Physics (PY)

PY 123 Stellar and Galactic Astronomy (3 credit hours)
Introductory, descriptive survey of stars, galaxies and cosmology, designed primarily for non-science majors. Exotic recent discoveries such as quasars, pulsars, and black holes will be included. Complements PY 124, Solar System Astronomy. Companion laboratory course PY 125.

GEP Natural Sciences
Typically offered in Fall and Spring

PY 124 Solar System Astronomy (3 credit hours)
Introductory, descriptive survey of the solar system designed primarily for non-science majors, including current results from space probes, history of astronomy, and the motions of the moon, stars, and planets in the night sky. Complementary course covering stars, galaxies and cosmology (PY 123). Companion laboratory course (PY 125).

GEP Natural Sciences
Typically offered in Fall and Spring

PY 125 Astronomy Laboratory (1 credit hours)
Introduction to astronomical observing. Twelve exercises include astronomical instruments; the nature of light; Kepler's and Newton's laws of motion; the constellations, planets, binary stars, stellar clusters, and galaxies. Use of small telescopes to observe celestial objects.

Corequisite: PY 123 or 124
GEP Natural Sciences
Typically offered in Fall and Spring

PY 131 Conceptual Physics (4 credit hours)
Fundamentals of physics from a conceptual rather than a mathematical viewpoint. Applications of physics to everyday phenomena and experiences. Numerous demonstrations and discovery-based laboratory. Mechanics, properties of matter, heat, sound, electricity and magnetism, light and relativity.

GEP Natural Sciences
Typically offered in Fall, Spring, and Summer

PY 201 University Physics I (4 credit hours)
First course of three semester sequence for students majoring in physical and mathematical sciences. Calculus used throughout. Principles of classical Newtonian mechanics covered in detail.

Corequisite: MA 141. Credit is not allowed for both PY 201 and PY 205 or PY 211.
Typically offered in Fall only

PY 202 University Physics II (4 credit hours)
Second course of three semester sequence designed primarily for students majoring in physical and mathematical sciences. Calculus used throughout. Principles of electricity and magnetism covered in detail.

Prerequisite: PY 201, MA 141, Corequisite: MA 241. Credit is not allowed for both PY 202 and PY 208 or PY 211.
Typically offered in Spring only

PY 203 University Physics III (4 credit hours)
Third course of three semester sequence designed primarily for students majoring in physical and mathematical sciences. Calculus is used throughout. Principles of wave optics and modern physics are covered in detail.

Prerequisite: PY 202, MA 241, Corequisite: MA 242
Typically offered in Fall only

PY 205 Physics for Engineers and Scientists I (3 credit hours)
First semester of a two-semester sequence in introductory physics, with coordinated problem-solving experiences. A calculus-based study of mechanics, sound and heat. Credit not allowed for more than one of PY 205, PY 201, and PY 211.

Prerequisite: MA 141 with a grade of C- or better or MA 241PL. Credit is not allowed for both PY 205 and PY 201 or PY 211. Co-requisite: PY 206. ADD BOTH PY 205 and PY 206 TO YOUR SHOPPING CART AND THEN ENROLL SIMULTANEOUSLY
GEP Natural Sciences
Typically offered in Fall, Spring, and Summer

PY 206 Physics for Engineers and Scientists I Laboratory (1 credit hours)
Laboratory course to accompany the PY 205 lecture course. A calculus-based study of mechanics, sound and heat.

Prerequisite: MA 141 with a grade of C- or better or MA 241 Placement. Co-requisite: PY 205. ADD BOTH PY 205 and PY 206 TO YOUR SHOPPING CART AND THEN ENROLL SIMULTANEOUSLY
GEP Natural Sciences
Typically offered in Fall, Spring, and Summer

PY 208 Physics for Engineers and Scientists II (3 credit hours)
Second semester of a two-semester sequence in introductory physics. A calculus-based study of electricity, magnetism, optics and modern physics. Credit not allowed for more than one of PY 208,PY 202, and PY 212

Prerequisite: C- or better in PY 205 and C- or better in MA 241. Credit is not allowed for both PY 208 and PY 202 or PY 212. Co-requisite: PY 209. ADD BOTH PY 208 and PY 209 TO YOUR SHOPPING CART AND THEN ENROLL SIMULTANEOUSLY
GEP Natural Sciences
Typically offered in Fall, Spring, and Summer

PY 209 Physics for Engineers and Scientists II Laboratory (1 credit hours)
Laboratory course to accompany the PY 208 lecture course. A calculus-based study of electricity, magnetism, optics and modern physics.

