

# Nuclear Engineering

The Department of Nuclear Engineering offers three graduate degree programs: the Doctor of Philosophy (PhD), the Master of Engineering (MEng), and the Public Policy (MPP)/Nuclear Engineering (MS) Concurrent Degree Program.

## Admission to the University

### Minimum Requirements for Admission

The following minimum requirements apply to all graduate programs and will be verified by the Graduate Division:

1. A bachelor's degree or recognized equivalent from an accredited institution;
2. A grade point average of B or better (3.0);
3. If the applicant comes from a country or political entity (e.g., Quebec) where English is not the official language, adequate proficiency in English to do graduate work, as evidenced by a TOEFL score of at least 90 on the iBT test, 570 on the paper-and-pencil test, or an IELTS Band score of at least 7 (note that individual programs may set higher levels for any of these); and
4. Sufficient undergraduate training to do graduate work in the given field.

### Applicants Who Already Hold a Graduate Degree

The Graduate Council views academic degrees not as vocational training certificates, but as evidence of broad training in research methods, independent study, and articulation of learning. Therefore, applicants who already have academic graduate degrees should be able to pursue new subject matter at an advanced level without need to enroll in a related or similar graduate program.

Programs may consider students for an additional academic master's or professional master's degree only if the additional degree is in a distinctly different field.

Applicants admitted to a doctoral program that requires a master's degree to be earned at Berkeley as a prerequisite (even though the applicant already has a master's degree from another institution in the same or a closely allied field of study) will be permitted to undertake the second master's degree, despite the overlap in field.

The Graduate Division will admit students for a second doctoral degree only if they meet the following guidelines:

1. Applicants with doctoral degrees may be admitted for an additional doctoral degree only if that degree program is in a general area of knowledge distinctly different from the field in which they earned their original degree. For example, a physics PhD could be admitted to a doctoral degree program in music or history; however, a student with a doctoral degree in mathematics would not be permitted to add a PhD in statistics.
2. Applicants who hold the PhD degree may be admitted to a professional doctorate or professional master's degree program if there is no duplication of training involved.

Applicants may apply only to one single degree program or one concurrent degree program per admission cycle.

## Required Documents for Applications

1. **Transcripts:** Applicants may upload *unofficial* transcripts with your application for the departmental initial review. *If the applicant is admitted*, then *official* transcripts of all college-level work will be required. Official transcripts must be in sealed envelopes as issued by the school(s) attended. If you have attended Berkeley, upload your unofficial transcript with your application for the departmental initial review. *If you are admitted*, an official transcript with evidence of degree conferral *will not* be required.
2. **Letters of recommendation:** Applicants may request online letters of recommendation through the online application system. Hard copies of recommendation letters must be sent directly to the program, not the Graduate Division.
3. **Evidence of English language proficiency:** All applicants from countries or political entities in which the official language is not English are required to submit official evidence of English language proficiency. This applies to applicants from Bangladesh, Burma, Nepal, India, Pakistan, Latin America, the Middle East, the People's Republic of China, Taiwan, Japan, Korea, Southeast Asia, most European countries, and Quebec (Canada). However, applicants who, at the time of application, have already completed at least one year of full-time academic course work with grades of B or better at a US university may submit an official transcript from the US university to fulfill this requirement. The following courses will not fulfill this requirement:
  - courses in English as a Second Language,
  - courses conducted in a language other than English,
  - courses that will be completed after the application is submitted, and
  - courses of a non-academic nature.

If applicants have previously been denied admission to Berkeley on the basis of their English language proficiency, they must submit new test scores that meet the current minimum from one of the standardized tests.

## Where to Apply

Visit the Berkeley Graduate Division application page (<http://grad.berkeley.edu/admissions/apply>).

