“Physics is the liberal arts education for a technological society.” —Joseph Pimbley

Participation in research and proficiency in the main subject areas of physics are the twin goals of the physics program. The major program is designed to develop competency in quantum theory, electromagnetism and optics, thermodynamics and statistical mechanics, classical dynamics, and condensed-matter physics. Preparation in mathematical and computational methods is an integral part of the program.

Interested and qualified students may pursue several opportunities for advanced work, including graduate courses and participation with graduate students and faculty in research. The department encourages its students to “do physics” at the earliest opportunity by making arrangements to work with one of the research groups or by arranging an independent research tutorial. Research may be experimental or theoretical and may, but need not, result in a senior honors thesis. Most majors who intend to write a thesis begin research no later than the junior year and continue it through the summer into the senior year. Current research interests include chaos theory, soft condensed-matter physics, granular flow, third sound in superfluid films, laser plasmas, spectroscopy, collision studies involving excited atoms and molecules, and wave transport in complex media.

Many students also take advantage of Wesleyan’s computing facilities in their research or coursework. The University has a large computer cluster available to all who are doing research.

Each semester, opportunities exist to serve as a teaching apprentice, course assistant, or department assistant in one of the introductory or intermediate-level courses. Many physics majors have found that this is a stimulating way to learn more about the fundamentals of the discipline and how to teach them. The Cady Lounge in the department serves as a focus for the major by providing a place where students can study and discuss physics. There is also a study room where students in the introductory courses can come to get help and to work together. Students are encouraged to attend the weekly colloquium series and to participate in the weekly research seminars in atomic and molecular physics, chemical physics, condensed-matter physics, and theory. The Society of Physics Students is also a great resource for sharing ideas and questions with like-minded students.

**FACULTY**

Reinhold Blümel  
PHD, Technical University Munich  
Charlotte Augusta Ayres Professor of Physics; Professor of Physics; Co-COordinator, Informatics and Modeling

Fred M. Ellis  
BS, University of Massachusetts Amherst; MAA, Wesleyan University; PHD, University of Massachusetts Amherst  
Professor of Physics

Candice Marie Etson  
BA, New York University; BFA, New York University; PHD, Harvard University  
Assistant Professor of Physics; Assistant Professor, Chemistry; Assistant Professor, Molecular Biology and Biochemistry

Lutz Hüwel  
PHD, University of Gottingen

**Professor of Physics**

Tsampikos Kottos  
BA, University of Crete; MS, University of Crete; PHD, University of Crete  
Professor of Physics; Professor, Integrative Sciences; Professor, Mathematics

Thomas J. Morgan  
BA, Montana State University; BS, Montana State University; MAA, Wesleyan University; MSC, University of California, Berkeley; PHD, University of California, Berkeley  
Foss Professor of Physics; Professor of Physics

Meng-ju Renee Sher  
BA, Wesleyan University; MA, Harvard University; PHD, Harvard University  
Assistant Professor of Physics; Assistant Professor, Integrative Sciences

Francis W. Starr  
BS, Carnegie Mellon University; MS, Boston University; PHD, Boston University  
Professor of Physics; Director, College of Integrative Sciences; Professor, Integrative Sciences; Professor, Molecular Biology and Biochemistry; Coordinator, Integrated Design, Engineering and Applied Science

Brian A. Stewart  
BS, Stanford University; PHD, Massachusetts Institute of Technology  
Professor of Physics; Professor, Environmental Studies

Greg A. Voth  
BS, Wheaton College; MS, Cornell University; PHD, Cornell University  
Professor of Physics; Chair, Physics; Professor, Integrative Sciences

Lynn Adrea Westling  
BA, Rollins College; BS, Georgia Technical; MA, University of Rochester; PHD, University of Rochester  
Associate Professor of the Practice in Physics

**EMERITI**

Ralph F. Baierlein  
BA, Harvard University; MAA, Wesleyan University; PHD, Princeton University  
Charlotte Ayres Professor of Physics, Emeritus

Richard W. Lindquist  
BS, Worcester Poly Institute; MA, Princeton University; MAA, Wesleyan University; PHD, Princeton University  
Professor of Physics, Emeritus

Robert J. Rollefson  
BA, University of Wisconsin; MAA, Wesleyan University; PHD, Cornell University  
Professor of Physics, Emeritus

William L. Trousdale  
Associate Professor of Physics, Emeritus

**DEPARTMENTAL ADVISING EXPERTS**

- Tsampikos Kottos, Class of 2019  
- Brian A. Stewart and Meng-Ju Renee Sher, Class of 2020  
- Undergraduate Physics Major (catalog.wesleyan.edu/departments/phys/ugrd-phys)
• Graduate Physics Program (catalog.wesleyan.edu/departments/phys/grad-phys)

PHYS105 Science of Sustainability
“What is sustainability? It most certainly is not switching light bulbs or “buying organic,” although perhaps those activities contribute to sustainability. The task for our course will be to undertake a scientific inquiry into the conditions for an enduring human presence on Earth. To do so, we must begin with physical principles, examining both what humans require and demand from the world and what the world is capable of providing. Our inquiry will broaden to include chemical and ecological principles, ultimately asking what the social sciences can do to illuminate the problem without violating the physical constraints nature imposes.