Pre-requisite: PY 205 with grade of C- or better, MA 241 with grade of C- or better, PY 206 with grade of C- or better. Co-requisite: PY 208. ADD BOTH PY 208 and PY 209 TO YOUR SHOPPING CART AND THEN ENROLL SIMULTANEOUSLY
GEP Natural Sciences
Typically offered in Fall, Spring, and Summer

PY 211 College Physics I (4 credit hours)
First semester of a two-semester introductory sequence in non-calculus physics, with laboratory. Mechanics, heat, wave motion and sound. Credit not allowed for more than one of PY 211, PY 201 or PY 205

Prerequisite: MA 107 or 111 or 121 or 131 or 108 or 141 with a C- or better, or 480 on the SAT Subject Test in Mathematics Level 2 or the NCSU Math Skills Test, or 2 or better on an AP Calc exam. Credit is not allowed for both PY 211 & PY 201 or PY 205
GEP Natural Sciences
Typically offered in Fall, Spring, and Summer

PY 212 College Physics II (4 credit hours)
Second semester of a two-semester introductory sequence in non-calculus physics, with laboratory. Electricity, and magnetism, light, modern physics. Credit not allowed for more than one of PY 212, PY 202, and PY 208

Prerequisite: PY 211 or PY 205. Credit is not allowed for both PY 212 and PY 202 or PY 208.
Typically offered in Fall, Spring, and Summer

PY 251 Introduction to Scientific Computing (3 credit hours)
An introductory course in scientific computing for the physical and mathematical sciences using python and other open-source tools. Using a problem-oriented approach, students will learn the basic computing skills needed to conduct scientific research and to prepare for upper-level courses in science and engineering. Topics will include algorithm development, numerical methods, elements of programming, data analysis, and data visualization.

Prerequisite: MA 241; Corequisite: PY 202 or PY 208
Typically offered in Fall and Spring

PY 252 Instrumental and Data Analysis for Physics (2 credit hours)
Digital data acquisition and lab computers (e.g. using LabView or MatLab) are tools used in nearly all current physics research labs. By using both analysis and thorough lab experimental investigation the student will learn basic skills with electronic devices (oscilloscope, power supplies, function generator, op-amps, high & low-pass filters, feedback circuits), electronic noise (measurement and analysis), and basic circuit construction methods (such as shielding/grounding, soldering).

Prerequisite: PY 202 or PY 208
Typically offered in Fall, Spring, and Summer

PY 299 Special Problems in Physics (1-3 credit hours)
Study in experimental or analytical topics in classical and modern physics.

Typically offered in Fall, Spring, and Summer

PY 301 Introduction to Quantum Mechanics (3 credit hours)
An introduction to wave mechanics and quantum phenomena including the Schroedinger equation for simple systems, the Hamiltonian operator, the use of commutator relations, and the application of angular momentum operators. Emphasis on mathematical tools used in wave mechanics, including complex numbers, function operators, eigenvalues and eigenvectors.

Prerequisite: C- or better in PY 203 or PY 407
Typically offered in Fall only

PY 328 Stellar and Galactic Astrophysics (3 credit hours)
Introduction to the study of stars, galaxies, and the universe. Stars and stellar evolution; interstellar medium; galaxies and galaxy clusters; cosmology. Recent developments in the understanding of neutron stars, black holes, active galaxies, quasars and inflationary cosmologies.

Prerequisite: PY 202 or PY 208
Typically offered in Fall only

PY 341 Relativity, Gravitation and Cosmology (3 credit hours)
Introduction to relativity, gravitation and cosmology in accordance with Einstein's special and general theories of relativity. Flat spacetime: Minkowski metric, time dilation, length contraction, doppler effect, twin paradox, and space travel. Curved spacetime: Schwarzchild metric, black holes and event horizons, particle and light motion, Global positioning system, precession of planetary orbits. Cosmology: hubble law, expansion of the universe, Friedman-Robertson-Walker metric, big bang, cosmological redshift, dark matter and dark energy.

