Physics

Applied Physics

The NJIT and Rutgers-Newark departments of physics offer a unique opportunity to pursue master's and doctoral degree physics in a joint program combining the resources of two of New Jersey's public research universities.

Interdisciplinary physics research is available in collaboration with faculties of NJIT, Rutgers-Newark and Rutgers-New Brunswick, and RBHSin areas such as device physics, materials research, ultrafast optical and optoelectronic phenomena, imaging technology, surface physics, free electron laser physics, biophysics, discharge physics, solar physics, and applied laser physics. Cooperative research efforts are underway with the National Renewable Energy Laboratory, National Solar Observatory, Lucent Technologies Bell Labs Innovations, U.S. Army Research Laboratory, and other industrial and federal research laboratories.

Master of Science in Applied Physics

The program is for students with an undergraduate degree in physics, applied physics, or engineering, who wish to apply physics to biological problems, optical science, microelectronics, device physics, materials science, solar cells, surface science, laser physics, solar phenomena, and other related areas.

Admission Requirements

A bachelor's degree in physics, applied physics, or related areas from an accredited institution is required. An undergraduate GPA above 3.0 is required. Students must submit GRE (general test) scores. In addition, applicants are required to provide letters of recommendation from their previous academic institutions. Students for whom English is not their native language are required to have TOEFL scores no lower than 550 (pencil and paper) and 213 (computer-based).

Doctor of Philosophy in Applied Physics

This program is for students in applied physics that are interested in and committed to scholarly research.

Admission Requirements

Applicants are expected to have a master's degree in physics, applied physics, or related engineering disciplines from an accredited institution. Highly qualified students with bachelor's degrees may be accepted directly into the doctoral program. A GPA of at least 3.5 in undergraduate and previous graduate studies is normally required for admission. The GRE (general test) and advanced (physics) test scores are required. Applicants are required to provide three letters of recommendation from their previous academic institutions. Students for whom English is not their native language are required to have TOEFL scores no lower than 550 (pencil and paper) and 213 (computer-based).

Materials Science and Engineering

This intercollegiate (CSLA and NCE), interdepartmental, and interdisciplinary degree program is intended for individuals with a strong background in science and/or engineering.

Master of Science in Materials Science and Engineering

Admissions Requirement

Applicants are expected to have an undergraduate degree from an accredited institution. A minimum undergraduate GPA of 3.0 on a 4.0 scale, or equivalent is normally required for admission. An undergraduate major in physics, chemistry, materials science, or a related engineering discipline is preferred. GRE quantitative scores of 700 or higher are highly desirable. Students from countries where English is not the native language should demonstrate TOEFL scores higher than 550 (pencil and paper) and 213 (computer-based).

Doctor of Philosophy in Materials Science and Engineering

This is an intercollegiate (CSLA and NCE), interdepartmental, and interdisciplinary degree program for superior students who wish to do advanced research in an area of materials science and engineering. Current areas of research include electronic and photonic materials, nano and particulate materials, polymer and biomaterials, and other areas of materials science and engineering.

Admission Requirements

Applicants are expected to have an appropriate master's degree in materials science or related field, physics, chemistry, or engineering from an accredited institution. Students entering with a master's degree must have at least a 3.5 GPA on a 4.0 scale in previous graduate study. Highly qualified students with bachelor's degrees may be accepted directly into the doctoral program. These students must have at least a 3.5 GPA in undergraduate work.
NJIT Faculty

A
Ahn, Keun Hyuk, Associate Professor
Ahn, Kwangsu, Assistant Research Professor

C
Cao, Wenda, Associate Professor
Chin, Ken K., Professor
Chen, Bin, Assistant Professor

D
Delahoy, Alan E., Research Professor
Deng, Na, Research Professor
Dias, Cristiano Luis, Assistant Professor

F
Farrow, Reginald C., Research Professor
Federici, John F., Distinguished Professor
Fleishman, Gregory David, Distinguished Research Professor

G
Gary, Dale E., Distinguished Professor
Gatley, Ian, Distinguished Professor
Georgiou, George E., University Lecturer
Gerrard, Andrew J., Professor
Gokce, Oktay Huseyin, Senior University Lecturer
Goode, Philip R., Distinguished Research Professor

