Department of Applied Physics
Yale University

Contemporary science and engineering are becoming increasingly interdisciplinary.

Traditional boundaries between fields have blurred, and new areas, such as nanotechnology and artificially structured materials, are constantly emerging. Applied Physics combines understanding the laws of nature at a fundamental level with a focus on technological applications to provide solutions to important societal problems. As such, it provides an essential link between physics and engineering. The range of phenomena, materials, devices and systems benefiting from research in applied physics is unmatched in its scope and importance.

The Yale Applied Physics major offers a unique combination of depth and flexibility through courses and research with which students can maximize their professional development and pursue their own interests. Students majoring in Applied Physics take courses in both Physics and Engineering, as well as courses specifically in Applied Physics. Students completing the B.S. degree in Applied Physics are prepared for graduate study in physics, applied physics, engineering, nanoscience and, with appropriate prerequisites, medicine or law. Our graduates have become leaders in a wide variety of fields spanning academia, industry and government service.

Department of Applied Physics
Yale University
15 Prospect Street, New Haven
CT 06511 U.S.A.

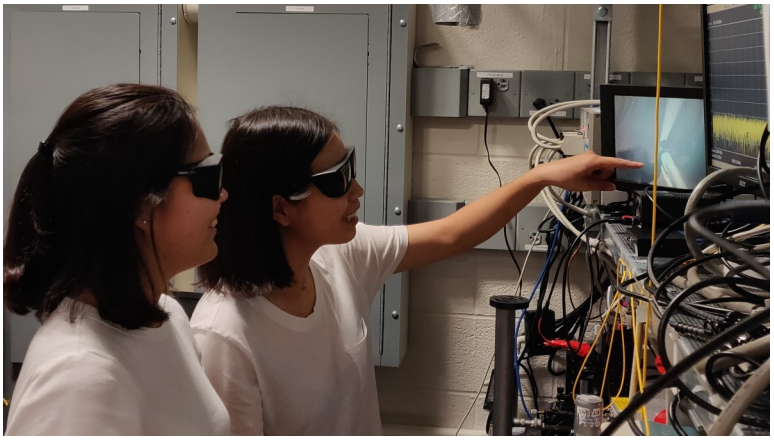
Applied Physics at Yale

The Applied Physics faculty are engaged in a broad range of research programs, including quantum computing, superconducting devices, complex materials and new devices based on them, nonlinear optics, nano- and micro-optical devices, as well as theoretical studies of novel materials, phenomena and optical microsystems. They collaborate with faculty in all of Yale's Engineering departments, as well as those in Physics, Chemistry, Biology, and the Yale School of Medicine.

Several Applied Physics faculty are members of the Center for Research on Interface Structures and Phenomena (CRISP), an interdisciplinary materials research center funded by the National Science Foundation.

