PHYSICS (PHYS)

PHYS 7010 General Relativity 1: A Relativistic Theory of Gravity 3 cr
Topics include Newtonian gravity, the theory of special relativity, relativistic hydrodynamics, relativistic electrodynamics, curved space-time, tensor calculus, and Einstein's equations. This course is taught together with PHYS 4010. Students may not hold credit for both PHYS 4010 and PHYS 4020.
Equiv To: PHYS 4010, PHYS 4020

PHYS 7250 Seminar course in Advanced Physics 6 cr
Selected topics in advanced physics may be offered from time to time by the faculty or visiting lecturers. Credit for this course will be determined by the head of the department of Physics.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: consent of instructor.

PHYS 7260 Mass Spectroscopy 3 cr
Two lectures per week for one term. The course covers the techniques and applications of mass spectroscopy. Special emphasis is given to the general principles of ion optics for use in the design of modern instruments.

PHYS 7360 Medical Radiation Physics 3 cr
The relevant physics of the production and interaction of radiation beams used in both diagnostic and therapeutic medicine will be covered. Such beams included X- and g-rays, particle beams, visible and I.R. radiation, microwaves, and ultrasound.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: PHYS 4560 or consent of instructor.

PHYS 7370 Radiation Therapy Physics 3 cr
The calculations and measurements necessary to determine the radiation dose distribution in patients receiving radiotherapy will be presented. Newer treatment modalities, e.g., pion therapy and hyperthermia will be discussed.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: PHYS 4510, PHYS 4560, or consent of instructor.

PHYS 7380 Radiation Biology 3 cr
The interaction of ionizing and non-ionizing radiations with living systems. The relevance to Radiotherapy. Nuclear medicine and diagnostic radiology.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: PHYS 1020 or consent of instructor.

PHYS 7390 Radiation Protection 3 cr
Ionizing radiation including X-ray, g-ray, neutrons, alpha-, beta-, and heavy ion-particle sources, bioeffects, and protection principles are covered. Non-ionizing radiation, including laser light, radio- frequency waves, ultraviolet and infrared light, and ultrasound, sources, bioeffects, and exposure protection guidelines are studied.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: PHYS 7360 and PHYS 7380 or consent of instructor.

PHYS 7400 Linear Systems for Imaging 3 cr
Fundamental principles of image formation, analysis of the characteristics of medical images, parametric description of image quality; application to transmission radiography.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: consent of instructor.

PHYS 7410 Diagnostic Methods 3 cr
This course is an intensive introduction to the fundamentals of medical imaging using magnetic resonance imaging and ultrasound. Included is an in-depth look at the physics and mathematics of image formation. Note this course is challenging with a great deal of mathematical content.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: PHYS 7400/4400 or consent of instructor.

PHYS 7422 Physics of X-ray Imaging 3 cr
X-ray imaging is the oldest form of medical imaging, yet continues to undergo dramatic technological development and innovation. This course will cover topics related to clinical and diagnostic x-ray imaging, including: x-ray production; x-ray detection; special radiographic systems; mammography; fluroscopy; digital imaging; computed tomography and theoretical and practical aspects of image reconstruction and image quality.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: PHYS 7400/PHYS 4400 or consent of instructor.

PHYS 7430 Physics of Nuclear Medicine 3 cr
Nuclear medicine covers a range of topics from radionuclide based imaging methods to treatments through administration of radioisotopes. Knowledge of nuclear structure, radioactive decay and the interaction of radiation with matter are essential to understanding the application of radiotracer methods to medicine and the function of highly sophisticated nuclear medicine imaging equipment. This course will cover topics related to clinical and diagnostic nuclear medicine including: radioactive decay; interaction of radiation with matter; radionuclide and radiotracer production counting statistics; radiation detection systems; nuclear medicine imaging systems; emission computed tomography; image reconstruction and evaluation and radiation dosimetry.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: PHYS 7400/4400 or consent of instructor.

PHYS 7440 Advanced Topics in Physics 3 cr
Selected topics in advanced physics. This course may be offered from time to time by the faculty or visiting lecturers.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: consent of instructor.

PHYS 7460 Methods in Medical and Health Physics 1 - (Medical Imaging and Radiation Protection) 3 cr
This practical course is designed to give students hands-on experience with equipment, clinical techniques and methods of analysis in medical imaging and health physics. Topics such as: dosimetry of unsealed sources, radiation shielding design and surveys, meter calibration, decontamination and plume dispersal, CT, Ultrasound, X-ray and Nuclear Medicine imaging techniques, mammography and quality assurance in medical and health physics will be covered. Students are required to take both PHYS 7460 and PHYS 7470 which will be offered in consecutive years. Note: only students accepted to the Medical Physics Program will be allowed to register for this course

PHYS 7470 Methods in Medical and Health Physics 2 - (Radiotherapy and Radiation Biology) 3 cr
This practical course is designed to give students hands-on experience with equipment, clinical techniques and methods of analysis in radiotherapy and radiation biology. Topics such as: error analysis and data reduction, dosimetry of ionizing radiation, radiotherapy treatment planning, calibration, HDR brachytherapy, micro-dosimetry and quality assurance in medical physics, will be covered. Students are required to take both PHYS 7460 and PHYS 7470 which will be offered in consecutive years. Note: only students accepted to the Medical Physics Program will be allowed to register for this course.