Prerequisite: C- or better in PY 203 or PY 407
Typically offered in Spring only

PY 401 Quantum Physics I (3 credit hours)
An introduction to the basic principles of quantum physics with an emphasis on selected applications to atoms, molecules, solids, nuclei and elementary particles.

Prerequisite: Grade of C- or better in PY 411 and grade of C- or better in PY 203.
Typically offered in Spring only

PY 402 Quantum Physics II (3 credit hours)
An introduction to the basic principles of quantum physics with an emphasis on selected applications to atoms, molecules, solids, nuclei and elementary particles.

Prerequisite: C- or better in PY 401
Typically offered in Fall only

PY 407 Introduction to Modern Physics (3 credit hours)
Major developments in modern physics: special relativity, origin of the quantum theory, atomic and molecular structure, radioactivity, properties of nuclei. Credit not allowed for both PY 203 and PY 407

Prerequisite: MA 242, PY 208
Typically offered in Spring only

PY 411/PY 511 Mechanics I (3 credit hours)
First semester of a two-semester sequence in particle and continuum mechanics at the intermediate level. Focuses on single-particle dynamics: Elementary Newtonian mechanics, harmonic oscillator, central force motion, conservation laws, motion in non-inertial frames, Coriolis and centrifugal forces, Lagrangian dynamics, Hamilton's equations.

Prerequisite: C- or better in PY 203 or C- or better in PY 407 Co-requisite: MA 341
Typically offered in Spring only

PY 412/PY 512 Mechanics II (3 credit hours)
Second semester of a two-semester sequence in particle and continuum mechanics at the intermediate level. Focuses on dynamics of systems of particles and continua: Center of mass, collisions, rigid bodies, inertia tensor, principal axes, stress andstrain tensors, mechanical properties of fluids and solids; Waves in discrete and continuum systems, coupled oscillators, normal modes, elements of special relativity.

Prerequisite: C- or better in PY 411
Typically offered in Fall only

PY 413 Thermal Physics (3 credit hours)
An introduction to statistical mechanics and thermodynamics. The statistical study of physical systems emphasizing the connection between the statistical description of macroscopic systems and classical thermodynamics. Concepts of heat, internal energy, temperature and entropy. Classical and quantum statistical distributions.

Prerequisite: PY 203 or PY 407; Corequisite: MA 341
Typically offered in Spring only

PY 414/PY 514 Electromagnetism I (3 credit hours)
First semester of a two-semester sequence. An intermediate course in electromagnetic theory using the methods of vector calculus. Electrostatic field and potential, dielectrics, solution to Laplace's and Poisson's equations, magnetic fields of steady currents.

Prerequisite: C- or better in PY 203 or C- or better in PY 407, and MA 341
Typically offered in Fall only

PY 415/PY 515 Electromagnetism II (3 credit hours)
A continuation of PY 414. Electromagnetic induction, magnetic fields in matter, Maxwell's equations, wave guides, radiation.

Prerequisite: C- o better in PY 414
Typically offered in Spring only

PY 452 Advanced Physics Laboratory (3 credit hours)
Introduction to laboratory electronics and instrumentation. Experiments in mechanics; electromagnetism; electronics; optics; and atomic, nuclear, plasma and solid state physics. Senior Physics students only

Prerequisite: Senior standing, Physics Majors
Typically offered in Fall and Spring

PY 489/PY 589/ECE 489/ECE 589/MSE 489/MSE 589 Solid State Solar and Thermal Energy Harvesting (3 credit hours)
This course studies the fundamental and recent advances of energy harvesting from two of the most abundant sources, namely solar and thermal energies. The first part of the course focuses on photovoltaic science and technology. The characteristics and design of common types of solar cells is discussed, and the known approaches to increasing solar cell efficiency will be introduced. After the review of the physics of solar cells, we will discuss advanced topics and recent progresses in solar cell technology. The second part of the course is focused on thermoelectric effect. The basic physical properties, Seebeck coefficient, electrical and thermal conductivities, are discussed and analyzed through the Boltzmann transport formalism. Advanced subject such as carrier scattering time approximations in relation to dimensionality and the density of states are studied. Different approaches for further increasing efficiencies are discussed including energy filtering, quantum confinement, size effects, band structure engineering, and phonon confinement.

