Nuclear Engineering

Bachelor of Science (BS)
The program is designed to prepare students for a career in industry, the national laboratories, or in state or federal regulatory agencies. The program, leading to a Bachelor of Science (BS) degree in Nuclear Engineering, emphasizes study in the following areas of nuclear engineering: nuclear reactions and radiation, introduction to medical imaging, nuclear reactor theory and design, fusion power engineering, radioactive waste management, radiological and biophysics, and nuclear materials.

Many students will go on to complete a one-year master's degree program (the department does not have a fifth-year MS program). Students interested in careers in scientific research or in college-level teaching go on to complete the doctorate.

Accreditation
This program is accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org).

Admission to the Major
Prospective undergraduates to the College of Engineering will apply for admission to a specific program in the College. For further information, please see the College of Engineering's website (http://coe.berkeley.edu/students/prospective-students/admissions.html).

Admission to Engineering via a Change of College application for current UC Berkeley students is highly unlikely and very competitive as there are few, if any, spaces that open in the College each year to students admitted to other colleges at UC Berkeley. For further information regarding a Change of College to Engineering, please see the College's website (http://coe.berkeley.edu/students/current-undergraduates/change-of-college).

Minor Program
The department offers a minor in Nuclear Engineering (NE) that is open to all students who are not majoring in NE and who have completed the necessary prerequisites for the minor requirements. For information regarding the prerequisites, please see the Minor Requirements tab on this page.

The Nuclear Engineering (NE) minor is open to any undergraduate who satisfies the following requirements:

- Declaration of a major (not NE) on the UC Berkeley campus
- A cumulative GPA of at least 3.0 at the time of applying
- Completion of the minor must not delay graduation

To apply for the minor, submit the Petition for Admission to the Undergraduate Minor (http://www.nuc.berkeley.edu/sites/default/files/undergrad-curriculum/Admission%20to%20minor%20in%20NE.pdf) to the undergraduate adviser after completion of the prerequisite courses. Upon completion of the minor requirements, submit a Petition for Completion of the Undergraduate Minor (http://www.nuc.berkeley.edu/sites/default/files/undergrad-curriculum/Completion%20of%20minor%20in%20NE.pdf) to the undergraduate adviser.

Joint Majors
The Department of Nuclear Engineering also offers three joint majors with other departments in the College of Engineering and one joint major with a Department in the College of Chemistry. For further information on these programs, please click the links below:

- Chemical Engineering/Nuclear Engineering (http://guide.berkeley.edu/undergraduate/degree-programs/chemical-engineering-nuclear-joint-major) (Department of Chemical and Biomolecular Engineering, College of Chemistry)
- Electrical Engineering and Computer Sciences/Nuclear Engineering (http://guide.berkeley.edu/undergraduate/degree-programs/electrical-engineering-computer-sciences-nuclear-joint-major) (Department of Electrical Engineering and Computer Sciences)
- Materials Science and Engineering/Nuclear Engineering (http://guide.berkeley.edu/undergraduate/degree-programs/materials-science-engineering-nuclear-joint-major) (Department of Materials Science and Engineering)
- Mechanical Engineering/Nuclear Engineering (http://guide.berkeley.edu/undergraduate/degree-programs/mechanical-engineering-nuclear) (Department of Mechanical Engineering)

In addition to the University, campus, and college requirements, students must fulfill the below requirements specific to their major program.

General Guidelines
1. All technical courses taken in satisfaction of major requirements must be taken for a letter grade.
2. No more than one upper division course may be used to simultaneously fulfill requirements for a student's major and minor programs.
3. A minimum overall grade point average (GPA) of 2.0 is required for all work undertaken at UC Berkeley.
4. A minimum GPA of 2.0 is required for all technical courses taken in satisfaction of major requirements.

For information regarding residence requirements and unit requirements, please see the College Requirements tab.

For a detailed plan of study by year and semester, please see the Plan of Study tab.

