

# Nuclear Engineering

---

## Overview

The Department of Nuclear Engineering was established in 1958. There are currently about 78 graduate students in the department. Graduates find opportunities for employment and professional careers in the United States and abroad. Recent graduates are employed in academia, industry, national laboratories, and state and federal agencies.

The Nuclear Engineering program is comprised of classroom and laboratory instruction at the undergraduate and graduate levels and has a strong, diverse research program. The projects are part of the department's ongoing mission to provide an education to individuals who will make key contributions and become future leaders serving California and the nation by improving and applying nuclear science and technology. The department's research areas include applied nuclear physics; bionuclear and radiological physics; computational methods; energy systems and the environment; ethics and the impact of technology on society; fission reactor design; fuel cycles and radioactive waste; plasma fusion science and technology; laser, particle beam, and plasma technologies; nuclear materials and chemistry; nuclear thermal hydraulics; risk, safety, and large-scale systems analysis, and nonproliferation.

The department has strong relations with the nearby Ernest Orlando Lawrence Berkeley National Laboratory (<http://lbl.gov/>), Lawrence Livermore National Laboratory (<http://www.llnl.gov/>), and Los Alamos National Laboratory (<http://www.lanl.gov/>). A number of faculty and students collaborate with researchers in these laboratories, and use the facilities of these laboratories in their research projects.

## Other Resources

The department sponsors the Rad Watch project (<http://radwatch.berkeley.edu/>). It has been performing a large range of radiation measurements starting in March 2011, following the releases of radioactive materials from the Daiichi Nuclear Power Plant in Japan. One of the goals of this activity was to measure the radioactivity in Californian samples that could potentially be associated with the releases in Japan using state-of-the-art experiments, to publish the data without filter or restriction, and to put the results in the context of the radiation we are exposed to in our daily lives. In response to the resurgent interest in radiation levels due to the expected arrival of cesium at the North American west coast, we are increasing our efforts again to measure samples potentially affected by the Pacific Ocean current transport.

## Undergraduate Programs

Nuclear Engineering (<https://guide.berkeley.edu/undergraduate/degree-programs/nuclear-engineering/>): BS, Minor  
 Chemical Engineering/Nuclear Engineering (<https://guide.berkeley.edu/undergraduate/degree-programs/chemical-engineering-nuclear-joint-major/>): BS (Joint Major in conjunction with the College of Chemistry)  
 Electrical Engineering and Computer Sciences/Nuclear Engineering (<https://guide.berkeley.edu/undergraduate/degree-programs/electrical-engineering-computer-sciences-nuclear-joint-major/>): BS (Joint Major)  
 Materials Science and Engineering/Nuclear Engineering (<https://guide.berkeley.edu/undergraduate/degree-programs/materials-science-engineering-nuclear-joint-major/>): BS (Joint Major)

Mechanical Engineering/Nuclear Engineering (<https://guide.berkeley.edu/undergraduate/degree-programs/mechanical-engineering-nuclear/>): BS (Joint Major)

## Graduate Programs

Nuclear Engineering (<https://guide.berkeley.edu/graduate/degree-programs/nuclear-engineering/>): MEng, MS/MPP, PhD

## Nuclear Engineering

### NUC ENG 10 What do nuclear engineers do? 1 Unit

Terms offered: Fall 2024, Fall 2023, Fall 2022

This seminar provides freshman and first year transfer students with an overview of the field of nuclear engineering (NE) and the research activities in the NE department. Every week a faculty member will introduce a topic and describe the main research challenges in that area.

#### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of seminar per week

#### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.

**Instructor:** Hosemann

### NUC ENG 24 Freshman Seminars 1 Unit

Terms offered: Spring 2025, Fall 2024, Spring 2024

The Berkeley Seminar Program has been designed to provide new students with the opportunity to explore an intellectual topic with a faculty member in a small-seminar setting. Berkeley Seminars are offered in all campus departments, and topics vary from department to department and semester to semester.

#### Rules & Requirements

**Repeat rules:** Course may be repeated for credit when topic changes.

#### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of seminar per week

#### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** The grading option will be decided by the instructor when the class is offered. Final Exam To be decided by the instructor when the class is offered.

## NUC ENG 100 Introduction to Nuclear Energy and Technology 3 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

The class provides students with an overview of the contemporary nuclear energy technology with emphasis on nuclear fission as an energy source. Starting with the basic physics of the nuclear fission process, the class includes discussions on reactor control, thermal hydraulics, fuel production, and spent fuel management for various types of reactors in use around the world as well as analysis of safety and other nuclear-related issues. This class is intended for sophomore NE students, but is also open to transfer students and students from other majors.

### Rules & Requirements

**Prerequisites:** PHYSICS 7A, PHYSICS 7B, and MATH 53

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructor:** Fratoni

## NUC ENG 101 Nuclear Reactions and Radiation 4 Units

Terms offered: Fall 2024, Fall 2023, Spring 2023

Energetics and kinetics of nuclear reactions and radioactive decay, fission, fusion, and reactions of low-energy neutrons; properties of the fission products and the actinides; nuclear models and transition probabilities; interaction of radiation with matter.

### Rules & Requirements

**Prerequisites:** PHYSICS 7C and NUC ENG 100

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructors:** Bernstein, L.

## NUC ENG 102 Nuclear Reactions and Radiation Laboratory 3 Units

Terms offered: Spring 2016, Spring 2015, Spring 2013

Laboratory course in nuclear physics. Experiments will allow students to directly observe phenomena discussed in Nuclear Engineering 101. These experiments will give students exposure to (1) electronics, (2) alpha, beta, gamma radiation detectors, (3) radioactive sources, and (4) experimental methods relevant for all aspects of nuclear science. Experiments include: Rutherford scattering, x-ray fluorescence, muon lifetime, gamma-gamma angular correlations, Mossbauer effect, and radon measurements.

### Rules & Requirements

**Prerequisites:** NUC ENG 101

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of lecture, 1 hour of discussion, and 4 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructor:** Norman

## NUC ENG 104 Radiation Detection and Nuclear Instrumentation Laboratory 4 Units

Terms offered: Spring 2025, Spring 2024, Fall 2022

Basic science of radiation measurement, nuclear instrumentation, neutronics, radiation dosimetry. The lectures emphasize the principles of radiation detection. The weekly laboratory applies a variety of radiation detection systems to the practical measurements of interest for nuclear power, nuclear and non-nuclear science, and environmental applications. Students present goals and approaches of the experiments being performed.

