

# DEPARTMENT OF PHYSICS AND ASTRONOMY

Bachelor of Arts, Bachelor of Science

**Matthew C. Sullivan, *Dana Professor and Chairperson***

The department of physics and astronomy offers a range of programs and courses designed to prepare students for a variety of career opportunities.

The physics B.S. degree provides a rigorous course of study in physics in preparation for graduate school or technical jobs in industry. The applied physics B.S. gives students the flexibility to concentrate in physics in combination with other professional interests such as secondary education, premedical training or biology, astronomy, electronics, chemistry, environmental science, or computer science. Finally, the mathematics-physics B.A. degree provides an option for students who want to concentrate equally on mathematics and physics rather than majoring in one or the other.

Our department also maintains a physics-engineering 3-2 program, which guides students through the completion of the physics or applied physics degree and prepares students to succeed in the engineering program of their choice.

## Physics-Engineering 3-2 Program

The department of physics and astronomy collaborates with Cornell University, Rensselaer Polytechnic Institute, the Rochester Institute of Technology, and other accredited engineering schools, and has a formal articulation agreement with the Thomas J. Watson School of Engineering, Applied Science, and Technology of Binghamton University. Through these partnerships the physics and astronomy department offers qualified students the opportunity to receive two bachelor's degrees, one from Ithaca College and one from the appropriate school of engineering, over the course of five years. Physics majors who are interested in this program complete all the requirements for a physics or applied physics B.S. in three years, and apply to transfer to the appropriate engineering school for two more years to complete an engineering degree.

Students who wish to enter this joint program must take, in addition to the physics program requirements, certain basic courses stipulated by the engineering department of their choice. Careful planning is necessary to ensure the proper program articulation, and students must therefore obtain the approval of the department chairperson no later than the end of the fifth semester. To complete this program, the student takes an academic leave of absence for the senior year. Students will transfer 30 credits from the engineering school toward the Ithaca College degree. Transfer will be subject to both the department's recommendation and acceptance by the engineering school.

To graduate from the program, a student must fulfill the degree requirements of the engineering school. In the event a student does not complete the engineering school portion of the program, an Ithaca College degree in physics can be awarded if all the requirements for a department-approved physics program have been met. Courses taken at the engineering school can be used toward fulfillment of the requirement upon approval of the department.

## Requirements for Honors in Physics and Astronomy

Students are awarded honors in physics on the basis of excellence in the three areas of academics, scholarly achievement, and service to the community. The department will invite meritorious seniors to apply for honors in November of their year of graduation. To be considered for honors, a student must submit an application that demonstrates that the student has achieved academic excellence, has been actively engaged in and contributed to original scholarly work, and has contributed physics-related service to the school, college, or wider community. The application will consist of a current resume and a 2-page statement addressing the previous three items and is due by November 15. The final decision to award honors is made by a vote of the full-time physics faculty.

Academic excellence will include a minimum 3.5 GPA in courses required for the physics degree program (inclusive of midterm grades in the semester in which the application is submitted), and may consist of items such as (but not limited to) breadth and depth of knowledge in the student's degree program. Scholarship may consist of activities such as (but not limited to) active involvement in research/technical projects over many semesters or summers, presentation of their research to an external audience, and authorship on a manuscript or technical document. Service may consist of activities such as (but not limited to) teaching assistantships, physics outreach presentations, peer mentoring and tutoring, student leadership, and any other relevant participation in projects serving the public interest.

## Majors & Minors

- Applied Physics Major — B.S. (<https://catalog.ithaca.edu/undergrad/schools/school-humanities-sciences/department-physics-astronomy/applied-physics-major-bs/>)
- Physics Major — B.S. (<https://catalog.ithaca.edu/undergrad/schools/school-humanities-sciences/department-physics-astronomy/physics-major-bs/>)
- Mathematics-Physics Major — B.A. (<https://catalog.ithaca.edu/undergrad/schools/school-humanities-sciences/department-physics-astronomy/mathematics-physics-major-ba/>)
- Physics Minor (<https://catalog.ithaca.edu/undergrad/schools/school-humanities-sciences/department-physics-astronomy/physics-minor/>)