Lower Division Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
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<tbody>
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<td>MATH 1A</td>
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<td>MATH 1B</td>
<td>Calculus</td>
<td>4</td>
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<tr>
<td>MATH 53</td>
<td>Multivariable Calculus</td>
<td>4</td>
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<td>MATH 54</td>
<td>Linear Algebra and Differential Equations</td>
<td>4</td>
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<td>CHEM 1A</td>
<td>General Chemistry</td>
<td>4</td>
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<tr>
<td>&amp; 1AL</td>
<td>and General Chemistry Laboratory</td>
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<tr>
<td>or CHEM 4A</td>
<td>General Chemistry and Quantitative Analysis</td>
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<td>PHYSICS 7A</td>
<td>Physics for Scientists and Engineers</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 7B</td>
<td>Physics for Scientists and Engineers</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 7C</td>
<td>Physics for Scientists and Engineers</td>
<td>4</td>
</tr>
<tr>
<td>ENGIN 7</td>
<td>Introduction to Computer Programming for Scientists and Engineers</td>
<td>4</td>
</tr>
<tr>
<td>ENGIN 40</td>
<td>Engineering Thermodynamics</td>
<td>4</td>
</tr>
<tr>
<td>EL ENG 16A</td>
<td>Designing Information Devices and Systems I</td>
<td>3-4</td>
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</tbody>
</table>
or PHYSICS 111A Instrumentation Laboratory
MAT SCI 45 Properties of Materials and Properties of Materials Laboratory 4
& 45L

1 CHEM 4A is intended for students majoring in chemistry or a closely-related field.

Upper Division Requirements

ENGIN 117 Methods of Engineering Analysis 3
NUC ENG 100 Introduction to Nuclear Engineering 1 3
NUC ENG 101 Nuclear Reactions and Radiation 4
NUC ENG 104 Radiation Detection and Nuclear Instrumentation Laboratory 4
NUC ENG 150 Introduction to Nuclear Reactor Theory 4
NUC ENG 170A Nuclear Design: Design in Nuclear Power Technology and Instrumentation 3

Ethics Requirement 2 3-4

Technical Electives: Minimum 29 units (see list below) 3,4 29

Must include at least 17 units of upper division NUC ENG courses

The remaining 12 technical elective units must be fulfilled by taking courses in engineering and science of which a minimum of 9 units must be upper division.

Upper Division Technical Electives

The following groups of electives should help undergraduate students focus their choices on specific professional goals. The electives selected need not be from any single group.

Beam and Accelerator Applications

NUC ENG 155 Introduction to Numerical Simulations in Radiation Transport 3
NUC ENG 180 Introduction to Controlled Fusion 3
PHYSICS 110A Electromagnetism and Optics 4
or EL ENG 117 Electromagnetic Fields and Waves
PHYSICS 110B Electromagnetism and Optics 4
or EL ENG 117 Electromagnetic Fields and Waves
PHYSICS 129 Particle Physics 4
PHYSICS 139 Special Relativity and General Relativity 3
PHYSICS 142 Introduction to Plasma Physics 4

Bionuclear Engineering

BIO ENG C165 Medical Imaging Signals and Systems 4
EL ENG 120 Signals and Systems 4
EL ENG C145B Medical Imaging Signals and Systems 4
NUC ENG 107 Introduction to Imaging 3
NUC ENG 162 Radiation Biophysics and Dosimetry 3

Computational Methods

COMPSCI 169 Software Engineering 4
MATH 104 Introduction to Analysis 4
MATH 110 Linear Algebra 4
MATH 128A Numerical Analysis 4
NUC ENG 155 Introduction to Numerical Simulations in Radiation Transport 3
STAT 150 Stochastic Processes 3
STAT 134 Concepts of Probability 4

Fission Power Engineering

MEC ENG 106 Fluid Mechanics 3-4
or CHM ENG 150/Transport Processes
MEC ENG 109 Heat Transfer 3-4
or CHM ENG 150/Transport Processes
NUC ENG 120 Nuclear Materials 4
NUC ENG 124 Radioactive Waste Management 3
NUC ENG 155 Introduction to Numerical Simulations in Radiation Transport 3
NUC ENG 161 Nuclear Power Engineering 4
NUC ENG 167 Risk-Informed Design for Advanced Nuclear Systems 3
NUC ENG 175 Methods of Risk Analysis 3

Fusion Power Engineering

NUC ENG 120 Nuclear Materials 4
NUC ENG 155 Introduction to Numerical Simulations in Radiation Transport 3
NUC ENG 180 Introduction to Controlled Fusion 3
PHYSICS 110A Electromagnetism and Optics 4
PHYSICS 110B Electromagnetism and Optics 4
PHYSICS 142 Introduction to Plasma Physics 4

