PHYSICS

Physics

Total minimum number of credits required for a Baccalaureate of Arts Degree in Physics – 123.
Total minimum number of credits required for a Baccalaureate of Arts Degree in Physics with a minor in Secondary Education – 124

Baccalaureate of Arts degree in Physics (BA in Physics) is designed to offer a track for all students who wish to combine a major in Physics with other career goals. Primary among them are those students who wish to become certified in Physics by the PA Department of Education to teach high school physics and other science courses. In addition, the program will support students who may wish to concentrate on careers in medicine, dentistry, or law.

Physics B.A. Degree- Required Courses and Recommended Course Sequence

First Semester

[[MTH-111]] Calculus I*	4
[[CHM-115]] Elements and Compounds* OR [[CHM-118]] Chemistry for Engineers*	3
[[CHM-113]] Elements and Compounds Lab* OR [[CHM-117]] Intro Chemistry Lab for Engineers*	1
[[ENG-101]] Composition	4
[[FYF-101]] First-Year Foundations	3
	15

Second Semester

[[MTH-112]] Calculus II*	4
[[PHY-201]] General Physics I*	3
[[PHY-204]] General Physics I Lab*	1
[[EE-140]] Scientific Programming*^	3
Physics Elective @	3
Distribution Requirement	3
	17

Third Semester

[[MTH-211]] Intro. to Differential Equations*	4
[[PHY-202]] General Physics II*	3
[[PHY-205]] General Physics II Lab*	1
Physics Elective @	3
Distribution Requirement	6
	17

Fourth Semester

[[MTH-212]] Multivariable Calculus*	4
[[PHY-203]] Modern Physics*	3
[[PHY-206]] Modern Physics Lab*	1
Physics Elective@	6
Distribution Requirement	3
	17

Fifth Semester

[[PHY-311]] Thermodynamics*	3
[[PHY-312]] Analytical Mechanics*	3
[[EE-337]] Electromagnetics I*	3
Physics Electives@	3
Distribution Requirement	3
	15

Sixth Semester

[[PHY-314]] Quantum Mechanics*	3
Physics Electives@	9
Distribution Requirement	3
	15

Seventh Semester

[[PHY-391]] Senior Project I*	1
Physics Electives@	6
Free Electives	6
	13

Eighth Semester

[[PHY-392]] Senior Projects II*	2
Physics Electives@	6
Free Electives	6
	14

**Required Core Course for BA in Physics Major.*
^Can be substituted with CS 125.
@Physics electives may be chosen from any advisor-approved mathematics, biology, chemistry, computer science, environmental science/engineering, electrical engineering, or mechanical engineering course numbered 200 or above.

Physics Major In Conjunction with the Secondary Education Major or Minor

Students interested in becoming secondary teachers in Physics should make an appointment with the chairperson of the Education Department or the Coordinator of the Secondary Education Program as early as possible in their course of study to plan their professional studies. These students will declare a major in Physics and as well as a major or minor in Secondary Education. The major in Secondary Education must be taken in conjunction with an approved major; it cannot stand alone as a major. Upon successful completion of the secondary education program, students may become certified in Pennsylvania to teach in grades 7-12 in their chosen field.

Students interested in pursuing either the major or the minor in Secondary Education should refer to the Education Department section of this bulletin for complete details of the curriculum and other degree requirements. Students should also consult carefully with their Education program and Physics program advisors in planning their course of studies.

Total credits required for **Secondary Education minor - 40 cr.**

Total credits required for **Secondary Education major - 47 cr.**

Required courses for the major(*) or minor in Secondary Education are as follows:

[[ED-180]] – Educational Psychology - 3 cr.

[[ED-190]] – Effective Teaching with Field Experience - 3 cr.

[[ED-191]] – Integrating Technology into the Classroom - 3 cr.

[[EDSP-210]] – Teaching Students with Special Needs - 3 cr.