Students should have a familiarity with quantitative and algebraic concepts and, above all, a desire to incorporate quantitative thinking into verbal discourse. Writing is also a core element of the course with frequent writing assignments in various formats.”
Offering: Host
Grading: OPT
Credits: 1.00
Gen Ed Area: NSM-PHYS
Identical With: ENVS235
Prereq: None

PHYS107 Life in the Cell from a Molecule’s Perspective
What does DNA look like when it is not condensed into chromosomes? How do partners in molecular processes find each other? If a molecular motor "walks," how does it take a step? We will explore these major topics in molecular biophysics by discussing primary scientific literature. Emphasis will be placed on revealing the ways in which our understanding of biological processes can be improved by understanding the underlying physics. Students should have a broad high school science background, familiarity with quantitative and algebraic concepts, and a desire to incorporate quantitative thinking into verbal discourse. Writing is a core element of the course.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-PHYS
Identical With: MB&B117
Prereq: None

PHYS111 Introductory Physics I
This is the first of two noncalculus courses covering the fundamental principles of physics. The emphasis is on developing a conceptual understanding of the physical processes that govern our universe. Proficiency in elementary algebra, vector algebra, trigonometry, and arithmetic is expected. The lab PHYS121 is recommended.
Offering: Host
Grading: OPT
Credits: 1.00
Gen Ed Area: NSM-PHYS
Prereq: None

PHYS112 Introductory Physics II
This is the second of two non-calculus courses covering fundamental principles of physics. The emphasis is on developing a conceptual understanding of the physical processes that govern our universe. Proficiency in elementary algebra, vector algebra, trigonometry, and arithmetic is required. The lab PHYS122 is recommended.
Offering: Host
Grading: OPT
Credits: 1.00
Gen Ed Area: NSM-PHYS
Prereq: PHYS111

PHYS113 General Physics I
"This course is the first term of a general physics course with calculus, recommended for students interested in majoring in the sciences. With the focus on Newtonian dynamics, PHYS 113 seeks to develop both conceptual understanding and the ability to use this knowledge to obtain quantitative predictions of how the universe works. Through a collaborative and interactive classroom experience, students develop problem-solving skills and a mathematical description of mechanics. The associated lab, PHYS123, is highly recommended.

PHYS113 and PHYS116 are part of a sequence of courses that lead into the physics major. PHYS113 is a pre-requisite for PHYS116; therefore, students must take them in sequence."
Offering: Host
Grading: OPT
Credits: 1.00
Gen Ed Area: NSM-PHYS
Prereq: None

PHYS115 Newtonian Mechanics
This course in classical mechanics assumes a level of familiarity with general physics and comfort with vectors and calculus that is not assumed in PHYS113. This course will study classical mechanics at a level that is rigorous and mathematically sophisticated, employing contemporary instructional techniques. It will also teach elementary programming and data analysis skills essential to physical science. The course may be ideal for students who have previously taken a general physics course but not at the level required as preparation for PHYS324, Electricity and Magnetism.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-PHYS
Prereq: None

PHYS116 General Physics II
This course is the second term of a general physics course with calculus, recommended for students interested in majoring in the sciences. The focus is on the physics of charged particles, including an introduction to the concepts of electric and magnetic fields. Students will develop both conceptual understanding of how charged particles give rise to both electricity and magnetism and the ability to use this knowledge to quantitatively describe the behavior of these particles in a variety of contexts, including electrical devices. Through a collaborative and interactive classroom experience, students develop problem-solving skills and a mathematical description of electricity and magnetism. The associated lab PHYS124 is highly recommended.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-PHYS
Prereq: PHYS113 OR PHYS115

PHYS121 Physics Laboratory I
This laboratory course provides experience with phenomena discussed in PHYS111 lectures. While this course is not required by the Physics Department, students planning to enter the health professions should be aware that a year of physics WITH LABORATORY is usually required for admission. Consult your major advisor if you are in doubt about similar requirements in your field. Each laboratory is limited to 16.
Offering: Host
Grading: Cr/U
Credits: 0.50
Gen Ed Area: NSM-PHYS
This laboratory course teaches students how to obtain, process, and evaluate data and compare these data with quantitative models of how our world works."