### ASTR 17400 Solar System Astronomy (LA)

Survey of the solar system from the earliest conceptions of motions in the sky to modern findings of space exploration in the solar system. Emphasis is placed on physical processes and dynamics of the moon, earth, planets, comets, meteoric matter, and asteroids. Astronomical instruments and measurements. Prerequisites: Math placement score 3 or higher, math placement assessment score of 46 or greater, or completion of MATH 10000 (with a C- or better). (Y)  
Attributes: SC, TIII, TWOS  
3 Credits

### ASTR 17500 Stars, Galaxies and the Universe (LA)

Survey of the universe lying beyond the solar system; introduction to characteristics and motions of stars; stellar structure and evolution; interstellar matter; star clusters, the sun, galaxies; introduction to cosmology; the question of life in the universe; astronomical instruments and measurements. Prerequisites: Math placement score 3 or higher, math placement assessment score of 46 or greater, or completion of MATH 10000 (with a C- or better). (Y)  
Attributes: SC, TIDE, TIII  
3 Credits

**ASTR 17800 Astronomy Laboratory (LA)**

Activities include both outdoor observing sessions and indoor lab exercises. Outdoor sessions emphasize learning the night sky and hands-on use of telescopes. Indoor laboratories emphasize data analysis through the use of celestial globes, spectrometers, computer simulation, and image processing. Prerequisites: ASTR 17400 or ASTR 17500 (either may be taken concurrently). (IRR)

1 Credit

**ASTR 37200 Astrophysics (LA)**

Calculus-based introduction to the thermal, electromagnetic, and quantum mechanical properties of celestial objects. Topics include celestial mechanics, interactions of radiation with matter, thermal radiation, formation of spectral lines, and structure, formation and evolution of stars and galaxies. Prerequisite: PHYS 21800. (S,O)

3 Credits

**PHYS 10100 Introduction to Physics I (LA)**

Principles and concepts of classical physics (algebra-based). Mechanics, including rotational motion and energy and momentum conservation, properties of matter. Three lectures and one recitation/laboratory per week or three two-hour lecture/recitation/laboratory sessions per week. Prerequisites: Math placement score 2 or higher, math placement assessment score of 54 or greater, or completion of MATH 10400, MATH 10800, or MATH 11000 (with a C- or better). (F,Y)

Attributes: 2A, ENRE, NS

4 Credits

**PHYS 10200 Introduction to Physics II (LA)**

A continuation from PHYS 10100 of the principles and concepts of classical physics (algebra-based). Standing waves and sound, physical and geometrical optics, electrostatics, magnetism, DC circuits, fluids, heat, and thermodynamics. Three lectures and one recitation/laboratory per week or three two-hour lecture/recitation/laboratory sessions per week. Prerequisite: PHYS 10100. (S,Y)

Attributes: ABSS

4 Credits

**PHYS 10400 Physics of Human Movement (LA)**

Introductory course in Newtonian mechanics (algebra-based) applied to movement of and within the human body. Covers fundamental principles and concepts of physics including: projectile motion, rotational motion, torque, and energy and momentum conservation. Prerequisite: Math placement in group 2 or higher, math placement assessment score of 54 or greater, or MATH 11000. (F,Y)

Attributes: 2A, SC, TIII

3 Credits

**PHYS 11000 Introductory Mathematical and Computational Methods for Physics (LA)**

Bridges mathematics and computational skills to physical applications and prepares students for future study in Physics and Astronomy.

