Professional MS Physics

Currently there is tremendous growth in optics, materials, and medical physics caused by rapid developments in the fields of superconductivity, electro-optic materials, nanotechnology, optical, acoustical, and NMR imaging, and tomography. The Physics Department of Cleveland State University offers a professional MS degree in physics designed for applied scientists and engineers who wish to develop competence in these rapidly advancing fields. In 2001, the American Physical Society classified the Master of Science in Physics program at Cleveland State as a "strong professional master's degree program."

The physics professional MS program has three specializations: Optics and Materials, Optics and Medical Imaging, Medical Physics. Each physics graduate student is enrolled in one and only one of the three specializations.

Contact Information: Dr. Miron Kaufman, Chair Physics Department, Cleveland State University, Cleveland, OH.44115, Tel. 216-6872436, Email: m.kaufman@csuohio.edu

MS Physics Specialization: Optics and Materials

The Optics and Materials specialization educates physicists and engineers working in high-tech companies or at NASA on contemporary optics and materials physics techniques, such as characterizing materials with light scattering.

Admission Information

To be considered for admission to the **Master of Science in Physics**, specialization Optics and Materials, students must meet College of Graduate Studies requirements for admission and have an undergraduate degree in physics, engineering, chemistry, mathematics, or an allied filed. Students with deficient backgrounds will be required to register for additional courses to remove deficiencies.

Financial Support

Student support is available through tuition grants.

Faculty

CSU Physics Department

Dr. Petru Fodor, Assistant Professor, Experimental Solid State Physics
Dr. Paul Hambourger, Associate Professor, Experimental Solid State Physics
Dr. Miron Kaufman, Chair and Professor, Statistical Physics
Dr. James Lock, Professor, Physics Graduate Program Director, Theoretical Optics
Dr. Kiril Streletzky, Assistant Professor, Experimental Optics
Dr. Thomas Taylor, Associate Professor, Experimental Optics
Dr. Ulrich Zurcher, Assistant Professor, Statistical Physics

Degree Requirements

The following courses constitute a typical program (32 credits) for the Optics and Materials specialization:
PHY 520: Computational Physics, 4cr
PHY 550: Optics, 4cr
PHY 555: Optics Lab, 4cr
PHY 560: Lasers, 4cr
PHY 565: Image Processing, 4cr
PHY 580: Optical Materials, 4cr
PHY 598: Project, 4cr
PHY 680: Physics of Materials, 4cr

Recommended course:
PHY 593: Monte Carlo Simulations of Complex Systems, 2 cr.

MS Physics Specialization: Optics and Medical Imaging

The Optics and Medical Imaging specialization is designed for (though not exclusively for) students that have an undergraduate degree in engineering and need an MS degree to apply for the doctoral program in engineering: applied bioengineering (ABE) specialization. Having a MS is a pre-requisite for the doctor in engineering (DRE) program. If a student with an undergraduate degree in engineering completes the MS in Physics program, he/she could then apply to the DRE-ABE specialization program. He/she would furthermore have the advantage of having completed a core course in the DRE-ABE program, the medical imaging course, and started research, in the project course, that may lead to the doctoral research. To deliver this specialization the Physics Department collaborates with CSU's Chemical and Bioengineering Department and with Cleveland Clinic Foundation's Lerner Institute and Radiation Oncology Department.

Admission Information

To be considered for admission to the **Master of Science in Physics**, specialization Optics and Medical Imaging, students must meet College of Graduate Studies requirements for admission and have an undergraduate degree in physics, engineering, chemistry, mathematics, or an allied filed. Students with deficient backgrounds will be required to register for additional courses to remove deficiencies.

Financial Support

Student support is available through tuition grants.

Faculty

CSU Physics Department

Dr. Miron Kaufman, Chair and Professor, Statistical Physics
Dr. James Lock, Professor, Physics Graduate Program Director, Theoretical Optics
Dr. Kiril Streletzky, Assistant Professor, Experimental Optics
Dr. Thomas Taylor, Associate Professor, Experimental Optics
Dr. Jacqueline Vitali, Assistant Professor, Experimental Biological Physics
Dr. Ulrich Zurcher, Assistant Professor, Statistical Physics

CSU Chemical Engineering and Bioengineering Department

Dr. George Chatzimavroudis, Associate Professor, Medical Imaging

CCF

Dr. Gordon Chan, Department of Radiation Oncology;
Dr. Brian L. Davis, Biomedical Engineering; Lerner Institute;
Dr. William Davros, Head, Medical Physics, Division of Diagnostic Radiology;
Dr. Christopher Deibel, Department of Radiation Oncology;
Dr. Toufik Djemil, Department of Radiation Oncology;
Dr. Gennady Neyman, Department of Radiation Oncology;
Dr. Martin Weinhous, Chief of Medical Physics, Department of Radiation Oncology;
Dr. Douglas A. Wilkinson, Department of Radiation Oncology.