Homeland Security and Nonproliferation

CHEM 143 Nuclear Chemistry 2
NUC ENG 102 Nuclear Reactions and Radiation Laboratory 3
NUC ENG 107 Introduction to Imaging 3
NUC ENG 130 Analytical Methods for Non-proliferation 3
NUC ENG 155 Introduction to Numerical Simulations in Radiation Transport 3
NUC ENG 175 Methods of Risk Analysis 3
PHYSICS 110A Electromagnetism and Optics 4
PHYSICS 110B Electromagnetism and Optics 4
PHYSICS 111A Instrumentation Laboratory 3
PHYSICS 111B Advanced Experimentation Laboratory 1-3

Materials in Nuclear Technology

MAT SCI 102 Bonding, Crystallography, and Crystal Defects 3
MAT SCI 104 Materials Characterization 4
MAT SCI 112 Corrosion (Chemical Properties) 3
MAT SCI 113 Mechanical Behavior of Engineering Materials 3
NUC ENG 120 Nuclear Materials 4
NUC ENG 124 Radioactive Waste Management 3
NUC ENG 155 Introduction to Numerical Simulations in Radiation Transport 3
NUC ENG 161 Nuclear Power Engineering 4

Nuclear Fuel Cycles and Waste Management

CHM ENG 150A Transport Processes 4
CHM ENG 150B Transport and Separation Processes 4
ENGIN 120 Principles of Engineering Economics 3
MAT SCI 112 Corrosion (Chemical Properties) 3
NUC ENG 120 Nuclear Materials 4
NUC ENG 124 Radioactive Waste Management 3
NUC ENG 155 Introduction to Numerical Simulations in Radiation Transport 3
NUC ENG 161 Nuclear Power Engineering 4
NUC ENG 175 Methods of Risk Analysis 3
Radiation and Health Physics
NUC ENG 120 Nuclear Materials 4
NUC ENG 155 Introduction to Numerical Simulations in Radiation Transport 3
NUC ENG 162 Radiation Biophysics and Dosimetry 3
NUC ENG 180 Introduction to Controlled Fusion 3

Risk, Safety and Systems Analysis
CIV ENG 193 Engineering Risk Analysis 3
CHM ENG 150A Transport Processes 4
ENGIN 120 Principles of Engineering Economics 3
IND ENG 166 Decision Analytics 3
NUC ENG 120 Nuclear Materials 4
NUC ENG 124 Radioactive Waste Management 3
NUC ENG 155 Introduction to Numerical Simulations in Radiation Transport 3
NUC ENG 161 Nuclear Power Engineering 4
NUC ENG 167 Risk-Informed Design for Advanced Nuclear Systems 3
NUC ENG 175 Methods of Risk Analysis 3

1. Junior transfer admits are exempt from NUC ENG 100.
2. Students must take one course with ethics content. This may be fulfilled within the Humanities/Social Sciences requirement by taking one of the following courses: ANTHRO 156B, BIO ENG 100, ENGIN 125, ENGIN 157AC, ESPM 161, ESPM 162A (ESPM 162 if taken Spring 2018 or earlier), GEOG 31, IAS 157AC, ISF 100E, L&S S 160B, PHILOS 2, PHILOS 104, PHILOS 107, SOCIOL 116. ENGIN 185 can be used to fulfill the ethics requirement.
3. Students must consult with and obtain approval from their faculty adviser no later than the fall semester of their junior year for their choices of technical electives. Students may receive up to 3 units of technical elective credit for graded research in H194 or H196.
4. Technical Electives cannot include:
   - Any course taken on a Pass/No Pass basis
   - Courses numbered 24, 39, 84, 88
   - Any of the following courses: BIO ENG 100, COMPSCI C79, COMPSCI 195, COMPSCI H195, DES INV courses (except DES INV 15, DES INV 22, DES INV 23, DES INV 90E, DES INV 190E), ENGIN 125, ENGIN 157AC, ENGIN 180, IND ENG 95, IND ENG 172, IND ENG 185, IND ENG 186, IND ENG 190 series, IND ENG 191, IND ENG 192, IND ENG 195, MEC ENG 191AC, MEC ENG 190K, and MEC ENG 191K. ENGIN 185 and ENGIN 187 cannot be used to fulfill technical elective units.