J
Janow, Richard H., University Lecturer
Jerez, Andres, University Lecturer
Jing, Ju, Research Professor

K
Kosovichev, Alexander G., Professor

L
Lanzerotti, Louis J., Distinguished Research Professor
Levy, Roland A., Distinguished Professor
Liu, Chang, Research Professor

M
Maljian, Libarid A., University Lecturer
N
Nita, Gelu M., Research Professor

O
Opyrchal, Halina, Senior University Lecturer

P
Piatek, Slawomir, Senior University Lecturer
Prodan, Camelia, Associate Professor

R
Ravindra, N. M., Professor
Russo, Onofrio L., Associate Professor

S
Shneidman, Vitaly A., Senior University Lecturer
Sirenko, Andrei, Professor

T
Thomas, Benjamin, Assistant Professor
Thomas, Gordon A., Professor
Towfik, Nissim M., Associate Professor
Tyson, Trevor A., Distinguished Professor

V
Varsik, John R., Research Professor

W
Wang, Haimin, Distinguished Professor

X
Xu, Yan, Research Professor

Y
Yurchyshyn, Vasyl, Research Professor

Z
Zhou, Tao, Associate Professor

Programs
• Applied Physics - M.S. (http://catalog.njit.edu/graduate/science-liberal-arts/physics/applied-physics-ms/)
• Materials Science and Engineering - M.S. (http://catalog.njit.edu/graduate/science-liberal-arts/physics/materials-science-engineering-ms/)

Programs
• Applied Physics - Ph.D. (http://catalog.njit.edu/graduate/science-liberal-arts/physics/applied-physics-phd/)
• Materials Science & Engineering - Ph.D. (http://catalog.njit.edu/graduate/science-liberal-arts/physics/materials-science-engineering-phd/)
Physics Courses

PHYS 590. Graduate Coop Work Exp I. 1 credit, 1 contact hour.

PHYS 591. Graduate Coop Work Exp II. 1 credit, 1 contact hour.

PHYS 607. Topics in Astronomy and Cosmology. 3 credits, 3 contact hours.
Prerequisites: college-level physics and mathematics. A survey of recent progress in astronomy, the physical principles involved, and the impact these new discoveries have on our understanding of the universe. Includes results from recent and ongoing planetary probes of our solar system, discovery of planetary systems around other stars, the evolution of stars, exotic objects such as neutron stars and black holes, the formation of galaxies, and current understanding of the birth and final fate of the universe. Observing sessions familiarize students with the sun, moon, and night sky.

PHYS 611. Adv Classical Mechanics. 3 credits, 3 contact hours.

PHYS 621. Classical Electrodynamic. 3 credits, 3 contact hours.

PHYS 641. Statistical Mechanics. 3 credits, 3 contact hours.

PHYS 652. Fund of Optical Imaging. 3 credits, 3 contact hours.
Prerequisites: PHYS 621 (Classical Electricity and Magnetism I). This is designed as a principal course of introducing optical engineering to master students in applied optics. The goal is to help students acquire the practical technical knowledge on optical systems and their design. The general approach throughout the course is to emphasize the application of basic optical principles to practice. Topics include general principles of geometric and physical optics, elemental geometric optics under paraxial ray approximation, aberrations, prisms and mirrors, the eye, stops and apertures, optical materials and interference coating, radiometry and photometry, basic optical devices, optical computation, image evaluation and optical system design, particularly computer aided designs.

PHYS 661. Solid-State Physics. 3 credits, 3 contact hours.
Properties of solid state materials are explained based on principles of physics. Electronic, magnetic, thermal, optical, and lattice properties of materials are studied. Various experimental and theoretical approaches are introduced.

PHYS 681. Solar Phys & Instrumentn. 3 credits, 3 contact hours.

PHYS 682. Introduction To Mems. 3 credits, 3 contact hours.

PHYS 687. Physics of Materials. 3 credits, 3 contact hours.
Prerequisite: PHYS 441 or equivalent (see undergraduate catalog for description). Fundamentals of quantum mechanics; energy bands in crystals; electrical conduction in metals and alloys, semiconductors; optical properties of materials; quantum mechanical treatment of optical properties; magnetic properties of materials; thermal properties, heat capacity, and thermal expansion in solids.

