APPLIED PHYSICS (MS)

Faculty

Marvin M Antonoff (Emeritus), PhD, *Cornell University* • Theoretical Solid State Physics

Stephen B Arnason, PhD, *Stanford University* • Materials Physics

Leonard A Catz, PhD, *Hebrew University of Jerusalem* • Experimental Atomic and Nuclear Spectroscopy

Edward S Ginsberg, PhD, *Stanford University* • Theoretical Elementary Particle Physics • Physics Education Research

Greg Huber, PhD, *Boston University* • Nonlinear Dynamics • Biophysics

Donald H Lyons (Emeritus), PhD, *University of Pennsylvania* • Theoretical Solid State Physics

Benjamin R Mollow, PhD, *Harvard University* • Theoretical Quantum Optics

D V G L N Rao, DSc, *Andhra University of India* • Experimental Laser Research • Nonlinear Optics

George Salzman (Emeritus), PhD, *University of Illinois* • Theoretical Research in General Relativity • Science for Humane Survival

Gregory Sun, PhD, *Johns Hopkins University* • Semiconductor Opto-Electronic Devices and Materials

The Program and Facilities

The Applied Physics Program is intended primarily to prepare students for rewarding careers in industry, corporate, and government research laboratories, hospitals, and other high-technology enterprises. In addition, it provides preparation to allow graduates to proceed to a doctoral program if they so choose. The program also offers courses meeting the professional licensure requirements for the Master's of Education Program.

Program emphasis is on the development of practical laboratory skills through broad experience in experimental course work, while fostering quantitative analytical techniques in theoretical physics at the level appropriate to the master's degree. Auxiliary skills in computer and information technology will also be developed.

During or following the initial year of course work, students may choose to begin a thesis project, working in a departmental research laboratory or on a computational or theoretical problem, under the direction of a faculty member. Alternatively, qualified students who are employed in technically related jobs may opt to complete a supervised internship project, equivalent to a thesis, at their place of employment. Through such internships, the program has established relationships with corporations, hospitals, and laboratories in the Boston area that offer students a unique opportunity to complete the requirements for a master's degree.

The Physics Department is located in the Science Building at the Harbor Campus. Facilities include ample teaching and research laboratories, computing facilities, electronics, and machine shops.

Research laboratories include facilities and equipment for:

- low-temperature studies
- non-linear optics, optical information processing
- nuclear spectroscopy
- millimeter-wave magnetic resonance
- soft condensed matter physics

Degree Requirements

The MS in Applied Physics is a 36-credit program. Each student must complete 1) seven courses, as follows: three one-semester laboratory courses, three one-semester theoretical courses, and one elective course, also in applied physics, to be chosen in consultation with his or her faculty advisor, totaling, at 4 credits each, 28 credits; and 2) either an internship at an off-campus research laboratory or an on-campus thesis project, either of which, when successfully completed, will earn 8 credits. In exceptional cases, with prior approval of the program, a student may graduate with nine courses (substituting two additional courses for the internship or thesis requirement). These courses must be chosen as a coherent subject of specialization in an applied area of special interest to the student.

Admission Requirements

Please see the general statement of admission requirements for all graduate studies programs in the "Admissions" section of this publication.

An applicant for admission to the Graduate Program in Applied Physics should present adequate evidence of his or her preparation and ability to do graduate work. Normally a bachelor's degree with a major in physics is required, though in certain instances other equivalent preparation may be acceptable. For applicants currently or recently in college, the three letters of recommendation should come from professors in the field of physics or in closely related fields. For an applicant who has been working in an industrial or scientific research laboratory for several years, it may be more valuable to seek one or more of the letters from senior scientists who are familiar with the applicant's work. It is also recommended, but not required, that an applicant plan a visit to the department for informal contacts with the faculty and to become acquainted with the research facilities. GRE scores are not required, but applicants, particularly international applicants, are encouraged to submit scores.

Courses

PHYSIC 570
Instrumentation Laboratory for Science Teachers
A laboratory in modern scientific instrumentation. Participants a) learn basic electronic, thermal, optical, and computer instrumentation techniques; b) study the way modern measuring instruments utilize them in the natural and applied sciences; and c) apply these techniques to carry out an instrumentation project in science. The course is both hands-on and laboratory based, and includes interdisciplinary applications.
3 Hrs, 3 Credits

Applied Physics

PHYSIC 571
Integrated Mathematics and Physical Science for Teachers
This course is designed for secondary school mathematics and science teachers. It develops interdisciplinary material from mathematics and the physical sciences to illustrate basic mathematical concepts as they apply to physical problems and phenomena. Participants learn modern techniques of instrumentation and analysis—including calculator- and computer-based systems, e.g., CBL and MBL data acquisition and analysis systems—and utilize them in hands-on data taking and analysis. The course uses inquiry-based methods to develop scientific and quantitative reasoning skills. Special emphasis is given to the development of effective pedagogies for teachers of middle and high school.
3 Hrs, 3 Credits