Minor programs are areas of concentration requiring fewer courses than an undergraduate major. These programs are optional but can provide depth and breadth to a UC Berkeley education. The College of Engineering does not offer additional time to complete a minor, but it is usually possible to finish within the allotted time with careful course planning. Students are encouraged to meet with their ESS adviser to discuss the feasibility of completing a minor program.

All the engineering departments offer minors. Students may also consider pursuing a minor in another school or college.

General Guidelines
1. All courses taken to fulfill the minor requirements must be taken for graded credit.
2. A minimum overall grade point average (GPA) of 3.0 and a minimum GPA of 3.0 in the prerequisite courses is required for acceptance into the minor program.
3. A minimum grade point average (GPA) of 2.0 is required for courses used to fulfill the minor requirements.
4. No more than one upper division course may be used to simultaneously fulfill requirements for a student’s major and minor programs.
5. Completion of the minor program cannot delay a student’s graduation.

Lower Division Prerequisites
MATH 1A Calculus 4
MATH 1B Calculus 4
MATH 53 Multivariable Calculus 4
MATH 54 Linear Algebra and Differential Equations 4
PHYSICS 7A Physics for Scientists and Engineers 4
PHYSICS 7B Physics for Scientists and Engineers 4
PHYSICS 7C Physics for Scientists and Engineers 4
ENGIN 45 Properties of Materials 3

Upper Division Requirements
NUC ENG 101 Nuclear Reactions and Radiation 4
Select three of the following: 9-12
   NUC ENG 102 Nuclear Reactions and Radiation Laboratory [3]
   NUC ENG 104 Radiation Detection and Nuclear Instrumentation Laboratory [4]
   NUC ENG 107 Introduction to Imaging [3]
   NUC ENG 120 Nuclear Materials [4]
   NUC ENG 124 Radioactive Waste Management [3]
   NUC ENG 130 Analytical Methods for Non-proliferation [4]
   NUC ENG 150 Introduction to Nuclear Reactor Theory [4]
   NUC ENG 155 Introduction to Numerical Simulations in Radiation Transport [3]
   NUC ENG 161 Nuclear Power Engineering [4]
   NUC ENG 170 Nuclear Design: Design in Nuclear Power Technology and Instrumentation [3]
   NUC ENG 170f Nuclear Design: Design in Bionuclear, Nuclear Medicine, and Radiation Therapy [3]
   NUC ENG 175 Methods of Risk Analysis [3]
   NUC ENG 180 Introduction to Controlled Fusion [3]

Students in the College of Engineering must complete no fewer than 120 semester units with the following provisions:
1. Completion of the requirements of one engineering major program (http://engineering.berkeley.edu/academics/undergraduate-programs) study.
2. A minimum overall grade point average of 2.00 (C average) and a minimum 2.00 grade point average in upper division technical coursework required of the major.
3. The final 30 units and two semesters must be completed in residence in the College of Engineering on the Berkeley campus.

4. All technical courses (math, science and engineering) that can fulfill requirements for the student's major must be taken on a letter graded basis (unless they are only offered P/NP).

5. Entering freshmen are allowed a maximum of eight semesters to complete their degree requirements. Entering junior transfers are allowed a maximum of four semesters to complete their degree requirements. (Note: junior transfers admitted missing three or more courses from the lower division curriculum are allowed five semesters.) Summer terms are optional and do not count toward the maximum. Students are responsible for planning and satisfactorily completing all graduation requirements within the maximum allowable semesters.

6. Adhere to all college policies and procedures (http://engineering.berkeley.edu/academics/undergraduate-guide) as they complete degree requirements.

7. Complete the lower division program before enrolling in upper division engineering courses.

Humanities and Social Sciences (H/SS) Requirement

To promote a rich and varied educational experience outside of the technical requirements for each major, the College of Engineering has a six-course Humanities and Social Sciences breadth requirement (http://engineering.berkeley.edu/student-services/degree-requirements/humanities-and-social-sciences), which must be completed to graduate. This requirement, built into all the engineering programs of study, includes two reading and composition courses (R&C), and four additional courses within which a number of specific conditions must be satisfied. Follow these guidelines to fulfill this requirement:

1. Complete a minimum of six courses from the approved Humanities/Social Sciences (H/SS) lists (http://engineering.berkeley.edu/hssreq).