Offering: Host
Grading: Cr/U
Credits: 0.50
Gen Ed Area: NSM-PHYS
Prereq: None

PHYS123 General Physics Laboratory I
This laboratory course provides experience with phenomena discussed in PHYS113 lecture, integrating calculus with the experiments.

Offering: Host
Grading: Cr/U
Credits: 0.50
Gen Ed Area: NSM-PHYS
Prereq: PHYS113 OR PHYS123

PHYS162 It's About Time
The course will explore ideas and tools that help us to conceptualize and quantify time. Measurement of time has been accomplished by careful observation of celestial objects, counting growth rings in trees, or determining the abundance of radioactive decay products, and with devices as varied as the hour glass and the atomic clock. A thorough investigation of these and other methods and tools will illuminate old and new views of time and will allow us to venture into various fields of physics such as classical mechanics, the theory of relativity, atomic and nuclear physics, electricity, and optics. Along the way, we will discuss concepts including, but not limited to: the origin of time, its smoothness, time dilation, the relativity of simultaneity, and the direction of time's arrow.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-PHYS
Prereq: PHYS113, PHYS116, AND PHYS213

PHYS172 Introduction to Design and Engineering
This course will provide a hands-on introduction to design and engineering.

Offering: Handing
Grading: Cr/U
Credits: 1.00
Gen Ed Area: NSM-PHYS
Prereq: None

PHYS219 Introduction to Contemporary Physics
This course examines the foundations of modern physics, including special relativity, the building blocks of matter, the fundamental interactions and gravity, and recent views of the universe such as entanglement, supersymmetry, strings, and dark matter and dark energy.

Offering: Host
Grading: A-F
Credits: 0.50
Gen Ed Area: NSM-PHYS

PHYS214 Quantum Mechanics I
This course provides an introduction to wave and matrix mechanics, including wave-particle duality, probability amplitudes and state vectors, eigenvalue problems, and the operator formulation of quantum mechanics.

Offering: Host
Grading: OPT
Credits: 1.00
Gen Ed Area: NSM-PHYS
Prereq: PHYS213

PHYS217 Non-linear Dynamics and Chaos
The techniques of nonlinear dynamics have been proven, over the years, useful for a variety of disciplines covering areas from physics and system biology to econophysics, sociophysics, epidemiology and even linguistics. This course gives a taste of these new developments with an emphasis on applications. Examples that we shall discuss in the class include the development of social relations and love affairs, opinion dynamics, superconducting circuits and laser dynamics, and even methods of cryptography using chaos.

Offering: Host
Grading: OPT
Credits: 1.00
Gen Ed Area: NSM-PHYS
Prereq: None

PHYS215 Special Relativity
This calculus-based half-credit, half-semester introduction to Einstein's theory of special relativity promotes both a qualitative understanding of the subject and a quantitative problem-solving approach.

Offering: Host
Grading: A-F
Credits: 0.50
Gen Ed Area: NSM-PHYS
Prereq: PHYS214

PHYS221 Waves and Oscillations
The properties of periodic motion recur in many areas of physics, including mechanics, quantum physics, and electricity and magnetism. We will explore the physical principles and fundamental mathematics related to periodic motions. Topics will include damped and forced harmonic motion, normal modes, the wave equation, Fourier series and integrals, and complex analysis. Principles and techniques developed in this course are central to many subsequent courses, particularly Quantum Mechanics (PHYS214, PHYS315), Classical Dynamics (PHYS313), and Electricity and Magnetism (PHYS324). An important component of this course is to develop the ability to use mathematical software packages to graph expressions, solve equations, and obtain numerical solutions to differential equations.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-PHYS
Prereq: PHYS113 OR PHYS116

Identical With: IDEA170, CIS170
Prereq: None

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This course provides an introduction to wave and matrix mechanics, including wave-particle duality, probability amplitudes and state vectors, eigenvalue problems, and the operator formulation of quantum mechanics.

Offering: Host
Grading: OPT
Credits: 1.00
Gen Ed Area: NSM-PHYS
Prereq: PHYS213

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Offering: Host
Grading: A-F
Credits: 0.50
Gen Ed Area: NSM-PHYS
Prereq: PHYS214

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Offering: Host
Grading: OPT
Credits: 1.00
Gen Ed Area: NSM-PHYS
Prereq: None

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Offering: Host
Grading: A-F
Credits: 0.50
Gen Ed Area: NSM-PHYS
Prereq: PHYS214

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Offering: Host
Grading: OPT
Credits: 1.00
Gen Ed Area: NSM-PHYS
Prereq: None

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Offering: Host
Grading: A-F
Credits: 0.50
Gen Ed Area: NSM-PHYS
Prereq: PHYS214

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Offering: Host
Grading: OPT
Credits: 1.00
Gen Ed Area: NSM-PHYS
Prereq: None
Prereq: (PHYS113 AND PHYS116)