The aim of this course is to develop tools for quantitatively analyzing problems common to courses in the Physics and Astronomy majors; topics will include applying algebraic tools, concepts from trigonometry, and use of spreadsheets to collect and analyze data in the Physics context. Prerequisites: Math placement in group 1 or higher, math placement assessment score of 76 or greater, MATH 10800 (may be taken concurrently) OR MATH 11100 (may be taken concurrently). (F,Y)

2 Credits

**PHYS 12100 Light and Special Relativity (LA)**

Intended as an introductory course for physics majors and science enthusiasts. Covers algebra-based topics in the physics core curriculum: light waves, optics, quantum properties of light, and special relativity. Emphasis is placed on the mathematical analysis of concepts as well as on developing conceptual understanding through active learning. Three two-hour lecture/recitation/laboratory sessions per week. Prerequisites: Math group 2 or higher, OR PHYS 11000 (may be taken concurrently). (F,Y)

4 Credits

**PHYS 12200 Momentum, Energy, and Heat (LA)**

Introductory calculus-based physics for students majoring in STEM fields. Topics include vectors, kinematics in one and two dimensions, dynamics, work, energy, momentum, heat, the first and second laws of thermodynamics, and entropy. Emphasis is placed on the mathematical analysis of concepts as well as developing conceptual understanding through active learning. Three two-hour lecture/recitation/laboratory sessions per week. Prerequisites: MATH 10800 or MATH 11100. (S,Y)

4 Credits

**PHYS 12300 Classical Fields: Gravity, Electricity, & Magnetism (LA)**

Introductory calculus-based physics for students majoring in STEM fields. Topics include gravity and the gravitational field, static electric fields and Coulomb's law, electric potential, capacitors, Ohm's law, the magnetic field and Ampere's law, induction and Faraday's law, and an introduction to fluids. Emphasis is placed on mathematical analysis as well as developing conceptual understanding through active learning. Three two-hour lecture/recitation/laboratory sessions per week. Prerequisites: PHYS 10100 OR PHYS 12200; MATH 11200. (F,Y)

4 Credits

**PHYS 14300 Power: Energy Options for a Global Society (LA)**

Survey of energy. Topics include energy technologies and energy resources (fossil fuels, nuclear, solar, wind, geothermal, biomass). Students are introduced to electricity, heat production and transfer, heat engines, energy efficiency, and sustainable energy systems. Energy use sectors such as residential, commercial, and transportation are examined. The course begins with a look at energy use in the home and gradually expands to complex subjects such as the electrical grid, national energy policy, deregulation, and international fusion research. The emphasis is on energy literacy and the goal is to provide students with the basic technical principles necessary to design energy projects of their own and to evaluate their costs and benefits. (S,E)

Attributes: 2A, NS

3 Credits

**PHYS 16000 Physics of Sound (LA)**

Physical basis of sound, with an emphasis placed on musical instruments, the human voice, and sound recording and reproduction. Physics concepts are introduced and developed as needed to understand these areas. Open to all students. Prerequisites: Math placement score 2 or higher, math placement assessment score of 76 or greater, or completion of MATH 10400, MATH 10800, or MATH 11000 (with a C- or better). (Y)

Attributes: 2A, NS

3 Credits

**PHYS 17100 Earth: Evolution of a Habitable World (LA)**

Formation and evolution of planet Earth from the astronomer's perspective: creation of elements, the first rocks, development of oceans, the first atmosphere, formation of the moon, records of climate history, and how life on Earth fits into the context of life in the universe. Examination of Venus and Mars as possible analogs for Earth's evolution (past and future). Other topics include the influence of the sun on Earth's climate, the greenhouse effect, the geologic record of the development of continents, and the asteroid and comet impact hazard. Emphasis is placed on our sources of knowledge, the errors of our measurements, and the attendant model uncertainties in predicting Earth's future. Students may not receive credit for both PHYS 17100 and PHYS 17200. Prerequisites: Math placement score 3 or higher, math placement assessment score of 46 or greater, or completion of MATH 10000 (with a C- or better). (S,Y)  
Attributes: 2A, NS  
3 Credits