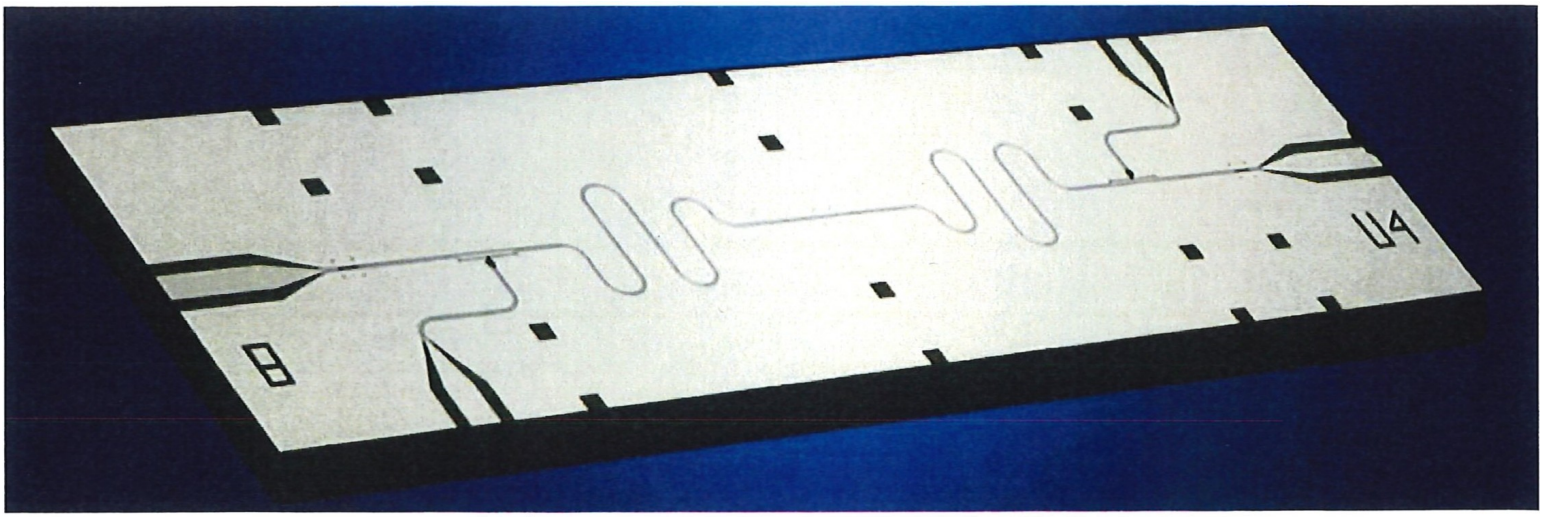
Applied Physics faculty are also central to the new Yale Quantum Institute (YQI), which facilitates research and teaching of quantum science on campus and hosts seminars, workshops and visitors from around the world, to ensure that Yale is an intellectual hub of the coming quantum information revolution. Our faculty also play a central role in the Yale Institute for Nanoscience and Quantum Engineering (YINQE), a key thrust of which is to bring together researchers in the physical sciences and engineering with those in the medical and biological research communities through nanoscale research and applications. The resources of these centers, and several others at Yale, are available for use by students in their research projects. Undergraduate research is strongly encouraged in the department, and our faculty are enthusiastic about working with undergraduate students.

For an overview of the department, see:
Applied Physics Department at Yale on Youtube.com.
https://www.youtube.com/watch?v=22QSgjw2oSU



The central theme of the Applied Physics major is to **allow students to take courses and do research in areas of interest to them**. In addition to the prerequisite courses in math and, science, all Applied Physics majors take three upper level core courses that are the foundation of much of modern science and engineering: Electromagnetic Waves and Devices (**APHY 322**), Statistical Thermodynamics (**APHY 420**), and Quantum Mechanics (**APHY 439**).

Because computers are so fundamental to the practical applications of physics, students are strongly encouraged to take a course in the use of computers early in their career. The remaining five courses - three classroom courses and two terms of independent research are determined by discussions between the student and the Director of Undergraduate Studies. The student chooses an area of science in which they have a special interest; the only requirement is that it contain a significant amount of physics. A faculty advisor is selected from Applied Physics, Physics, Engineering, the Medical School, or other departments who will supervise the research. Three elective courses are chosen that are related to the research, so that the classes and research are intellectually coherent. The student thus graduates with a **solid background in their area of interest**, well prepared for graduate school, industry, etc.



Quantum Information Processing Chip. This circuit consists of superconducting transmission lines and Josephson tunnel junctions; it has demonstrated simple quantum algorithms like Grover's algorithm.

The Applied Physics Major

(for Yale College classes 2022 and later) - B.S.

Director of Undergraduate Studies

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Physics is the study of the fundamental laws of nature. Applied physics uses these laws to understand phenomena that have practical applications. Engineering in turn makes use of these phenomena for human purposes. Applied physics thus forms a link between the fundamental laws of nature and their applications. Students majoring in Applied Physics take courses in both physics and engineering, as well as courses specifically in applied physics. Students completing the program in Applied Physics are prepared for graduate study in applied physics, in physics, in nanoscience, or in engineering, and, with appropriate prerequisites, in medicine; or they may choose careers in a wide range of technical and commercial fields, or in fields such as technical writing or patent law that draw on interdisciplinary subjects.

Contemporary physical science and engineering are becoming increasingly interdisciplinary. Traditional boundaries between fields have blurred, and new areas are constantly emerging, e.g., nanotechnology. The Applied Physics major provides a flexible framework on which students can build a curriculum tailored to their own interests, in consultation with the director of undergraduate studies.

Prerequisites

During their first year, students interested in Applied Physics should start by taking courses in mathematics, and physics if possible, appropriate to their level of preparation. The choice between different starting points is generally made on the basis of performance on Advanced Placement tests; see the First-year Student Website for more information.