### Rules & Requirements

**Prerequisites:** NUC ENG 101 or consent of instructor; NUC ENG 150 recommended

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 4 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructor:** Vetter

**Formerly known as:** 104A

## NUC ENG 107 Introduction to Imaging 3 Units

Terms offered: Spring 2024, Fall 2022, Fall 2020

Introduction to medical imaging physics and systems, including x-ray computed tomography (CT), nuclear magnetic resonance (NMR), positron emission tomography (PET), and SPECT; basic principles of tomography and an introduction to unfolding methods; resolution effects of counting statistics, inherent system resolution and human factors.

### Rules & Requirements

**Prerequisites:** NUC ENG 101 and NUC ENG 104

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructor:** Vetter

## NUC ENG 120 Nuclear Materials 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

Effects of irradiation on the atomic and mechanical properties of materials in nuclear reactors. Fission product swelling and release; neutron damage to structural alloys; fabrication and properties of uranium dioxide fuel.

### Rules & Requirements

**Prerequisites:** MAT SCI 45 and one of the following: ENGIN 40, MEC ENG 40, or CHM ENG 141

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructor:** Wirth

## NUC ENG 124 Radioactive Waste Management 3 Units

Terms offered: Fall 2024, Fall 2022, Spring 2021

Components and material flowsheets for nuclear fuel cycle, waste characteristics, sources of radioactive wastes, compositions, radioactivity and heat generation; waste treatment technologies; waste disposal technologies; safety assessment of waste disposal.

### Rules & Requirements

**Prerequisites:** NUC ENG 100

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructor:** Ahn

## NUC ENG 130 Analytical Methods for Non-proliferation 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

Use of nuclear measurement techniques to detect clandestine movement and/or possession of nuclear materials by third parties. Nuclear detection, forensics, signatures, and active and passive interrogation methodologies will be explored. Techniques currently deployed for arms control and treaty verification will be discussed. Emphasis will be placed on common elements of detection technology from the viewpoint of resolution of threat signatures from false positives due to naturally occurring radioactive material. Topics include passive and active neutron signals, gamma ray detection, fission neutron multiplicity, and U and Pu isotopic identification and age determination.

### Rules & Requirements

**Prerequisites:** NUC ENG 101 (or similar background in nuclear physics), or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructor:** Morse

## NUC ENG C146 Radiochemical Methods in Nuclear Technology and Forensics 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

Experimental illustrations of the interrelation between chemical and nuclear science and technology and nuclear forensics; radioactive decay and counting techniques; nuclear spectroscopy; fundamental radiochemical techniques; radiochemical separations techniques; tracers; activation analysis; forensic applications of radiochemistry; fusion, fission and nuclear reactors.

### Objectives & Outcomes

**Course Objectives:** Familiarize students with principles of nuclear and radiochemistry and its many important applications in our daily lives; provide hands-on training.

**Student Learning Outcomes:** A solid understanding of nuclear and radiochemistry; proficiency in safe handling of radioactive materials in the laboratory, and appreciation for the wide application of radiochemical techniques in chemistry, nuclear technology, and nuclear forensics.

### Rules & Requirements

**Prerequisites:** CHEM 4B or CHEM 15; and CHEM 143 is recommended

**Credit Restrictions:** Students will receive no credit for CHEM 146 after completing CHEM 144, or CHEM C144.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1.5 hours of lecture and 4.5 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Formerly known as:** Chemistry 146

**Also listed as:** CHEM C146

## NUC ENG 150 Introduction to Nuclear Reactor Theory 4 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

Neutron interactions, nuclear fission, and chain reacting systematics in thermal and fast nuclear reactors. Diffusion and slowing down of neutrons. Criticality calculations. Nuclear reactor dynamics and reactivity feedback. Production of radionuclides in nuclear reactors.

### Rules & Requirements

**Prerequisites:** MATH 53, MATH 54, and NUC ENG 100

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructors:** Greenspan, Vujic

## NUC ENG 155 Introduction to Numerical Simulations in Radiation Transport 3 Units

Terms offered: Spring 2025, Spring 2022, Spring 2021

Computational methods used to analyze radiation transport described by various differential, integral, and integro-differential equations. Numerical methods include finite difference, finite elements, discrete ordinates, and Monte Carlo. Examples from neutron and photon transport; numerical solutions of neutron/photon diffusion and transport equations. Monte Carlo simulations of photon and neutron transport. An overview of optimization techniques for solving the resulting discrete equations on vector and parallel computer systems.

### Rules & Requirements

**Prerequisites:** MATH 53, MATH 54, and ENGIN 7

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructors:** Vujic, Wirth

## NUC ENG 156 Nuclear Criticality Safety 3 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

This course provides an introduction to the field of nuclear criticality safety. Topics include: a review of basic concepts related to criticality (fission, cross sections, multiplication factor, etc.); criticality safety accidents; standards applicable to criticality safety; hand calculations and Monte Carlo methods used in criticality safety analysis; criticality safety evaluation documents.

### Objectives & Outcomes

**Course Objectives:** The objective of this course is to acquaint Nuclear Engineering students with the concepts and practice of nuclear criticality safety, and to help prepare them for a future career in this field.

**Student Learning Outcomes:** At the end of this course, students should be able to:

- Explain and define criticality safety factors for operations.
- Discuss previous criticality accidents and their causal factors, including parameters involved in solution and metal critical accidents.
- Identify and discuss the application of several common hand calculation methods.
- Describe the importance of validation of computer codes and how it is accomplished.
- Discuss ANSI/ANS criticality safety regulations.
- Describe DOE regulations and practices in the nuclear criticality safety field.
- Complete a Criticality Safety Evaluation.

### Rules & Requirements

**Prerequisites:** NUC ENG 150 or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Alternate method of final assessment during regularly scheduled final exam group (e.g., presentation, final project, etc.).

**Instructor:** Fratoni

## NUC ENG 161 Nuclear Power Engineering 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

Energy conversion in nuclear power systems; design of fission reactors; thermal and structural analysis of reactor core and plant components; thermal-hydraulic analysis of accidents in nuclear power plants; safety evaluation and engineered safety systems.

### Rules & Requirements

**Prerequisites:** Course(s) in fluid mechanics and heat transfer (MEC ENG 106 and MEC ENG 109; or CHM ENG 150A); Course in Thermodynamics (ENGIN 40, MEC ENG 40, or CHM ENG 141)

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructor:** Peterson

## NUC ENG 162 Radiation Biophysics and Dosimetry 3 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

Interaction of radiation with matter; physical, chemical, and biological effects of radiation on human tissues; dosimetry units and measurements; internal and external radiation fields and dosimetry; radiation exposure regulations; sources of radiation and radioactivity; basic shielding concepts; elements of radiation protection and control; theories and models for cell survival, radiation sensitivity, carcinogenesis, and dose calculation.