PHYS221 Modeling and Data Analysis: From Molecules to Markets
The development of models to describe physical or social phenomena has a long history in several disciplines, including physics, chemistry, economics, and sociology. With the emergence of ubiquitous computing resources, model building is becoming increasingly important across all disciplines. This course will examine how to apply modeling and computational thinking skills to a range of problems. Using examples drawn from physics, biology, economics, and social networks, we will discuss how to create models for complex systems that are both descriptive and predictive. The course will include significant computational work. No previous programming experience is required, but a willingness to learn simple programming methods is essential.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-PHYS
Identical With: CIS231, QAC221
Prereq: None

PHYS313 Classical Dynamics
This is a course in classical mechanics at the intermediate level that utilizes problem solving instruction and learning. It approaches Newtonian mechanics from a more advanced point of view and introduces Lagrangian and Hamiltonian dynamics.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-PHYS
Identical With: PHYS313
Prereq: (PHYS213 AND MATH221 AND MATH222 AND MATH122)

PHYS315 Quantum Mechanics II
This course will expand the formalism of quantum mechanics to include spin and angular momentum in three dimensions. The quantum theory of identical particles will be developed and applied to multi-electron atoms. The remainder of the course will explore approximation methods for applying quantum mechanics to more complex systems.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-PHYS
Identical With: PHYS315
Prereq: (PHYS213 AND MATH221 AND MATH222 AND MATH122)

PHYS316 Thermal and Statistical Physics
Thermodynamics and statistical mechanics are pillars of physics. In this course, we conceptually focus on building the understanding of how the statistical properties of microscopic states relate to the macroscopic properties of matter. As such, the approach differs from many previous physics courses and requires a mixture of statistical and counting skills, coupled with physical intuition for the nature of matter. Focus areas include phase transitions, critical phenomena, and the statistical properties of fermions and bosons.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-PHYS
Identical With: PHYS316
Prereq: PHYS214

PHYS317 Molecular Biophysics Journal Club I
This course includes presentation and active discussion of a series of current research articles in the field of molecular biophysics and biophysical chemistry from journals including but not limited to the Biophysical Journal, Biopolymers, Current Opinion in Structural Biology, Journal of Biomolecular Structure and Dynamics, and the Annual Review of Molecular Biophysics and Biomolecular Structure.
Offering: Crosslisting
Grading: Cr/U
Credits: 0.50
Gen Ed Area: NSM-CHEM
Identical With: CHEM507, PHYS317, MB&B507, MB&B307, CHEM307
Prereq: None

PHYS318 Molecular Biophysics Journal Club II
Offering: Crosslisting
Grading: Cr/U
Credits: 0.50
Gen Ed Area: NSM-CHEM
Identical With: PHYS318, MB&B308, CHEM508, MB&B508, CHEM308
Prereq: None

PHYS324 Electricity and Magnetism
This course covers the classical field theory of electricity and magnetism. The core of the course covers electrostatics and magnetostatics with emphasis on both physical insight and the partial differential equations that describe these fields. We then cover electrodynamics to complete Maxwell's equations and to derive the elementary properties of electromagnetic radiation.
Offering: Host
Grading: OPT
Credits: 1.00
Gen Ed Area: NSM-PHYS
Identical With: PHYS324
Prereq: (PHYS116 AND PHYS124 AND MATH222)

PHYS325 Radiation and Optics
In this course, you will have the opportunity to apply your electrodynamics knowledge to explore electromagnetic waves and optics, radiation, and a bit of relativistic electrodynamics. You will get to relate these topics to a wide variety of recent physics research, such as invisibility cloaks, metamaterials with negative index of refraction, stopping and storing light in atomic gases, polarization of the cosmic microwave background, and the optical properties of bird feathers and iridescent butterfly wings. The goal is for you to leave this course with a deeper understanding and appreciation for electrodynamics and its applications.
Offering: Host
Grading: A-F
Credits: 0.50
Gen Ed Area: NSM-PHYS
Identical With: PHYS325
Prereq: [PHYS324 or PHYS524]

PHYS339 Molecular and Cellular Biophysics
This course is an integrated consideration of the biophysics and biophysical chemistry of biological systems from molecules to cells. The objective is to develop a critical sense of the quantitative data currently being obtained from microscopy to spectroscopy, considering both ensemble and single-molecule experiments, and to gain familiarity and facility with interpretation using mathematical and computational models. Biological systems are inherently complex, and some form of modeling is always involved in developing an explanation of how they work. However, these models typically involve only a few basic constructs (simple harmonic motion, ideal fluids, two-state Ising models, random walks, electrostatic interactions, classical dynamics, rate equations, QM energy levels, distribution functions, and network analysis)
and only elementary aspects of linear algebra, calculus, differential equations, and statistics. This course deals with how these constructs are integrated in the framework of Boltzmann statistical mechanics to formulate mathematical models of biological phenomena, how these models are validated and refined, and how they are used to form explanations and make testable predictions. Model systems to be considered include the nucleosome, the ribosome, membrane dynamics and ion channels, molecular devices and motors, prototype signal transduction systems, and regulatory processes. This course is suitable for physics and chemistry students who wish to learn about biological applications and for molecular and cellular biology students to develop skills with quantitative physicochemical modes of inquiry applied to the life sciences.

Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Identical With: CHEM309, MB&B309, CHEM509, MB&B509, PHYS539
Prereq: (CHEM251 AND CHEM252)

**PHYS340 Computational Physics**

The aim of this course is to introduce students to both numerical techniques and the software used in modern computational physics. In the first part of the course, we will learn the basics of operating systems and the essential components of lower- and upper-level programming languages. The majority of material in the course will focus on the most important numerical techniques that we will implement in weekly exercises.

Offering: Host
Grading: Cr/U
Credits: 0.50
Gen Ed Area: NSM-PHYS
Prereq: (MATH221 AND PHYS213) OR (MATH223 AND PHYS213)

**PHYS342 Experimental Optics**

This is an experimental course in optics, including lenses, lens combinations, interference and diffraction, interferometry, and spectrometry.

Offering: Host
Grading: A-F
Credits: 0.50
Gen Ed Area: NSM-PHYS
Identical With: PHYS542
Prereq: (PHYS116 AND PHYS213)

**PHYS345 Electronics Lab**

This laboratory course covers the fundamentals of analog and digital electronics: passive DC and AC circuits, linear transistor and integrated circuits, and digital integrated circuits.

Offering: Host
Grading: Cr/U
Credits: 0.50
Gen Ed Area: NSM-PHYS
Identical With: PHYS545
Prereq: (PHYS116 AND PHYS213)

**PHYS358 Condensed Matter**

This course is an introduction to condensed-matter physics with emphasis on fundamental properties of solids. We will explore crystal structure, phonons, and electrons in solids as a basis for understanding the thermal, electronic, and magnetic properties of materials. In addition to lectures and problem sets, there will be several numerical experiments in which computer simulation and visualization tools will be used to explore microscopic properties of materials.

Offering: Host
Grading: OPT
Credits: 1.00
Gen Ed Area: NSM-PHYS
Identical With: PHYS558
Prereq: [PHYS315 or PHYS515] AND [PHYS324 or PHYSS24]

**PHYS377 Chemistry of Materials and Nanomaterials**

This course will provide an introduction to materials chemistry, with a special emphasis on nanomaterials. Topics covered will include colloidal metal nanomaterials; semiconductors and quantum dots; carbon nanotubes, fullerenes, and graphene; metal-organic frameworks; self-assembly and metamaterials; electron and scanning probe microscopies; and lithography. The course will also discuss applications of these materials and techniques in areas such as plasmonics and sensing, catalysis, energy generation, and medicine.

Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Identical With: CHEM377
Prereq: CHEM251

**PHYS395 Structural Biology Laboratory**

One of the major catalysts of the revolution in biology that is now under way is our current ability to determine the physical properties and three-dimensional structures of biological molecules by x-ray diffraction, nuclear magnetic resonance (NMR) spectroscopy, and other spectroscopic methods. This course is designed to familiarize students with current research techniques in biochemistry and molecular biophysics. Students will perform spectroscopic investigations on a protein that they have isolated and characterized using typical biochemical techniques, such as electrophoresis, enzyme extraction, and column chromatography. The course will provide hands-on experience with spectroscopic methods such as NMR, fluorescence, UV-Vis absorption, and Raman as well as bioinformatic computational methods. All of these methods will be applied to the study of biomolecular structure and energetics. This course provides a broad knowledge of laboratory techniques valuable for independent research at the undergraduate level and beyond.

Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MBB
Identical With: CHEM395, MB&B395
Prereq: [(MB&B208 or BIOL208) AND CHEM141 AND CHEM142] OR [(MB&B208 or BIOL208) AND CHEM143 AND CHEM144]

**PHYS400 Professional Development**

The objectives of this course are (1) to build a supportive cohort that will help students sustain their goals when they enter graduate school and (2) to provide students with skills they will need to succeed in graduate school. Students will work on writing, presentation, and discussion skills. This will be done by reading classic books on writing, critiquing the ability of different figures and graphs to convey information, reading and discussing scientific papers, and giving research presentations.

Offering: Crosslisting
Grading: A-F
Credits: 0.50
Gen Ed Area: NSM-EES
Identical With: PSYC400, NS&B400, E&ES400
Prereq: None

**PHYS401 Individual Tutorial, Undergraduate**

Topic to be arranged in consultation with the tutor.

