Physics

The Department of Physics offers a program leading to the Bachelor of Science degree. An undergraduate minor is also available.

The goals of the Physics program are to:

1. provide students with a solid foundation in classical and modern physics;
2. develop skills which enable students to enter careers in business, teaching, research, and technology;
3. prepare students for graduate study in physics.

Courses offered at the 100 level are for non-majors, and can be used to fulfill General Education program requirements, and require minimal math preparation.

Students should also be aware of the University requirements for the Bachelor's degree. All students must complete a minimum of 40 semester hours at the 300 level.

All 300-level courses in Physics are offered in the evening.

Facilities available to students include computer workstations, a BEOWULF supercomputer, a scanning tunneling microscope, a wide array of sophisticated electronic, nuclear, and optical instruments, a Mössbauer effect apparatus, a fully equipped cryogenics laboratory, a fully equipped optics laboratory including a Spiricon Laser Beam Analyzer, a vacuum laboratory, and a 14” reflecting telescope. Students are encouraged to undertake independent projects of their own choosing.

Qualified undergraduate majors and minors are eligible to apply for a limited number of tuition waivers, scholarships, and part-time jobs offered. Please contact the Physics advisor for information and application forms.

Newly admitted students-at-large, and all entering freshmen and transfer students who intend to major in physics must consult the Physics advisor or the Physics Department chair before their first registration.

- Major in Physics (http://catalog.neiu.edu/arts-sciences/physics/physics/)
- Minor in Physics (http://catalog.neiu.edu/arts-sciences/physics/minor-physics/)
- Major in Environmental Science (http://catalog.neiu.edu/arts-sciences/physics/environmental-science/)

Greg Anderson, Ph.D., Professor, Chair
Paulo Acioli, Ph.D., Professor
Orin M. Harris, Ph.D., Associate Professor
Sudha Srinivas, Ph.D., Professor

PHYS-103. Introduction To Astronomy. 3 Hours.
An introduction to the field of Astronomy. Course topics include: the history of astronomy and the philosophy of science; methods of observational astronomy; an overview of the scientific method; gravitation and orbital dynamics; the origin, dynamics, and composition of our solar system; descriptions of asteroids, comets, and planets; the formation, evolution and death of stars; white dwarfs, neutron stars and black holes; novae and supernovae; star clusters, galaxies, and galactic clusters; the Big Bang theory, cosmology, dark energy and dark matter; the possibility of extraterrestrial life.

PHYS-104. Energy. 3 Hours.
A course for non-science majors requiring no previous college-level mathematics or science background. Physics and its application to the problems of energy consumption and production are discussed. Topics include the need for nuclear reactors and the implications thereof, the dumping of nuclear waste at sea and alternatives, better energy sources and energy depletion, the motion of pollutants through the environment, and other related topics.

PHYS-108. Physics Concepts For Educators. 4 Hours.
A laboratory-oriented course designed to support future educators in the implementation of interdisciplinary math and science curricula by integrating concepts from geometry, algebra, and trigonometry. Central concepts of physics (the laws of mechanics and electricity, the properties of light, atoms and nuclei) and how they are applied in the modern world (rockets, electric motors, automobiles, fuel cells, alternative fuels, stationary i.e. power plant and non-stationary i.e. aircraft, green technology etc.) are investigated. Issues of smart materials, nanotechnology, quantum computing and other contemporary technologies may be investigated. Discussions include topics and concepts related to robotics, kinematics and dynamics of particles and rigid bodies and electrostatics, electric fields, electric potentials, currents, magnetic fields, and wave motion. Basic concepts of geology, meteorology, oceanography, the solar system, or any other related discipline are threaded throughout. Course content is aligned to the National Science Teachers Association and the Next Generation of Science Standards. This course is paired and integrated with MATH-280 and it is strongly suggested that they are taken together.
Prerequisite: MATH-149 with a minimum grade of C.

PHYS-110. Physics In Everyday Life. 3 Hours.
A laboratory oriented course for the non-science major. Central concepts of physics (the laws of mechanics and electricity, the properties of light, atoms and nuclei) and how they are applied in the modern world (rockets, electric motors, optical instruments, automobiles, toys, etc.). Knowledge of basic algebra skills is assumed. Lecture 2 hours, lab 2 hours.
Prerequisite: (MATH-092 - 499 or MATH-092A - 499Z or NEIU Math Placement Result 30 - 40 or ACT Math 22 - 36 or Accuplacer College Level Math 020 - 120 or SAT Math 530 - 800 or Accuplacer Adv. Algebra & Func 237 - 300).