**PHYS 17200 Earth: Evolution of a Habitable World with Lab (LA)**

Formation and evolution of planet Earth from the astronomer's perspective: creation of elements, the first rocks, development of oceans, the first atmosphere, formation of the moon, records of climate history, and how life on Earth fits into the context of life in the universe. Examination of Venus and Mars as possible analogs for Earth's evolution (past and future). Other topics include the influence of the sun on Earth's climate, the greenhouse effect, the geologic record of the development of continents, and the asteroid and comet impact hazard. Emphasis is placed on our sources of knowledge, the errors of our measurements, and the attendant model uncertainties in predicting Earth's future. Students enrolled in this course attend the lecture of PHYS 17100, but also meet for an additional weekly lab. Students may not receive credit for both PHYS 17100 and PHYS 17200. Prerequisites: Math placement in group 3 or higher, math placement assessment score of 46 or greater, or completion of MATH 10000 (with a C- or better). (S,Y)  
Attributes: 2A, NS  
4 Credits

**PHYS 17801 Professional Physics and Astronomy Seminar I (NLA)**

Introduction to the physics program for all beginning physics majors or those considering the major. Discussions about career opportunities, the various physics degree paths, and strategies for being a successful and engaged physics major. Participation in the physics department seminar required. (F,Y)  
1 Credit

**PHYS 21000 Intermediate Mathematical and Computational Methods for Physics (LA)**

Applies quantitative and analytical techniques to physical applications and supports students in their intermediate course study of Physics and Astronomy. Topics include practice applying mathematical and computational tools such as single variable integration, series, the complex plane, ordinary differential equations and computer programming to physical situations. Prerequisites: PHYS 11000; MATH 11200. (F,Y)  
2 Credits

**PHYS 22400 Classical and Quantum Waves (LA)**

Completes a comprehensive introduction to the principles of physics necessary for advanced coursework in the field. Topics include: mechanical oscillations of one and several particles, the classical wave equation and the behavior of its solutions, one-dimensional quantum mechanics, classical angular momentum, and an introduction to quantum mechanics in three dimensions. Emphasizes analytical techniques common across both classical and quantum domains. Prerequisites: PHYS 12100; PHYS 12300; PHYS 21000; MATH 21100. (S,Y)  
4 Credits

**PHYS 23900 Introductory Independent Study: Physics (LA)**

One-semester course in which a student may pursue a topic of interest in physics. Offered on demand only. May be repeated up to a total of six credits. Permission of instructor required. (IRR)  
0.5-3 Credits

**PHYS 24300 Sustainable Energy: Powering the World (LA)**

Survey of energy. Topics include solar, wind, geothermal, electricity, fossil fuels, heat transfer, and the economic and environmental opportunities created by energy efficiency and sustainable energy systems. The course culminates with a final Energy Design Project. Cross-listed as ENVS 24300. Students may not earn credit for both ENVS 24300 and PHYS 24300. Prerequisite: Math placement score 2 or higher, math placement assessment score of 54 or greater, or completion of MATH 10400, MATH 10800, or MATH 11000 (with a C- or better). (S,Y)  
Attributes: NS, QL, SC, TQSF  
4 Credits

**PHYS 25000 Intermediate Applied Physics Design Laboratory (LA)**

Intermediate design laboratory course in which students conduct investigations in various areas of applied physics. Emphasis is placed on the development of good laboratory techniques, simple circuit building, computer interfacing to equipment for data-taking, data analysis, data presentation (using computer graphical interface), and formal report writing. Prerequisites: PHYS 12100; PHYS 12300; PHYS 21000 (maybe taken concurrently) or COMP 17100 (may be taken concurrently). (S,Y)  
2 Credits

**PHYS 26000 Intermediate Physics Laboratory (LA)**

Intermediate laboratory course in which students conduct three investigations in various areas of physics. Emphasis is placed on the development of good laboratory techniques, data-taking procedures, data analysis, data presentation (using computer graphical interface), and formal report writing. Prerequisite: PHYS 12100; PHYS 12300; PHYS 21000 or COMP 17100 (may be taken concurrently). (S,Y)  
2 Credits

**PHYS 27800 Professional Physics and Astronomy Seminar II (NLA)**

Continuation of professional preparation for careers in physics and astronomy. Covers introduction to effective communication skills, effective teamwork strategies, and includes tutorials in software commonly used in physics careers. Students will also engage in a series of discussions about undergraduate research, summer opportunities for research and internships, and careers in physics, and will draft resumes and cover letters. (F,Y)  
1 Credit