Offering: Host
Grading: OPT

**PHYS402 Individual Tutorial, Undergraduate**

Topic to be arranged in consultation with the tutor.

Offering: Host
Grading: OPT
PHYS407 Senior Tutorial (downgraded thesis)
Downgraded Senior Thesis Tutorial - Project to be arranged in consultation with the tutor. Only enrolled in through the Honors Coordinator.
Offering: Host
Grading: A-F

PHYS408 Senior Tutorial (downgraded thesis)
Downgraded Senior Thesis Tutorial - Project to be arranged in consultation with the tutor. Only enrolled in through the Honors Coordinator.
Offering: Host
Grading: A-F

PHYS409 Senior Thesis Tutorial
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

PHYS410 Senior Thesis Tutorial
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

PHYS411 Group Tutorial, Undergraduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

PHYS412 Group Tutorial, Undergraduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

PHYS419 Student Forum
Student-run group tutorial, sponsored by a faculty member and approved by the chair of a department or program.
Offering: Host
Grading: Cr/U

PHYS420 Student Forum
Student-run group tutorial, sponsored by a faculty member and approved by the chair of a department or program.
Offering: Host
Grading: Cr/U

PHYS421 Undergraduate Research, Science
Individual research projects for undergraduate students supervised by faculty members.
Offering: Host
Grading: OPT

PHYS422 Undergraduate Research, Science
Individual research projects for undergraduate students supervised by faculty members.
Offering: Host
Grading: OPT

PHYS423 Advanced Research Seminar, Undergraduate
Advanced research tutorial; project to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

PHYS424 Advanced Research Seminar, Undergraduate
Advanced research tutorial; project to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

PHYS491 Teaching Apprentice Tutorial
The teaching apprentice program offers undergraduate students the opportunity to assist in teaching a faculty member’s course for academic credit.
Offering: Host
Grading: OPT

PHYS492 Teaching Apprentice Tutorial
The teaching apprentice program offers undergraduate students the opportunity to assist in teaching a faculty member’s course for academic credit.
Offering: Host
Grading: OPT

PHYS500 Graduate Pedagogy
"The elements of good teaching will be discussed and demonstrated through lectures, practice teaching sessions, and discussions of problems encountered in the actual teaching environment. The staff consists of faculty and experienced graduate students. An integral part of the course is a required one-day workshop BEFORE the first day of formal classes.

Training in pedagogy in the first semester of attendance is required for all incoming Wesleyan MA and PhD students who have not already fulfilled this requirement at Wesleyan. BA/MA students are not required to get training in pedagogy but may choose to do so."
Offering: Crosslisting
Grading: Cr/U
Credits: 0.50
Gen Ed Area: None
Identical With: ASTR500, MB&B500, MUSC500, PSYC500, CHEM500, BIOL500, E&E500, MATH500
Prereq: None

PHYS501 Individual Tutorial, Graduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

PHYS502 Individual Tutorial, Graduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

PHYS504 Selected Topics, Graduate Sciences
Topic to be arranged in consultation with the tutor. A seminar primarily concerned with papers taken from current research publications designed for, and required of, graduate students.
Offering: Host
Grading: A-F

PHYS505 Condensed Matter Physics Seminar I
Presentations and discussions of material at the forefront of the discipline, emphasizing emerging, novel physics topics.
Offering: Host
Grading: Cr/U
Credits: 0.25
Gen Ed Area: None
Prereq: None

PHYS506 Condensed Matter Physics Seminar II
Presentations and discussions of material at the forefront of the discipline, emphasizing emerging, novel physics topics.
Offering: Host
Grading: Cr/U
Credits: 0.25
Gen Ed Area: None
Prereq: None