PHYS-180. Fundamentals Of Data Science. 4 Hours.
Foundations of data science considers data from three perspectives: inferential thinking, computational thinking, and real-world relevance. Given data arising from some real-world phenomenon, how does one analyze that data to understand that phenomenon? The course teaches critical concepts and skills in computation and statistical inference, in conjunction with hands on analysis of real-world datasets, including economic data, document collections, geographical data, and data from social networks. It delves into social, ethical, and legal issues surrounding data analysis, including privacy and data ownership.
Prerequisite: MATH-173 with a minimum grade of C.

PHYS-200. Introduction To College Physics. 3 Hours.
Prerequisite: MATH-106 (may be taken concurrently) with a minimum grade of D.

PHYS-201. College Physics I. 3 Hours.
This is the first course of a two-term algebra-based lecture sequence intended for non-physics majors: PHYS-201 and PHYS-202. The companion laboratory is PHYS-203. Kinematics and dynamics of a particle and systems of particles, momentum, energy, angular momentum, conservation laws, applications to problems involving collisions, oscillatory motion and motion in a gravitational field, rigid body motion, temperature, heat, the laws of thermodynamics, application to thermodynamic engines, and ideal gases are discussed. Lecture: 3hrs.
Prerequisite: MATH-185 with a minimum grade of C or MATH-106 with a minimum grade of C.

PHYS-201L. College Physics I With Lab. 5 Hours.
This is the first course of a two-term algebra-based lecture and laboratory sequence intended for non-physics majors: PHYS-201L and PHYS-202L. Kinematics and dynamics of a particle and systems of particles, momentum, energy, angular momentum, conservation laws, applications to problems involving collisions, oscillatory motion and motion in a gravitational field, rigid body motion, temperature, heat, the laws of thermodynamics, application to thermodynamic engines, and ideal gases are discussed. Lecture: 4hrs. Lab: 2 hrs.
Prerequisite: MATH-185 with a minimum grade of C or (MATH-173 with a minimum grade of C and MATH-175 with a minimum grade of C) or (MATH-173W with a minimum grade of C and MATH-175W with a minimum grade of C) or (MATH-173C with a minimum grade of C and MATH-175 with a minimum grade of C) or MATH-187 with a minimum grade of C.

PHYS-202. College Physics II. 3 Hours.
This is the second course of a two-term algebra-based lecture sequence intended for non-physics majors: PHYS-201 and PHYS-202. The companion laboratory is PHYS-204. Electrostatics, Coulomb's law, electric fields, electric potentials, currents, Ohm's law, magnetism, magnetic fields, the forces on or due to moving charges, induction, electromagnetic radiation, wave motion, physical and geometrical optics will be discussed. Time permitting concepts in modern physics such as special relativity, quantum physics and radioactivity will also be discussed. Lecture: 3 hrs.
Prerequisite: PHYS-201 with a minimum grade of C or PHYS-201L with a minimum grade of C.

PHYS-202L. College Physics II With Lab. 5 Hours.
This is the second course of a two-term algebra based lecture and laboratory sequence intended for non-physics majors, PHYS-201L and PHYS-202L. Electrostatics, Coulomb's law, electric fields, electric potentials, currents, Ohm's law, magnetism, magnetic fields, the forces on or due to moving charges, induction, electromagnetic radiation, wave motion, physical and geometrical optics will be discussed. Time permitting concepts in modern physics such as special relativity, quantum physics and radioactivity will also be discussed. Lecture: 4 hrs. Lab: 2 hrs.
Prerequisite: PHYS-201 with a minimum grade of C or PHYS-201L with a minimum grade of C or PHYS-206 with a minimum grade of C or PHYS-206L with a minimum grade of C.

PHYS-203. Physics I Laboratory. 1 Hour.
This is a laboratory course covering the subject matter of Physics I, and it is meant to be taken concurrently with either PHYS-201 or PHYS-206.
Prerequisite: PHYS-201 with a minimum grade of C or PHYS-206 with a minimum grade of C.

PHYS-204. Physics II Laboratory. 1 Hour.
This is a laboratory course covering the subject matter of Physics II, and it is meant to be taken concurrently.
Prerequisite: PHYS-202 with a minimum grade of C or PHYS-207 with a minimum grade of C.