### Rules & Requirements

**Prerequisites:** Upper division standing or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructor:** Vujic

## NUC ENG 167 Risk-Informed Design for Advanced Nuclear Systems 3 Units

Terms offered: Fall 2023, Fall 2021, Fall 2019

Project-based class for design and licensing of nuclear facilities, including advanced reactors. Elements of a project proposal. Regulatory framework and use of deterministic and probabilistic licensing criteria. Siting criteria. External and internal events. Identification and analysis of design basis and beyond design basis events. Communication with regulators and stakeholders. Ability to work in and contribute to a design team.

### Objectives & Outcomes

**Course Objectives:** \* Introduce students to the methods and models for event identification, accident analysis, and risk assessment and management for internally and externally initiated events.

\* Introduce students to the regulatory requirements for design, construction and operation of nuclear facilities licensed by the U.S. Nuclear Regulatory Commission.

\* Introduce students to the safety principles and methods used to design, construct and operate a safe nuclear facility, for a specific site and application.

\* Provide a basic understanding of similarities and differences in regulation of nuclear facilities versus other technologies (biotech, commercial aviation, commercial space launch, civil infrastructure).

\* Provide a basic understanding the risk-informed design process and an opportunity to experience contributing in a focused area to a design project.

\* Provide students with experiential knowledge in developing schedules, allocating work responsibilities, and working in teams.

\* Provide students with experiential knowledge in the preparation and evaluation a Safety Analysis Report for meeting USNRC regulatory requirements, including response to Requests for Additional Information (RAIs).

**Student Learning Outcomes:** \* Develop a broad understanding of safety principles and methods used in design, construction and licensing of nuclear facilities.

\* Develop a broad understanding of the U.S. Nuclear Regulatory Commission's regulatory requirements for nuclear facilities.

\* Have awareness of key similarities and differences in regulation of nuclear facilities versus other technologies (biotech, commercial aviation, commercial space launch, civil infrastructure).

\* Have awareness of the major topics covered in a Safety Analysis Report (SAR) and experience in developing and writing at least one element of a SAR.

\* Have developed experience and skills in communication with the business community, the public, and regulators.

\* Have developed experience and skills in establishing a project schedule, allocating work responsibilities, and working in teams.

\* Have understanding of application of event identification, event frequency and consequence analysis, risk assessment and management for internally and externally initiated events in the design process.

### Rules & Requirements

**Prerequisites:** Completion of at least two upper division engineering courses providing relevant skills. Choose from the following:

CHM ENG 150A, CHM ENG 180, CIV ENG 111, CIV ENG 120, CIV ENG 152, CIV ENG 166, CIV ENG 175, ENGIN 120, IND ENG 166, IND ENG 172, MEC ENG 106, MEC ENG 109, MEC ENG C134 / EL ENG C128, MEC ENG 146, NUC ENG 120, NUC ENG 124, NUC ENG 150, and NUC ENG 161

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

## NUC ENG 170A Nuclear Design: Design in Nuclear Power Technology and Instrumentation 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

Design of various fission and fusion power systems and other physically based applications. Each semester a topic will be chosen by the class as a whole. In addition to technology, the design should address issues relating to economics, the environment, and risk assessment.

### Rules & Requirements

**Prerequisites:** Senior standing or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Formerly known as:** 170

## NUC ENG 170B Nuclear Design: Design in Bionuclear, Nuclear Medicine, and Radiation Therapy 3 Units

Terms offered: Spring 2010, Spring 2009, Spring 2008

A systems approach to the development of procedures for nuclear medicine and radiation therapy. Each semester a specific procedure will be studied and will entail the development of the biological and physiological basis for a procedure, the chemical and biochemical characteristics of appropriate drugs, dosimetric requirements and limitations, the production and distribution of radionuclides and/or radiation fields to be applied, and the characteristics of the instrumentation to be used.

### Rules & Requirements

**Prerequisites:** Senior standing

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Formerly known as:** 167

## NUC ENG 175 Methods of Risk Analysis 3 Units

Terms offered: Fall 2024, Fall 2022, Fall 2020

Methodological approaches for the quantification of technological risk and risk based decision making. Probabilistic safety assessment, human health risks, environmental and ecological risk analysis.

### Rules & Requirements

**Prerequisites:** Upper division standing

### Hours & Format

**Fall and/or spring:** 15 weeks - 4 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructor:** Kastenber

## NUC ENG 180 Introduction to Controlled Fusion 3 Units

Terms offered: Spring 2025, Fall 2023, Fall 2022

Introduction to energy production by controlled thermonuclear reactions. Nuclear fusion reactions, energy balances for fusion systems, survey of plasma physics; neutral beam injection; RF heating methods; vacuum systems; tritium handling.

### Rules & Requirements

**Prerequisites:** PHYSICS 7C

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructor:** Morse

## NUC ENG H194 Honors Undergraduate Research 1 - 4 Units

Terms offered: Fall 2024, Fall 2023, Spring 2023

Supervised research. Students who have completed three or more upper division courses may pursue original research under the direction of one of the members of the staff. A final report or presentation is required. A maximum of three units of H194 may be used to fulfill a technical elective requirement in the Nuclear Engineering general program or joint major programs.

### Rules & Requirements

**Prerequisites:** Upper division technical GPA of 3.3, consent of instructor and faculty advisor

**Repeat rules:** Course may be repeated for credit up to a total of 8 units.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-4 hours of independent study per week

**Summer:** 10 weeks - 1.5-6 hours of independent study per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

## NUC ENG 198 Group Study for Advanced Undergraduates 1 - 4 Units

Terms offered: Spring 2025, Fall 2024, Spring 2024

Group studies of selected topics.

### Rules & Requirements

**Prerequisites:** Upper division standing

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-4 hours of directed group study per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.

## NUC ENG 199 Supervised Independent Study 1 - 4 Units

Terms offered: Spring 2025, Fall 2024, Spring 2024

Supervised independent study. Enrollment restrictions apply; see the Introduction to Courses and Curricula section of this catalog.

### Rules & Requirements

**Prerequisites:** Consent of instructor and major adviser

**Credit Restrictions:** Course may be repeated for credit for a maximum of 4 units per semester.

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 0 hours of independent study per week

### Summer:

6 weeks - 1-5 hours of independent study per week

8 weeks - 1-4 hours of independent study per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.

## NUC ENG S199 Supervised Independent Study 1 - 4 Units

Terms offered: Prior to 2007

Supervised independent study. Please see section of the for description and prerequisites.

