# PHYSICS (PHYS)

## Physics Graduate Courses

**PHYS 8110 REPRESENTATIONS IN PHYSICS INSTRUCTION (3 credits)**
In this course, students will integrate pedagogical knowledge with content knowledge in physics. Specifically, students will learn how to plan instruction in physics and physical science using research-based tools that target state and national science standards. Students in this class will learn what productive representations their students can use to assist them in bridging phenomena, words and mathematics. The course will focus on cross-cutting concepts in motion, forces, and energy/momentum. This course is designed for pre- and in-service teachers.
**Prerequisite(s):** PHYS 1050, PHYS 1110, PHYS 2110, or permission of the instructor.

**PHYS 8120 EXPERIMENTS IN PHYSICS INSTRUCTION (3 credits)**
In this course, students will learn to reconceptualize the role experiments play in the teaching and learning of physics. Specifically, students will learn a framework for thinking about experiments that engage understanding, and they will use this framework to plan instruction in physics and physical science that targets state and national science standards. Students in this class will also learn the role of labs and their integration, multilayered experiments, and practical aspects of experimentation. This course is designed for pre- and in-service teachers.
**Prerequisite(s):** PHYS 1050, PHYS 1110, PHYS 2110, or permission of the instructor.

**PHYS 8206 INTRODUCTION TO QUANTUM MECHANICS (3 credits)**
This course provides an introduction to the historical development of modern physics and to the Schroedinger formulation of quantum mechanics. Specific topics will include square wells potential barriers, the simple harmonic oscillator potential and the hydrogen atom. Characteristics of multi-electron atoms, including angular momentum coupling schemes, spectra and transition rules will also be included. (Cross-listed with PHYS 4200)
**Prerequisite(s):** PHYS 3250 or permission.

**PHYS 8210 TEACHING PROBLEM-SOLVING IN PHYSICS (3 credits)**
In this course, students will learn how to teach problem-solving process abilities within the context of physics. Specifically, students will learn how the Zone of Proximal Development can be used as a model for designing structured problem-solving activities that build student abilities with time and acquisition of content knowledge, leading to their students solving multi-step and multi-concept problems. Students will also learn how to assess problem-solving process in a consistent and rigorous way. Concepts include problem framing and getting students to see beyond surface features, physics representations, translating physics representations into mathematics, multi-equation and multi-concepts problems, and reflection. Content includes motion, force, energy, momentum, electric force and fields, and magnetism.
**Prerequisite(s):** PHYS 1050, PHYS 1110, PHYS 2110, or permission of the instructor.

**PHYS 8216 QUANTUM THEORY (3 credits)**
The matrix operator formalism is covered along with philosophical implications of this approach. The methods developed will be applied to simple harmonic oscillator and hydrogen atom potentials. Raising and lowering operators, creation-annihilation operators, and first and second order perturbation theory will be discussed. (Cross-listed with PHYS 4210)
**Prerequisite(s):** PHYS 4200 or permission.

**PHYS 8226 PHYSICS OF MOLECULES AND SOLIDS (3 credits)**
This course covers the various types of atomic bonding found in molecules and solids. Electronic energy levels and spectra of molecules will be discussed. Topics in solid state physics will include mechanics and thermodynamics of crystals, the scattering of waves including x-ray and neutron scattering, electron scattering and phonon and photon interactions. (Cross-listed with PHYS 4220)
**Prerequisite(s):** PHYS 4200 or permission.

**PHYS 8230 PHYSICS EDUCATION METHODS (3 credits)**
In this course, students will integrate the research on learning theories with effective educational practices in the teaching of physics. Specifically, students will learn how to implement active learning strategies that support eliciting of student ideas, listening and questioning, and relationship building. In effect, this course focuses on the 'soft' skills needed for effective teaching of physics. Students will read articles from the education literature both specific to physics and in general. They will reflect on their experiences with their own students and how this relates to the literature they read.
**Prerequisite(s):** PHYS 1050, PHYS 1110, PHYS 2110, or permission of the instructor.

**PHYS 8236 SPECIAL RELATIVITY AND NUCLEAR PHYSICS (3 credits)**
This course includes a brief historical background of the development of relativity theory and the importance of the experiments performed in conjunction with it. Lorentz transformations and covariant formalism will be developed and applied to certain problems in mechanics and electricity and magnetism. The nuclear physics portion of the course will include the historical development of the concept of the nuclear atom. Theoretical models of nuclear structure will be discussed, along with the theory of alpha, beta and gamma decay. Fission and fusion discussed as time permits. (Cross-listed with PHYS 4230)
**Prerequisite(s):** PHYS 4200 or permission.

**PHYS 8306 GENERAL RELATIVITY (3 credits)**
A study of general relativity theory and its leading applications. Physical motivations and conceptual foundations will be explored. Students will be guided step-by-step to mastery of the tensor analysis required by this theory. Topics covered will include the equivalence principle, recap of special relativity, tensors, curvature and geodesics, Einstein field equations, black holes, cosmology, and gravitational waves. (Cross-listed with PHYS 4300)
**Prerequisite(s):** PHYS 3750 and PHYS 4230, or permission of instructor.