Degree Requirements

The following courses constitute a typical program (33 credits) for the Optics and Medical Imaging specialization:

PHY 520: Computational Physics, 4cr
PHY 530: Introduction to Medical Physics, 4cr
PHY 550: Optics, 4cr
PHY 555: Optics Lab, 4cr
PHY 560: Lasers, 4cr
PHY 565: Image Processing, 4cr
PHY 593: Monte Carlo Simulations, 2cr
PHY 598: Project, 4cr
CHE 659: Medical Imaging, 3cr

MS Physics Specialization: Medical Physics

The Physics Department and the Cleveland Clinic Foundation's Radiation Oncology Department collaborate since 1999 to offer the Medical Physics specialization. It is the only program of its kind in northeast Ohio and is listed on the American Association of Physicists in Medicine website: http://www.aapm.org/education/noncampep.asp. Medical physicists are highly skilled specialists who apply the concepts and methods of physics to the diagnosis and treatment of human disease. Among other duties, they optimize mamographic systems and help deliver radiation therapy to cancer patients. The specialization is aimed at attracting trained physicists and getting them into the medical physics workforce, which is experiencing a shortage nationwide.

Admission Information

To be considered for admission to the **Master of Science in Physics**, specialization Medical Physics, applicants must meet the College of Graduate Studies admission requirements and have an undergraduate degree in physics, chemistry, electrical engineering, chemical engineering, mechanical engineering, or nuclear engineering. All students applying for the MS in Physics program with specialization in medical physics must take the GRE general test: verbal reasoning, quantitative reasoning and analytical writing. Students whose undergraduate training is not in the United States must also take the TOEFL exam and score above 600 (paper version) and the Test for Spoken English (TSE) and score above 300. All applications must be received by April 1.

Financial Support

Student support is available through the Medical Physics Fellowship program, tuition grants and other employment opportunities at the Cleveland Clinic Foundation. The Medical Physics Fellow could work during the first year of the program in the Physics Department at Cleveland State University and during the second year of the program in the Radiation Oncology Department at the Cleveland Clinic Foundation, contingent on availability of funds and on academic performance.

Faculty

CSU Physics Department

Dr. Paul Hambourger, Associate Professor, Experimental Solid State Physics
Dr. James Lock, Professor, Physics Graduate Program Director, Theoretical Optics
Dr. Miron Kaufman, Chair and Professor, Statistical Physics
Dr. Jacqueline Vitali, Assistant Professor, Experimental Biological Physics
Dr. Theodore Wood, Associate Professor, Electronics

CCF

Dr. Gordon Chan, Department of Radiation Oncology,
Dr. William Davros, Head, Section of Medical Physics, Division of Diagnostic Radiology,
Dr. Christopher Deibel, Lead Physicist for Quality Assurance, Department of Radiation Oncology,
Dr. Toufik Djemil, Department of Radiation Oncology, Co-Lead Physicist, IMRT Program,
Dr. Gennady Neyman, Lead Physicist for Gamma Knife Radiosurgery**,** Department of Radiation Oncology,
Dr. Martin Weinhous, Chief of Medical Physics, Department of Radiation Oncology,
Dr. Douglas Wilkinson, Vice-Chief of Medical Physics, Department of Radiation Oncology.

Degree Requirements

The Medical Physics specialization includes the following courses (32 credits):
PHY 515: Introduction to Biological Physics, 4cr
PHY 520: Computational Physics, 4cr
PHY 530: Introduction to Medical Physics, 4cr
PHY 535: Radiation Therapy Physics, 4cr
PHY 565: Image Processing, 4cr
PHY 570: Environmental Physics, 4cr
PHY 596: Laboratory Training in Radiation Therapy Physics I, 4cr
PHY 597: Laboratory Training in Radiation Therapy Physics II, 4cr

Recommended course:
PHY 593: Monte Carlo Simulations of Complex Systems, 2 cr.

Undergraduate Deficiencies:
For Medical Physics specialization, the following courses must be taken if there are deficiencies in the student's undergraduate preparation.
PHY 330: Introduction to Modern Physics, 4cr
PHY 350: Electricity and Magnetism, 4cr
PHY 360: Electronics Laboratory, 4cr
PHY 474: Thermal Physics, 4cr
BIO266 Human Anatomy and Physiology, 3 cr
BIO267 Human Anatomy and Physiology Laboratory, 1cr

Graduate Courses

PHY 510 Holography (2-4-3). Laboratory course in holography. Production of single- and multiple-beam transmission and reflection holograms and three-dimensional cylindrical holograms.

PHY 515 Introduction to Biological Physics (4-0-4). As the body of knowledge in physics expands and diffuses into the life sciences, the need for instruction in biological physics increases. Students learn how to use the concepts of physics to analyze and understand important aspects of biological systems. The course is appropriate for graduate students majoring in physics, chemistry, biology, or engineering.

PHY 516 Macromolecular Crystallography (4-0-4). Macromolecular crystallography is at the heart of the genomics age allowing the determination of the three-dimensional structures of the proteins for which the genomes code. This information is used to determine and understand their function and to develop new drugs that cure diseases. This course teaches the fundamentals of diffraction theory, crystal properties, and the basic concepts of solving the structures of macromolecular crystals. The course is appropriate for graduate students in physics, chemistry, and biology.