### Rules & Requirements

**Prerequisites:** Consent of instructor and major adviser

**Credit Restrictions:** Course may be repeated for credit for a maximum of 4 units per semester.

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Summer:** 8 weeks - 0 hours of independent study per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.

## NUC ENG 200M Introduction to Nuclear Engineering 3 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

Overview of the elements of nuclear technology in use today for the production of energy and other radiation applications. 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.

### Objectives & Outcomes

**Course Objectives:** (1) To give students an understanding of the basic concepts of nuclear energy and other radiation applications, together with an overview of related aspects such as proliferation and waste management.

(2) To provide students an overview of the elements of nuclear technology in use today for the production of energy and to set those elements in the broader context of nuclear technology.

**Student 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 difference between PWR and BWR 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 fuel cycle
- understand the fundamental aspects of used fuel reprocessing and disposal

### Rules & Requirements

**Prerequisites:** PHYSICS 7A, PHYSICS 7B, and MATH 54

**Credit Restrictions:** This course is restricted to students enrolled in the Master of Engineering degree program.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Fratoni

## NUC ENG 201 Nuclear Reactions and Interactions of Radiation with Matter 4 Units

Terms offered: Spring 2025, Spring 2022, Spring 2020

Interaction of gamma rays, neutrons, and charged particles with matter; nuclear structure and radioactive decay; cross sections and energetics of nuclear reactions; nuclear fission and the fission products; fission and fusion reactions as energy sources.

### Rules & Requirements

**Prerequisites:** NUC ENG 101

### Hours & Format

**Fall and/or spring:** 15 weeks - 4 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Norman

## NUC ENG 204 Advanced Concepts in Radiation Detection and Measurements 3 Units

Terms offered: Fall 2022, Fall 2018, Fall 2015

Advanced concepts in the detection of ionizing radiation relevant for basic and applied sciences, nuclear non-proliferation, and homeland security. Concepts of signal generation and processing with advantages and drawbacks of a range of detection technologies. Laboratory comprises experiments to compare conventional analog and advanced digital signal processing, information generation and processing, position-sensitive detection, tracking, and imaging modalities.

### Rules & Requirements

**Prerequisites:** Graduate standing, NUC ENG 104 or similar course, or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 4 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Vetter

## NUC ENG 207 Principles of CT, PET, SPECT, MR, and Ultrasound Imaging 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

This course is designed to build the basic knowledge base to understand the principles of x-ray computed tomography (CT), positron emission tomography (PET), single photon emission computed tomography (SPECT), magnetic resonance (MR), and ultrasound (US) imaging modalities used in biomedical imaging. Using examples of CT, PET, SPECT, MRI, and US used in everyday disease management, this course will introduce principles and foundations as well as practical applications for comprehensive understanding of these important noninvasive imaging techniques.

### Objectives & Outcomes

**Course Objectives:** The objective of this course is to understand physical principles of how biomedical imaging systems utilizing ionizing radiation (i.e., x-ray and gamma-ray) and nonionizing techniques (i.e., MRI and ultrasound) work.

**Student Learning Outcomes:** The students will have good understanding of physical principles of CT, PET, SPECT, ultrasound, and MR imaging, and how these imaging modalities are used in medicine and biomedical research.

### Hours & Format

**Fall and/or spring:** 15 weeks - 4 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Youngho

## NUC ENG 210M Nuclear Reactions and Radiation 4 Units

Terms offered: Fall 2024, Fall 2023, Spring 2023

Energetics and kinetics of nuclear reactions and radioactive decay, fission, fusion, and reactions of low-energy neutrons; properties of the fission products and the actinides; nuclear models and transition probabilities; interaction of radiation with matter.

### Objectives & Outcomes

**Course Objectives:** Provide the students with a solid understanding of the fundamentals of those aspect of low-energy nuclear physics that are most important to applications in such areas as nuclear engineering, nuclear and radiochemistry, geosciences, biotechnology, etc.

**Student Learning Outcomes:** Calculate estimates of nuclear masses and energetics based on empirical data and nuclear models. Calculate estimates of the lifetimes of nuclear states that are unstable to alpha-,beta- and gamma decay and internal conversion based on the theory of simple nuclear models.

Calculate the consequences of radioactive growth and decay and nuclear reactions.

Calculate the energies of fission fragments and understand the charge and mass distributions of the fission products, and prompt neutron and gamma rays from fission

Calculate the kinematics of the interaction of photons with matter and apply stopping power to determine the energy loss rate and ranges of charged particles in matter

Use nuclear models to predict low-energy level structure and level energies.

Use nuclear models to predict the spins and parities of low-lying levels and estimate their consequences with respect to radioactive decay

Use nuclear models to understand the properties of neutron capture and the Breit-Wigner single level formula to calculate cross sections at resonance and thermal energies.

### Rules & Requirements

**Prerequisites:** PHYSICS 7C or consent of instructor

**Credit Restrictions:** This course is restricted to students enrolled in the Master of Engineering degree program.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Bernstein

## NUC ENG 211M Radiation Detection and Nuclear Instrumentation Laboratory 4 Units

Terms offered: Prior to 2007

Basic science of radiation measurement, nuclear instrumentation, neutronics, radiation dosimetry. The lectures emphasize the principles of radiation detection. The weekly laboratory applies a variety of radiation detection systems to the practical measurements of interest for nuclear power, nuclear and non-nuclear science, and environmental applications. Students present goals and approaches of the experiments being performed.

### Rules & Requirements

**Prerequisites:** Nuclear Engineering 101 or equivalent or consent of instructor; Nuclear Engineering 150 or equivalent recommended

**Credit Restrictions:** This course is restricted to students enrolled in the Master of Engineering degree program.

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 4 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Vetter

## NUC ENG 215M Introduction to Nuclear Reactor Theory 4 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

Neutron interactions, nuclear fission, and chain reacting systematics in thermal and fast nuclear reactors. Diffusion and slowing down of neutrons. Criticality calculations. Nuclear reactor dynamics and reactivity feedback. Production of radionuclides in nuclear reactors. General aspects of nuclear core designs.

### Rules & Requirements

**Prerequisites:** NUC ENG 101; MATH 53; and MATH 54

**Credit Restrictions:** This course is restricted to students enrolled in the Master of Engineering degree program.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructors:** Vujic, Fratoni, Slaybaugh

## NUC ENG 220 Irradiation Effects in Nuclear Materials 3 Units

Terms offered: Spring 2025, Spring 2023, Spring 2021  
Physical aspects and computer simulation of radiation damage in metals. Void swelling and irradiation creep. Mechanical analysis of structures under irradiation. Sputtering, blistering, and hydrogen behavior in fusion reactor materials.