PHYS-206. University Physics I. 3 Hours.
This is the first term of a two-term calculus-based lecture sequence intended for students majoring in physics, biology, chemistry, earth science or mathematics: PHYS-206 and PHYS-207. The companion laboratory is PHYS-203. Kinematics and dynamics of a particle and systems of particles, momentum, energy, angular momentum, conservation laws, applications to problems involving collisions, oscillatory motion and motion in a gravitational field, rigid body motion, temperature, heat, the laws of thermodynamics, application to thermodynamic engines, and ideal gases are discussed. Lecture: 3 hrs.
Prerequisite: MATH-187 with a minimum grade of C.

PHYS-206L. University Physics I With Lab. 5 Hours.
This is the first term of a two-term calculus-based lecture and laboratory sequence intended for students majoring in physics, biology, chemistry, earth science or mathematics: PHYS-206L and PHYS-207L. Kinematics and dynamics of a particle and systems of particles, momentum, energy, angular momentum, conservation laws, applications to problems involving collisions, oscillatory motion and motion in a gravitational field, rigid body motion, temperature, heat, the laws of thermodynamics, application to thermodynamic engines, and ideal gases are discussed. Lecture: 4 hrs. Lab: 2 hrs.
Prerequisite: MATH-187 (may be taken concurrently) with a minimum grade of C.

PHYS-207. University Physics II. 3 Hours.
This is the second course of a two-term calculus-based lecture sequence intended for students majoring in physics, biology, chemistry, earth science or mathematics. The companion laboratory is PHYS-204. Charges, Coulomb's and Gauss's laws, conductors and dielectrics, Ohm's law, magnetic fields, Ampere's law, motion of charges in a magnetic field, Faraday's law, inductance, simple L.R.C. circuits, magnetic properties of matter, electromagnetic waves, kinematics of wave motion, reflection, refraction, interference, and diffraction are discussed. Lecture: 3 hrs.
Prerequisite: (PHYS-206 with a minimum grade of C or PHYS-206L with a minimum grade of C or PHYS-201 with a minimum grade of C or PHYS-201L with a minimum grade of C) and MATH-187 with a minimum grade of C.

PHYS-207L. University Physics II With Lab. 5 Hours.
This is the second course of a two-term calculus based lecture and laboratory sequence intended for students majoring in physics, biology, chemistry, earth science or mathematics. Charges, Coulomb's and Gauss's laws, conductors and dielectrics, Ohm's law, magnetic fields, Ampere's law, motion of charges in a magnetic field, Faraday's law, inductance, simple L.R.C. circuits, magnetic properties of matter, electromagnetic waves, kinematics of wave motion, reflection, refraction, interference, and diffraction are discussed. Lecture: 4 hrs. Lab: 2 hrs.
Prerequisite: PHYS-201 with a minimum grade of C and MATH-187 with a minimum grade of C or (PHYS-206 with a minimum grade of C or PHYS-206L with a minimum grade of C).

PHYS-211. Physics I Seminar. 1 Hour.
Enrighment Seminar accompanying PHYS-201 or PHYS-206. Students do problem solving in collaborative groups on material derived from and supplementing University Physics I or College Physics I to gain a deeper understanding of concepts and applications.

PHYS-212. Physics II Seminar. 1 Hour.
Enrichment Seminar accompanying PHYS-202 or PHYS-207. Students do problem solving in collaborative groups on material derived from and supplementing University Physics II or College Physics II to gain a deeper understanding of concepts and applications.

PHYS-215. Physics III. 4 Hours.
Introduction to the physics of the twentieth century, including application to related fields such as biology, chemistry, earth science, and engineering. Fundamental concepts of special relativity, quantum mechanics, and statistical physics as applied to atomic, molecular, nuclear and solid state physics.
Prerequisite: PHYS-202 with a minimum grade of D or PHYS-207 with a minimum grade of D.

PHYS-300. Interdisciplinary Seminar In STEM. 2 Hours.
This course uses a hands-on approach to modern inquiry-based research problems and techniques in the physical and computational sciences. The course is structured around a series of modular problem-based exercises, covering topics from the fields of Chemistry, Computer Science, Earth Science, Mathematics and Physics, and is designed to provide the content and pedagogical background for students to be successful peer leaders. The cross-disciplinary modules will draw connections between scientific disciplines, and showcase common research tools and techniques used in the sciences. The workshop will also incorporate discussions on a range of topics, from scientific ethics, scientific methodology and error analysis.
Prerequisite: MATH-185 with a minimum grade of C.