PHYS507 Atomic and Molecular Physics Seminar I
Presentations and discussions of material at the forefront of the discipline, emphasizing current research at Wesleyan.
Offering: Host
<table>
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<tr>
<td>PHYS508</td>
<td>Atomic and Molecular Physics Seminar II</td>
<td>None</td>
<td>1.00</td>
<td>Cr/U</td>
<td>OPT</td>
<td>-(PHYS213 AND MATH221) OR (PHYS214 AND MATH223)</td>
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<td>PHYS510</td>
<td>Theoretical Physics Seminar I</td>
<td>None</td>
<td>0.25</td>
<td>Cr/U</td>
<td>OPT</td>
<td>[PHYS315 or PHYS515] AND [PHYS313 or PHYS513]</td>
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<td>PHYS511</td>
<td>Group Tutorial, Graduate</td>
<td>None</td>
<td>0.25</td>
<td>Cr/U</td>
<td>OPT</td>
<td>PHYS214 AND MATH223 OR (PHYS214 AND MATH221)</td>
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<td>PHYS512</td>
<td>Group Tutorial, Graduate</td>
<td>None</td>
<td>0.25</td>
<td>Cr/U</td>
<td>OPT</td>
<td>None</td>
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<td>PHYS513</td>
<td>Classical Dynamics</td>
<td>None</td>
<td>0.25</td>
<td>Cr/U</td>
<td>Host</td>
<td>(PHYS213 AND MATH221) AND MATH222 AND MATH122</td>
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<td>PHYS515</td>
<td>Quantum Mechanics II</td>
<td>None</td>
<td>1.00</td>
<td>A-F</td>
<td>Cr/U</td>
<td>None</td>
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<td>PHYS516</td>
<td>Thermal and Statistical Physics</td>
<td>None</td>
<td>1.00</td>
<td>Cr/U</td>
<td>Cr/U</td>
<td>[PHYS315 or PHYS515] AND [PHYS313 or PHYS513]</td>
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<td>PHYS517</td>
<td>Molecular Biophysics Journal Club I</td>
<td>None</td>
<td>0.50</td>
<td>Cr/U</td>
<td>Host</td>
<td>CHEM507, PHYS317, MB&amp;B307, MB&amp;B307, CHEM307</td>
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<td>PHYS518</td>
<td>Molecular Biophysics Journal Club II</td>
<td>None</td>
<td>0.50</td>
<td>Cr/U</td>
<td>Host</td>
<td>CHEM507, PHYS317, MB&amp;B307, MB&amp;B307, CHEM307</td>
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<td>PHYS521</td>
<td>Physics Colloquium I</td>
<td>None</td>
<td>1.00</td>
<td>A-F</td>
<td>OPT</td>
<td>None</td>
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<td>PHYS522</td>
<td>Physics Colloquium II</td>
<td>None</td>
<td>0.25</td>
<td>Cr/U</td>
<td>OPT</td>
<td>None</td>
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<td>PHYS524</td>
<td>Electricity and Magnetism</td>
<td>None</td>
<td>1.00</td>
<td>A-F</td>
<td>Cr/U</td>
<td>None</td>
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both physical insight and the partial differential equations that describe these fields. We then cover electrodynamics to complete Maxwell's equations and to derive the elementary properties of electromagnetic radiation.

Offering: Crosslisting
Grading: OPT
Credits: 1.00
Gen Ed Area: NSM-PHYS
Identical With: PHYS324
Prereq: (PHYS116 AND PHYS124 AND MATH222)

PHYS525 Radiation and Optics
In this course, you will have the opportunity to apply your electrodynamics knowledge to explore electromagnetic waves and optics, radiation, and a bit of relativistic electrodynamics. You will get to relate these topics to a wide variety of recent physics research, such as invisibility cloaks, metamaterials with negative index of refraction, stopping and storing light in atomic gases, polarization of the cosmic microwave background, and the optical properties of bird feathers and iridescent butterfly wings. The goal is for you to leave this course with a deeper understanding and appreciation for electrodynamics and its applications.

Offering: Crosslisting
Grading: A-F
Credits: 0.50
Gen Ed Area: NSM-PHYS
Identical With: PHYS325
Prereq: [PHYS324 or PHYS524]

PHYS539 Molecular and Cellular Biophysics
This course is an integrated consideration of the biophysics and biophysical chemistry of biological systems from molecules to cells. The objective is to develop a critical sense of the quantitative data currently being obtained from microscopy to spectroscopy, considering both ensemble and single-molecule experiments, and to gain familiarity and facility with interpretation using mathematical and computational models. Biological systems are inherently complex, and some form of modeling is always involved in developing an explanation of how they work. However, these models typically involve only a few basic constructs (simple harmonic motion, ideal fluids, two-state Ising models, random walks, electrostatic interactions, classical dynamics, rate equations, QM energy levels, distribution functions, and network analysis) and only elementary aspects of linear algebra, calculus, differential equations, and statistics. This course deals with how these constructs are integrated in the framework of Boltzmann statistical mechanics to formulate mathematical models of biological phenomena, how these models are validated and refined, and how they are used to form explanations and make testable predictions. Model systems to be considered include the nucleosome, the ribosome, membrane dynamics and ion channels, molecular devices and motors, prototype signal transduction systems, and regulatory processes. This course is suitable for physics and chemistry students who wish to learn about biological applications and for molecular and cellular biology students to develop skills with quantitative physicochemical modes of inquiry applied to the life sciences.

Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Identical With: CHEM309, MB&B309, CHEM509, MB&B509, PHYS339
Prereq: (CHEM251 AND CHEM252)

PHYS542 Experimental Optics
This is an experimental course in optics, including lenses, lens combinations, interference and diffraction, interferometry, and spectrometry.