### Rules & Requirements

**Prerequisites:** NUC ENG 120 or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Wirth

## NUC ENG 220M Nuclear Materials 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

Effects of irradiation on the atomic and mechanical properties of materials in nuclear reactors. Fission product swelling and release; neutron damage to structural alloys; fabrication and properties of uranium dioxide fuel.

### Objectives & Outcomes

**Course Objectives:** Develop an understanding of failure mechanism in materials and their impact in nuclear technology.

Explain quantitatively the production of damage, in materials.

Give an understanding of the behavior of fission products in ceramic fuel, how they are formed, how they migrate, and how they affect properties of the fuel.

Review those aspects of fundamental solid state physics that are pertinent to understanding the effects of radiation on crystalline solids. Show how radiation, particularly by fast neutrons, affects the mechanical properties of fuel, cladding, and structural materials in a reactor core.

**Student Learning Outcomes:** Analyze the processes of fission gas release and swelling of reactor fuel.

Deal with point defects in solids; how they are produced at thermal equilibrium and by neutron irradiation; how they agglomerate to form voids in metals or grow gas bubbles in the fuel. Kinchin-Pease model. Know the principal effects of radiation on metals: dislocation loops, voids, precipitates, and helium bubbles.

Solve diffusion problems beginning from Fick's law; understand how the diffusion coefficient is related to the mobility of atoms in the crystalline lattice.

Understand how the grain structure influences properties such as creep rate and fission product release (ceramic UO<sub>2</sub>).

Understand the concept and quantitative properties of dislocations, and how irradiation-produced point defects influences their motion and hence material properties.

### Rules & Requirements

**Prerequisites:** Introductory course on properties of materials (MAT SCI 45); and upper division course in thermodynamics (ENGIN 40 or CHM ENG 141)

**Credit Restrictions:** This course is restricted to students enrolled in the Master of Engineering degree program.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Hosemann

## NUC ENG 221 Corrosion in Nuclear Power Systems 3 Units

Terms offered: Spring 2024, Spring 2022, Spring 2018

Structural metals in nuclear power plants; properties and fabrication of Zircaloy; aqueous corrosion of reactor components; structural integrity of reactor components under combined mechanical loading, neutron irradiation, and chemical environment.

### Rules & Requirements

**Prerequisites:** NUC ENG 120. MAT SCI 112 recommended

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Wirth

## NUC ENG 224 Safety Assessment for Geological Disposal of Radioactive Wastes 3 Units

Terms offered: Spring 2014, Spring 2013, Spring 2012

Multi-barrier concept; groundwater hydrology, mathematical modeling of mass transport in heterogeneous media, source term for far-field model; near-field chemical environment, radionuclide release from waste solids, modeling of radionuclide transport in the near field, effect of temperature on repository performance, effect of water flow, effect of geochemical conditions, effect of engineered barrier alteration; overall performance assessment, performance index, uncertainty associated with assessment, regulation and standards.

### Rules & Requirements

**Prerequisites:** NUC ENG 124 or an upper division course in differential equations

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Ahn

## NUC ENG 225 The Nuclear Fuel Cycle 3 Units

Terms offered: Spring 2024, Spring 2015, Spring 2013

This course is intended for graduate students interested in acquiring a foundation in nuclear fuel cycle with topics ranging from nuclear-fuel reprocessing to waste treatment and final disposal. The emphasis is on the relationship between nuclear-power utilization and its environmental impacts. The goal is for graduate engineering students to gain sufficient understanding in how nuclear-power utilization affects the environment, so that they are better prepared to design an advanced system that would result in minimized environmental impact. The lectures will consist of two parts. The first half includes mathematical models for individual processes in a fuel cycle, such as nuclear fuel reprocessing, waste solidification, repository performance, and nuclear transmutation in a nuclear reactor. In the second half, these individual models are integrated, which enables students to evaluate environmental impact of a fuel cycle.

### Rules & Requirements

**Prerequisites:** Graduate standing or consent of instructor; 124 and 150 are recommended

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Ahn

## NUC ENG C226 Modeling and Simulation of Advanced Manufacturing Processes 3 Units

Terms offered: Spring 2025, Fall 2024, Spring 2024, Spring 2023

This course provides the student with a modern introduction to the basic industrial practices, modeling techniques, theoretical background, and computational methods to treat classical and cutting edge manufacturing processes in a coherent and self-consistent manner.

### Objectives & Outcomes

**Course Objectives:** An introduction to modeling and simulation of modern manufacturing processes.

### Rules & Requirements

**Prerequisites:** An undergraduate course in strength of materials or 122

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Zohdi

**Also listed as:** MAT SCI C286/MEC ENG C201

## NUC ENG 230 Analytical Methods for Non-Proliferation 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

Use of nuclear measurement techniques to detect clandestine movement and/or possession of nuclear materials by third parties. Nuclear detection, forensics, signatures, and active and passive interrogation methodologies will be explored. Techniques currently deployed for arms control and treaty verification will be discussed. Emphasis will be placed on common elements of detection technology from the viewpoint of resolution of threat signatures from false positives due to naturally occurring radioactive material. Topics include passive and active neutron signals, gamma ray detection, fission neutron multiplicity, and U and Pu isotopic identification and age determination.

### Rules & Requirements

**Prerequisites:** NUC ENG 101, PHYSICS 7C, or equivalent course in nuclear physics

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Morse

## NUC ENG C231 Medical Imaging Signals and Systems 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

Biomedical imaging is a clinically important application of engineering, applied mathematics, physics, and medicine. In this course, we apply linear systems theory and basic physics to analyze X-ray imaging, computerized tomography, nuclear medicine, and MRI. We cover the basic physics and instrumentation that characterizes medical image as an ideal perfect-resolution image blurred by an impulse response. This material could prepare the student for a career in designing new medical imaging systems that reliably detect small tumors or infarcts.

### Objectives & Outcomes

#### Course Objectives:

- understand how 2D impulse response or 2D spatial frequency transfer function (or Modulation Transfer Function) allow one to quantify the spatial resolution of an imaging system.
- understand 2D sampling requirements to avoid aliasing
- understand 2D filtered backprojection reconstruction from projections based on the projection-slice theorem of Fourier Transforms
- understand the concept of image reconstruction as solving a mathematical inverse problem.
- understand the limitations of poorly conditioned inverse problems and noise amplification
- understand how diffraction can limit resolution---but not for the imaging systems in this class
- understand the hardware components of an X-ray imaging scanner
- understand the physics and hardware limits to spatial resolution of an X-ray imaging system
- understand tradeoffs between depth, contrast, and dose for X-ray sources
- understand resolution limits for CT scanners
- understand how to reconstruct a 2D CT image from projection data using the filtered backprojection algorithm
- understand the hardware and physics of Nuclear Medicine scanners
- understand how PET and SPECT images are created using filtered backprojection
- understand resolution limits of nuclear medicine scanners
- understand MRI hardware components, resolution limits and image reconstruction via a 2D FFT
- understand how to construct a medical imaging scanner that will achieve a desired spatial resolution specification.