2. Courses must be a minimum of 3 semester units (or 4 quarter units).

3. Two of the six courses must fulfill the college's Reading and Composition (R&C) requirement. These courses must be taken for a letter grade (C- or better required) and must be completed by no later than the end of the sophomore year (fourth semester of enrollment). The first half of R&C, the "A" course, must be completed by the end of the freshman year; the second half of R&C, the "B" course, must be completed by no later than the end of the sophomore year. Use the Class Schedule (http://classes.berkeley.edu) to view R&C courses offered in a given semester. View the list of exams (http://engineering.berkeley.edu/academics/undergraduate-guide/exams) that can be applied toward the first half of the R&C requirement. Note: Only the first half of R&C can be fulfilled with an AP or IB exam score. Test scores do not fulfill the second half of the R&C requirement for College of Engineering students.

4. The four additional courses must be chosen within College of Engineering guidelines from the H/SS lists (see below). These courses may be taken on a Pass/Not Passed basis (P/NP).

5. Two of the six courses must be upper division (courses numbered 100-196).

6. One of the six courses must satisfy the campus American Cultures requirement. For detailed lists of courses that fulfill American Cultures requirements, visit the American Cultures (http://guide.berkeley.edu/undergraduate/colleges-schools/engineering/american-cultures-requirement#site).

7. A maximum of two exams (Advanced Placement, International Baccalaureate, or A-Level) may be used toward completion of the H/SS requirement. View the list of exams (http://engineering.berkeley.edu/academics/undergraduate-guide/exams) that can be applied toward H/SS requirements.

8. Courses may fulfill multiple categories. For example, CY PLAN 118AC (http://guide.berkeley.edu/search/?P=CY%20PLAN%20118AC) satisfies both the American Cultures requirement and one upper division H/SS requirement.

9. No courses offered by any engineering department other than BIO ENG 100 (http://guide.berkeley.edu/search/?P=BIO%20ENG%20100), COMPSCI C79 (http://guide.berkeley.edu/search/?P=COMPSCI%20C79), ENGIN 125 (http://guide.berkeley.edu/search/?P=ENGIN%20125), ENGIN 157AC (http://guide.berkeley.edu/search/?P=ENGIN%20157AC), and MEC ENG 191K (http://guide.berkeley.edu/search/?P=MEC%20ENG%20191K) may be used to complete H/SS requirements.

10. Foreign language courses may be used to complete H/SS requirements. View the list of language options (http://guide.berkeley.edu/undergraduate/colleges-schools/engineering/approved-foreign-language-courses).

11. Courses numbered 97, 98, 99, or above 196 may not be used to complete any H/SS requirement.

12. The College of Engineering uses modified versions of five of the College of Letters and Science (L&S) breadth requirements lists to provide options to our students for completing the H/SS requirement. The five areas are:

   • Arts and Literature
   • Historical Studies
   • International Studies
   • Philosophy and Values
   • Social and Behavioral Sciences

Within the guidelines above, choose courses from any of the Breadth areas listed above. (Please note that you cannot use courses on the Biological Science or Physical Science Breadth list to complete the H/SS requirement.) To find course options, go to the Class Schedule (http://classes.berkeley.edu), (http://classes.berkeley.edu/search/class) select the term of interest, and use the Breadth Requirements (https://ls.berkeley.edu/sites/default/files/breadth_search_annotation_in_guide.png) filter.

Class Schedule Requirements

- Minimum units per semester: 12.0
- Maximum units per semester: 20.5
- Minimum technical courses: College of Engineering undergraduates must enroll each semester in no fewer than two technical courses (of a minimum of 3 units each) required of the major program of study in which the student is officially declared. (Note: For most majors, normal progress will require enrolling in 3-4 technical courses each semester).
- All technical courses (math, science, engineering) that satisfy requirements for the major must be taken on a letter-graded basis (unless only offered as P/NP).

Minimum Academic (Grade) Requirements

- A minimum overall and semester grade point average of 2.00 (C average) is required of engineering undergraduates. Students will
be subject to dismissal from the University if during any fall or spring semester their overall UC GPA falls below a 2.00, or their semester GPA is less than 2.00.

- Students must achieve a minimum grade point average of 2.00 (C average) in upper division technical courses required for the major curriculum each semester.
- A minimum overall grade point average of 2.00, and a minimum 2.00 grade point average in upper division technical course work required for the major is needed to earn a Bachelor of Science in Engineering.

