeley.edu/teachingguide/misconduct/prevent-plag.htmlLinks to an external site.

Academic Integrity and Ethics: Cheating on exams and plagiarism are two common examples of dishonest, unethical behavior. Honesty and integrity are of great importance in all facets of life. They help to build a sense of self-confidence, and are key to building trust within relationships, whether personal or professional. There is no tolerance for dishonesty in the academic world, for it undermines what we are dedicated to doing – furthering knowledge for the benefit of humanity. Your experience as a student at UC Berkeley is hopefully fueled by passion for learning and replete with fulfilling activities. And we also appreciate that being a student can be stressful. There may be times when there is temptation to engage in some kind of cheating in order to improve a grade or otherwise advance your career. This could be as blatant as having someone else sit for you in an exam, or submitting a written assignment that has been copied from another source. And it could be as subtle as glancing at a fellow student's exam when you are unsure of an answer to a question and are looking for some confirmation. One might do any of these things and potentially not get caught. However, if you cheat, no matter how much you may have learned in this class, you have failed to learn perhaps the most important lesson of all.

Accommodation Policy

I honor and respect the different learning needs of our students, and are committed to ensuring you have the resources you need to succeed in class. If you need religious or disability-related accommodations, if you have emergency medical information you wish to share with me, or if you need special arrangements in case the building must be evacuated, please share this information with me as soon as possible. You may speak with me privately after class or during office hours. Also see DSP under "Resources".

1. I like music, so in my free time I would usually be practicing playing the bass guitar. I'm learning how to play the kalimba, too.

2. "No well-actuallys".

HW 0: by sept 2 submit on bcourses

1. What is your favorite activity outside of class?
2. What is one principle of engagement from the code of conduct?

Other Policies and Resources

- Student mental health resources: http://www.uhs.berkeley.edu/students/counseling/cps.shtml
- Sexual assault support on campus: http://survivorsupport.berkeley.edu/
- Accommodation of religious creed: https://sa.berkeley.edu/uga/religion
- Conflicts between extracurricular activities and academic requirements: https://teaching.berkeley.edu/checklist-scheduling-conflicts-academic-requirements
- In case of illness, personal issue, or life event that may impact your performance please let me know as soon as possible so that we can make appropriate arrangements. Things happen and we can work around them; no need to make your life more complicated.

Center for Access to Engineering Excellence (CAEE)

The Center for Access to Engineering Excellence (227 Bechtel Engineering Center; https://engineering.berkeley.edu/student-services/academic-support) is an inclusive center that offers study spaces, nutritious snacks, and tutoring in >50 courses for Berkeley engineers and other majors across campus. The Center also offers a wide range of professional development, leadership, and wellness programs, and loans clickers, laptops, and professional attire for interviews.

Disabled Students' Program (DSP)

The Disabled Student's Program (260 César Chávez Student Center #4250; 510-642-0518; http://dsp.berkeley.edu) serves students with disabilities of all kinds. Services are individually designed and based on the specific needs of each student as identified by DSP's Specialists

Counseling and Psychological Services

The main University Health Services Counseling and Psychological Services staff is located at the Tang Center (http://uhs.berkeley.edu; 2222 Bancroft Way; 642-9494) and provides confidential assistance to students managing problems that can emerge from illness such as financial, academic, legal, family concerns, and more.

To improve access for engineering students, a licensed psychologist from the Tang Center also holds walk-in appointments for confidential counseling in 241 Bechtel Engineering Center (check here for schedule: https://engineering.berkeley.edu/student-services/advising-counseling).

The Care Line (PATH to Care Center)
The Care Line (510-643-2005; https://care.berkeley.edu/care-line/) is a 24/7, confidential, free, campus-based resource for urgent support around sexual assault, sexual harassment, interpersonal violence, stalking, and invasion of sexual privacy. The Care Line will connect you with a confidential advocate for trauma-informed crisis support including time-sensitive information, securing urgent safety resources, and accompaniment to medical care or reporting.

Ombudsperson for Students
The Ombudsperson for Students (102 Sproul Hall; 642-5754; http://students.berkeley.edu/Ombuds) provides a confidential service for students involved in a University-related problem (academic or administrative), acting as a neutral complaint resolver and not as an advocate for any of the parties involved in a dispute. The Ombudsman can provide information on policies and procedures affecting students, facilitate students' contact with services able to assist in resolving the problem, and assist students in complaints concerning improper application of University policies or procedures. All matters referred to this office are held in strict confidence. The only exceptions, at the sole discretion of the Ombudsman, are cases where there appears to be imminent threat of serious harm.

UC Berkeley Food Pantry
The UC Berkeley Food Pantry (#68 Martin Luther King Student Union; https://pantry.berkeley.edu) aims to reduce food insecurity among students and staff at UC Berkeley, especially the lack of nutritious food. Students and staff can visit the pantry as many times as they need and take as much as they need while being mindful that it is a shared resource. The pantry operates on a self-assessed need basis; there are no eligibility requirements. The pantry is not for students and staff who need supplemental snacking food, but rather, core food support.