**PHYS 28000 Learning Assistant Practicum in Physics (NLA)**

This course prepares our undergraduate Learning Assistants with the foundations of pedagogy necessary to assist our introductory physics students with their coursework. Additionally, this course provides procedural support for the Learning Assistants by strengthening students' pedagogical content knowledge. Prerequisites: B or higher in PHYS 10100, PHYS 10200, PHYS 10400, PHYS 11700, PHYS 11800, PHYS 16000, ASTR 17400, or ASTR 17500. (F,S)

1 Credit

**PHYS 29400 Introductory Independent Study: Physics (LA)**

One-semester course in which a student may pursue a topic of interest in physics. Offered on demand only. May be repeated up to a total of six credits. Permission of instructor required. (IRR)

0.5-3 Credits

**PHYS 29900-29910 Introductory Physics Research (LA)**

Original research participation with a faculty member in a specialized field. Prerequisites: Sophomore standing or above; permission of instructor. Six credit limit. (F-S,Y)

0.5-3 Credits

**PHYS 30100 Advanced Mathematical and Computational Methods for Physics (LA)**

Applies analytical and computational techniques to physical applications, and supports students in their advanced course study of Physics and Astronomy. Topics include practice applying mathematical tools such as multivariate calculus, fields, linear algebra, and advanced differential equations to physical situations. Applications include the use of mathematical techniques in advanced computational analysis.

Prerequisites: COMP 17100; PHYS 22400. (F,Y)

Attributes: NS

4 Credits

**PHYS 30500 Electromagnetism (LA)**

Intermediate course in electricity and magnetism that builds on the foundation received in PHYS 12300. Topics include electric and magnetic fields, Gauss's law, electric potential, circuits, Ampere's law, Faraday's law, and Maxwell's equations. Explores electromagnetic phenomena through both analytical and computational exercises. Prerequisites: COMP 17100; PHYS 22400. (F,Y)

Attributes: NS

4 Credits

**PHYS 31000 Advanced Mathematical and Computational Methods for Physics (LA)**

Applies analytical and computational techniques to physical applications, and supports students in their advanced course study of Physics and Astronomy. Topics include practice applying mathematical tools such as multivariate calculus, fields, linear algebra, and advanced differential equations to physical situations. Applications include the use of mathematical techniques in advanced computational analysis.

Prerequisites: COMP 17100; PHYS 22400. (F,Y)

4 Credits

**PHYS 31100 Classical Mechanics (LA)**

Intermediate mechanics, including statics and dynamics of particles and rigid bodies, central forces, planetary motion, and Lagrange's equations. Extensive computer analysis. Culminates in a computational simulation of a physical system based on the equations of motion. Prerequisites: Either PHYS 31000 or the combination of PHYS 22400, MATH 21400, and MATH 23100. (S,Y)

Attributes: NS

4 Credits

**PHYS 31400 Professional Physics and Astronomy Seminar III (NLA)**

Continuation of professional preparation for careers in physics and astronomy. Students will practice both written and oral communication skills and model effective teamwork strategies. Students will also engage in a series of discussions about careers in physics, and how to maximize opportunities in the junior and senior years to be competitive in the job market. Prerequisites: PHYS 21400. (F,Y)

1 Credit

**PHYS 32000 Thermal Physics (LA)**

Topics include laws of thermodynamics with applications, thermodynamic functions and potentials, kinetic theory, statistical mechanics, real and idealized systems, and intermolecular processes. Prerequisites: COMP 17100 and PHYS 22400. (F,Y)

Attributes: NS

4 Credits

**PHYS 32200 Classical Mechanics (LA)**

Intermediate mechanics, including statics and dynamics of particles and rigid bodies, central forces, planetary motion, and Lagrange's equations. Extensive computer analysis. Culminates in a computational simulation of a physical system based on the equations of motion. Prerequisites: Either PHYS 31000 or the combination of PHYS 22400, MATH 21400, and MATH 23100. (S,Y)