## Admission to the Program

Admission to the graduate program in nuclear engineering is available to qualified individuals who have obtained a bachelor's degree from a recognized institution in one of the fields of engineering or the physical sciences. For all programs, required preparation in undergraduate coursework includes mathematics through partial differential equations and advanced analysis, nuclear reactions, and thermodynamics. Admission is granted on the basis of undergraduate and graduate records (if any), statement of purpose, record of work experience and professional activities, letters of recommendation, and the Graduate Record Examination (GRE) and Test of English as a Foreign Language (TOEFL), if applicable.

In order to receive the PhD in Nuclear Engineering, all students must successfully complete the following three milestones:

- Required coursework: major and minor requirements
- Departmental exams: first year screening exams and the oral qualifying exam

- Dissertation

## Curriculum

### Courses Required

Major Field (6 Graduate Level Nuclear Engineering Electives). A 3.5 GPA in the major is required.

One Technical Minor Field Outside Nuclear Engineering (2-3 courses; 1 course must be graduate level). A 3.0 GPA minimum is required for both minors.

One Technical Minor Field Outside or in Nuclear Engineering (2-3 courses; 1 course must be graduate level). All courses taken to fulfill the PhD course requirement must be letter-graded.

## Departmental Exams

### Screening Exam

Students must pass a written screening exam during the first year in graduate study. The exam is based on undergraduate thermodynamics, nuclear materials, heat transfer and fluid mechanics, nuclear physics, neutronics, radioactive waste management and fusion theory. Four of the seven areas must be passed in order to pass the exam. There are two chances to pass.

### Oral Exam

After completion of the coursework for the PhD the student takes the oral exam. The content of the exam is usually a presentation of the student's research and questions relating the coursework in the outside minor. The exam committee is composed of four faculty members (normally three from the department and a non-departmental faculty member who represents an outside minor).

### PhD Dissertation

A dissertation on a subject chosen by the candidate, bearing on the principal subject of the student's major study and demonstrating the candidate's ability to carry out independent investigation, must be completed and receive the approval of the dissertation committee and the dean of the Graduate Division. The committee consists of three members, including the instructor in charge of the dissertation and one member outside the candidate's department.

## Master of Engineering (MEng)

In collaboration with other departments in the College of Engineering, Nuclear Engineering offers a one-year professional master's degree. The accelerated program is designed to develop professional engineering leaders who understand the technical, environmental, economic, and social issues involved in the design and operation of nuclear engineering devices, systems, and organizations. Prospective students will be engineers, typically with industrial experience, who aspire to substantially advance in their careers and ultimately to lead large, complex organizations, including governments.

The interdisciplinary degree will consist of three major components, comprising a technical specialization in NE (minimum 12 graduate units), a "breadth" curriculum of engineering leadership courses (6 units), and an integrative capstone project (5 units). See The Fung Institute (<http://funginstitute.berkeley.edu/berkeley-master-engineering>) for more details.

## Coursework

### Nuclear Engineering Course Requirements:

- 12 units of 200 level NE graduate courses in area of concentration.

- Courses must be taken for a letter grade

### Core Leadership Course Requirements:

6 units of 200 level leadership courses consisting of:

- Engineering Leadership I (3 units)
- Engineering Leadership II (3 units)
- Courses must be taken for a letter grade

### Capstone Project Course Requirements:

- 5 units of 296M A-B (Capstone Project)
  - 2 units during the fall semester
  - 3 units during the spring semester
- 2 units of 295 (Capstone Integration)
  - 1 unit during the fall semester
  - 1 unit during the spring semester
- Courses must be taken for a letter grade

### Capstone Project:

Students are required to complete a capstone project. The project enables the student to integrate the core leadership curriculum with the concentration and gain hands-on industry experience. The capstone committee must consist of two members, one of which must be in the department of Nuclear Engineering. Both committee members must also be members of the UC Berkeley Academic Senate.

### Oral Presentation and Report:

An oral presentation and a written report of the capstone project are required by the end of the spring semester. The audience at the oral presentation must consist of the students NE Advisor, instructor(s), peers, and industry partners.