#### Student Learning Outcomes:

- students will be tested for their understanding of the key concepts above
- undergraduate students will apply to graduate programs and be admitted

• students will apply this knowledge to their research at Berkeley, UCSE

## NUC ENG C235 Principles of Magnetic Resonance Imaging 4 Units

Terms offered: Spring 2025, Spring 2023, Spring 2021

Fundamentals of MRI including signal-to-noise ratio, resolution, and contrast as dictated by physics, pulse sequences, and instrumentation. Image reconstruction via 2D FFT methods. Fast imaging reconstruction via convolution-back projection and gridding methods and FFTs.

Hardware for modern MRI scanners including main field, gradient fields, RF coils, and shim supplies. Software for MRI including imaging methods such as 2D FT, RARE, SSFP, spiral and echo planar imaging methods.

### Objectives & Outcomes

**Course Objectives:** Graduate level understanding of physics, hardware, and systems engineering description of image formation, and image reconstruction in MRI. Experience in Imaging with different MR Imaging systems. This course should enable students to begin graduate level research at Berkeley (Neuroscience labs, EECS and Bioengineering), LBNL or at UCSF (Radiology and Bioengineering) at an advanced level and make research-level contribution

### Rules & Requirements

**Prerequisites:** EL ENG 120 or BIO ENG C165/EL ENG C145B or consent of instructor

**Credit Restrictions:** Students will receive no credit for Bioengineering C265/EI Engineering C225E after taking EI Engineering 265.

**Repeat rules:** Course may be repeated for credit under special circumstances: Students can only receive credit for 1 of the 2 versions of the class, BioEc265 or EE c225e, not both

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructors:** Conolly, Vandsburger

**Also listed as:** BIO ENG C265/EL ENG C225E

## NUC ENG 250 Nuclear Reactor Theory 4 Units

Terms offered: Fall 2022, Fall 2020, Fall 2017

Fission characteristics; neutron chain reactions, neutron transport and diffusion theory; reactor kinetics; multigroup methods, fast and thermal spectrum calculations, inhomogeneous reactor design, effects of poisons and fuel depletion.

### Rules & Requirements

**Prerequisites:** NUC ENG 101 and NUC ENG 150; ENGIN 117 recommended

### Hours & Format

**Fall and/or spring:** 15 weeks - 4 hours of lecture per week

**Summer:** 6 weeks - 10 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Greenspan

## NUC ENG 255 Numerical Simulation in Radiation Transport 3 Units

Terms offered: Spring 2025, Spring 2022, Spring 2021

Computational methods used to analyze nuclear reactor systems described by various differential, integral, and integro-differential equations. Numerical methods include finite difference, finite elements, discrete ordinates, and Monte Carlo. Examples from neutron and photon transport, heat transfer, and thermal hydraulics. An overview of optimization techniques for solving the resulting discrete equations on vector and parallel computer systems.

### Rules & Requirements

**Prerequisites:** NUC ENG 150

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Vujic

## NUC ENG 256M Nuclear Criticality Safety 3 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

This course provides an introduction to the field of nuclear criticality safety. Topics include: a review of basic concepts related to criticality (fission, cross sections, multiplication factor, etc.); criticality safety accidents; standards applicable to criticality safety; hand calculations and Monte Carlo methods used in criticality safety analysis; criticality safety evaluation documents.

### Objectives & Outcomes

**Course Objectives:** The objective of this course is to acquaint Nuclear Engineering students with the concepts and practice of nuclear criticality safety, and to help prepare them for a future career in this field.

**Student Learning Outcomes:** At the end of this course, students should be able to:

- Explain and define criticality safety factors for operations.
- Discuss previous criticality accidents and their causal factors, including parameters involved in solution and metal critical accidents.
- Identify and discuss the application of several common hand calculation methods.
- Describe the importance of validation of computer codes and how it is accomplished.
- Discuss ANSI/ANS criticality safety regulations.
- Describe DOE regulations and practices in the nuclear criticality safety field.
- Complete a Criticality Safety Evaluation

### Rules & Requirements

**Prerequisites:** NUC ENG 150 or instructor consent

**Credit Restrictions:** This course is restricted to students enrolled in the Master of Engineering degree program.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Fratoni

## NUC ENG 260 Thermal Aspects of Nuclear Reactors 4 Units

Terms offered: Spring 2024, Fall 2016, Fall 2014

Fluid dynamics and heat transfer; thermal and hydraulic analysis of nuclear reactors; two-phase flow and boiling; compressible flow; stress analysis; energy conversion methods.

### Rules & Requirements

**Prerequisites:** MEC ENG 106 and MEC ENG 109; or CHM ENG 150B

### Hours & Format

**Fall and/or spring:** 15 weeks - 4 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Peterson

## NUC ENG 261M Nuclear Power Engineering 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

The class covers a wide range of topics applicable to nuclear power plant engineering. Energy conversion in nuclear power systems; design of fission reactors; thermal and structural analysis of reactor core and plant components; thermal-hydraulic analysis of accidents in nuclear power plants; safety evaluation and engineered safety systems. The instructor has 30 years' experience in the commercial power industry.

### Rules & Requirements

**Prerequisites:** Course(s) in fluid mechanics and heat transfer; junior-level course in thermodynamics. Must be enrolled in the Master of Engineering degree program

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Berger

## NUC ENG 262 Radiobiology 3 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

Radiobiology is concerned with the action of ionizing radiation on biological tissues and living organisms. It combines two disciplines: radiation physics and biology. Radiobiology combines our understanding of ionizing radiation and molecular biology, and is a required knowledge for health physicists, radiation biologists and medical physicists. This course will provide such knowledge for a diverse group of students with need in either disciplines. This course represents one of the requisites for the Joint UC Berkeley-UC San Francisco Medical Physics Certificate Program.

### Objectives & Outcomes

**Course Objectives:** A group project will be expected from students and computer models will be turned in at the end of the semester, either focusing on cancer risk tools, epidemiologic analysis, radiation cancer models or cancer treatment by radiation. The project should give students strong foundation to tackle more advanced risk models or dynamic cancer models.