[[ED-220]] – Teaching Culturally and Linguistically Diverse Learners - 3 cr.

[[EDSP-225]] – Special Education Methods I with Field Experience - 3 cr.

[[ED-300]] – Teaching of a Foreign Language with Field Experience - 4 cr.

*[[ED-345]] – Assessment - 3 cr.

*[[ED-375]] – Middle Level/Secondary School Methods with Field Exp. - 4 cr.

[[ED-371]] – Teaching Methods in Science with Field Experience - 4 cr.

[[ED-380]] – Content Area Literacy - 3 cr.

[[EDSP-388]] – Inclusionary Practices (taken concurrently with ED 390) - 3 cr.

[[ED-390]]– Student Teaching with Seminar - 12 cr.

**These additional courses required in order to complete the major in Secondary Education.*

- All Teacher Education candidates must apply for admission to the Teacher Education Program in the sophomore or junior year.
- To be admitted into the Teacher Education Program, candidates must
  - o Attain a 3.0 GPA
  - o Complete 48 credits including six credits in both Mathematics and English
  - o Pass a test of basic skills
  - o Submit required clearances showing 'no record'
- To remain in the Teacher Education Program, candidates must
  - o Maintain a 3.0 GPA
  - o Adhere to the Code of Professionalism and Academic Honesty
- To be certified as a teacher in Pennsylvania in grades 7-12, candidates must
  - o Successfully complete all required Education courses, including student teaching
  - o Graduate with a 3.0 cumulative GPA
  - o Pass the appropriate exit test(s) in their content area
  - o Apply for certification through the Pennsylvania Teacher Information Management System (TIMS).

PHY. PHYSICS

PHY-198-298-398. TOPICS IN PHYSICS
Credits: variable

Selected topics in the field of physics. These may include one or more of the following: astronomy; geophysics; biophysics; nuclear power and waste; relativity; quantum mechanics; semi-conductors; cryogenics; health physics. May be repeated for credit.

Pre-Requisites

Varies with topic studied.

PHY-395-396. INDEPENDENT RESEARCH
Credits: 1 - 3

Independent study and research for advanced students in the field of physics under the direction of a staff member. A research paper at a level significantly beyond a term paper is required.

Pre-Requisites

Senior standing and approval of the department chairperson.

PHY-105. CONCEPTS IN PHYSICS
Credits: 3

Basic concepts of physical science, including the scientific method, will be studied. Theories, laws, and experiments from mechanics, electricity and magnetism, thermodynamics, optics, and atomic and nuclear physics may be included. Viewpoints will be classical and modern, including quantum and relativistic. Class meets for four hours per week: two hours of lecture and one two-hour lab each week.
Click here for course fees.

Pre-Requisites

No previous background in either science or college-level mathematics is required.

PHY-140. SCIENTIFIC PROGRAMMING
Credits: 3

This course presents an introduction to computer programming with an emphasis on the techniques needed for data analysis and numerical problem solving for scientific and engineering applications. Basic programming idioms are presented including control structures, data types, methods for handling input and output as well as numerical methods such as array computing and vectorization. Emphasis is placed on proper software engineering practice as well as data analysis and presentation. Two hours of lecture and two hours of laboratory per week.

Pre-Requisites

Or Concurrent
[[MTH-100]] or [[MTH-111]]

PHY-171. PRINCIPLES OF CLASSICAL AND MODERN PHYSICS
Credits: 4

An introductory course designed to promote and understanding of the more important fundamental laws and methods of mechanics and electricity and magnetism. Laboratory work to emphasize basic principles and to acquaint the student with measuring instruments and their use, as well as the interpretation of experimental data. Three hours of demonstration and lecture, one hour of recitation, and two hours of lab per week. Co-requisite: [[MTH-111]]
Click here for course fees.