***The Master's of Science Track is only accessible to students enrolled in our PhD program. Applicants interested in the Master's degree are encouraged to apply to the Nuclear Engineering Master of Engineering program.***

Master's students must choose between two degree plan options: Plan I or Plan II. Plan I requires at least **20 semester units** of upper division and graduate courses, **plus a thesis**. At least 8 of these units must be in 200 series courses in the student's major subject. Plan II requires at least **24 semester units** of upper division and graduate courses, followed by a **comprehensive final examination administered by the department**. At least 12 units must be in graduate courses in the student's major subject. In Nuclear Engineering, the examination takes the form of a project and presentation. An overall GPA of 3.0 is required at the time of graduation.

## Curriculum

### Courses Required

Thesis: Approved study list of Nuclear Engineering Electives (8 graduate courses minimum)	20
Project Plan: Approved study list of Nuclear Engineering Electives (12 graduate courses minimum)	24

### Both MS Plan I and Plan II are subject to the following:

- i) Units for 298 (seminar) courses are not counted towards the degree.

ii) A study plan approved by the major field adviser is required each semester.

iii) A maximum of 4 units of coursework from approved non-academic institutions or 4 units from another academic institution can be used, provided course was taken while in graduate standing and meets departmental approval.

iv) Units for graduate courses taken as an undergraduate are allowed if the units were in excess of units required to satisfy the BS degree requirements.

### Other Requirements

Plan I: Thesis (Requires thesis committee composed of three faculty.)

Plan II: Completion of a project culminating in a written report and an oral presentation before a committee of three faculty members or two faculty members and one approved non-university person. Approval by the professor in charge of the research project and the chair of the graduate advisers is required.

All students must take at least two letter-grade NE courses during the first year as a graduate student.

## Public Policy (MPP) and Nuclear Engineering (MS) Concurrent Degree Program

Government and technology interact more, and with greater consequences, every year. Whether the issue area is nuclear security, environmental protection, intellectual property (copyright and the internet), health care, water supply, or any of myriad other contexts, government agencies at all levels, non-profit organizations and private industry need people who understand technology on its own terms and also the ways government supports, controls, or directs it. Because this program is small, each student's program tends to be customized with the agreement of advisors in both programs.

### Basic Requirements

#### Year 1

Completion of the MPP first year core curriculum.

Summer Internship.

#### Year 2

Complete required units in nuclear engineering, plus six elective agreeable to both schools.

Complete a paper that satisfies the MS Plan I or Plan II requirement, and the MPP APA (Advanced Policy Analysis) requirement.

For more information about this program, contact Michael Nacht (Professor of Public Policy, 510-643-4038) or Karl van Bibber (Chair of the Nuclear Engineering Department, 510-642-3477).

## Nuclear Engineering

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

Terms offered: Spring 2018, Spring 2017

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.

Introduction to Nuclear Engineering: Read More [\[+\]](#)

#### 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:** Students taking the class should have completed the equivalents of the Physics 7 sequence and the Mathematics 50 sequence 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 per week

#### Additional Details

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

**Grading:** Letter grade.

**Instructor:** Fratoni

Introduction to Nuclear Engineering: Read Less [\[-\]](#)

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

Terms offered: Spring 2018, Spring 2016, Spring 2014

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.

Nuclear Reactions and Interactions of Radiation with Matter: Read More [\[+\]](#)

### Rules & Requirements

**Prerequisites:** 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

Nuclear Reactions and Interactions of Radiation with Matter: Read Less [\[-\]](#)

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

Terms offered: Fall 2018, Fall 2015, Fall 2013

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.

Advanced Concepts in Radiation Detection and Measurements: Read More [\[+\]](#)

### Rules & Requirements

**Prerequisites:** Graduate standing, 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

Advanced Concepts in Radiation Detection and Measurements: Read Less [\[-\]](#)

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

Terms offered: Spring 2017, Spring 2015, Spring 2013

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.

Irradiation Effects in Nuclear Materials: Read More [\[+\]](#)

### Rules & Requirements

**Prerequisites:** 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

Irradiation Effects in Nuclear Materials: Read Less [\[-\]](#)

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

Terms offered: Spring 2018, Spring 2016, Spring 2014

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.