PHYSIC 600
Electronic Instrumentation I: Analog
A lecture and laboratory course in analog electronics. Emphasis is placed on pragmatic and intuitive approaches to analog electronic circuit designs. A supervised independent project illustrating an aspect of basic analog electronics is required of each student.
Prerequisite: Graduate standing or permission of instructor.
2 Lect Hrs, 4 Lab Hrs, 4 Credits

PHYSIC 601
Electronic Instrumentation II: Digital
A lecture and laboratory course to provide understanding of digital electronics and microprocessors. Emphasis is placed on digital logic components, digital circuit design, and techniques for incorporating microprocessors and microcomputers into laboratory experiments.
Prerequisite: Graduate standing or permission of instructor.
2 Lect Hrs, 4 Lab Hrs, 4 Credits

PHYSIC 602
Laser Optics Laboratory
A lecture and laboratory course to provide a working understanding of modern optics, lasers, and applications. Topics include optical resonators; solid state, gas and semiconductor lasers; tunable dye lasers; non-linear optics; and spectroscopy applications. Selected topics, which may vary from year to year according to the interests of the faculty and recent developments in technology, will stress practical instrumentation as well as relevant theory.
Prerequisite: Permission of instructor.
3 Lect Hrs, 3 Lab Hrs, 4 Credits

PHYSIC 603
Nuclear Radiation Physics and Biophysics Laboratory
A laboratory-based course to illustrate the theory and experimental techniques utilized in nuclear radiation physics and biophysics. Topics include modes of production of nuclear radiation (charged particles, electromagnetism, neutrons), interaction of radiation with matter (including biological tissue), instruments and techniques for radiation detection and spectroscopy, radiation protection and safety, and the use of radioisotopes in physical, chemical, and biomedical research. Additional topics may include neutron activation analysis, X-ray fluorescence, the Mossbauer effect, radio immunoassay techniques utilizing radioisotopes, computer assisted tomography (CAT), and experiments on the interaction of radiation with tumor cells.
Prerequisite: Permission of instructor.
2 Lect Hrs, 4 Lab Hrs, 4 Credits

PHYSIC 604
Cryogenics and Vacuum Technology
A lecture and laboratory course to provide a working understanding of modern practice in cryogenics and vacuum technology. Topics include low temperature properties of materials, gas purification, separation and liquefaction systems, instrumentation for measurement of temperatures and pressure and vacuum technology. Selected topics, which may vary from year to year according to the interests of the faculty and recent developments in technology, will stress practical instrumentation and applications.
Prerequisite: Permission of instructor.
2 Lect Hrs, 4 Lab Hrs, 4 Credits

PHYSIC L608 (BIOL L608)
Biophysical Instrumentation
A lecture and laboratory course on the application of microcomputers and microprocessor-based electronics to laboratory experiments in the biological and physical sciences. Emphasis is on techniques for interfacing the microcomputer with laboratory experiments for automated data acquisition, data reduction and analysis, information display, and real-time control of experiments.
Prerequisite: Graduate standing or permission of instructor.
2 Lect Hrs, 4 Lab Hrs, 4 Credits

PHYSIC 609
Physics of Medical Imaging
General introduction to the physical principles involved in various medical imaging modalities, including X-ray imaging, X-ray tomography, radio-nuclide imaging, ultrasonic imaging, nuclear magnetic resonance imaging.
Prerequisite: Graduate standing or permission of instructor.
4 Lect Hrs, 4 Credits

PHYSIC 610
Topics in Medical Imaging
This course focuses on an in-depth study of specific topics in the various medical imaging modalities.
Prerequisite: PHYSIC 609 or permission of instructor.
4 Lect Hrs, 4 Credits

PHYSIC 611
Theory of Classical Mechanics and Fluid Mechanics
Principles of classical mechanics: generalized coordinates, Lagrangian and Hamiltonian formulations, variational principles, multiple periodic systems, continuous media, fluid mechanics.
Prerequisite: Permission of instructor.
4 Lect Hrs, 4 Credits

PHYSIC 612
Electromagnetic Theory
A lecture course to develop electromagnetic theory and to treat various applications. Topics include Maxwell's equations in vacuum and in material media, electromagnetic theory of continuous media, reflection, refraction, diffraction and radiation of electromagnetic waves. Applications are selected from such topics as wave guides and resonant cavities, and magneto hydrodynamics and plasma physics.
Prerequisite: Permission of instructor.
4 Lect Hrs, 4 Credits