PHY-174. APPLICATION OF CLASSICAL AND MODERN PHYSICS
Credits: 4

An introductory course designed to promote an understanding of the more important fundamental laws and methods of heat, optics, and modern physics. Laboratory work to emphasize basic principles and to acquaint the student with measuring instruments and their use, as well as the interpretation of experimental data. Three hours of demonstration and lecture, one hour of recitation, and two hours of lab per week. Co-requisite: [[MTH-111]]
Click here for course fees.

PHY-201. GENERAL PHYSICS I
Credits: 3

A thorough grounding in the concepts, principles, and laws of mechanics, and wave motion. Instruction by demonstration and lecture, recitation, and problem solving. Four hours of demonstration and lecture per week.

Click here for course fee.

Co-Requisites

[[MTH-111]] and [[PHY-204]]

PHY-202. GENERAL PHYSICS II
Credits: 3

A thorough grounding in the concepts, principles, and laws of Electricity and magnetism, optics and light. Instruction by demonstration and lecture, recitation, and problem solving. Four hours of demonstration and lecture per week.

Click here for course fee.

Pre-Requisites

[[PHY-201]]

Co-Requisites

[[MTH-112]]
[[PHY-205]]

PHY-203. MODERN PHYSICS
Credits: 3

Modern physics including the experimental basis, concepts, and principles of atomic and nuclear physics. Three hours of demonstration and lecture per week.

Pre-Requisites

[[PHY-202]].

PHY-204. GENERAL PHYSICS I LAB
Credits: 1
Fees: $100

This is a one-semester introductory physics laboratory course for science and engineering students. Experiments are performed to reinforce the concepts learned in PHY 201. Includes one two-hour laboratory exercise per week.
Click here for course fee.

Co-Requisites

[[PHY-201]]

PHY-205. GENERAL PHYSICS II LAB
Credits: 1
Fees: $100

This is a one-semester introductory physics laboratory course for science and engineering students. Experiments are performed to reinforce the concepts learned in PHY 202. Includes one two-hour laboratory exercise per week.
Click here for course fee.

Pre-Requisites

[[PHY-204]]

Co-Requisites

[[PHY-202]]

PHY-206. MODERN PHYSICS LAB
Credits: 1
Fees: $150
This intermediate level laboratory course offers a modern view of some of the famous experiments in the history of physics leading to the development of relativity and quantum theory. Additionally, the experiments are designed to prepare students to conduct experiments in contemporary physics labs. In doing so, this course presents a hands-on experience to reinforce the learning of fundamental concepts in EM theory, relativity, statistical mechanics, quantum mechanics, solid state physics, atomic physics, and nuclear physics.

Click here for course fee.

Pre-Requisites
[[PHY-201]] and [[PHY-202]]
Co-Requisites
[[PHY-203]]

PHY-214. APPLIED PHYSICS
Credits: 3
Modeling of various problems in physical, chemical, biological, and environmental sciences, particularly physical dynamical systems; Includes application of ordinary differential equations, and Laplace, Fourier, and Z transforms to continuous and discrete processes, matrix mechanics and eigenvalue problems, statistics and probability, random processes and distribution functions.
2 hours of lecture and 2 hours of laboratory per week.

Click here for course fee.

Pre-Requisites
[[MTH-211]]

PHY-311. THERMODYNAMICS & STATISTICAL MECHANICS
Credits: 3
This course focuses on the laws of thermodynamics and other thermodynamic concepts including entropy, free energy, equilibrium, and fluctuations as well as their pivotal role in physics and other scientific disciplines. Topics in statistical mechanics will be covered including partition functions, ensembles, kinetic theory, and phase transitions. Three hours of lecture per week.

Pre-Requisites
[[PHY-203]] and [[MTH-211]].

