# PHYSICS (PHYS)

**PHYS 6101. Classical Mechanics I. 3 Credit Hours.**
Newtonian mechanics, Hamilton's variational principle, Lagrangian and Hamiltonian mechanics, central forces, rigid body motion, and small oscillations.

**PHYS 6103. Electromagnetism I. 3 Credit Hours.**
Static and quasistatic phenomena in electromagnetism. Boundary value problems in electrostatics and magnetostatics. Maxwell's equations.

**PHYS 6104. Electromagnetism II. 3 Credit Hours.**
Theory of generation of electromagnetic waves, their propagation, scattering, and diffraction. Covariant formulation of electrodynamics and application to radiation from charged particles.

**PHYS 6105. Quantum Mechanics I. 3 Credit Hours.**
An axiomatic development of quantum mechanics. Topics include linear vector spaces, linear operators, infinitesimal transformations, function space, representation and transformation groups.

**PHYS 6106. Quantum Mechanics II. 3 Credit Hours.**
Applications of quantum mechanics. Topics include systems with spin and angular momentum, atomic structure, time-dependent phenomena, scattering, and various methods of modeling and approximations.

**PHYS 6107. Statistical Mechanics I. 3 Credit Hours.**
Equilibrium statistical mechanics for closed and open systems. Probability distribution for classical and quantum systems. Partition functions and associated thermodynamical potentials.

**PHYS 6124. Mathematical Methods of Physics I. 3 Credit Hours.**
First of two courses on mathematical methods used in classical mechanics, electromagnetism, quantum mechanics, and statistical physics. Topics include complex analysis, vectors and matrices, and Sturm-Liouville theory.

**PHYS 6203. Solid State Physics. 3 Credit Hours.**
A first course in the physics of crystalline solids. Core topics include crystal lattices, diffraction, bonding, elastic properties, band theory, as well as others.

**PHYS 6204. Electronics I. 4 Credit Hours.**
A first course in both theoretical and applied electronics that is based on a thorough grounding in circuit as well as device physics.

**PHYS 6206. Electronics II. 4 Credit Hours.**
A course in electronic instrumentation with an emphasis on signal processing, both analog and digital, and computer interfacing.

**PHYS 6210. Condensed Matter Physics I. 3 Credit Hours.**
Introduction to condensed matter physics. Crystal structure, electronic and thermal properties, response to external electric and magnetic fields.

**PHYS 6211. Condensed Matter Physics II. 3 Credit Hours.**
Collective and many-electron properties in condensed matter systems. Topics include second quantization, magnetism, phase transitions, and superconductivity.

**PHYS 6250. Biophysics. 3 Credit Hours.**
Introduction to physical concepts connect to the workings of biological systems at a molecular level. Topics include polymer theory of proteins, diffusion, and bioelectricity.

**PHYS 6260. Computational Physics. 3 Credit Hours.**
Applications of numerical methods and computer programming to condensed matter; astrophysical hydrodynamics, gravitational physics, black holes and cosmology.

**PHYS 6262. Data Science for Physicists. 3 Credit Hours.**
Introduction to probability theory, classical statistics and machine learning, and their application to physics.

**PHYS 6265. Atomic Physics I. 3 Credit Hours.**
This course provides a detailed description of atomic structures and interactions. It contains applications of advanced quantum mechanics to problems in modern atomic physics.

**PHYS 6267. Atomic Physics II. 3 Credit Hours.**
This course will provide detailed descriptions of non-relativistic atomic/molecular scattering/reaction processes.

**PHYS 6268. Nonlinear Dynamics and Chaos. 3 Credit Hours.**
A modern introduction to nonlinear phenomena. Topics include driven oscillators, entrainment, bifurcation, fractals, and control of chaos. Examples are drawn from physical systems.

**PHYS 6567. Ultrafast Optics. 3 Credit Hours.**
A modern introduction to ultrafast optical phenomena. Topics include the generation, amplification, measurement, nonlinear optics, propagation, focusing, shaping and applications of ultrashort laser pulses.

**PHYS 6740. Estimation and Approximation in Physics. 3 Credit Hours.**
Applications of order-of-magnitude estimates, dimensional analysis, scaling arguments, and perturbation theory in different areas of physics.

**PHYS 6750. Foundations of Quantitative Biosciences. 4 Credit Hours.**
Introduction to quantitative methods and logic that enable key advances in understanding living systems, spanning molecules, cells, organisms, and biomes.

**PHYS 6771. Optoelectronics: Materials, Processes, Devices. 3 Credit Hours.**
Optoelectronic materials, physical processes, and devices. Includes compound semiconductor materials, excitation, recombination, gain, and modulation processes, and devices such as emitters, detectors, and modulators. Crosslisted with ECE 6771.

**PHYS 6801. Grant Writing and Navigating the Scientific Landscape. 3 Credit Hours.**
An introduction to the skills of a professional scientist both within academia and beyond, focusing on preparing grants and proposals, scientific communication and career preparation.

**PHYS 6XXX. Physics Elective. 1-21 Credit Hours.**

**PHYS 7000. Master's Thesis. 1-21 Credit Hours.**

**PHYS 7123. Statistical Mechanics II. 3 Credit Hours.**
Principles of nonequilibrium statistical mechanics, both classical and quantal. Emphasis is on the dynamics of fluctuations, their measurement, and their relationship to transport properties.