PHYS-301. Independent Study In Physics. 1 Hour.
Research, laboratory work, study or tutorial in a specific area of physics under faculty supervison.

PHYS-302. Independent Study In Physics. 2 Hours.
(See PHYS-301 for description.).

PHYS-303. Independent Study In Physics. 3 Hours.
(See PHYS-301 for description.).

PHYS-304. Physics For Elementary School Teachers I. 3 Hours.

PHYS-305. Modern Physics I. 3 Hours.
This course covers advances made in physics during the first half of the twentieth century. These advances lead to many of the technologies we have today and they continue to drive innovation. The course content includes an introduction to the theory of relativity, particle-wave duality, elementary quantum theory, and the application of quantum theory to atomic, molecular, and nuclear physics.
Prerequisite: (PHYS-207L with a minimum grade of C or PHYS-207 with a minimum grade of C or PHYS-202L with a minimum grade of C or PHYS-202 with a minimum grade of C) and MATH-202 with a minimum grade of C.

PHYS-306A. Modern Physics II. 3 Hours.
Modern Physics II is the second part of a two-course sequence covering advances made in physics during the twentieth century. This course introduces students to statistical physics and focuses on applications of statistical physics, relativity, and quantum mechanics. These applications include atomic and molecular physics, condensed matter physics, nuclear physics, particle physics, astrophysics, and cosmology.
Prerequisite: PHYS-305 with a minimum grade of C.

PHYS-307. Writing Intensive Program: Modern Physics Lab. 3 Hours.
An introduction to intermediate-level experimental methods, scientific writing, and investigations which provided the experimental foundation for the major revolutions in 20th century physics. Students will perform classic modern physics experiments which demonstrate quantization in nature, wave particle duality, and the properties and interactions of fundamental particles. Students will present written results of their investigations in a variety of formats common in the discipline.
Prerequisite: ENGL-101 with a minimum grade of C and PHYS-305 with a minimum grade of C.

PHYS-308. Introductory Mathematical Physics. 3 Hours.
This course is an introduction to mathematical methods in physics, which include partial differentiation, multiple integration, vector analysis, complex numbers, complex variables, linear algebra, Fourier series, ordinary differential equations, special functions, and tensor analysis.
Prerequisite: MATH-203 with a minimum grade of C and (PHYS-207 with a minimum grade of C or PHYS-207L with a minimum grade of C).

PHYS-309. Computing For Scientists. 3 Hours.
Introduction to the use of computers in modeling scientific problems; modern programming languages are introduced and used to model several phenomena in the natural sciences and engineering.
Prerequisite: MATH-187 with a minimum grade of C.

PHYS-311. Mechanics I. 3 Hours.
Statics of particles and rigid bodies, kinematics and dynamics of particles (including damped and forced harmonic oscillators), work and energy, linear and angular momentum, conservation laws, dynamics of rigid bodies, introduction to special relativity.
Prerequisite: (PHYS-201L with a minimum grade of C or PHYS-206L with a minimum grade of C) and MATH-202 with a minimum grade of C.

PHYS-321. Electricity And Magnetism I. 3 Hours.
Coulomb's law, electric fields and electrostatic potential, Gauss's law, Poisson's equation, capacitance, dielectric media, current density, simple circuits, magnetic fields, Lorentz force, magnetic media, induction, Ampere's law, inductance, Maxwell's equations.
Prerequisite: (PHYS-202L with a minimum grade of C or PHYS-207L with a minimum grade of C) and MATH-203 with a minimum grade of C.

PHYS-324. Advanced Classical Physics. 3 Hours.
This course is an introduction to advanced topics in classical physics. Topics include the Lagrangian formalism of classical mechanics and its application to the theories of planetary motion, small oscillations, rigid body mechanics; Maxwell's equations, radiation, and propagation of electromagnetic waves.
Prerequisite: PHYS-311 with a minimum grade of C and PHYS-321 with a minimum grade of C.