PHY-312. ANALYTICAL MECHANICS
Credits: 3
Employs advanced mathematical tools to study applications in complex mechanical systems. It offers an advanced differential reformulation of Newton's laws to study dynamical systems in multiple dimensions, conservative force fields, damped and driven oscillations, two-body problem, central forces and planetary motion, and the rotational dynamics of rigid bodies. Additionally, the course delivers a thorough grounding on the calculus of variations, Lagrange's formalism and Hamiltonian mechanics, all being the essential foundations for the development of modern physics (relativity, quantum mechanics, and quantum field theory). Three hours of lecture per week.

Pre-Requisites
[[PHY-202]] and [[MTH-211]].

PHY-314. QUANTUM MECHANICS
Credits: 3
This course presents an intermediate level of Quantum Mechanics using the abstract formulation of linear vector spaces in the Dirac formalism. Topics covered include: spin, addition of angular momentum, scattering and bound particles, the harmonic oscillator, two-body problem and central potential wells in 3D, H-atom and H-like atoms, time-independent perturbation theory, identical particles and the He-atom. In addition to the foundations of Quantum Mechanics, the course offers a selection of advanced and modern topics like entanglement and quantum teleportation. Three hours of lecture per week.

Pre-Requisites
[[PHY-203]], [[CHM-115]], [[MTH-211]], and [[MTH-212]].

PHY-374. IMAGING IN BIOMEDICINE
Credits: 3
This course will cover different aspects of imaging important to medicine and biomedicine including optical microscopy, scanning probe microscopy, scanning electron microscopy, magnetic resonance, ultrasound X-ray, nuclear radiation, microwave and electro-/magneto-encephalographic techniques as well as image processing. Three hours of lecture and three hours of lab per week.
Click here for course fee.

Pre-Requisites
[[PHY-201]] & [[PHY-202]] or [[PHY-171]] & [[PHY-174]], [[MTH-112]].

PHY-377. BIOPHYSICS
Credits: 3

This course presents an overview of the important physical principles governing the behavior of cells and macromolecules. Upper-level mathematics that are useful to understand these phenomena are introduced in a way that is comprehensible to biology majors lacking background beyond basic calculus. In addition to the physical models governing the most ubiquitous molecular and cellular processes, the physics behind the most common experimental techniques used in biology, bioengineering, and biophysics are covered. Three hours of lecture and two hours of lab per week.

Pre-Requisites

[[PHY-201]] & [[PHY-202]] or [[PHY-171]] & [[PHY-174]], [[MTH-112]].

PHY-391. SENIOR PROJECT I
Credits: 1

Students will plan and execute a research project in the field of physics or at the intersection of physics and another related discipline. Projects can be theoretical, experimental or both and can include the design of unique experiments and simulations. A detailed progress report and presentation are required. Students pursuing a dual degree or double major may be eligible to combine this project with the capstone project of another program (subject to the approval of their advisors in both programs).
Click here for course fee.

Pre-Requisites

Senior standing in Physics

PHY-392. SENIOR PROJECT II
Credits: 2

Students will plan and execute a research project in the field of physics or at the intersection of physics and another related discipline. This is a continuation of PHY 391. A professional paper and progress report are required. Students will present the results of their work in an open-forum. Students pursuing a dual degree or double major may be eligible to combine this project with the capstone project of another program (subject to the approval of their advisors in both programs).
Click here for course fee.

Pre-Requisites

[[PHY-391]]

EGR. ENGINEERING

EGR-200. MATERIALS SCIENCE
Credits: 3

Application of materials properties to engineering design. Introduction to atomic arrangements, crystal structures, imperfection, phase diagrams, and structure-property relations. Fundamentals of iron, steel, and non-ferrous materials. The behavior of materials in environmental conditions.

Pre-Requisites

[[CHM-118]] or [[CHM-115]].

EGR-201. PROFESSIONALISM AND ETHICS
Credits: 1

Responsibility of an engineer as a professional; ethics in science and engineering; role of professional societies; recent trends in technological innovations; career planning. Review of professional exam. Requirement: Junior standing in engineering.