Corrosion in Nuclear Power Systems: Read More [\[+\]](#)

### Rules & Requirements

**Prerequisites:** 120, Materials Science and Mineral Engineering 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

Corrosion in Nuclear Power Systems: Read Less [\[-\]](#)

## 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.

Safety Assessment for Geological Disposal of Radioactive Wastes: Read More [\[+\]](#)

### Rules & Requirements

**Prerequisites:** 124 or 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

Safety Assessment for Geological Disposal of Radioactive Wastes: Read Less [\[-\]](#)

## NUC ENG 225 The Nuclear Fuel Cycle 3 Units

Terms offered: Spring 2015, Spring 2013, Spring 2011

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.

The Nuclear Fuel Cycle: Read More [\[+\]](#)

### 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

The Nuclear Fuel Cycle: Read Less [\[-\]](#)



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

Terms offered: Spring 2018, Spring 2017, Spring 2016

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.

Analytical Methods for Non-Proliferation: [Read More](#) [+]

### Rules & Requirements

**Prerequisites:** 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

Analytical Methods for Non-Proliferation: [Read Less](#) [-]

## NUC ENG 250 Nuclear Reactor Theory 4 Units

Terms offered: Fall 2017, Fall 2015, Fall 2013

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.

Nuclear Reactor Theory: [Read More](#) [+]

### Rules & Requirements

**Prerequisites:** 101, 150; Engineering 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

Nuclear Reactor Theory: [Read Less](#) [-]

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

Terms offered: Fall 2018, Fall 2016, Fall 2014

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.

Numerical Simulation in Radiation Transport: [Read More](#) [+]

### Rules & Requirements

**Prerequisites:** 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

Numerical Simulation in Radiation Transport: [Read Less](#) [-]

## NUC ENG 256M Nuclear Criticality Safety 3 Units

Terms offered: Not yet offered

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.

Nuclear Criticality Safety: Read More [+]

### 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

Nuclear Criticality Safety: Read Less [-]

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

Terms offered: Fall 2016, Fall 2014, Fall 2012

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

Thermal Aspects of Nuclear Reactors: Read More [+]

### Rules & Requirements

**Prerequisites:** Mechanical Engineering 106 and 109 or Chemical Engineering 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

Thermal Aspects of Nuclear Reactors: Read Less [-]

## NUC ENG 262 Radiobiology 3 Units

Terms offered: Prior to 2007

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.

Radiobiology: Read More [ + ]

### 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 by consent of the 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.

## 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.

Design Analysis of Nuclear Reactors: Read More [ + ]

### Rules & Requirements

**Prerequisites:** 150 and 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

Design Analysis of Nuclear Reactors: Read Less [ - ]

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

Terms offered: Fall 2017, Fall 2015, Fall 2012

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.

Risk-Informed Design for Advanced Nuclear Systems: Read More [ + ]

### Rules & Requirements

**Prerequisites:** Completion of at least two upperdivision engineering courses providing relevant skills: ChemE 150A, ChemE 180, CE 111, CE 120, CE152, CE 166, CE 175, E 120, IEOR 166, IEOR 172, ME 106, ME 109, ME 128, ME 146, Nuc Eng 120, Nuc Eng 124, Nuc Eng 150, 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

Risk-Informed Design for Advanced Nuclear Systems: Read Less [ - ]



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

Terms offered: Fall 2018, Fall 2013, Fall 2011

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

Principles and Methods of Risk Analysis: Read More [+]

### Rules & Requirements

**Prerequisites:** Consent of instructor. Civil Engineering 193 and Industrial Engineering 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:** Kastenberg

Principles and Methods of Risk Analysis: Read Less [-]

## NUC ENG 280 Fusion Reactor Engineering 3 Units

Terms offered: Spring 2017, Spring 2015, Spring 2013

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.