4 Credits

**PHYS 32300 Electromagnetism (LA)**

Intermediate course in electricity and magnetism that builds on the foundation received in PHYS 12300. Topics include electric and magnetic fields, Gauss's law, electric potential, circuits, Ampere's law, Faraday's law, and Maxwell's equations. Explores electromagnetic phenomena through both analytical and computational exercises. Prerequisites: COMP 17100; PHYS 22400. (F,Y)

4 Credits

**PHYS 32400 Quantum Mechanics (LA)**

Advanced theory course with emphasis on understanding the nature of quantum theory and how it differs from classical ideas. Topics include the Stern-Gerlach experiments and quantum measurements, the Schrödinger equation and solutions to various potentials, angular momentum, and the hydrogen atom. Prerequisites: Either PHYS 31000 or the combination of PHYS 22400, MATH 21400, and MATH 23100. (S,Y)

4 Credits

**PHYS 32500 Thermal Physics (LA)**

Topics include laws of thermodynamics with applications, thermodynamic functions and potentials, kinetic theory, statistical mechanics, real and idealized systems, and intermolecular processes. Prerequisites: COMP 17100 and PHYS 22400. (F,Y)

4 Credits

**PHYS 32600 Analog Electronics (LA)**

A laboratory course on electronics covering the origination, amplification, processing, and digital conversion of analog signals. Experiments involve bipolar transistors, operational amplifiers, active and passive filters, oscillators, and analog-to-digital and digital-to-analog converters. Emphasis is placed on the basic theory underlying the circuits and devices and on general lab techniques. Prerequisites: PHYS 22500. (S,E)

Attributes: ENRE, NS

3 Credits

**PHYS 33900 Intermediate Independent Study: Physics (LA)**

One-semester course in which a student may pursue a topic of interest in physics. Offered on demand only. May be repeated for a total of six credits. Permission of instructor required. Prerequisites: PHYS 22400. (IRR)

0.5-3 Credits

**PHYS 34000 Linking Science Learning to Science Teaching (LA)**

This course reviews the science education literature and discusses successful approaches to helping K12 and college students learn science. The course provides an opportunity for students thinking about careers in teaching science, or serving as a science teaching assistant in graduate school, to consider research-based best practices for helping students learn science. Prerequisite: QL designated course; Junior standing or above. (FY)

Attributes: NS

1 Credit

**PHYS 35000 Advanced Applied Physics Design Laboratory (LA)**

Advanced laboratory course in which students will learn how to apply the engineering design process to identify a design need, consider the associated requirements and constraints of the project, brainstorm design solutions, analyze the proposed solutions to identify the strongest option, build a prototype, and iterate through stages of testing and improvement until a viable end product is produced. Students work as part of a design team with individual responsibilities and will practice presenting their design through “pitches” and customer presentations. All students will complete post-design reflections. Prerequisites: COMP 17100; PHYS 25000; PHYS 27800. (FY)

Attributes: QL

4 Credits

**PHYS 36000 Advanced Physics Laboratory (LA)**

Advanced laboratory course in which students are expected to conduct four or five investigations in areas such as mechanics, optics, thermodynamics, and electricity and magnetism. Emphasis is placed on the development of good laboratory techniques and data-taking procedures. Students are expected to become familiar with modern developments in instrumentation, formal report writing (in LaTeX), and the statistical basis for data and uncertainty analysis. Includes both independent work and work in teams. Prerequisites: COMP 17100; PHYS 22400; PHYS 26000; PHYS 27800. (S,Y)

Attributes: ENRE, NS, QL

4 Credits

**PHYS 36100 Advanced Applied Physics Design Laboratory (LA)**

Advanced laboratory course in which students will learn how to apply the engineering design process to identify a design need, consider the associated requirements and constraints of the project, brainstorm design solutions, analyze the proposed solutions to identify the strongest option, build a prototype, and iterate through stages of testing and improvement until a viable end product is produced. Students work as part of a design team with individual responsibilities and will practice presenting their design through “pitches” and customer presentations. All students will complete post-design reflections. Prerequisite: COMP 17100; PHYS 25000; PHYS 27800. (FY)