They will be exposed to the multi-scale complexity of the tissue response to ionizing radiation from the whole organism to individual cells and down to the DNA. Molecular biology describing the cellular response and the DNA repair mechanisms will be covered, with an emphasis on cell kinetics such as recovery processes and cell cycle sensitivity. The overall tissue response will also be discussed with an effort to distinguish acute and delayed effects. Radiation risk models and their impact on limits will be introduced and described in the context of past and current research. This course is designed for Nuclear Engineering students and in particular those pursuing a Medical Physics Certificate with knowledge essential to radiobiology. Students will learn about the history of radiation effects, epidemiology of radiation and evidence of cancer in populations.

**Student Learning Outcomes:** By the end of the class, students should:

- Be proficient in the main mechanisms describing the interaction of ionizing radiation with tissue;
- Be able to know the existing gaps in this field and where more research is needed;
- Understand how radiation affects DNA and leads to gene mutation
- Understand how cancer rises from various radiation damage in the tissue (targeted and non-targeted effects)
- Able to write computer model for radiation risk assessment
- Able to write computer model for cancer formation
- Understand the main methods to treat cancer with radiation
- Can differentiate tissue effect between low and high LET
- Understand the various risk issues dealing with radiation: occupational (medical, nuclear worker, astronauts ...), vs population (accident, terrorism ...)
- Be able to read scientific articles in the radiation biology field

### Rules & Requirements

**Prerequisites:** Students are expected to have completed a course in basic radiology, radiation protection, and dosimetry (NE162 or equivalent). In addition, a class in radiation detection and instrumentation (e.g. NE104 or equivalent) and in introductory programming (Engineering 7 or equivalent) are recommended, but not required. Prerequisites may be waived at the discretion of the instructor.

## NUC ENG 265 Design Analysis of Nuclear Reactors 3 Units

Terms offered: Fall 2016, Fall 2015, Fall 2013

Principles and techniques of economic analysis to determine capital and operating costs; fuel management and fuel cycle optimization; thermal limits on reactor performance, thermal converters, and fast breeders; control and transient problems; reactor safety and licensing; release of radioactivity from reactors and fuel processing plants.

### Rules & Requirements

**Prerequisites:** NUC ENG 150 and NUC ENG 161

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Greenspan

## NUC ENG 267 Risk-Informed Design for Advanced Nuclear Systems 3 Units

Terms offered: Fall 2023, Fall 2021, Fall 2019

Project-based class for design and licensing of nuclear facilities, including advanced reactors. Elements of a project proposal. Regulatory framework and use of deterministic and probabilistic licensing criteria. Siting criteria. External and internal events. Identification and analysis of design basis and beyond design basis events. Communication with regulators and stakeholders. Ability to work in and contribute to a design team.

### Rules & Requirements

**Prerequisites:** Completion of at least two upperdivision engineering courses providing relevant skills: CHM ENG 150A, CHM ENG 180, CIV ENG 111, CIV ENG 120, CIV ENG 152, CIV ENG 166, CIV ENG 175, ENGIN 120, IND ENG 166, IND ENG 172, MEC ENG 106, MEC ENG 109, MEC ENG C128, MEC ENG 146, NUC ENG 120, NUC ENG 124, NUC ENG 150, or NUC ENG 161

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Peterson

## NUC ENG 270 Advanced Nuclear Reactors 3 Units

Terms offered: Fall 2021, Spring 2019

The scope of this class is to provide students with a broad overview of Gen IV and beyond reactor systems, advanced fuel cycles, and new trends in reactor design (e.g., small modular, load following, etc.).

### Objectives & Outcomes

**Course Objectives:** The main objective of this course is to provide students with an understanding of how advanced nuclear reactors work, their mission, their benefits, and the challenges that remain to be addressed.

This class is intended for all graduate students (PhD, MS, and MEng) at any stage in their academic career.

**Student Learning Outcomes:** By the end of this course students are expected to be able:

- to identify the main advanced reactor concepts and recognize their main features;
- to discuss the benefits and challenges associated with each concept;
- to understand the difference between fuel cycle options and associated characteristics such as resource utilization, waste generation, non-proliferation and safeguards;
- to recognize the contribution and limitation of advanced reactors towards various applications (i.e., load-following, hydrogen generation, etc.).

### Rules & Requirements

**Prerequisites:** Students will benefit the most from this class if they have basic knowledge of light water reactor design, reactor physics, and reactor thermal-hydraulics (these topics are covered in NUC ENG 150 and NUC ENG 161). Students are expected to be familiar with the following topics (mostly related to LWR): main reactor components and function; reactor layout; auxiliary systems; criticality, reactivity and reactivity feedbacks; and heat transfer, fluid flow

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Fratoni

## NUC ENG 275 Principles and Methods of Risk Analysis 4 Units

Terms offered: Fall 2024, Fall 2022, Fall 2020

Principles and methodological approaches for the quantification of technological risk and risk-based decision making.

### Rules & Requirements

**Prerequisites:** Consent of instructor. CIV ENG 193 and IND ENG 166 recommended

### Hours & Format

**Fall and/or spring:** 15 weeks - 4 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Kastenber

## NUC ENG 280 Fusion Reactor Engineering 3 Units

Terms offered: Spring 2023, Spring 2021, Spring 2019

Engineering and design of fusion systems. Introduction to controlled thermonuclear fusion as an energy economy, from the standpoint of the physics and technology involved. Case studies of fusion reactor design. Engineering principles of support technology for fusion systems.

### Rules & Requirements

**Prerequisites:** NUC ENG 120 and NUC ENG 180

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Morse

## NUC ENG 281 Fully Ionized Plasmas 3 Units

Terms offered: Spring 2022, Spring 2020, Spring 2018

Introduction to warm and hot magnetized plasmas. Single particle motion in electric and magnetic fields. Collective particle oscillations, waves and instabilities. Magnetohydrodynamic equilibria, stability and transport. Magnetically confined plasmas for controlled fusion. Space plasmas.

### Rules & Requirements

**Prerequisites:** Consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Morse

**Formerly known as:** Electrical Engineering 239B

## NUC ENG C282 Charged Particle Sources and Beam Technology 3 Units

Terms offered: Spring 2024, Spring 2022, Spring 2020, Fall 2015, Fall 2013, Fall 2011

Topics in this course will include the latest technology of various types of ion and electron sources, extraction and formation of charge particle beams, computer simulation of beam propagation, diagnostics of ion sources and beams, and the applications of beams in fusion, synchrotron light source, neutron generation, microelectronics, lithography, and medical therapy. This is a general accelerator technology and engineering course that will be of interest to graduate students in physics, electrical engineering, and nuclear engineering.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructors:** Leung, Steier

**Also listed as:** ENGIN C282

## NUC ENG C285 Nuclear Security: The Nexus Between Policy and Technology 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

The course will review the origins and evolution of nuclear energy, how it has been applied for both peaceful and military purposes, and the current and prospective challenges it presents. The purpose of the course is to educate students on the policy roots and technological foundations of nuclear energy and nuclear weapons so they are positioned to make original contributions to the field in their scholarly and professional careers.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructors:** Nacht, Prussin

**Also listed as:** PUB POL C285

## NUC ENG 290A Special Topics in Applied Nuclear Physics 3 Units

Terms offered: Fall 2017, Spring 2016, Fall 2014

Special topics in applied nuclear physics. Topics may include applied nuclear reactions and instrumentation, bionuclear and radiological physics, and subsurface nuclear technology, among other possibilities. Course content may vary from semester to semester depending upon the instructor.