PHYS 688. Mathematical and Statistical Methods in Materials Science. 3 credits, 3 contact hours.
More emphasis on analytical methods and statistics. Course will be required for Ph.D. students in Materials Science.

PHYS 690. Directed Study Appl Phys. 3 credits, 3 contact hours.

PHYS 698. ST:. 3 credits, 3 contact hours.

PHYS 700. Master'S Project. 3 credits, 3 contact hours.
Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics who do not take Phys 701 Master's Thesis. An extensive paper involving experimental or theoretical investigation of a topic in microelectronics or other applied physics area is required. Cooperative projects with industry or government agencies may be acceptable. The project is carried out under the supervision of a designated physics graduate faculty member.

PHYS 700B. Master's Project. 3 credits, 3 contact hours.
Approval of the project advisor is required for registration. Experimental and/or theoretical investigation of a relevant topic in applied physics. A written report must be submitted to the project advisor. The student cannot register in PHYS 700B more than once and the incomplete (I) grade is not allowed. Master's students registering for the first time in Master's Project must take simultaneously the INTD 799 (Responsible Contact of Research) course.

PHYS 701B. Master's Thesis. 3 credits, 3 contact hours.
Approval of the thesis advisor is required for registration. Experimental and/or theoretical investigation of a relevant topic in applied physics that can lead to a quality publication. A written thesis must be defended and approved by a committee of at least three faculty members. The student is expected to defend the thesis upon accrual of six thesis credits. Additional registration in PHYS 701B, beyond six credits, is required every semester until successful thesis defense (six credits count toward degree requirements and time limits apply). Master's students registering for the first time in Master's Thesis must take simultaneously the INTD 799 (Responsible Contact of Research) course.

PHYS 701C. Master's Thesis. 6 credits, 6 contact hours.
Approval of the thesis advisor is required for registration. Experimental and/or theoretical investigation of a relevant topic in applied physics that can lead to a quality publication. A written thesis must be defended and approved by a committee of at least three faculty members. The student must continue registering for three thesis credits (PHYS 701B) each semester until successful thesis defense (six credits count toward degree requirements and time limits apply).
PHYS 721. Classical Electrodynamics II. 3 credits, 3 contact hours.
Prerequisite: PHYS 621 or equivalent; basic knowledge of tensor analysis. Simple radiating systems, scattering and diffraction; special theory of relativity; dynamics of relativistic particles and electromagnetic fields; collisions between charged particles, energy loss, and scattering; radiation from accelerated charge, synchrotron radiation, and bremsstrahlung.

PHYS 725. Independent Study I. 3 credits, 3 contact hours.
Approvals of the academic advisor and course instructor are required for registration. Students working on their PhD dissertation or MS thesis cannot normally register for this course with their respective dissertation/thesis advisor. This special course covers areas of study in which one or more students may be interested but there is not sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once.

PHYS 726. Independent Study II. 3 credits, 3 contact hours.
Approvals of the academic advisor and course instructor are required for registration. Students working on their PhD dissertation or MS thesis cannot normally register for this course with their respective dissertation/thesis advisor. This special course covers areas of study in which one or more students may be interested but there is not sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once. Students should only register for PHYS 726 if they have taken PHYS 725 in a prior semester.

PHYS 728. Radio Astronomy. 3 credits, 3 contact hours.
Prerequisites: PHYS 621 and PHYS 641 or the equivalent, or approval of the instructor. An introduction to radio emission processes, radiative transfer, radio diagnostics, and radio instrumentation. Topics include radio flux measurements with single antenna, radio imaging with interferometer arrays (Fourier Transform imaging), and image reconstruction techniques (CLEAN, MEM). Application is to astronomical objects with special emphasis on the Sun.

PHYS 731. Quantum Mechanics II. 3 credits, 3 contact hours.
Prerequisite: PHYS 631 or equivalent. Review of quantum mechanics and theory of special relativity; second quantization; relativistic one-particle problem; Klein-Gordon equation and Dirac equation; canonical field theory; relativistic scattering theory; introduction to quantum electrodynamics and quantum field theory; Feynman diagrams and applications.