**Unit Requirements**

To earn a Bachelor of Science in Engineering, students must complete at least 120 semester units of courses subject to certain guidelines:

- Completion of the requirements of one engineering major program (https://engineering.berkeley.edu/academics/undergraduate-guide/degree-requirements/major-programs) of study.
- A maximum of 16 units of special studies coursework (courses numbered 97, 98, 99, 197, 198, or 199) is allowed towards the 120 units.
- A maximum of 4 units of physical education from any school attended will count towards the 120 units.
- Students may receive unit credit for courses graded P (including P/ NP units taken through EAP) up to a limit of one-third of the total units taken and passed on the Berkeley campus at the time of graduation.

**Normal Progress**

Students in the College of Engineering must enroll in a full-time program and make normal progress each semester toward the bachelor's degree. The continued enrollment of students who fail to achieve minimum academic progress shall be subject to the approval of the dean. (Note: Students with official accommodations established by the Disabled Students’ Program, with health or family issues, or with other reasons deemed appropriate by the dean may petition for an exception to normal progress rules.)

**University of California Requirements**

Entry Level Writing (http://guide.berkeley.edu/undergraduate/colleges-schools/natural-resources/entry-level-writing-requirement)

All students who will enter the University of California as freshmen must demonstrate their command of the English language by fulfilling the Entry Level Writing Requirement. Satisfaction of this requirement is also a prerequisite to enrollment in all reading and composition courses at UC Berkeley.

American History and American Institutions (http://guide.berkeley.edu/undergraduate/colleges-schools/natural-resources/american-history-institutions-requirement)

The American History and Institutions requirements are based on the principle that a U.S. resident graduated from an American university should have an understanding of the history and governmental institutions of the United States.

**Campus Requirement**

American Cultures (http://guide.berkeley.edu/undergraduate/colleges-schools/natural-resources/american-cultures-requirement)

American Cultures (AC) is the one requirement that all undergraduate students at UC Berkeley need to take and pass in order to graduate.

The requirement offers an exciting intellectual environment centered on the study of race, ethnicity, and culture in the United States. AC courses offer students opportunities to be part of research-led, highly accomplished teaching environments, grappling with the complexity of American Culture.

For more detailed information regarding the courses listed below (e.g., elective information, GPA requirements, etc.), please see the College Requirements and Major Requirements tabs.

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<th>Freshman</th>
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<tr>
<td></td>
<td>Fall</td>
<td>Units</td>
<td>Spring</td>
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<td>CHEM 4A or 1A and 1AL</td>
<td>4 MATH 1B</td>
<td>4</td>
<td>4</td>
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<td>MATH 1A</td>
<td>4</td>
<td>PHYSICS 7A</td>
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<tr>
<td>Reading &amp; Composition course from List A</td>
<td>4 ENG 7</td>
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<td>Humanities/Social Sciences course</td>
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<td>Reading &amp; Composition course from List A</td>
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<td>Any Freshman seminar</td>
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<td>MAT SCI 45 &amp; 45L</td>
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<td>Electronic Circuits Elective</td>
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<td>Humanities/Social Sciences course</td>
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<td>Spring</td>
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<td>NUC ENG 104</td>
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<tr>
<td>Total Units: 120-125</td>
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1. CHEM 4A is intended for students majoring in chemistry or a closely-related field.
2. Electronic Circuits Elective: Choose one course from EL ENG 16A, EL ENG 49, or PHYSICS 111A.
3. Junior transfer admits for Fall 2018 are exempt from completing NUC ENG 100. Junior transfer admits for Fall 2019 will be expected to complete NUC ENG 100.
Students must take one course with ethics content. This may be fulfilled within the Humanities/Social Sciences requirement by taking one of the following courses: ANTHRO 156B, BIO ENG 100, ENGIN 125, ENGIN 157AC, ESPM 161, ESPM 162A (ESPM 162 if taken Spring 2018 or earlier), GEOG 31, IAS 157AC, ISF 100E, L & S 160B, PHILOS 2, PHILOS 104, PHILOS 107, SOCIOL 116. ENGIN 185 can be used to fulfill the ethics requirement.