P: ECE 302 or E 304 or MSE 355 or PY 407
Typically offered in Spring only

PY 495 Special Topics in Physics (1-4 credit hours)
Special Topics in theoretical, experimental, or computational physics at the advanced undergraduate level. Course offerings vary from semester to semester. Course may be repeated if course content varies.

Typically offered in Fall, Spring, and Summer

PY 499 Independent Research in Physics (1-6 credit hours)
Study and research in physics. Topics for experimental or theoretical investigation. Individualized/Independent Study and Research courses require a Course Agreement for Students Enrolled in Non-Standard Courses be completed by the student and faculty member prior to registration by the department.

Typically offered in Fall, Spring, and Summer

PY 501 Quantum Physics I (3 credit hours)
Basic principles of quantum physics with emphasis on selected applications to atoms, molecules, solids, nuclei and elementary particles. PY 501 - first semester in two-semester sequence in quantum mechanics; PY 501 - second semester of sequence. Credit for both PY 401 and PY 501 is not allowed

Prerequisite: Graduate Level Status in Physics or Physics Departmental Approval
Typically offered in Spring only

PY 502 Quantum Physics II (3 credit hours)
Basic principles of quantum physics with emphasis on selected applications to atoms, molecules, solids, nuclei and elementary particles. PY 502 - second semester in two-semester sequence in quantum mechanics; PY 501, first semester of sequence. Credit for both PY 402 and PY 502 is not allowed.

Prerequisite: PY 501
Typically offered in Fall only

PY 506 Nuclear and Subatomic Physics (3 credit hours)
Introduction to nuclear and subatomic phenomena: properties of nuclear radiations and detectors, accelerators, nuclear forces and nuclear structure, elementary particles, fundamental symmetries and conservation laws.

Prerequisite: PY 203 or 407; PY 412
Typically offered in Fall only

PY 507 Elementary Particle Physics (3 credit hours)
Introduction to fundamental symmetries and dynamics of quarks and leptons. The Standard Model, Dirac equation, Feynman rules in QED and QCD, the Higgs mechanism and electroweak unification.

Prerequisite: PY 401 and PY 506
Typically offered in Spring only

PY 509 General Relativity (3 credit hours)
This course provides in-depth knowledge of general relativity covering: Einstein's equation, Schwarzschild metric, Kerr metric, Friedman-Robertson-Walker metric, Christoffel symbols, Killing vectors, Riemann curvature,and Ricci tensors. Theoretical computations are compared with experimental data including the precession rate of the perihelion for Mercury and the deflection in the solar eclipse, the geodelic affect and the frame dragging effect measured in Gravity Probe B experiment.

P: MA 401 and MA 405 and PY 412 and PY 415; R: Graduate Standing
Typically offered in Spring only

PY 511/PY 411 Mechanics I (3 credit hours)
First semester of a two-semester sequence in particle and continuum mechanics at the intermediate level. Focuses on single-particle dynamics: Elementary Newtonian mechanics, harmonic oscillator, central force motion, conservation laws, motion in non-inertial frames, Coriolis and centrifugal forces, Lagrangian dynamics, Hamilton's equations.

Prerequisite: C- or better in PY 203 or C- or better in PY 407 Co-requisite: MA 341
Typically offered in Spring only

PY 512/PY 412 Mechanics II (3 credit hours)
Second semester of a two-semester sequence in particle and continuum mechanics at the intermediate level. Focuses on dynamics of systems of particles and continua: Center of mass, collisions, rigid bodies, inertia tensor, principal axes, stress andstrain tensors, mechanical properties of fluids and solids; Waves in discrete and continuum systems, coupled oscillators, normal modes, elements of special relativity.

Prerequisite: C- or better in PY 411
Typically offered in Fall only

PY 514/PY 414 Electromagnetism I (3 credit hours)
First semester of a two-semester sequence. An intermediate course in electromagnetic theory using the methods of vector calculus. Electrostatic field and potential, dielectrics, solution to Laplace's and Poisson's equations, magnetic fields of steady currents.

