

# Applied Science and Technology

The Applied Science and Technology graduate group is administered by the College of Engineering. The program is aimed at students with research interests that are truly interdisciplinary. Faculty members associated with the program are drawn from several departments within the College of Engineering, as well as from the departments of physics, chemistry, chemical and biomolecular engineering, statistics, and mathematics. Topics of interest include but are not limited to the properties and applications of nanostructures, thin-film and interface science, microelectromechanical systems (MEMS), short-wavelength coherent radiation, X-ray micro-imaging for the life and physical sciences, plasma physics and plasma-assisted materials processing, laser-induced chemical processes, laser probing of complex reacting systems, ultrafast phenomena, particle accelerators, nonlinear dynamics, chaotic systems, numerical methods, and topics in computational fluid mechanics and reacting flows.

Within the program students design their own course of study in consultation with their advisers, choosing from the vast array of technical offerings throughout the campus. The chosen coursework should prepare the student for interdisciplinary research. Students in the PhD program may pursue a Designated Emphasis (DE) such as the DE in Nanoscale Science and Engineering (DE NSE); Energy, Science, and Technology (DE EST); and Computational Science and Engineering (DE CSE).

Graduate research in the AS&T Program benefits from state-of-the-art experimental facilities on the Berkeley campus and at the Lawrence Berkeley National Laboratory. Among these facilities are the National Center for Electron Microscopy, with the world's highest resolution high-voltage microscope; a microfabrication lab for student work involving lithography, MEMS ion-implantation, and thin-film deposition; an integrated sensors laboratory; femtosecond laser laboratories; optical, electrical, and magnetic resonance spectroscopies; short wavelength laser and X-ray research laboratories; an unparalleled variety of material, chemical, and surface science analytic equipment; and a soft X-ray synchrotron dedicated to materials, chemical, and biological research using high-brightness and partially coherent X-rays. The interdisciplinary collaborative nature of the AS&T Program provides ample opportunity to develop new research directions by making the best use possible of these facilities and of the other research instrumentation available to AS&T faculty.

## 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>) .

## Course Requirements

A minimum of thirty-six (36) semester units of letter-graded coursework is required, exclusive of seminars and research. Of these thirty-six (36) letter-graded units, at least twenty-four (24) units must be graduate-level (200 series) courses, and the remaining 12 units must be upper division or graduate level courses. Thirty (30) of the thirty-six (36) units must be from approved technical courses. The student is required to complete at least eighteen (18) letter-graded semester units from technical courses relating to the student's major research field. In addition, a minor must be established. This is done by taking twelve (12) letter-graded semester units from technical courses in the chosen minor emphasis area. In summary, of the thirty-six (36) required units for the doctoral degree, thirty (30) units are specified to lie within the major area and minor fields of study, leaving six (6) discretionary units. **The 30 units in the major and minor programs must come from approved technical courses (not from seminars or survey courses).**

## Preliminary Exam

All students who enter the PhD program must take a one and a half hour oral AS&T preliminary examination based upon basic courses in their field of expertise. The exam must be taken no later than the second semester of the first academic year within the program (typically in late spring semester). Students who fail to pass the exam are allowed one more attempt, to be taken no later than the end of their third semester. A selection of courses to be covered in each of the examination areas will be established, and an oral examination will be arranged.

## Qualifying Exam

By the requirements of the Graduate Division, students enrolled in the PhD program must pass an oral qualifying examination in subjects appropriate to their approved areas of study. The examination will test the student's broad knowledge of areas related to his or her chosen areas of emphasis, as well as the depth of understanding in the areas in which the student anticipates undertaking research. The oral qualifying examination can be scheduled at any time mutually agreeable to the student and his or her graduate advisor, but in no case later than the third year after passing the AS&T preliminary examination. Students are urged to check the general University requirements for this examination.

## Dissertation

The dissertation, the product of independent investigation under faculty supervision, is the final requirement for the doctoral program. Dissertation

research is conducted in close collaboration with members of the AS&T faculty who agree to serve on the student's dissertation committee. The student's research adviser is the chair of the dissertation committee, who is joined by two (2) other faculty members, one of whom is the "outside" member (not on the AS&T faculty roster). The dissertation committee must be approved by both the head graduate advisor and the Dean of the Graduate Division.