The multiplicity of choices facing students interested in this general area indicates the importance of informed advice for first-year students. Students should consult freely with directors of undergraduate studies and individual faculty members in their departments of interest to optimize choices and to ensure maximum flexibility at the time a major is selected.

The prerequisite requirements for the Class of 2021 and previous classes

Students who declared their major under previous requirements, must follow the prerequisite requirements, as indicated when they declared.

The prerequisite requirements for the Class of 2022 and subsequent classes

The required prerequisites for students interested in Applied Physics include two Physics courses and one Physics lab; **APHY 151** or **MATH 120**; and **PHYS 301** or **APHY 194** with either **MATH 222** or **MATH 225**.

The recommended starting courses in physics are **PHYS 200** and **201**. These courses should be taken in the first year by students who have a strong preparation in mathematics and physics. Students with a particularly strong background in physics and mathematics may take **PHYS 260** and **261** instead. Students who are less well prepared in physics and mathematics may choose to take **PHYS 180** and **181** during their first year, or **PHYS 200** and **201** during their sophomore year after they have taken more mathematics courses. One laboratory course, **PHYS 166L** or **206L** should be taken at some time during the first or second year.

Katherine Aidala
Chair of Physics; Professor of Physics; Chair of Engineering, Mount Holyoke College, Massachusetts.

The 2020 APS prize recipient for a Faculty Member for Research in an Undergraduate Institution, graduated from Yale University, undergraduate program in Applied Physics.

Requirements of the Major

The major in Applied Physics requires eight courses beyond the introductory sequence. Two of these must be **APHY 471** and **472**. All majors are also required to take **APHY 322**, **439**, and **APHY 420** or equivalents. The three remaining advanced courses should focus on a particular area of concentration. For example, a student interested in solid-state and/or quantum electronics might choose from **APHY 321**, **448**, **449**, **EENG 320**, and **325**.

A student interested in the physics of materials and/or nanoscience might choose from **APHY 448**, **449**, **CHEM 220**, **450**, and **MENG 285**. Many other concentrations are possible.

Senior Requirement

Seniors must complete an independent research project, taken as **APHY 471** and **472**. The independent research project is under the supervision of a faculty member in Applied Physics, Physics, Engineering, or related departments. The project may be started in the junior year and continued into the senior year. Students planning to do a research project should contact the director of undergraduate studies as early as possible to discuss available options and general requirements.

Advising

The Applied Physics major provides for various programs corresponding to a range of student interests. Substitutions of equivalent courses may be permitted. Students interested in an Applied Physics major should contact the director of undergraduate studies as early as possible, and in any case by the end of the sophomore year.

A well-prepared student interested in materials physics or quantum electronics who starts the senior research in the junior year might elect the following course sequence:

First-Year	Sophomore
APHY 151	APHY 322
PHYS 200	APHY 439
PHYS 201	PHYS 301
PHYS 206L	

Junior	Senior
APHY 471	APHY 448
EENG 320	APHY 449
APHY 420	APHY 472

Typical Sequence of Courses

A student interested in alternative energy who starts physics in the sophomore year and conducts research in the senior year might elect:

First-Year	Sophomore
MATH 120	PHYS 200
	PHYS 201
	PHYS 206L
	PHYS 301

Junior	Senior
APHY 322	APHY 448
APHY 439	APHY 471
EENG 320	APHY 472
APHY 420	EENG 406

REQUIREMENTS OF THE MAJOR

Prerequisites: **PHYS 180, 181, or 200, 201**,with appropriate math courses and **PHYS 166L** or **206L**; **APHY 151** or **MATH 120**; **PHYS 301** (or **APHY194** with either **MATH 222** or **MATH 225**)

Number of courses: 8 term courses beyond prerequisites (including senior requirements)

Distribution of courses: 3 advanced courses in physical or mathematical sciences or engineering in area of concentration, with DUS approval.