EGR-202. ENGINEERING PROFESSIONAL DEVELOPMENT I
Credits: 1

The subjects the student will learn and develop in this course are important in securing an internship, a spot in graduate school, or a professional position. This professional development course will allow the student to experience a variety of communicative activities that prepare a student to be an experienced, informed, and professional engineer. The student will be introduced to networking with professionals as well as provided with the ability to communicate skills to employers at job fairs or on-campus mentoring events. Emphasis will be placed on professional interactions as well as attendance at events and mastering the fundamentals of written resumes, cover letters, and creating professional profiles.

Pre-Requisites

Permission of the instructor.

EGR-203. ENGINEERING PROFESSIONAL DEVELOPMENT II
Credits: 1

Emphasis will be placed on development of enhanced interview skills with effective interview strategies. Students will attend professional panel interview discussions to engage with industry mentors. They will attend professional collaborations as well as campus hosted events such the Career and Intern Fair. Students will seek to master the essentials of job searches, written resumes, cover letters, elevator speeches, applying to grad schools, networking, and creating professional profiles on LinkedIn.

Pre-Requisites

Permission of the instructor.

EGR-219. INTRODUCTION TO WEAPONS SYSTEMS
Credits: 3

Introduction to military weapons and warfare, with a focus on how the modern period has resulted in greater complexity and the development of weapons systems. Basic principles of explosives, internal and exterior ballistics, calculation of probabilities of hit given randomness, fire control, guidance algorithms, radar and other sensors, detection and tracking, nuclear weapons and their effects.

Co-Requisites

[[PHY-202]] concurrent or before

EGR-222. MECHATRONICS
Credits: 3
Introduction to mechatronics system design with emphasis on using sensors to convert engineering system information into an electrical domain, signal conditioning and hardware integration, programming, and using actuators to effect system changes.
Click here for course fees.

Pre-Requisites
[[EE-211]], [[EE-283]], [[ME-140]] and [[PHY-202]]

EGR-391. SENIOR PROJECTS I
Credits: 1
Design and development of selected projects in the field of engineering under the direction of a staff member. Technical as well as economic factors will be considered in the design. A professional paper and detailed progress report are required.
Click here for course fees.

Pre-Requisites
Senior standing in engineering

EGR-392. SENIOR PROJECTS II
Credits: 2
Design and development of selected projects in the field of engineering under the direction of a staff member. Technical as well as economic factors will be considered in the design. This is a continuation of [[EGR-391]]. A professional paper to be presented and discussed in an open forum is required.
Click here for course fees.

Pre-Requisites
[[EGR-391]]

EGR-399. COOPERATIVE EDUCATION
Credits: 0-6
Professional cooperative education placement in a private or public organization related to the student's academic objectives and career goals. In addition to their work experiences, students are required to submit weekly reaction papers and an academic project to a Faculty Coordinator in the student's discipline. See the Cooperative Education section of this bulletin for placement procedures.
Requirements: Junior standing; minimum 2.0 cumulative GPA; consent of the academic advisor; and approval of placement by the department chairperson.

EES. EARTH AND ENVIRONMENTAL SCIENCES

EES-198/298/398. TOPICS IN EES
Credits: Varies with topic
Departmental courses on topics of special interest, not extensively treated in regularly scheduled offerings, will be presented under this course number on an occasional basis. May be repeated for credit.
Click here for fee for courses with a lab.

Pre-Requisites
Varies with topic studied.

EES-105. PLANET EARTH
Credits: 3
The nature of our planet and how it works are examined in the context of Earth as a constantly changing dynamic system. An emphasis on global scale processes and the interaction of humans and their physical environment is coupled with in-depth coverage of how science is done and the scientific principles that influence our planet, its rocks, mountains, rivers, atmosphere, and oceans. Major sub-topical areas in the Planet Earth series may include geology (Forces of Geologic Change), oceanography (The Restless Ocean), astronomy (The Cosmic Perspective), geography (Global Regions and Geography), and the relationship between people and their physical surroundings (The Global Environment). Intended for students who are not majoring in science, engineering, pre-pharmacy, nursing, or B.S. programs in mathematics or computer science. Two hours of lecture and two hours of lab per week.
Click here for course fees.