PHY 520 Computational Physics (4-0-4). Numerical simulations such as Monte Carlo and visualizations of complex physical systems; examples from fractals, chaos, and cellular automata.

PHY 530 Introduction to Medical Physics (4-0-4). Prerequisites: PHY 241 (or PHY 243) and PHY 242 (or PHY 244), or permission of the instructor. An introduction to the medical applications of radiation and imaging physics. Topics include interactions of radiation with biological tissues, production and properties of radionuclides, radiation therapy physics, dosimetry, diagnostic radiology, nuclear medicine, and issues of radiation safety.

PHY 535 Radiation Therapy Physics (4-0-4). Prerequisite: PHY 430 (or PHY 530), or permission of the instructor. An examination of therapeutic applications of ionizing radiation. Included are basic radiological physics and dosimetry, modern methods of using radiation in teletherapy and brachytherapy, and radiation protection.

PHY 550 Optics (4-0-4). Geometrical optics with applications to microscopes, cameras, and vision; thick lenses and aberrations; polarization; interference and interferometers; Fresnel and Fraunhofer diffraction; and Rayleigh scattering.

PHY 555 Advanced Optics Laboratory (2-6-4). Hands-on knowledge in optical principles and techniques; dispersion in glass, diffraction, and interferometry. Includes a student-selected project.

PHY 560 Laser Physics and Photonics (4-0-4). Basics of laser operation and photonics. Topics include spontaneous and stimulated emission laser types, optical detectors, integrated optics, rate equation models for lasers, quantum noise limits, and elementary nonlinear optics.

PHY 565 Image Processing (4-0-4). Fraunhofer and Fresnel diffraction, linear systems theory, optical image processing with coherent light, optical transfer function for incoherent light, FFT algorithm, and digital image processing in pixel space and in Fourier space.

PHY 570 Environmental Physics (4-0-4). Study of physical phenomena underlying environmental issues. Topics include energy and entropy laws; electromagnetic radiation; forms of energy, such as fuels, nuclear, and solar; percolation model; and chaos theory as it pertains to population dynamics and climate.

PHY 580 Optical Materials (4-0-4). Fundamentals of electron motion in solids; physics of LEDs, diode lasers, and solar cells; optoelectronic properties of transparent and porous semiconductors; materials for optical modulation, data storage, and computing; liquid crystals; and flat panel displays.
PHY 593 Special Topics in Physics (1 to 6 credits). Topics from condensed matter physics, optics, computational physics, and pedagogy.
PHY 596 Laboratory Training in Radiation Therapy Physics I (2-6-4). Prerequisites: BIO 266, BIO 267, PHY 330, PHY 350, PHY 360, PHY 474 (or equivalents), PHY 530, PHY 535 (may be taken concurrently), permission of instructor and departmental approval. The student will work with medical physicists and on his or her own to perform tasks required in a radiation therapy department, including quality assurance, absorbed dose calibrations, calculations, and measurements for external beams and brachytherapy.
PHY 597 Laboratory Training in Radiation Therapy Physics II (2-6-4). Prerequisites: PHY 596, permission of instructor and departmental approval. The student will work with medical physicists and on his or her own to perform tasks required in a radiation therapy department, including quality assurance, absorbed dose calibrations, calculations, and measurements for external beams and brachytherapy, as a continuation of the work started in PHY 596.
PHY 598 Project (2-6-4). Students work on an approved research problem, experimental or theoretical, under the guidance of the faculty advisor.
PHY 680 Physics of Materials (4-0-4). Binding energy of materials, heat capacity, thermal and electrical conductivity, free-electron and band theories of solids, and quantum statistics.
CHE 659 Medical Imaging (3-0-3). Introduction to signal processing, Tomographic reconstruction techniques, Ultrasound, Radionuclide imaging and MRI.

Undergraduate Courses

PHY330 (4-0-4) Introduction to Modern Physics. Theory of special relativity, wave properties of particles and particle properties of light, atomic and nuclear structure, radioactivity, semiconductors.
PHY350 (4-0-4) Electricity and Magnetism. Vector analysis; Gauss law, electrostatic potential; electric dipoles; dielectrics; Ampere law and Biot-Savart law; magnetic dipoles, law of induction, displacement currents, Maxwell equations.
PHY360 (2-4-4) Electronics Laboratory. AC and DC circuit analysis; steady states and transients; equivalent circuits; diodes, transistors and microprocessors; digital integrated circuits; sequential logic circuits.
PHY474 (4-0-4) Thermal Physics. temperature, entropy, thermal equilibrium, equations of state, thermodynamic potentials, thermodynamic stability, phase transitions, applications: fluids, electromagnetic radiation, computer simulations.
BIO 266 (3-0-3) Human Anatomy and Physiology I. Systems approach to human anatomy and physiology.
BIO 267 (0-2-1) Human Anatomy and Physiology I Laboratory. Selected exercises designed to reinforce concepts covered in BIO 266.