Prerequisite: C- or better in PY 203 or C- or better in PY 407, and MA 341
Typically offered in Fall only

PY 515/PY 415 Electromagnetism II (3 credit hours)
A continuation of PY 414. Electromagnetic induction, magnetic fields in matter, Maxwell's equations, wave guides, radiation.

Prerequisite: C- o better in PY 414
Typically offered in Spring only

PY 516 Physical Optics (3 credit hours)
Physical optics with major emphasis on wave properties of light. Boundary conditions, interference and diffraction, optics of thin films, fiber optics and applications to absorption, scattering and laser operation. A background in Maxwell's equations and vector analysis required.

Prerequisite: PY 415
Typically offered in Fall only

PY 517 Atomic and Molecular Physics (3 credit hours)
The quantum mechanical treatment of structure and spectra for atoms and molecules. The hydrogen atom, helium atom, multielectron atoms, selection rules, diatomic and simple polyatomic molecules and nuclear magnetic resonance spectroscopy.

Prerequisite: PY 401, 412
Typically offered in Spring only

PY 519 Biological Physics (3 credit hours)
This course presents the application of physics principles and methods to problems in biological systems. Important biological molecules, their structures and their processes are introduced for physical scientists. Functional mechanisms are analyzed with concepts from thermodynamics, statistical mechanics, fluid mechanics, and electrostatics. Modern experimental methods and computational approaches to molecular and cellular level biological phenomena are emphasized.

Prerequisite: PY 413 or Graduate Standing
Typically offered in Spring only

PY 525 Computational Physics (3 credit hours)
Computational approach to physics problem solving using standard software relevant for physicists. Electrostatic potentials, data analysis, Monte Carlo simulations, Fourier optics, particle orbits, Schrodinger's equation. Examples and assignments for each topic chosen to complement other physics courses.

Prerequisite: CSC 112 or equivalent; Corequisite: of PY 401
Typically offered in Fall only

PY 528/NE 528 Introduction to Plasma Physics and Fusion Energy (3 credit hours)
Concepts in plasma physics, basics of thermonuclear reactions; charged particle collisions, single particle motions and drifts, radiation from plasmas and plasma waves, fluid theory of plasmas, formation and heating of plasmas, plasma confinement, fusion devices and other plasma applications.

Prerequisite: MA 401 and PY 208
Typically offered in Fall only

PY 529/NE 529 Plasma Physics and Fusion Energy II (3 credit hours)
This course expands on the treatment of plasmas as a system of coupled fluids and introduces the foundations of plasma kinetic theory. Derivation of the plasma kinetic equation and the Vlasov equation serve as the starting point to introduce the kinetic study of plasma systems. From this introduction of the governing equations for full kinetic treatment, methods for analyzing plasma response to electromagnetic and electrostatic perturbations using the linearized Vlasov model for uncorrelated plasmas are introduced. Kinetic stability of Vlasov plasmas is introduced and the Nyquist method is used to determine conditions for kinetic stability. The concept of correlated plasmas is then introduced through the introduction of reduced distribution functions and the BBGKY heirarchy. Finally, simple correlated systems and the Liouville model for two-system correlation is covered to look at the impact of particle correlation due to collisions and coulomb interaction.

Prerequisite: NE 528
Typically offered in Spring only

PY 543 Astrophysics (3 credit hours)
Basic physics necessary to investigate, from observational data, internal conditions and evolution of stars. The formation and structure of spectral lines, methods of energy generation and transport, stellar structure, degeneracy, white dwarfs and neutron stars.

Prerequisite: PY 203 or 407; PY 411
Typically offered in Spring only

PY 552 Condensed Matter Physics I (3 credit hours)
Basic considerations of crystalline solids, metals, conductors and semiconductors.

Prerequisite: C- or better in PY 401
Typically offered in Spring only

PY 570/TE 570 Polymer Physics (3 credit hours)
Polymer microstructures, polymer solutions, polymer physical states (including amorphous polymers, crystalline polymers, polymer melts, melting of polymers, glass-transition, and other transitions), polymer blends, polymer mechanical properties, polymer viscoelasticity and flow, multicomponent polymer systems, and modern polymer topics. The physics of polymer fibers. Graduate standing or permission of instructor.