Pre-Requisites
No previous background in science or college-level mathematics is required.

EES-201. ENVIRONMENTAL ETHICS AND SUSTAINABILITY
Credits: 1
This course entails an examination of the central topics of environmental ethics and sustainability as viewed from the perspectives of science. Ethical and sustainability paradigms that all environmental scientists should be aware of will be studied. Course is delivered online.

Pre-Requisites
[[EES-240]] and [[EES-241]], or permission of the instructor.

EES-210. GLOBAL CLIMATE CHANGE
Credits: 3
The nature and function of earth's global climate are examined from a unified system perspective. Major questions focus on scientific versus public understanding of trends in global temperature, precipitation, and sea level. The course emphasizes negative and positive feedback processes that force key changes in the earth's climate system: past, present, and future. Topics include fundamentals of global and regional heat and water balance, the role of elemental cycles in controlling climate (e.g., the carbon cycle), descriptive climate classification, long-term, short-term, and catastrophic climatic change (e.g., ice ages and bolide impacts), and human effects on climate (e.g., enhanced greenhouse, rising sea level). This course integrates a scientific understanding of climatic change and explores contemporary social and economic policy responses to change scenarios. Three hours of lecture per week.

EES-213. CLIMATE MODELING
Credits: 1

Students will utilize software to construct basic models of Earth Systems. No prior knowledge of the software is assumed or required. Weekly assignments will consist of computer-based modeling exercises, each progressively building upon previous assignments. Specifically, students will utilize software to construct relatively simple models of world population growth, fossil fuel consumption, the global carbon cycle, and the Earth's energy balance. The final modeling exercise couples the population growth, carbon cycle, and Earth energy balance assignments in an effort to explore the effect of future population growth and carbon dioxide emissions on global mean temperature. Two hours of lab per week.

Co-Requisites

[[EES-210]]

EES-218. ENVIRONMENTAL ETHICS
Credits: 3

An examination of the central problems of environmental ethics as viewed from the perspectives of science and of philosophy. The value of nature and 'natural objects,' differing attitudes toward wildlife and the land itself, implications of anthropocentrism, individualism, ecocentrism, and ecofeminism, bases for land and water conservation, and other topics will be examined within a framework of moral and scientific argument. Cross-listed with [[PHL-218]].

Pre-Requisites

[[PHL-101]] or [[EES-240]] and [[EES-241]], or permission of the instructor.

EES-230. OCEAN SCIENCE
Credits: 4

An interdisciplinary approach to the study of the fundamentals of oceanography emphasizing physical, chemical, and biological interrelationships. Three hours of lecture and three hours of lab. Requirements: For CS, Engineering, Math, and Science majors only
Click here for course fees.

EES-240. PRINCIPLES OF ENVIRONMENTAL ENGINEERING & SCIENCE
Credits: 3

A study of physical, chemical, and biological components of environmental systems and a discussion of processes involved in water quality management, air quality management, waste management, and sustainability. Three hours of lecture per week.

Pre-Requisites

[[MTH-111]] or permission of the instructor. Requirements: for CS, Engineering, Math, and Science majors only.

EES-241. PRINCIPLES OF ENVIRONMENTAL ENGINEERING & SCIENCE LAB
Credits: 1

Experiments with and analysis of the physical, chemical, and biological components of environmental systems.
Click here for course fees.

Co-Requisites

[[EES-240]] concurrent or prior.

EES-242. ENVIRONMENTAL HEALTH
Credits: 3

To provide students with an understanding of man's impact on the environment and how those impacts can be controlled or mitigated. Students completing this course should be able to recognize environmental problems and understand control and preventative measures. Three hours of lecture.