Technical elective units must include at least 17 units of upper division NUC ENG courses. The remaining 12 technical elective units must be fulfilled by taking courses in engineering and science of which a minimum of 9 units must be upper division. See Major Requirements tab for lists of suggested electives. Students must consult with and obtain approval from their faculty adviser no later than the fall semester of their junior year for their choices of technical elective courses. Students may receive up to three units of technical elective credit for graded research in H194 or 196.

4. Students must take one course with ethics content. This may be fulfilled within the Humanities/Social Sciences requirement by taking one of the following courses: ANTHRO 156B, BIO ENG 100, ENGIN 125, ENGIN 157AC, ESPM 161, ESPM 162A (ESPM 162 if taken Spring 2018 or earlier), GEOG 31, IAS 157AC, ISF 100E, L & S 160B, PHILOS 2, PHILOS 104, PHILOS 107, SOCIOL 116. ENGIN 185 can be used to fulfill the ethics requirement.

3. Exhibit strong, independent learning, analytical and problem solving skills, with special emphasis on design, communication, and an ability to work in teams.

4. Demonstrate an understanding of the broad social, ethical, safety, and environmental context within which nuclear engineering is practiced.


**Mission**

The mission of the Department of Nuclear Engineering is to maintain and strengthen the University of California’s only center of excellence in nuclear engineering education and research and to serve California and the nation by improving and applying nuclear science and technology. The mission of the undergraduate degree program in Nuclear Engineering is to prepare our students to begin a lifetime of technical achievement and professional leadership in academia, government, the national laboratories, and industry.

**Learning Goals for the Major**

The foundation of the UC Berkeley Nuclear Engineering (NE) program is a set of five key objectives for educating undergraduate students. The NE program continuously reviews these objectives internally to ensure that they meet the current needs of the students, and each spring the Program Advisory Committee meets to review the program and recommend changes to better serve students. The NE Program Advisory Committee was established in 1988 and is composed of senior leaders from industry, the national laboratories, and academia.

Nuclear engineering at UC Berkeley prepares undergraduate students for employment or advanced studies with four primary constituencies: industry, the national laboratories, state and federal agencies, and academia (graduate research programs). Graduate research programs are the dominant constituency. From 2000 to 2005, sixty-eight percent of graduating NE seniors indicated plans to attend graduate school in their senior exit surveys. To meet the needs of these constituencies, the objectives of the NE undergraduate program are to produce graduates who as practicing engineers and researchers do the following:

1. Apply solid knowledge of the fundamental mathematics and natural (both physical and biological) sciences that provide the foundation for engineering applications.

2. Demonstrate an understanding of nuclear processes, and the application of general natural science and engineering principles to the analysis and design of nuclear and related systems of current and/or future importance to society.
NUC ENG 100 Introduction to Nuclear Engineering 3 Units
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.

Introduction to Nuclear Engineering: Read More [+]

Rules & Requirements
Prerequisites: Physics 7A and 7B, Physics 7C may be taken concurrently. Mathematics 53 and 54 may be taken concurrently

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.

Introduction to Nuclear Engineering: Read Less [-]

NUC ENG 101 Nuclear Reactions and Radiation 4 Units
Terms offered: Fall 2018, Fall 2017, Fall 2016
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.

Nuclear Reactions and Radiation: Read More [+]

Rules & Requirements
Prerequisites: Physics 7C

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.

Nuclear Reactions and Radiation: Read Less [-]

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.

Nuclear Reactions and Radiation Laboratory: Read More [+]

Rules & Requirements
Prerequisites: 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

Nuclear Reactions and Radiation Laboratory: Read Less [-]

NUC ENG 104 Radiation Detection and Nuclear Instrumentation Laboratory 4 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
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.

Radiation Detection and Nuclear Instrumentation Laboratory: Read More [+]

Rules & Requirements
Prerequisites: 101 or equivalent or consent of instructor; 150 or equivalent 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

Radiation Detection and Nuclear Instrumentation Laboratory: Read Less [-]
NUC ENG 107 Introduction to Imaging 3 Units
Terms offered: Fall 2018, Fall 2016, Fall 2014
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: 101 and 104A 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: Vetter
Introduction to Imaging: Read Less [-]

NUC ENG 120 Nuclear Materials 4 Units
Terms offered: Fall 2018, Fall 2017, Fall 2016
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: Engineering 45 and an upper division course in thermodynamics
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
Nuclear Materials: Read Less [-]