Attributes: QL

4 Credits

**PHYS 39400 Intermediate Independent Study: Physics (LA)**

One-semester course in which a student may pursue a topic of interest in physics. Offered on demand only. May be repeated for a total of six credits. Permission of instructor required. Prerequisites: PHYS 22400. (IRR)

0.5-3 Credits

**PHYS 39800 Senior Thesis Proposal (LA)**

Provides opportunity for physics majors to prepare a written proposal in preparation for senior thesis research. Emphasis placed on describing the problem, methodology, equipment, and data analysis needed to successfully complete the research project. Completed proposals are submitted to each student's research advisor for review and approval. Corequisites: PHYS 49900. (IRR)

1 Credit

**PHYS 39900-39910 Intermediate Physics Research (LA)**

Original research participation with a faculty member in a specialized field. Intended for students with prior experience from PHYS 29900-29910. Prerequisites: Permission of instructor. Six credit limit. (F-S,Y)

0.5-3 Credits

**PHYS 41400 Professional Physics and Astronomy Seminar Capstone (LA)**

Provides opportunities for students to explore connections between the integrative core curriculum, the physics major, other learning experiences while at Ithaca College or abroad, and future goals. Students will develop a written reflection and engage in career preparation activities. (FY)

Attributes: CP, NS

1 Credit

**PHYS 42100 Quantum Mechanics (LA)**

Advanced theory course with emphasis on understanding the nature of quantum theory and how it differs from classical ideas. Topics include the Stern-Gerlach experiments and quantum measurements, the Schrödinger equation and solutions to various potentials, angular momentum, and the hydrogen atom. Prerequisites: Either PHYS 31000 or the combination of PHYS 22400, MATH 21400, and MATH 23100. (S,Y)

Attributes: NS

4 Credits

**PHYS 42300 Electrodynamics (LA)**

Building on the foundation gained in PHYS 32300, this course completes the mathematical treatment of electromagnetic fields, including: electric and magnetic fields in matter, energy and momentum of EM fields, EM waves, EM potential theory, EM radiation, and special relativity. Prerequisites: PHYS 31000; PHYS 32300. (IRR)

4 Credits

**PHYS 43000 Selected Topics in Advanced Physics (LA)**

Advanced course in which students apply their physics skills to advanced topics. Current topics will be chosen based on faculty and student interests and may include environmental science, geophysics, and physics topics such as atomic, condensed matter, nuclear, and optical physics. This course may be repeated for credit for selected topics on different subjects. Prerequisites: PHYS 22400. (Y)

2-4 Credits

**PHYS 44000 Inquiry and the Nature of Science for the Science Teacher (LA)**

Considers issues pertaining to the nature and practice of science, especially as they relate to science education. Explores aspects that distinguish scientific inquiry from other forms of inquiry. Examines safety issues of teaching science in a classroom, and teaching science in the context of the community. Cross-listed with CHEM 44000 and PHYS 44000. Students can receive credit for only one of: BIOL 44000, PHYS 44000, CHEM 44000. Prerequisites: EDUC 34000 and junior standing. (IRR)

Attributes: NS

3 Credits

**PHYS 45500 Electrodynamics (LA)**

Building on the foundation gained in PHYS 32300, this course completes the mathematical treatment of electromagnetic fields, including: electric and magnetic fields in matter, energy and momentum of EM fields, EM waves, EM potential theory, EM radiation, and special relativity. Prerequisites: PHYS 31000; PHYS 32300. (IRR)

Attributes: NS

4 Credits

**PHYS 47000-47001 Selected Topics in Advanced Physics (LA)**

Advanced course in which students apply their physics skills to advanced topics. Current topics will be chosen based on faculty and student interests and may include environmental science, geophysics, and physics topics such as atomic, condensed matter, nuclear, and optical physics. This course may be repeated for credit for selected topics on different subjects. Prerequisites: PHYS 22400. (Y)