### Rules & Requirements

**Prerequisites:** Graduate standing or consent of instructor

**Repeat rules:** Course may be repeated for credit when topic changes.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** van Bibber

## NUC ENG 290B Special Topics in Nuclear Materials and Chemistry 3 Units

Terms offered: Fall 2022, Fall 2020, Spring 2016

Special topics in nuclear materials and chemistry. Topics may include advanced nuclear materials and corrosion. Course content may vary from semester to semester depending upon the instructor.

### Rules & Requirements

**Repeat rules:** Course may be repeated for credit when topic changes.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

## NUC ENG 290C Special Topics in Nuclear Energy 3 Units

Terms offered: Spring 2025, Summer 2002 10 Week Session

Special topics in nuclear energy. Topics may include fission reactor analysis and engineering, nuclear thermal hydraulics, and risk, safety and large-scale systems analysis. Course content may vary from semester to semester depending on the instructor.

### Rules & Requirements

**Prerequisites:** Graduate standing or consent of instructor

**Repeat rules:** Course may be repeated for credit when topic changes.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

## NUC ENG 290D Special Topics in Nuclear Non-Proliferation 3 Units

Terms offered: Spring 2021, Fall 2014, Summer 2005 10 Week Session

Special topics in nuclear non-proliferation. Topics may include homeland security and nuclear policy, and nuclear fuel cycle and waste management. Course content may vary from semester to semester depending on the instructor.

### Rules & Requirements

**Prerequisites:** Graduate standing or consent of instructor

**Repeat rules:** Course may be repeated for credit when topic changes.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

## NUC ENG 290E Special Topics in Environmental Aspects of Nuclear Energy 1 - 3 Units

Terms offered: Fall 2021, Spring 2019, Fall 2015

Special topics in environmental aspects of nuclear energy. Lectures on special topics of interest in environmental impacts of nuclear power utilizations, including severe accidents. The course content may vary from semester to semester, and will be announced at the beginning of each semester.

### Rules & Requirements

**Prerequisites:** Graduate standing or consent of instructor

**Repeat rules:** Course may be repeated for credit when topic changes.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

## NUC ENG 290F Special Topics in Fusion and Plasma Physics 3 Units

Terms offered: Summer 2007 10 Week Session, Summer 2007 3 Week Session

Special topics in fusion and plasma physics. Topics may include laser, particle beam and plasma technologies, fusion science and technology, and accelerators. Course content may vary from semester to semester depending upon the instructor.

### Rules & Requirements

**Prerequisites:** Graduate standing or consent of instructor

**Repeat rules:** Course may be repeated for credit when topic changes.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Letter grade.

## NUC ENG 295 Nuclear Engineering Colloquium 0.0 Units

Terms offered: Spring 2025, Fall 2024, Spring 2024  
Presentations on current topics of interest in nuclear technology by experts from government, industry and universities. Open to the campus community.

### Rules & Requirements

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of colloquium per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Offered for satisfactory/unsatisfactory grade only.

**Instructor:** van Bibber

## NUC ENG 298 Group Research Seminars 1 Unit

Terms offered: Spring 2025, Fall 2024, Spring 2024  
Seminars in current research topics in nuclear engineering: Section 1 - Fusion; Section 2 - Nuclear Waste Management; Section 3 - Nuclear Thermal Hydraulics; Section 4 - Nuclear Chemistry; Section 6 - Nuclear Materials; Section 7 - Fusion reaction design; Section 8 - Nuclear Instrumentation.

### Rules & Requirements

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1.5 hours of seminar per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Offered for satisfactory/unsatisfactory grade only.

## NUC ENG 299 Individual Research 1 - 12 Units

Terms offered: Spring 2025, Fall 2024, Spring 2024  
Investigation of advanced nuclear engineering problems.

### Rules & Requirements

**Prerequisites:** Graduate standing

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 0 hours of independent study per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Offered for satisfactory/unsatisfactory grade only.

## NUC ENG N299 Individual Research 1 - 6 Units

Terms offered: Summer 2024 8 Week Session, Summer 2023 8 Week Session, Summer 2022 8 Week Session  
Investigation of advanced nuclear engineering problems.

### Rules & Requirements

**Prerequisites:** Graduate standing

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Summer:** 8 weeks - 1-6 hours of independent study per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Graduate

**Grading:** Offered for satisfactory/unsatisfactory grade only.

## NUC ENG 375 Teaching Techniques in Nuclear Engineering 1 - 3 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016  
This course is designed to acquaint new teaching assistants with the nature of graduate student instruction in courses in the department of Nuclear Engineering. Discussion, practice, and review of issues relevant to the teaching of nuclear engineering. Effective teaching methods will be introduced by experienced GSIs and faculty.

### Rules & Requirements

**Prerequisites:** Graduate standing or ASE status

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-3 hours of lecture and 1-3 hours of discussion per week

### Additional Details

**Subject/Course Level:** Nuclear Engineering/Professional course for teachers or prospective teachers

**Grading:** Offered for satisfactory/unsatisfactory grade only.

**Formerly known as:** Nuclear Engineering 301

## **NUC ENG 602 Individual Study for Doctoral Students 1 - 8 Units**

Terms offered: Fall 2017, Spring 2017, Fall 2016

Individual study in consultation with the major field adviser, intended to provide an opportunity for qualified students to prepare themselves for the various examinations required of candidates for the Ph.D.

### **Rules & Requirements**

**Prerequisites:** For candidates for doctoral degree

**Credit Restrictions:** Course does not satisfy unit or residence requirements for doctoral degree.

**Repeat rules:** Course may be repeated for credit without restriction.

### **Hours & Format**

**Fall and/or spring:** 15 weeks - 0 hours of independent study per week

### **Additional Details**

**Subject/Course Level:** Nuclear Engineering/Graduate examination preparation

**Grading:** Offered for satisfactory/unsatisfactory grade only.