Typically offered in Fall only

PY 581 Matter & Interactions for Teachers I (3 credit hours)
First semester (mechanics) of a two-semester sequence intended to broaden and deepen in high school physics teachers their knowledge of introductory-level physics from a contemporary point of view. Includes an introduction to computational physics.Departmental permission required: normally restricted to in-service high school physics teachers.

Typically offered in Spring only

PY 582 Matter & Interactions for Teachers II (3 credit hours)
Second semester (electricity and magnetism) of a two-semester sequence intended to broaden and deepen in high school physics teachers their knowledge of introductory-level physics from a contemporary point of view. Includes an introduction to computational physics. Departmental permission required: normally restricted to in-service high school physics teachers. PY 581 prerequisite may be waived with strong background in physics and mathematics.

Typically offered in Fall only

PY 589/ECE 489/ECE 589/MSE 489/MSE 589/PY 489 Solid State Solar and Thermal Energy Harvesting (3 credit hours)
This course studies the fundamental and recent advances of energy harvesting from two of the most abundant sources, namely solar and thermal energies. The first part of the course focuses on photovoltaic science and technology. The characteristics and design of common types of solar cells is discussed, and the known approaches to increasing solar cell efficiency will be introduced. After the review of the physics of solar cells, we will discuss advanced topics and recent progresses in solar cell technology. The second part of the course is focused on thermoelectric effect. The basic physical properties, Seebeck coefficient, electrical and thermal conductivities, are discussed and analyzed through the Boltzmann transport formalism. Advanced subject such as carrier scattering time approximations in relation to dimensionality and the density of states are studied. Different approaches for further increasing efficiencies are discussed including energy filtering, quantum confinement, size effects, band structure engineering, and phonon confinement.

P: ECE 302 or E 304 or MSE 355 or PY 407
Typically offered in Spring only

PY 590 Special Topics In Physics (1-6 credit hours)
Investigations in physics under staff guidance. May consist of literature reviews, experimental or theoretical projects or special topics lectures. Credits Arranged

Typically offered in Fall, Spring, and Summer

PY 599 Special Topics in Physics (1-6 credit hours)
Investigations in physics under staff guidance. May consist of literature reviews, experimental or theoretical projects or special topics lectures. Credits arranged

Typically offered in Fall, Spring, and Summer

PY 601 Seminar (1 credit hours)
Reports on topics of current interest in physics. Several sections offered so that students with common research interests may be grouped together.

Typically offered in Fall and Spring

PY 610 Special Topics (1-6 credit hours)
Investigations in physics under staff guidance. May consist of literature reviews, experimental or theoretical projects or special topics lectures. Credits Arranged.

Typically offered in Fall and Spring

PY 693 Master's Supervised Research (1-9 credit hours)
Instruction in research and research under the mentorship of a member of the Graduate Faculty.

Prerequisite: Master's student
Typically offered in Spring only

PY 695 Master's Thesis Research (1-9 credit hours)
Thesis Research

Prerequisite: Master's student
Typically offered in Fall, Spring, and Summer

PY 699 Master's Thesis Preparation (1-9 credit hours)
For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis. Credits Arranged

Prerequisite: Master's student
Typically offered in Fall, Spring, and Summer

PY 711 Advanced Quantum Mechanics I (3 credit hours)
Introduction to relativistic quantum theory of Dirac particles and the positron. Other topics including second quantization technique and its application to many-body problems, radiation theory and quantization of the electromagnetic field.

Prerequisite: MA 512, PY 782
Typically offered in Fall only

PY 712 Advanced Quantum Mechanics II (3 credit hours)
A general propagator treatment of Dirac particles, photons and scalar and vector mesons. Applications of Feynman graphs and rules illustrating basic techniques employed in treatment of electromagnetic, weak and strong interactions. Renormalization theory, the effects of radiative corrections and aspects of the general Lorentz covariant theory of quantized fields.

Prerequisite: PY 711
Typically offered in Spring only

PY 721 Statistical Physics I (3 credit hours)
Basic elements of kinetic theory and equilibrium statistical mechanics, both classical and quantum; applications of the techniques developed to various ideal models of noninteracting particles.