Fusion Reactor Engineering: Read More [+]

### Rules & Requirements

**Prerequisites:** 120 and 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

Fusion Reactor Engineering: Read Less [-]

## NUC ENG 281 Fully Ionized Plasmas 3 Units

Terms offered: Spring 2018, Spring 2016, Spring 2014

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.

Fully Ionized Plasmas: Read More [+]

### 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

Fully Ionized Plasmas: Read Less [-]

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

Terms offered: Spring 2018, 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.

Charged Particle Sources and Beam Technology: Read More [+]

### 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

Charged Particle Sources and Beam Technology: Read Less [-]

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

Terms offered: Spring 2018, Spring 2017, Spring 2016

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.

Nuclear Security: The Nexus Between Policy and Technology: Read More [\[+\]](#)

### 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

Nuclear Security: The Nexus Between Policy and Technology: Read Less [\[-\]](#)

## 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.

Special Topics in Applied Nuclear Physics: Read More [\[+\]](#)

### Rules & Requirements

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

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

Special Topics in Applied Nuclear Physics: Read Less [\[-\]](#)

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

Terms offered: Spring 2016, Spring 2015, Spring 2013

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.

Special Topics in Nuclear Materials and Chemistry: Read More [\[+\]](#)

### Rules & Requirements

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

Special Topics in Nuclear Materials and Chemistry: Read Less [\[-\]](#)

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

Terms offered: 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.

Special Topics in Nuclear Energy: Read More [\[+\]](#)

### Rules & Requirements

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

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

Special Topics in Nuclear Energy: Read Less [\[-\]](#)

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

Terms offered: Fall 2014, Summer 2005 10 Week Session, Summer 2004 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.

Special Topics in Nuclear Non-Proliferation: Read More [\[+\]](#)

### Rules & Requirements

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

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

Special Topics in Nuclear Non-Proliferation: Read Less [\[-\]](#)

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

Terms offered: Fall 2015, Fall 2014, Fall 2008

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.

Special Topics in Environmental Aspects of Nuclear Energy: Read More [\[+\]](#)

### Rules & Requirements

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

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

Special Topics in Environmental Aspects of Nuclear Energy: Read Less [\[-\]](#)

## 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.

Special Topics in Fusion and Plasma Physics: Read More [\[+\]](#)

### Rules & Requirements

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

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

Special Topics in Fusion and Plasma Physics: Read Less [\[-\]](#)

## NUC ENG 295 Nuclear Engineering Colloquium 0.0 Units

Terms offered: Fall 2018, Spring 2018, Fall 2017

Presentations on current topics of interest in nuclear technology by experts from government, industry and universities. Open to the campus community.

Nuclear Engineering Colloquium: Read More [\[+\]](#)

### 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

Nuclear Engineering Colloquium: Read Less [\[-\]](#)

## NUC ENG 298 Group Research Seminars 1 Unit

Terms offered: Fall 2018, Spring 2018, Fall 2017

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.

Group Research Seminars: Read More [\[+\]](#)

### 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.

Group Research Seminars: Read Less [\[-\]](#)

## NUC ENG 299 Individual Research 1 - 12 Units

Terms offered: Fall 2018, Spring 2018, Fall 2017

Investigation of advanced nuclear engineering problems.

Individual Research: Read More [\[+\]](#)

### 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.

Individual Research: Read Less [\[-\]](#)

## NUC ENG N299 Individual Research 1 - 6 Units

Terms offered: Summer 2009 10 Week Session, Summer 2006 10 Week Session, Summer 2005 10 Week Session

Investigation of advanced nuclear engineering problems.

Individual Research: Read More [\[+\]](#)

### 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.

Individual Research: Read Less [\[-\]](#)

## 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.

Teaching Techniques in Nuclear Engineering: Read More [\[+\]](#)

### 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 hour of lecture and 1 hour 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

Teaching Techniques in Nuclear Engineering: Read Less [\[-\]](#)

## 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.

Individual Study for Doctoral Students: [Read More](#) [+]

### 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.

Individual Study for Doctoral Students: [Read Less](#) [-]