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 (CSU) offers a professional MS degree in physics designed for applied scientists and engineers who wish to develop competence in these rapidly advancing fields. The CSU MS in Physics program is in the "strongest professional programs" category, according to the American Institute of Physics (AIP) http://www.aip.org/professionalmasters/msreport. html . The criteria used by AIP include enrollment, graduates employability, evening courses, active external advisory committee etc.

The physics professional MS program has the following specializations: Optics and Materials and Optics and Medical Imaging. Each physics graduate student is enrolled in one and only one of the two 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. Andrew Resnick, Assistant Professor, Experimental 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. 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. Andrew Resnick, Assistant Professor, Experimental Biological Physics
Dr. Kiril Streletzky, Assistant Professor, Experimental Optics
Dr. Thomas Taylor, Associate Professor, Experimental Optics
Dr. Jacqueline Vitali, Associate Professor, Experimental Biological Physics
Dr. Ulrich Zurcher, Associate Professor, Statistical Physics
Dr. Martin Weinhous, Adjunct Faculty

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. Douglas A. Wilkinson, Department of Radiation Oncology.
Dr. Ping Xia, 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

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 660 Electronics (2-4-4). Prerequisites PHY241 (or 243 or 243H), PHY242 (or 244 or 244H). Topics covered include: AC and DC circuit analysis; steady and transient states; diodes and their application for rectification and voltage regulation; transistors (bipolar junction, FET and MOSFET) and amplifying and switching circuits; operational amplifiers; microprocessors, digital electronics and sequential logic circuits; noise (thermal, shot) analysis and management; signal processing techniques such as FFT. Students will become acquainted with electronic instrumentation: analog and digital meters, resistance and capacitance bridges, power supplies, signal generators, oscilloscopes, sensors and transducers. They will learn the basics of data acquisition and computer interfacing hardware and software (including specialized tools Lab View).
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.