PHYS-330. Writing Intensive Program: Experimental Methods. 3 Hours.
This course is an introduction to scientific measurement procedures, with special attention paid to scientific writing, the examination of error and uncertainty, and to widely used experimental techniques and their applications. Experiments are chosen according to the student's needs and interests. Students will present written results of their investigations in a variety of formats common in the discipline.
Prerequisite: (PHYS-202L with a minimum grade of C or PHYS-207L with a minimum grade of C) and ENGL-101 with a minimum grade of C and MATH-187 with a minimum grade of C.

PHYS-331. Optics. 4 Hours.
This course covers the fundamental principles of geometrical and physical optics and their application to the design of modern instruments as well as atomic spectra, properties of photons, and lasers. Principles discussed in lecture will be explored in various lab exercises. Lecture 2 hours, Lab 4 hours.
Prerequisite: (PHYS-207L with a minimum grade of C or PHYS-207 with a minimum grade of C or PHYS-202L with a minimum grade of C or PHYS-202 with a minimum grade of C) and MATH-202 with a minimum grade of C.

PHYS-332. Electronics. 4 Hours.
This course covers, through both lecture and laboratory, the basic structure of various electronic components, and their use and behavior in circuits. The course begins with linear elements, such as resistors, inductors and capacitors and proceeds through various semiconductor devices, diodes, transistors and operational amplifiers and culminates with the structure and use of logic circuits. Major emphasis is placed on laboratory work where the properties and interactions of various circuits are investigated. Lecture 2 hours, lab 4 hours.
Prerequisite: (PHYS-207L with a minimum grade of C or PHYS-207 with a minimum grade of C or PHYS-202L with a minimum grade of C or PHYS-202 with a minimum grade of C) and MATH-202 with a minimum grade of C.

PHYS-333. Vibration And Sound. 3 Hours.
Prerequisite: (PHYS-201 with a minimum grade of D or PHYS-206 with a minimum grade of D) and PHYS-203 with a minimum grade of D.

PHYS-335. Thermal Physics. 3 Hours.
Thermal Physics provides an introduction to thermodynamics and statistical mechanics. Course content includes the relationship between volume, pressure, heat, work, energy, temperature, entropy, free energy, enthalpy, chemical potential, heat capacities, and other quantities. Topics presented in this course include the first, second, and third laws of thermodynamics; heat engines, refrigerators, and heat pumps; mechanical, thermal, and chemical equilibrium, phase diagrams, phase transitions, Boltzmann and Gibbs distributions, partition functions, the equipartition theorem, blackbody radiation, and degenerate fermi gasses.
Prerequisite: PHYS-305 with a minimum grade of C.

PHYS-336. Quantum Mechanics. 3 Hours.
This course provides an introduction to Quantum Mechanics and is intended for physics majors/minors, and math or chemistry majors. The knowledge base covered is an essential foundation for students seeking to understand physical phenomena at a microscopic level. The Schrodinger equation is introduced and applied to problems in quantum mechanics including square wells, potential barriers, the harmonic oscillator, angular momentum, and the hydrogen atom. Time permitting, spin and many-particle systems will be discussed.
Prerequisite: PHYS-305 with a minimum grade of C and MATH-203 with a minimum grade of C.

PHYS-338. Quantum Mechanics II. 3 Hours.
This second course in quantum mechanics is intended for Physics majors who seek to build a solid background in the applications of quantum mechanics. It builds on the foundations introduced in Quantum Mechanics and covers applications of exact and approximate methods in quantum mechanics to real physical systems.
Prerequisite: PHYS-336 with a minimum grade of C.

PHYS-340. The Science Of Sustainable Energy. 3 Hours.
Sustainable energy provides a quantitative understanding of energy use and energy resources on both global scales and local settings. This courses will identify and quantify current energy resources, provide an understanding of energy conservation, efficiency, and the conversion of energy from less useful to more useful forms. PHYS-340 investigates the environmental consequences of our energy use, and emphasizes an interdisciplinary approach required to solving real-world problems. This course focuses on the science which informs development, policy, and management decisions.
Prerequisite: (PHYS-207L with a minimum grade of C or PHYS-202L with a minimum grade of C) and MATH-187 with a minimum grade of C.

PHYS-344. Introduction To Solid State Physics. 3 Hours.
Crystal strucutre, crystal bonding, thermal properties of solids, dielectric properties, free electron model of metals, band theory of solids, magnetism, superconductivity, current applications.
Prerequisite: PHYS-305 with a minimum grade of C.