NUC ENG 124 Radioactive Waste Management 3 Units
Terms offered: Spring 2019, Spring 2017, Spring 2016
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: Engineering 117 or equivalent course
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
Radioactive Waste Management: Read Less [-]

NUC ENG 130 Analytical Methods for Non-proliferation 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
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: 101 or equivalent course 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
Analytical Methods for Non-proliferation: Read Less [-]
NUC ENG 150 Introduction to Nuclear Reactor Theory 4 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
Neutron interactions, nuclear fission, and chain reaction 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.
Introduction to Nuclear Reactor Theory: Read More [+]
Rules & Requirements
Prerequisites: 101; Mathematics 53 and 54
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: Greenspan, Vujic
Introduction to Nuclear Reactor Theory: Read Less [-]

NUC ENG 155 Introduction to Numerical Simulations in Radiation Transport 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
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.
Introduction to Numerical Simulations in Radiation Transport: Read More [+]
Rules & Requirements
Prerequisites: Mathematics 53 and 54
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
Introduction to Numerical Simulations in Radiation Transport: Read Less [-]

NUC ENG 156 Nuclear Criticality Safety 3 Units
Terms offered: Fall 2018
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.
Introduction to Nuclear Reactor Theory: 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 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
Nuclear Criticality Safety: Read Less [-]
NUC ENG 161 Nuclear Power Engineering 4 Units
Terms offered: Fall 2018, Fall 2017, Fall 2016
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. Nuclear Power Engineering: Read More [+]

Rules & Requirements
Prerequisites: Course(s) in fluid mechanics and heat transfer; junior-level course in thermodynamics

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: Peterson

NUC ENG 162 Radiation Biophysics and Dosimetry 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
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. Radiation Biophysics and Dosimetry: Read More [+]

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
Radiation Biophysics and Dosimetry: Read Less [-]

NUC ENG 167 Risk-Informed Design for Advanced Nuclear Systems 3 Units
Terms offered: Fall 2017, Fall 2015, Fall 2014
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 [+]

Objectives

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 of 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: 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, NE 120, NE 124, NE 150, NE 161

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Nuclear Engineering/Undergraduate
NUC ENG 170A Nuclear Design: Design in Nuclear Power Technology and Instrumentation 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
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.
Nuclear Design: Design in Nuclear Power Technology and Instrumentation: Read More [+]
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
Nuclear Design: Design in Nuclear Power Technology and Instrumentation: Read Less [-]

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.
Nuclear Design: Design in Bionuclear, Nuclear Medicine, and Radiation Therapy: Read More [+]
Rules & Requirements
Prerequisites: 107, 161, 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: 167
Nuclear Design: Design in Bionuclear, Nuclear Medicine, and Radiation Therapy: Read Less [-]

NUC ENG 175 Methods of Risk Analysis 3 Units
Terms offered: Fall 2018, Fall 2013, Fall 2011
Methodological approaches for the quantification of technological risk and risk based decision making. Probabilistic safety assessment, human health risks, environmental and ecological risk analysis.
Methods of Risk Analysis: Read More [+]
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: Kastenberg
Methods of Risk Analysis: Read Less [-]

NUC ENG 180 Introduction to Controlled Fusion 3 Units
Terms offered: Fall 2018, Fall 2017, Fall 2016
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.
Introduction to Controlled Fusion: Read More [+]
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
Introduction to Controlled Fusion: Read Less [-]
NUC ENG H194 Honors Undergraduate Research 1 - 4 Units
Terms offered: Summer 2019, Spring 2019, Fall 2018
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.
Honors Undergraduate Research: Read More [+] 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.
Honors Undergraduate Research: Read Less [-]

NUC ENG 198 Group Study for Advanced Undergraduates 1 - 4 Units
Terms offered: Spring 2019, Fall 2018, Spring 2018
Group studies of selected topics.
Group Study for Advanced Undergraduates: Read More [+] 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.
Group Study for Advanced Undergraduates: Read Less [-]

NUC ENG 199 Supervised Independent Study 1 - 4 Units
Terms offered: Spring 2019, Fall 2018, Spring 2018
Supervised independent study. Enrollment restrictions apply; see the Introduction to Courses and Curricula section of this catalog.
Supervised Independent Study: Read More [+] 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.
Supervised Independent Study: Read Less [-]

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.
Supervised Independent Study: Read More [+] 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.
Supervised Independent Study: Read Less [-]