Attributes: NS

2-4 Credits

**PHYS 47900 Internship in Physics (NLA)**

Designed to offer applications of physics concepts in a setting appropriate to students' interest and training. Internships are arranged individually at the student's request with an instructor and a sponsoring agency and with departmental approval. Students must follow the guidelines of the School of Humanities and Sciences and complete the H&S internship application. Permission of instructor required. (IRR) 1-12 Credits

**PHYS 48900 Review of Undergraduate Physics (LA)**

Review of all the major topics in the physics curriculum, both at the introductory and advanced level. Instruction and practice in taking standardized multiple choice exams, including the Physics GRE. Course culminates in a comprehensive examination. Prerequisites: PHYS 21800; senior standing; Physics majors only. (S,Y)

1 Credit

**PHYS 49000 Professional Physics and Astronomy Seminar Capstone (LA)**

Provides opportunities for students to explore connections between the integrative core curriculum, the physics major, other learning experiences while at Ithaca College or abroad, and future goals. Students will develop a written reflection and engage in career preparation activities. (F,Y)

Attributes: CP

1 Credit

**PHYS 49300 Senior Project Proposal (LA)**

First half of the capstone experience in which students design, conduct, and report on a senior project. The final project can be a research paper, theory project, computational project, engineering project, or experimental project. Emphasis placed on independent work. Culminates in a formal written proposal. Prerequisites: PHYS 36000, PHYS 32600 or PHYS 35000 (any of which may be taken concurrently); WRTG 10600 or equivalent. (IRR)

Attributes: WI

1 Credit

**PHYS 49301 Senior Design Team I (LA)**

First half of the capstone experience in which students create and begin to implement a solution to a design challenge. Students will pitch a design solution (both orally and in writing) then work in teams to further develop and begin implementing their proposed solution. Students will learn about project management and resources available to organize tasks. Progress reports will provide students with opportunity for reflection and writing practice. The course will culminate in a team demonstration of the in-process design prototype. Prerequisites:

PHYS 31400; PHYS 36100. (F,Y)

2 Credits

**PHYS 49500 Senior Project (LA)**

Second half of the capstone experience in which students complete a senior project, culminating in a formal written project report. Emphasis placed on independent work. Prerequisite: PHYS 49300; WRTG 10600 or equivalent. (IRR)

Attributes: WI

2 Credits

**PHYS 49501 Senior Design Team II (LA)**

Second half of the capstone experience in which students complete and present their solution to a design challenge. Students will reinforce project management, communication, and teamwork skills. Progress reports will provide students with opportunities for reflection and writing practice. Students will complete a design report describing their iterative design process and ultimate solution to their design challenge. The course will culminate in a team demonstration of the final design solution. Prerequisites: PHYS 49301. (S,Y)

2 Credits

**PHYS 49600 Internship in Physics (NLA)**

Designed to offer applications of physics concepts in a setting appropriate to students' interest and training. Internships are arranged individually at the student's request with an instructor and a sponsoring agency and with departmental approval. Students must follow the guidelines of the School of Humanities and Sciences and complete the H&S internship application. Permission of instructor required. (IRR) 1-12 Credits

**PHYS 49700 Senior Thesis I (LA)**

Capstone experience in which seniors prepare, summarize, present and defend their own basic or applied research in physics in a formal written thesis. Emphasis on development of the first draft of the senior thesis. Prerequisite: WRTG 10600 or ICSM 10800 or ICSM 11800; concurrent enrollment in PHYS 49900-PHYS 49910. (IRR)

Attributes: WI

1 Credit

**PHYS 49800 Senior Thesis II (LA)**

Capstone experience in which seniors prepare, summarize, and present, their own basic or applied research in physics in a formal written thesis. Completion of final draft of the senior thesis, and presentation of thesis research required. Corequisites: PHYS 49900. Prerequisites: PHYS 49700. (IRR)

Attributes: WI

2 Credits

**PHYS 49900-49910 Advanced Physics Research (LA)**

Original research participation with a faculty member in a specialized field. Intended for students with prior experience from PHYS 39900-39910. Prerequisites: Permission of instructor. Six credit limit. (F-S,Y)

0.5-3 Credits