PHYS 741. Basic Plasma Phys w Space, Lab. 3 credits, 3 contact hours.
Prerequisites: PHYS 611, PHYS 621, other equivalent, or approval of the instructor. The course will introduce students to basic concepts of plasma physics and its applications to laboratory experiments and space research. The course will cover the following topics: particle motions in magnetic field, adiabatic invariants, magnetic traps, radiation belts, electromagnetic waves in plasma, electrostatic oscillations, waves in magnetized plasma, collisional processes in plasma, kinetic effects on plasma waves, Landau damping, wave instabilities, plasma as fluid, magnetohydrodynamics, magnetic configurations of laboratory and space plasma, MHD instabilities, reconnection, helicity, dynamo theories, the origin of cosmic magnetic fields, stochastic processes, Fermi process, particle acceleration, and cosmic rays.

PHYS 747. Intro to Helioseismology. 3 credits, 3 contact hours.
Prerequisites: Phys 621, Phys 621 or other equivalent, or approval of the instructor. The course will introduce the physical principles and methods to study wave oscillations, and the interior structure of the Sun. The course covers processes of acoustic and gravity wave excitation and propagation, interaction with turbulence and magnetic fields, oscillation spectrum, sunquakes, inferences of the structure and composition, the differential rotation, large-scale flows and meridional circulation. It includes the theory of normal modes, inversion techniques, wave dispersion analysis, acoustic tomography and holography, applications to the solar dynamo and magnetic activity.

PHYS 751. Applied Optics. 3 credits, 3 contact hours.
Prerequisites: PHYS 621 (Classical Electricity and Magnetism I) The course will introduce students to basic concepts of applied optics, light propagation and light and matter interactions. The course will cover the following topics: light propagation through mirrors and lenses, matrix optics, basic concepts of wave optics, reflection, refraction and transmission, equations governing wave propagation, Gaussian beams, Maxwell’s equations, absorption, dispersion, light polarization states, temporal and spatial coherences.

PHYS 753. Light Sources & Photodetectors. 3 credits, 3 contact hours.
Prerequisites: PHYS 621 (Classical Electricity and Magnetism I) and PHYS 631 (Quantum Mechanics I) This is a survey course on theory and practical aspects of light sources and photodetectors. The specific light sources covered will be: black body, discharge tubes, X-ray, light.

PHYS 774. Fundamentals of Spectroscopy. 3 credits, 3 contact hours.
The major objectives of this course are to integrate theory and practice and to bring together different branches of Academic Studies and Industrial Research through the presentation of critical aspects of modern Spectroscopy. The course will provide a valuable theoretical introduction and an overview of modern topics in spectroscopy, which are of current interest and importance in Semiconductor Industry and Biomedicine. A wide range of techniques is considered, including optical Near field spectroscopy, X-ray, Raman, Neutron scattering, and FT-IR spectroscopy.

PHYS 780. Curr Topics Applied Phys. 3 credits, 3 contact hours.

PHYS 787. New Concepts of Semiconductor. 3 credits, 3 contact hours.
Prerequisite: PHYS 687 and ECE 657. This is an advanced course on semiconductor physics targeted at describing polycrystalline materials, e.g. cadmium telluride or copper indium diselenide, that are currently used in thin-film photovoltaic panels. An overview of classical semiconductor and solar cell theory is followed by topics such as non-shallow dopants, multi-level defects, defect transition energy level, and metastability. These concepts are applied to examine minority carrier lifetime and carrier collection in devices, and to extend the theories of admittance and deep level transient spectroscopy.
Physics

PHYS 789. Physics of Advanced Semiconductor Device Processing. 3 credits, 3 contact hours.
Prerequisites: NJIT: EE 657, R755 687; or equivalent. Intended for doctoral students in applied physics, electrical engineering, and materials science. (Rutgers = R755 789) Silicon and GaAs technologies: crystal growth methods, epitaxy, oxidation, lithography, dry and wet etching techniques, polysilicon, diffusion, ion implantation, metallization (including silicidation), process integration, analytical characterization techniques, assembly and packaging, and yield and reliability.

PHYS 790. Doct Dissertation & Res. 0 credits, 0 contact hours.
Prerequisites: passing grade on departmental qualifying examination and approval of doctoral candidacy. Corequisite: PHYS 791. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester. Registration for additional credits, up to 12 per semester, is permitted with the approval of the department graduate advisor. Experimental or theoretical investigation of a topic in applied physics, including microelectronics, materials science, and laser physics. Cooperative projects with industry or government agencies may be acceptable. Research and writing are carried out under the supervision of a designated graduate faculty member. The completed written dissertation should be a substantial contribution to the knowledge of the topic under research, and should be of sufficient merit to warrant publication in a leading scientific or technical journal.