PHYS 7500 Condensed Matter Physics 1 3 cr
The principles of electrical and vibrational properties of primarily crystalline structures. Topics include free electron theory, electron-electron interactions, screening, phonons, electron-phonon coupling and transport properties.

PHYS 7510 Condensed Matter Physics 2 3 cr
A comprehensive survey of advanced topics in condensed matter physics. The topics may change from year to year but include collective excitations, defects, localized states, superconductivity, Josephson effect, superfluids, quantum Hall effect.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: PHYS 7500 or consent of instructor.

PHYS 7530 Physics of Magnetism 3 cr
A comprehensive survey of magnetism and magnetic materials. Topics include the origins of magnetic interactions, types of magnetic order, domain structures, magnetization processes, dynamics, thin films, applications.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: PHYS 7500 or consent of instructor.

PHYS 7540 Statistical Mechanics 3 cr
The principles of statistical mechanics. Topics include statistical ensembles, entropy, Fermi gas, Bose-Einstein condensation, superfluidity, phase transitions and equilibria, fluctuations, Fluctuation-Dissipation and Wiener-Khintchin theorems, liquids and dense gases.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: PHYS 4390 or consent of instructor.

PHYS 7550 Advanced Statistical Mechanics 3 cr
An advanced treatment of phase transitions and critical phenomena in a variety of systems. Topics include solvable models, mean field theory, Landau theory, scaling laws, series methods, renormalization group methods, linear response theory, generalized rigidity.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: PHYS 7540 or consent of instructor.

PHYS 7560 Relativistic Quantum Mechanics 3 cr
Relativistic single particle equations for bosons and fermions, quantization of fields, interacting fields, elementary quantum electrodynamics, covariant perturbation theory and Feyman diagrams.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: PHYS 7420 or consent of instructor.

PHYS 7570 Nuclear Physics 3 cr
Hadron and lepton scattering, the nucleon-nucleon interaction, nuclear structure, nuclear shell model, nuclear excitations and decay, hadronic interactions and decays, the quark model.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: PHYS 4510 or consent of instructor.

PHYS 7580 Advanced Topics in Nuclear Physics 3 cr
A selection of advanced topics in nuclear and intermediate energy physics.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: PHYS 7570 or consent of instructor.

PHYS 7590 Electromagnetic Theory 3 cr
Maxwell's equations, electromagnetic potentials, gauge conditions, conservation laws, Green function methods, diffraction theory, simple radiating systems, Lagrangian derivation of Maxwell's equations and the covariant structure of electromagnetism.

PHYS 7600 Applied Electromagnetism 3 cr
Wave guides and resonant cavities, charged particles collision theory, Bremsstrahlung, radiation of moving charged particles, multipole radiation.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: PHYS 7590 or consent of instructor.

PHYS 7630 Particle Physics 3 cr
Basic particles and interactions, symmetries and conservation laws, the quark model, deep inelastic scattering, electroweak theory, introduction to QCD.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: PHYS 7420 or consent of instructor.

PHYS 7660 Astronomy 1: The Phenomenology of Galaxies 3 cr
Describes astronomical standards such as intensity magnitudes, colour and metalicity; the properties of stars and the interstellar medium; galactic structure, kinematics, and the evolution of galactic components.

PHYS 7670 Astronomy 2: Galactic Dynamics 3 cr
A continuation of PHYS 7660, this course provides mathematical descriptions of potential theory, disk dynamics and spiral structure, collisions between galaxies, and dark matter. Additional topics are galaxy evolution, large-scale structure of the universe and cosmology.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: PHYS 7660.

PHYS 7680 Astrophysics 1: Stars 3 cr
Covers the basic physical concepts required to extract qualitative estimates of astrophysical parameters, describes several aspects of observational astronomy, and it emphasizes in a more mathematical way the astrophysics of stellar structure and evolution.

PHYS 7690 Astrophysics 2: Interstellar Matter and Galaxies 3 cr
Emphasizes the physics of interstellar matter and dust grains, gaseous nebulae, basic hydrodynamics, shock waves, and supernova remnants.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: PHYS 7680.

PHYS 7700 Research Project in Medical Health Physics 0 cr
Students undertake a relevant research project in an approved laboratory. At least six months of full-time research is expected. The research project report shall be submitted in a style and length as specified by the department. A comprehensive oral examination will follow the submission of the project report.

PHYS 7710 Quantum Optics 6 cr
Matter-radiation interaction, spectral line broadening, quantization of the radiation field, degree of coherence of light; number, coherent, chaotic and squeezed states of light, quantum theory of detection, laser theory, resonance fluorescence, light scattering, non-linear quantum optics.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: permission of instructor.

PHYS 7720 Quantum Mechanics 1 3 cr
Topics include the concepts and foundations of quantum mechanics, continuous and discrete symmetries, time dependent perturbation theory including interaction with electromagnetic fields and scattering theory. Not to be held with the former PHYS 7420.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: PHYS 4380 (C+).