Pre-Requisites

Introductory physics and chemistry. Students who have taken [[EES-240]] will be admitted only with the consent of the instructor.

EES-251. SYNOPTIC METEOROLOGY
Credits: 4

Topics include surface and upper air weather systems, weather phenomena, climate, and local weather influences. Synoptic map analysis and interpretation are emphasized. Three hours of lecture and three hours of lab per week. Requirements: For CS, Engineering, Math, and Science majors only
Click here for course fees.

EES-261. REGIONAL GEOGRAPHY
Credits: 3

Topics covered include maps and charts and basic elements of physical, cultural, historical, and economic geography as applied to specific geographic regions. Three hours of lecture per week.

EES-280. PRINCIPLES OF ASTRONOMY
Credits: 4

Topics include orbital mechanics, results of planetary probes, spectra and stellar evolution, and cosmology. Three hours of lecture and three hours of lab per week. Requirements: For Science majors only
Click here for course fees.

EES-302. SCIENCE RESEARCH AND COMMUNICATION
Credits: 1

The aim for this course is to provide students with the necessary foundation to think critically about scientific research and communication. The course introduces students to the (1) philosophy of science, (2) design, execution, and evolution of scientific projects, (3) exploration, evaluation, and management of scientific literature, (4) methods and ethics of scientific communication, and (5) proposal design for a project to be continued into Senior Project (EES/GEO 391/392) that includes a literature review, definition of research questions, objectives, or testable hypotheses, and the methods used to carry out the project. The broader social and political context in which scientific research is situated and must respond to and interact with is also explored. More than that, this course explores the important connections between research design and communication by having students focus on the application of learned theory and skills to projects with Senior Project advisor.

Pre-Requisites

Junior standing.

EES-304. ENVIRONMENTAL DATA ANALYSIS
Credits: 2

To acquaint students majoring in earth and environmental sciences with the techniques and methods of data acquisition and analysis, including environmental sampling methodology and data management. Emphasis will be placed on examination of real data sets from various areas of the earth and environmental sciences with particular emphasis placed on using and applying graphical and statistical procedures used in [[EES-391]]-392 (Senior Projects). Two hours of lecture per week.

Pre-Requisites

[[MTH-150]] and Junior standing or permission of the instructor.

EES-340. CONSERVATION BIOLOGY
Credits: 3

This course covers the major topics of conservation biology including an introduction to biodiversity, threats to biodiversity, and solutions to diminish extinctions and population declines. Lecture: three hours per week. Offered each year. Cross-listed with [[BIO-340]].

Pre-Requisites

[[BIO-225]] - [[BIO-226]] or permission of the instructor.

EES-341. FRESHWATER ECOSYSTEMS
Credits: 3

A study of the biological and ecological aspects of streams, lakes, and wetlands from a watershed perspective. An initial introduction to physical, chemical, and geological principles of limnology is followed by a focus on freshwater biology. Laboratories include field-based watershed investigations and lake management assessments using geographic information systems techniques. Cross-listed with [[BIO-341]]. Two hours of lecture and three hours of lab per week. Offered in alternate years.
Click here for course fees.

Pre-Requisites

[[GEO-101]] - [[GEO-103]], or [[EES-240]] - [[EES-241]], or [[BIO-121]] - [[BIO-122]] or permission of the instructor.

EES-343. MARINE ECOLOGY
Credits: 3

An examination of the biology of marine life within the context of modern ecological principles. The structure and physiology of marine organisms will be studied from the perspectives of adaptation to the ocean as habitat, biological productivity, and interspecific relationships. Emphasis will be placed on life in intertidal zones, estuaries, surface waters, and the deep sea. Two hours of lecture and three hours of lab per week. Cross-listed with [[BIO-343]]. Offered in alternate years.
Click here for course fees.

Pre-Requisites

[[EES-230]] and [[BIO-121]] - [[BIO-122]] or permission of the instructor.Students must have formal course experiences in oceanography and biology at the science major level or have completed their sophomore year as a biology major.