Prerequisite: PY 401, PY 413
Typically offered in Spring only

PY 722 Statistical Physics II (3 credit hours)
A continuation of PY 721, with emphasis on the static and dynamic properties of real (interacting) systems. Topics including equilibrium theory of fluids and linear response theory of time-dependent phenomena.

Prerequisite: PY 721
Typically offered in Fall only

PY 753 Condensed Matter Physics II (3 credit hours)
The properties of semiconductors, superconductors, magnets, ferroelectrics and crystalline defects and dislocations.

Prerequisite: PY 552
Typically offered in Fall only

PY 781 Quantum Mechanics I (3 credit hours)
Fundamental concepts and formulations, including interpretation and techniques, and the application of theory to simple physical systems, such as the free particle, the harmonic oscillator, the particle in a potential well and central force problems. Other topics including approximation methods, identical particles and spin, transformation theory, symmetries and invariance, and an introduction to quantum theory of scattering and angular momentum.

Prerequisite: MA 512; PY 411 or 414; Graduate standing
Typically offered in Fall only

PY 782 Quantum Mechanics II (3 credit hours)
Fundamental concepts and formulations, including interpretation and techniques, and the application of theory to simple physical systems, such as the free particle, the harmonic oscillator, the particle in a potential well and central force problems. Other topics including approximation methods, identical particles and spin, transformation theory, symmetries and invariance, and an introduction to quantum theory of scattering and angular momentum.

Prerequisite: MA 512; PY 411 or 414; Graduate standing
Typically offered in Spring only

PY 783 Advanced Classical Mechanics I (3 credit hours)
Introduction to theoretical physics in preparation for advanced study. Emphasis on classical mechanics, special relativity and the motion of charged particles. Topics including variational principles, Hamiltonian dynamics and canonical transformation theory, structure of the Lorentz group and elementary dynamics of unquantized fields.

Prerequisite: MA 512, PY 412, PY 414; Graduate standing
Typically offered in Fall only

PY 785 Advanced Electricity and Magnetism I (3 credit hours)
Topics including techniques for solution of potential problems, development of Maxwell's equations; wave equations, energy, force and momentum relations of an electromagnetic field; covariant formulation of electrodynamics; radiation from accelerated charges.

Prerequisite: PY 415; Graduate standing
Typically offered in Fall only

PY 786 Advanced Electricity and Magnetism II (3 credit hours)
Topics including techniques for solution of potential problems, development of Maxwell's equations; wave equations, energy, force and momentum relations of an electromagnetic field; covariant formulation of electrodynamics; radiation from accelerated charges.

Prerequisite: PY 415; Graduate standing
Typically offered in Spring only

PY 790 Special Topics in Physics (1-99 credit hours)

PY 801 Seminar (1 credit hours)
Reports on topics of current interest in physics. Several sections offered so that students with common research interests may be grouped together.

Typically offered in Fall and Spring

PY 810 Special Topics In Physics (1-6 credit hours)
Investigations in physics under staff guidance. May consist of literature reviews, experimental or theoretical projects or special topics lectures. Credits Arranged

Typically offered in Fall and Spring

PY 885 Doctoral Supervised Teaching (1-3 credit hours)
Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment and evaluate the student upon completion of the assignment.

Prerequisite: Doctoral student
Typically offered in Spring only

PY 893 Doctoral Supervised Research (1-9 credit hours)
Instruction in research and research under the mentorship of a member of the Graduate Faculty.

Prerequisite: Doctoral student
Typically offered in Spring only

PY 895 Doctoral Dissertation Research (1-9 credit hours)
Dissertation Research

Prerequisite: Doctoral student
Typically offered in Fall, Spring, and Summer

PY 896 Summer Dissertation Research (1 credit hours)
For graduate students whose programs of work specify no formal course work during a summer session and who will be devoting full time to thesis research.

Prerequisite: Doctoral student
Typically offered in Summer only

PY 899 Doctoral Dissertation Preparation (1-9 credit hours)
For students who have completed all credit hour requirements, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

Prerequisite: Doctoral student
Typically offered in Fall, Spring, and Summer