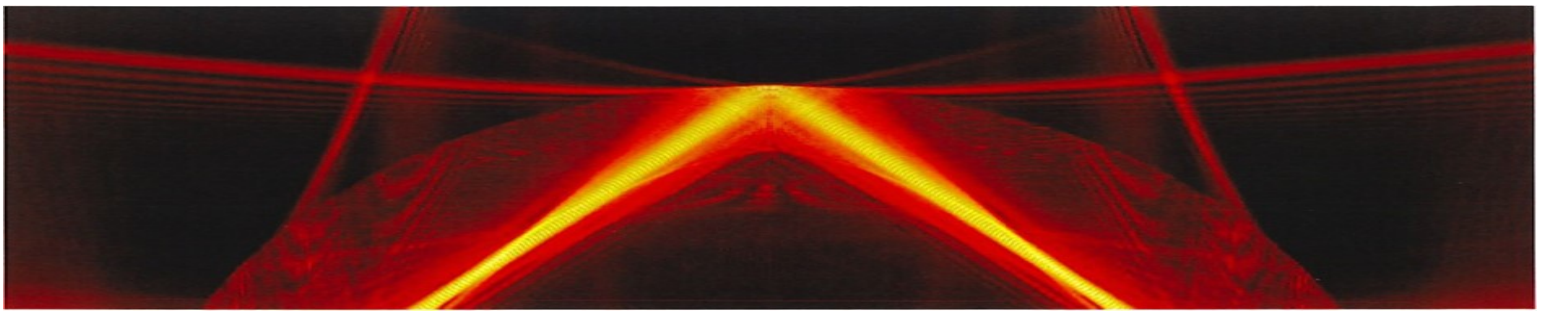
Specific courses required: **APHY 322**, **439**, **APHY 420**, or equivalents

Substitution permitted: Any relevant course approved by DUS.

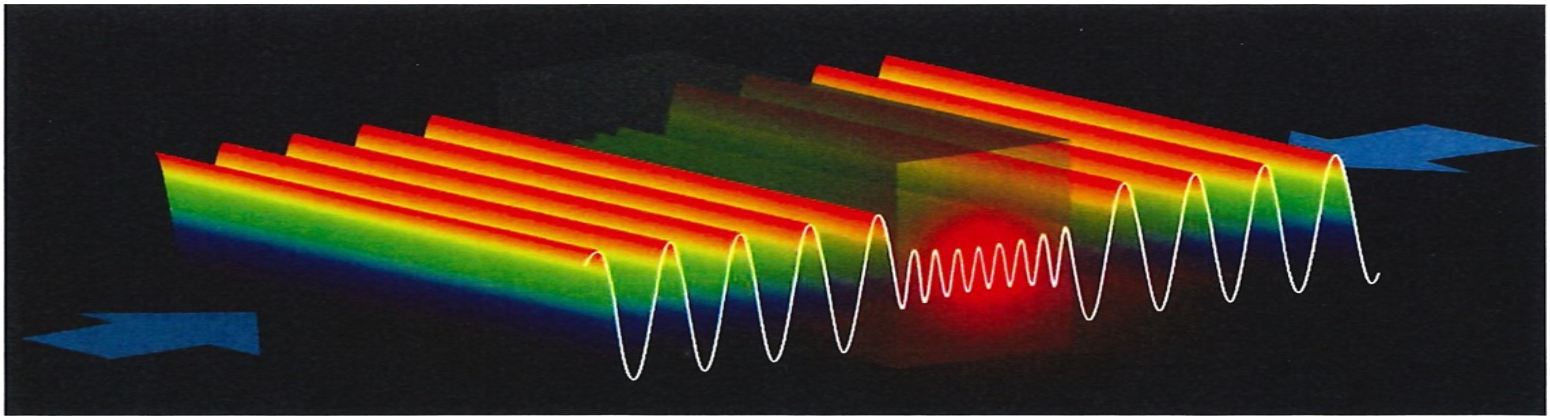
Senior requirement: **APHY 471** and **472**

The major in Applied Physics requires eight courses beyond the introductory sequence. All majors are required to take **APHY 322b**, **439a**, and **APHY 420a**, or equivalents. The three remaining advanced courses should focus on a particular area of special interest to the student. The student can choose from almost any field of science or engineering, as long as it contains a significant amount of physics. The courses should be related to the student's senior research project (see below), so that the courses and research are intellectually coherent.

Seniors must complete two terms of an independent research project, taken as **APHY 471a** and **472b**. The independent research project is under the supervision of a faculty member in Applied Physics or related departments, including the Medical School. The project may be started in the junior year and continued into the senior year.



Spatial intensity of an optical mode along a marginally unstable periodic orbit in a mushroom-shaped cavity. Light, trapped by total internal reflection, partially escapes through diffracting evanescent fields.



Schematic of a coherent perfect absorber (an "anti-laser"): two incident laser beams are perfectly absorbed and the energy is transformed into heat or electrical current. The effect can be turned on and off based on controllable properties of the incident light.