PHYSIC 613
Quantum Mechanics, Atomic, and Molecular Physics
A lecture course on the fundamental principles and applications of the quantum theory of matter. Topics include bound systems (potential well harmonic oscillator, hydrogen atom), angular momentum, spin, identical particles, the periodic table, exchange forces, chemical bonding, linear vector spaces, perturbation theory. Such other topics as magnetic resonance, symmetry groups, and elementary particles are selected for study according to student and faculty interests.
Prerequisite: Permission of instructor.
4 Lect Hrs, 4 Credits

Applied Physics

PHYSIC 614
Thermodynamics and Statistical Mechanics
A lecture course on the principles of thermodynamics and statistical mechanics. Topics include fundamentals of thermodynamics, first and second laws, thermodynamic potentials, phase transitions, classical kinetic theory, classical statistical mechanics, and quantum statistical mechanics. Applications of the principles are made to physical, chemical, and biological systems of special or current interest.
Prerequisite: Permission of instructor.
4 Lect Hrs, 4 Credits

PHYSIC 615
Solid State Physics
The application of quantum mechanics to the theory of the solid state. Topics include periodic structures, lattice waves, band theory of solids, dynamics of electrons in solids and magnetic resonance. Some applications of the theory to semi-conductor devices are made.
Prerequisite: Permission of instructor.
4 Lect Hrs, 4 Credits

PHYSIC 616
Mathematical Methods for Physicists
A course in intermediate mathematics with applications to analytical and quantum mechanics and electromagnetic theory. Selected topics from vector analysis, tensor algebra, linear algebra and group theory, functions of a complex variable, second-order differential equations, Fourier series and transforms, calculus of variations.
4 Lect Hrs, 4 Credits

PHYSIC 621
Physics of Semiconductor Materials
A lecture course on the physics of semiconductor materials. An understanding of the properties of semiconductor devices is related to the underlying physical principles of quantum mechanics and solid state physics. Topics include electrical, optical, and thermal properties of semiconductor materials; theory of transport, scattering, and recombination of free carriers; theory of p-n junctions.
Prerequisites or Corequisites: PHYSIC 613 and 615, or permission of instructor.
4 Lect Hrs, 4 Credits

PHYSIC 622
Solid State Electronic Devices
A lecture and laboratory course on the physical principles and technology of semiconductor electronic devices and materials. The laboratory involves such techniques as the Hall effect, resistivity, and optical measurement, used to characterize the properties of semiconductor materials and devices—silicon and gallium arsenide substrates, bipolar and metal semiconductor junctions, VLSI and MOSFET devices. Topics may vary according to faculty interests and recent developments in the technology.
Prerequisite: PHYSIC 621 or permission of instructor.
2 Lect Hrs, 4 Lab Hrs, 4 Credits

PHYSIC 632
Advanced Laser Optics (with Lab)
This is a one-semester lecture and lab course offered as a follow-up to PHYSIC 602. Topics include wave propagation in isotropic and anisotropic media, birefringence, the physical origin of nonlinear polarization, wave propagation in nonlinear media, optical second harmonic generation, parametric oscillation and amplification, electro-optic effects in crystals, third order non-linearities, third harmonic generation, the interaction of light and phase conjugate optics, four-wave mixing, intensity dependent transmission, and selected topics as time permits.
Prerequisite: PHYSIC 602 or permission of instructor.
3 Lect Hrs, 3 Lab Hrs, 4 credits

PHYSIC 680
Readings in Physics
An opportunity for qualified graduate students to pursue advanced independent readings in specialized topics in applied physics, with the guidance of a faculty member. This course may be taken more than once for credit.
Prerequisite: Permission of the department.
Hrs by arrangement, 3-6 Credits

PHYSIC 690
Projects in Physics
Qualified graduate students may pursue advanced independent projects in applied physics, with the guidance of a faculty supervisor. This course may be taken more than once for credit.
Prerequisite: Permission of the department.
Hrs by arrangement, 3-6 Credits

PHYSIC 697
Special Topics in Applied Physics
The study of a particular topic of current interest in applied physics, such as photonics, nuclear reactor physics, semiconductor device physics, superconductivity, magnetic resonance.
Prerequisite: Permission of instructor.
4 Lect Hrs, 4 Credits

PHYSIC 698
Master's Internship
Internship in collaboration with industry in the greater Boston area. Requires a faculty supervisor in the Physics Department.
Prerequisite: Permission of the department.
Hrs by arrangement, 3-6 Credits

PHYSIC 699
Master's Thesis Research
Prerequisite: Permission of the department.
Hrs by arrangement, 3-6 Credits