PHYS 790A. Doct Dissertation & Res. 1 credit, 1 contact hour.
Co-requisite: PHYS 791. Approval of the dissertation advisor is required for registration. Experimental and/or theoretical investigation of a relevant topic in applied physics. For PhD students who have successfully defended their dissertation proposal. The student must register in PHYS 790A every semester until successful dissertation defense. A written dissertation must be defended and approved by a committee of at least five members. Students enrolled in the PhD program before 2015 Fall must accumulate a minimum number of credits in Doctoral Dissertation Research and Pre-Doctoral Research (see graduate catalog for program-specific details; the same requirement may apply to joint PhD programs with other universities).

PHYS 790B. Doct Dissertation & Res. 3 credits, 3 contact hours.
Co-requisite: PHYS 791. Since the PHYS 790A course should normally be taken instead, approvals of academic and dissertation advisors are required for registration. Experimental and/or theoretical investigation of a relevant topic in applied physics. For PhD students who have successfully defended their dissertation proposal. Students enrolled in the PhD program before 2015 Fall must accumulate a minimum number of credits in Doctoral Dissertation Research and Pre-Doctoral Research (see graduate catalog for program-specific details; the same requirement may apply to joint programs with other universities).

PHYS 790C. Doct Dissertation & Res. 6 credits, 6 contact hours.
Co-requisite: PHYS 791. Since the PHYS 790A course should normally be taken instead, approvals of academic and dissertation advisors are required for registration. For PhD students who have successfully defended their dissertation proposal. Experimental and/or theoretical investigation of a relevant topic in applied physics. Students enrolled in the PhD program before 2015 Fall must accumulate a minimum number of credits in Doctoral Dissertation Research and Pre-Doctoral Research (see graduate catalog for program-specific details; the same requirement may apply to some joint programs with other universities).

PHYS 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.

PHYS 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.

PHYS 790F. Doct Dissertation & Res. 15 credits, 3 contact hours.

PHYS 790G. Doct Dissertation & Res. 18 credits, 3 contact hours.

PHYS 791. Doctoral Seminar. 0 credits, 0 contact hours.

PHYS 792. Pre-Doctoral Research. 3 credits, 3 contact hours.
Co-requisite: PHYS 791. Approval of the dissertation advisor is required for registration. Preliminary experimental and/or theoretical investigation of a relevant topic in applied physics. For students who have passed the qualifying examination but have not defended the dissertation proposal. Permission is needed of the academic advisor as well for students who have completed the required coursework but have not passed the qualifying examination.
Rutgers-Newark Courses

R750 501. Quantum Mechanics. 3 credits, 3 contact hours.
R750 509. Physics Appli Cmptrs. 3 credits, 3 contact hours.
R750 537. Recent Intl. Relations. 3 credits, 0 contact hours.
R750 543. Galaxies And Milky Ways. 3 credits, 3 contact hours.
R750 601. Solid State Physics I. 3 credits, 0 contact hours.
R750 602. Solid State Physics II. 3 credits, 3 contact hours.
R750 617. Genl Theo Relativity. 3 credits, 0 contact hours.
R750 620. Many Body Physics. 3 credits, 3 contact hours.
R750 621. Adv Many Body. 3 credits, 3 contact hours.
R750 681. Adv Top Sol State. 3 credits, 3 contact hours.
R750 771. Quantum Electronics. 3 credits, 3 contact hours.
R750 631. Quantum Mechanics. 3 credits, 3 contact hours.
R755 701. Dissertation Research. 3 credits, 0 contact hours.
R755 702. Diss Research. 3 credits, 0 contact hours.
R755 771. Quantum Electronics. 3 credits, 0 contact hours.
R755 772. Plasma Physics. 3 credits, 0 contact hours.
R755 774. Intro To Spectro. 3 credits, 0 contact hours.
R755 780. Adv Quantum Mech. 3 credits, 3 contact hours.
R755 866. Grad Assistant. 6 credits, 3 contact hours.