**PHYS 8356 ASTROPHYSICS (3 credits)**
This course introduces the fundamental of astrophysics to students with a prior knowledge of physics and mathematics. A review will be given of light and telescopes, classical and quantum mechanics and special relativity. Basic laws of physics will be applied to various topics such as: the sun, nuclear fusion and particle physics, evolution and end state of stars, interstellar medium, galaxies and cosmology. (Cross-listed with PHYS 4350)
**Prerequisite(s):** PHYS 2130 or 4200 and MATH 1970. Recommended: PHYS 1350.

**PHYS 8455 CLASSICAL MECHANICS (3 credits)**
Statics and dynamics of particles and rigid bodies including the equations of Lagrange and Hamilton.
**Prerequisite(s):** MATH 1970, PHYS 3250 or permission.

**PHYS 8505 ELEMENTS OF ELECTRONICS (3 credits)**
The topics covered will include basic circuit theory, principles and operation of electronic devices such as diodes, transistors and integrated circuits. Application of these devices in various electronic circuits. Both analog and digital circuitry will be studied. (Cross-listed with PHYS 3500)
**Prerequisite(s):** PHYS 1120 or PHYS 2120 and MATH 1970

**PHYS 8506 BIOLOGICAL PHYSICS (3 credits)**
This course is designed primarily for students specializing in Biomedical Physics. As a part of Biomedical Physics program at the Department of Physics, the course introduces the fundamental principles of physics and the use of these principles for various biological applications. PHYS 4500/8506 covers various topics including cells, polymers, polyelectrolytes, membranes, mesoscopic forces, self-assembly, photonics, fluid mechanics, motility, chemical kinetics, enzyme kinetics, modern experimental techniques of biophysics. Each topic connects biomolecules with their functions and relevant biological phenomena from a physics perspective. This course will benefit students with interests in biological and medical physics, as well as chemistry, biology. (Cross-listed with PHYS 4500).
**Prerequisite(s):** PHYS 2110 or permission of instructor required. PHYS 2120 and 3300 are recommended.

**PHYS 8556 PHYSICS IN MEDICINE (3 credits)**
This course is designed primarily for students desiring to specialize in Biomedical Physics. The course introduces principles and applications of various medical imaging modalities and medical physics based therapies. Topics include such imaging techniques as ultrasound, X-ray imaging, Computed Tomography (CT), MRI imaging, and positron emission tomography. The course discusses physical principles behind medical imaging and therapeutic applications and covers interaction of different kinds of radiation with biological matter. (Cross-listed with PHYS 4550).

**PHYS 8605 THERMODYNAMICS AND STATISTICAL PHYSICS (3 credits)**
Topics include: empirical and absolute temperature, equations of state, work, heat, entropy, the four laws of thermodynamics, phase changes, thermodynamic potentials, classical and quantum statistics of an ideal gas (e.g., blackbody radiation). Possible applications to be included: Einstein theory of a solid, paramagnetism, blackbody radiation, and conduction of electrons. (Cross-listed with PHYS 3600)
**Prerequisite(s):** PHYS 2120 and MATH 1970.

**PHYS 8755 ELECTRICITY AND MAGNETISM I (3 credits)**
An advanced study of electrostatics and magnetostatics, including Coulomb's law, Gauss' law, the scalar potential, conductors and dielectrics, electrostatic energy, special methods, electric currents, Ampere's law, the magnetic induction, Faraday's law, and the electromagnetic wave equation as obtained from Maxwell's equations, with simple examples such as transmission lines and antennas. (Cross-listed with PHYS 3750)
**Prerequisite(s):** MATH 1950, MATH 1960, MATH 1970, PHYS 3250, or permission.

**PHYS 8765 ELECTRICITY AND MAGNETISM II (3 credits)**
A selection of more advanced topics from electromagnetic theory, including a deeper treatment of the electromagnetic wave equations derived from Maxwell's equations, extending to propogation, reflection, and refraction of plane waves, waves in wave guides, and radiation. Other topics covered might be magnetism and magnetic energy, plasmas, and special relativity. (Cross-listed with PHYS 3760)
**Prerequisite(s):** PHYS 3750.

**PHYS 8805 OPTICS (3 credits)**
The behavior of electromagnetic radiation as formulated in the ray, wave, and quantum models. Topics will include: reflection and refraction, vergence, matrix method, optical instruments, scalar waves, electromagnetic waves, blackbody radiation, interference, diffraction, and lasers; if time permits, fiber optics and holography will also be included. (Cross-listed with PHYS 3800)
**Prerequisite(s):** PHYS 1120 or PHYS 2120 and MATH 1970.

**PHYS 8956 PROBLEMS IN PHYSICS (1-3 credits)**
Individual laboratory and/or library work, or reading course in some field of physics. (Cross-listed with PHYS 4950, PHYS 4960, PHYS 8966)
**Prerequisite(s):** PHYS 2120 and permission of instructor.

**PHYS 8966 PROBLEMS IN PHYSICS (1-3 credits)**
Individual laboratory and/or library work, or reading course in some field of physics. (Cross-listed with PHYS 4950, PHYS 4960, PHYS 8956)
**Prerequisite(s):** PHYS 2120 and permission of instructor.