**PHYS 7125. Introduction to Relativity. 3 Credit Hours.**
The theory of gravity, describing how matter curves spacetime and spacetime guides matter, with its experimental and theoretical applications.

**PHYS 7127. Cosmology & Galaxies. 3 Credit Hours.**
Overview of the relevant physics that govern cosmological processes, and galaxy formation and evolution. Topics include inflation, gravitational collapse, large-scale clustering, and galaxy mergers.

**PHYS 7129. High-Energy Astrophysics. 3 Credit Hours.**
Introduction to high-energy astrophysical processes and environments, including astrophysical fluid dynamics (e.g., shocks and blast waves), accretion onto compact objects, and clusters of galaxies.

**PHYS 7141. Many-Particle Quantum Mechanics. 3 Credit Hours.**
Quantum mechanics of interacting Fermi and Bose particles. Topics include second quantization, diagrammatic purturbation theory, variational methods, and path integrals.

**PHYS 7143. Group Theory and Quantum Mechanics. 3 Credit Hours.**
Foundations of group representation theory with applications in atomic, molecular, nuclear, and solid state physics.

**PHYS 7147. Quantum Field Theory. 3 Credit Hours.**
Introduction to quantum field theory, with an emphasis in quantum electrodynamics. Second quantization, Dirac equation, Feynman diagrams, quantum electrodynamics, electro-weak interactions.

**PHYS 7222. Quantum Optics I. 3 Credit Hours.**
Basic course on the interaction of light with matter, based on quantum theory. Applications to the laser and to the study of coherence properties of light.

**PHYS 7223. Quantum Optics II. 3 Credit Hours.**
Advanced treatment of the interaction of light with matter using modern methods of open quantum systems. Applications to current research.

**PHYS 7224. Nonlinear Hamiltonian Dynamics and Chaos. 3 Credit Hours.**
A course on nonlinear dissipative dynamical systems, with an emphasis in aspects relevant to physicists. Topics include bifurcation theory, attractors, renormalization group techniques, and pattern formation.

**PHYS 7268. Spatio-Temporal Dynamics and Pattern Formation. 3 Credit Hours.**
A theoretical description of dynamics and pattern formation in physical, chemical and biological systems driven out of equilibrium. Topics include linear and weakly nonlinear analysis of patterns, bifurcation theory and amplitude equations.

**PHYS 7741. Robotics Professional Preparation. 1 Credit Hour.**
Preparation for a professional career in Robotics. Local & visiting speakers. Program introduction. Technical resume preparation. GT Robotics labs & resources.

**PHYS 7742. Robotics Professional Preparation 2. 1 Credit Hour.**
Preparation for a professional career in Robotics. Local & visiting speakers. Selecting and applying for Internship. Developing capstone project proposal. Public speaking practice and preparation.

**PHYS 7743. Robotics Professional Preparation 3. 1 Credit Hour.**
Preparation for a professional career in Robotics. Local & visiting speakers. Interview preparation & career search. Technical report writing and presentation.

**PHYS 8001. Seminar. 1 Credit Hour.**
Representative research programs in the School are described by advanced graduate students, post-doctoral fellows, and faculty members. The experimental basis of physics is illustrated through accounts of great experiments of importance to contemporary research.

**PHYS 8002. Graduate Student Seminar. 2 Credit Hours.**
Representative research programs in the School are described by advanced graduate students, post-doctoral fellows, and faculty members. The experimental basis of physics is illustrated through accounts of great experiments of importance to contemporary research.

**PHYS 8740. Robotics Internship. 1-21 Credit Hours.**
Graduate Internship at a partner company, GTRI or a GT Robotics lab.

**PHYS 8741. Robotics Capstone Project. 3 Credit Hours.**
Teams or individuals apply the knowledge and skills acquired throughout the MS program to a faculty supervised robotics project.

**PHYS 8801. Special Topics. 1 Credit Hour.**

**PHYS 8802. Special Topics. 2 Credit Hours.**

**PHYS 8803. Special Topics. 3 Credit Hours.**

**PHYS 8804. Special Topics. 4 Credit Hours.**

**PHYS 8805. Special Topics. 5 Credit Hours.**

**PHYS 8813. Special Topics. 3 Credit Hours.**
Courses in special topics of current interest in physics are presented from time to time.

**PHYS 8814. Special Topics. 4 Credit Hours.**
Special Topics for Physics (lecture + supervised lab).

**PHYS 8823. Special Topics. 3 Credit Hours.**
Courses in special topics of current interest in physics are presented from time to time.

**PHYS 8833. Special Topics. 3 Credit Hours.**
Courses in special topics of current interest in physics are presented from time to time.

**PHYS 8901. Special Problems. 1-21 Credit Hours.**

**PHYS 8991. Master's Practicum. 1-21 Credit Hours.**

**PHYS 8992. Master's Practicum. 1-21 Credit Hours.**

**PHYS 8993. Master's Practicum. 1-21 Credit Hours.**

**PHYS 8997. Teaching Assistantship. 1-9 Credit Hours.**
For graduate students holding a graduate teaching assistantship.

**PHYS 8998. Research Assistantship. 1-9 Credit Hours.**
For graduate students holding a graduate research assistantship.

**PHYS 9000. Doctoral Thesis. 1-21 Credit Hours.**