PHYS-350. Field Experiences In Physics. 3 Hours.
Practical experience in industrial or government physics laboratories under the joint supervision of the department and the laboratory. There are six hours of field experience required per week. This course may be taken up to three times.

PHYS-361. Materials I: Structural, Mechanical And Thermal Properties. 3 Hours.
An introductory course on the properties of materials for students in all areas of science and technology. Topics include structural, thermal and mechanical properties of metals, alloys, ceramics and plastics, and their explanation in terms of molecular and atomic properties. Lecture 2 hours, lab 2 hours.
Prerequisite: PHYS-305 with a minimum grade of C.

PHYS-362. Materials II: Electric And Optical Properties. 3 Hours.
Companion course to Material I with primary emphasis on the elctronic properties of materials and their industrial use. Topics include conductors, semiconductors, superconductors, ferromagnetism and ferroelectricity, optical and infra-red properties. Lecture 2 hours, lab 2 hours.
Prerequisite: PHYS-305 with a minimum grade of C.

PHYS-366. Communication Electronics. 3 Hours.
The course covers tuned circuits, radio frequency amplifiers, intermeidate frequency amplifiers, cavity resonators and U.H.F. amplifiers, modulation, detection, R.F. powe amplifiers, transmitters, transmission lines, antennas, television and special topics in communication electronics, including digital methods and telemetry. Lecture 2 hours, lab 2 hours.
Prerequisite: PHYS-332 with a minimum grade of D.

PHYS-367. Transducer And Special Purpose Electronics. 4 Hours.
Lecture and laboratory on the characteristics of devices which convert physical quantities such as heat, light, motion and sound into electrical signal. This includes both the practical aspects of using such devices and the intrinsic physical properties which make their use possible. Sensors used include thermistors, thermopiles, microphones, solar cells, and piezoelectric/ pyroelectric films. The course culminates with each student doing a major project, which may include computer interfacing to the transducers. Lecture 2 hours, lab 4 hours.

PHYS-369. Instrumentation Electronics. 4 Hours.
Lecture and laboratory course on the properties and uses of electronic scientific instruments used in making physical measurements, including computer interfacing. The instruments are studied from input transducer to final output. A major emphasis is placed on laboratory work, where actual instrumentation circuits are built and tested. The course culminates with each student building an actual scientific instrument. Lecture 2 hours, Lab 4 hours.

PHYS-391. Astrophysics. 3 Hours.
Astrophysics applies the laws of physics to celestial objects and phenomena. Course content includes orbital mechanics, the formation and evolution of the solar system, and solar system objects like planets, asteroids, comets, and satellites. This course covers the physics of stars including the birth, evolution, and death of stars, nuclear fusion, stellar atmospheres, solar cycles, HR diagrams, supernovae, white dwarfs, neutron stars and black holes. On larger scales, this course discusses clusters of stars, galaxies, the interstellar medium, and galactic clusters.
Prerequisite: PHYS-305 with a minimum grade of C.

PHYS-392. Cosmology. 3 Hours.
Cosmology is the study of the history, structure, constituents, and dynamics of the universe. Course content includes primordial nucleosynthesis, cosmological and astronomical observations, the Friedmann equation, dark matter and dark energy, the cosmological constant, cosmic inflation, the accelerating and expanding universe, the cosmic microwave background, inflation, and baryogenesis.
Prerequisite: PHYS-305 with a minimum grade of C.

PHYS-400. Introduction To Quantum Mechanics. 3 Hours.

PHYS-401. Advanced Experimental Physics. 3 Hours.

PHYS-402. Atomic Physics. 3 Hours.

PHYS-403. Solid State Physics. 3 Hours.

PHYS-404. Advanced Electronics For Scientists. 3 Hours.
Prerequisite: PHYS-393 with a minimum grade of D.

PHYS-405. Elementary Particles. 3 Hours.

PHYS-406. Statistical Mechanics. 3 Hours.

PHYS-407. Relativity And Gravitation. 3 Hours.

PHYS-408. Independent Study In Physics. 3 Hours.

PHYS-409. Thesis Seminar-Physics. 6 Hours.

PHYS-410. Electrodynamics. 3 Hours.
Prerequisite: PHYS-323 with a minimum grade of D.

PHYS-411. Classical Dynamics. 3 Hours.
Prerequisite: PHYS-312 with a minimum grade of D.