EES-344. ECOLOGY
Credits: 4

Ecology examines contemporary ecological thinking as it pertains to the interrelationships of organisms and their environments. Interactions at the populations and community level are emphasized. Two hours of lecture and three hours of lab per week. Cross-listed with [[BIO-344]]. Offered in alternate years.
Click here for course fees.

Pre-Requisites

[[BIO-121]] - [[BIO-122]] or permission of the instructor.

EES-366. FIELD BOTANY
Credits: 3

This is a specialized summertime field course, which emphasizes a taxonomic, phylogenetic, and ecological survey of higher plants indigenous to Northeastern Pennsylvania. Due to the extensive field work, enrollment is somewhat more restricted than in other courses; therefore, written permission from the instructor is the primary prerequisite for those upperclassmen who wish to register for the course. Cross-listed with [[BIO-366]]. Offered in alternate years.
Click here for course fees.

Pre-Requisites

[[BIO-121]] - [[BIO-122]] or permission of the instructor.

EES-390. ENVIRONMENTAL SCIENCE SEMINAR
Credits: 3

This course is presented seminar-style, focusing on Environmental Science topics relevant to current problems, trends, and news. The course serves as an open and constructive venue where students will have an opportunity to delve into themed topics and more holistically discuss environmental science issues. The theme of the course will change each term, but will remain within the Environmental Sciences: ecology, environmental chemistry, sustainability, climate change, hazardous waste, etc. Students are required to read and actively discuss scientific literature, assemble and analyze relevant data, formulate and criticize quantitative/ qualitative theories, and explore case studies. Three hours of seminar per week. Requirement: students with senior standing only.

EES-391. SENIOR PROJECTS I
Credits: 1

Design and development of selected projects in earth and environmental sciences and other related fields under the direction of a staff member. Technical as well as economical factors will be considered in the design. A professional paper and detailed progress report are required.
Click here for course fees.

Pre-Requisites

Department permission

EES-392. SENIOR PROJECTS II
Credits: 2

Design and development of selected projects in earth and environmental sciences and other related fields under the direction of a staff member. Technical as well as economical factors will be considered in the design. A professional paper to be presented and discussed in an open forum is required.
Click here for course fees.

Pre-Requisites

[[EES-391]] or department permission. (See the department for more details about the department permission.)

EES-394. FIELD STUDY
Credits: 1-3

On-site study of an earth or environmental problem or situation incorporating field documentation and investigative techniques. May be repeated for credit when no duplication of experience results. One hour of lecture, plus field trips.
Click here for course fees.

Pre-Requisites

[[EES-240]], [[EES-241]], [[GEO-101]] and [[GEO-103]].

EES-395. AND 396. INDEPENDENT RESEARCH
Credits: Varies with topic1-3 credits.

Independent study or research of specific earth or environmental science topic at an advanced level under the direction of a departmental faculty member.
Click here for course fees.

Pre-Requisites

Upper class standing and approval of academic advisor, research advisor, and department chairperson.

EES-399. COOPERATIVE EDUCATION
Credits: 1-6

Professional cooperative education placement in a private or public organization related to the student's academic objectives and career goals. In addition to their work experience, students are required to submit weekly reaction papers and an academic project to a Faculty Coordinator in the student's discipline. See the Cooperative Education section of this bulletin for placement procedures.

Pre-Requisites

Sophomore standing; minimum 2.0 cumulative GPA; consent of the academic advisor; and approval of placement by the department chairperson.

EES-498. TOPICS
Credits: Varies with topic

Departmental courses on advanced topics of special interest, not extensively treated in regularly
scheduled offerings, will be presented under this course number on an occasional basis. Available for either undergraduate or graduate credit. May be repeated for credit.
Click here for fee for courses with a lab.

Pre-Requisites

Senior or graduate standing