## Curriculum

Electives per approved study list, according to highly individualized study along such major AS&T areas of concentration, such as applied physics, engineering sciences, and mathematical sciences

## Applied Science and Technology

### AST C210 X-rays and Extreme Ultraviolet Radiation 3 Units

Terms offered: Fall 2017, Fall 2016, Spring 2009

This course explores modern developments in the physics and applications of x-rays and extreme ultraviolet (EUV) radiation. It begins with a review of electromagnetic radiation at short wavelengths including dipole radiation, scattering and refractive index, using a semi-classical atomic model. Subject matter includes the generation of x-rays with synchrotron radiation, high harmonic generation, x-ray free electron lasers, laser-plasma sources. Spatial and temporal coherence concepts are explained. Optics appropriate for this spectral region are described. Applications include nanoscale and astrophysical imaging, femtosecond and attosecond probing of electron dynamics in molecules and solids, EUV lithography, and materials characteristics.

X-rays and Extreme Ultraviolet Radiation: Read More [+]

#### Rules & Requirements

**Prerequisites:** Physics 110, 137, and Mathematics 53, 54 or equivalent

#### Hours & Format

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

#### Additional Details

**Subject/Course Level:** Applied Science and Technology/Graduate

**Grading:** Letter grade.

**Instructor:** Attwood

**Also listed as:** EL ENG C213

X-rays and Extreme Ultraviolet Radiation: Read Less [-]

## AST C225 Thin-Film Science and Technology 3 Units

Terms offered: Spring 2018, Spring 2017, Spring 2016

Thin-film nucleation and growth, microstructural evolution and reactions. Comparison of thin-film deposition techniques. Characterization techniques. Processing of thin films by ion implantation and rapid annealing. Processing-microstructure-property-performance relationships in the context of applications in information storage, ICs, micro-electromechanical systems and optoelectronics.

Thin-Film Science and Technology: Read More [+]

### Rules & Requirements

**Prerequisites:** Graduate standing in engineering, physics, chemistry, or chemical engineering

### Hours & Format

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

### Additional Details

**Subject/Course Level:** Applied Science and Technology/Graduate

**Grading:** Letter grade.

**Instructors:** Wu, Dubon

**Also listed as:** MAT SCI C225

Thin-Film Science and Technology: Read Less [-]

## AST C239 Partially Ionized Plasmas 3 Units

Terms offered: Spring 2010, Spring 2009, Spring 2007

Introduction to partially ionized, chemically reactive plasmas, including collisional processes, diffusion, sources, sheaths, boundaries, and diagnostics. DC, RF, and microwave discharges. Applications to plasma-assisted materials processing and to plasma wall interactions.

Partially Ionized Plasmas: Read More [+]

### Rules & Requirements

**Prerequisites:** An upper division course in electromagnetics or fluid dynamics

### Hours & Format

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

### Additional Details

**Subject/Course Level:** Applied Science and Technology/Graduate

**Grading:** Letter grade.

**Formerly known as:** 239

**Also listed as:** EL ENG C239

Partially Ionized Plasmas: Read Less [-]

## AST C295R Applied Spectroscopy 3 Units

Terms offered: Spring 2009, Spring 2007, Spring 2002

After a brief review of quantum mechanics and semi-classical theories for the interaction of radiation with matter, this course will survey the various spectroscopies associated with the electromagnetic spectrum, from gamma rays to radio waves. Special emphasis is placed on application to research problems in applied and engineering sciences. Graduate researchers interested in systematic in situ process characterization, analysis, or discovery are best served by this course.

Applied Spectroscopy: Read More [+]

### Rules & Requirements

**Prerequisites:** Graduate standing in engineering, physics, chemistry, or chemical engineering; courses: quantum mechanics, linear vector space theory

### Hours & Format

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

### Additional Details

**Subject/Course Level:** Applied Science and Technology/Graduate

**Grading:** Letter grade.

**Instructor:** Reimer

**Also listed as:** CHM ENG C295R

Applied Spectroscopy: Read Less [-]

## AST 299 Individual Study or Research 1 - 12 Units

Terms offered: Spring 2018, Fall 2017, Spring 2017

Investigations of advanced problems in applied science and technology. Sponsored by Engineering Interdisciplinary Studies Center.

Individual Study or Research: Read More [+]

### Rules & Requirements

**Prerequisites:** Consent of instructor; graduate standing

**Repeat rules:** Course may be repeated for credit.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-12 hours of independent study per week

### Summer:

3 weeks - 5-60 hours of independent study per week

8 weeks - 1-12 hours of independent study per week

### Additional Details

**Subject/Course Level:** Applied Science and Technology/Graduate

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

Individual Study or Research: Read Less [-]