Offering: Crosslisting
Grading: A-F
Credits: 0.50
Gen Ed Area: NSM-PHYS

Identical With: PHYS342
Prereq: (PHYS116 AND PHYS213)

PHYS543 Analytical Mechanics
Advanced classical mechanics and mathematical physics, description of multidimensional motion, vibrations, perturbation theory, and chaos.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: (PHYS213 AND PHYS217 AND [PHYS313 or PHYS513] AND [PHYS316 or PHYS516])

PHYS545 Electronics Lab
This laboratory course covers the fundamentals of analog and digital electronics: passive DC and AC circuits, linear transistor and integrated circuits, and digital integrated circuits.

Offering: Crosslisting
Grading: Cr/U
Credits: 0.50
Gen Ed Area: NSM-PHYS
Identical With: PHYS345
Prereq: (PHYS116 AND PHYS213)

PHYS549 Advanced Research Seminar, Graduate
Advanced research tutorial; project to be arranged in consultation with the tutor.

Offering: Host
Grading: OPT

PHYS550 Advanced Research Seminar, Graduate
Advanced research tutorial; project to be arranged in consultation with the tutor.

Offering: Host
Grading: OPT

PHYS558 Condensed Matter
This course is an introduction to condensed-matter physics with emphasis on fundamental properties of solids. We will explore crystal structure, phonons, and electrons in solids as a basis for understanding the thermal, electronic, and magnetic properties of materials. In addition to lectures and problem sets, there will be several numerical experiments in which computer simulation and visualization tools will be used to explore microscopic properties of materials.

Offering: Crosslisting
Grading: OPT
Credits: 1.00
Gen Ed Area: NSM-PHYS
Identical With: PHYS358
Prereq: [PHYS315 or PHYS515] AND [PHYS324 or PHYS524]

PHYS565 Mathematical Physics
Historically, physics and mathematics are closely related. Physics uses powerful tools developed by mathematicians, while physicists, investigating the actually existing universe, provide mathematicians with new concepts and ideas to explore. This way, many mathematical techniques, and even entire areas of mathematics, developed from the need to solve certain real-life problems posed by physical reality. The purpose of this course is to give students an overview of the powerful array of mathematical tools available for the solution of physical problems. Starting with the presentation of tools of complex analysis, we will apply them to the solution of ordinary and partial differential equations. We will encounter Fourier and Laplace transforms and will study the Green's function method for the solution of bound and scattering problems. We will also look into the elements of Group Theory and apply it to angular momentum in quantum many-body systems.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
PHYS566 Electrodynamics
This course covers boundary value problems, Green’s functions, multipoles, fields in dielectric and magnetic media, electromagnetic radiation, and wave guides.
Offering: Host
Grading: OPT
Credits: 1.00
Gen Ed Area: None
Prereq: None

PHYS567 Statistical Mechanics
This course will develop important concepts in statistical physics by examining several applications in detail. The areas covered will include the classical and quantum gases, critical behavior and phase transitions, and elementary transport phenomena.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: [PHYS316 or PHYS516]

PHYS568 Quantum Mechanics
This course will develop advanced aspects of theory and application of quantum mechanics.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: [PHYS315 or PHYS515]

PHYS571 Advanced Topics in Atomic and Molecular Physics
This course will introduce classical and quantum collision theory, with special consideration of atomic and molecular collisions.
Offering: Host
Grading: OPT
Credits: 0.50
Gen Ed Area: None
Prereq: PHYS5315

PHYS572 Advanced Topics in Atomic and Molecular Physics
The course will cover advanced topics in structure, spectroscopy, and dynamics of atoms and molecules.
Offering: Host
Grading: OPT
Credits: 0.50
Gen Ed Area: None
Prereq: None

PHYS573 Advanced Topics in Condensed Matter
The course will cover advanced topics in condensed-matter physics, with emphasis on current research problems within the department.
Offering: Host
Grading: OPT
Credits: 0.50
Gen Ed Area: None
Prereq: ([PHYS558 or PHYS558] AND [PHYS315 or PHYS515])

PHYS574 Advanced Topics in Condensed Matter: Fluid Mechanics
This course will be an introduction to fluid mechanics, with emphasis on current research problems within the department. Topics will include Navier-Stokes equations, boundary layers, instabilities and turbulence.
Offering: Host
Grading: OPT
Credits: 0.50
Gen Ed Area: None
Prereq: None

PHYS575 Advanced Topics in Theoretical Physics
This graduate course presents advanced topics in theory of relevance for current research in the department. The specific material varies each time the course is taught.
Offering: Host
Grading: OPT
Credits: 0.50
Gen Ed Area: None
Prereq: PHYS213 AND PHYS214 AND PHYS324

PHYS576 Advanced Topics in Theory
This graduate course will present advanced topics in theory of relevance for current research in the department.
Offering: Host
Grading: OPT
Credits: 0.50
Gen Ed Area: NSM-PHYS
Prereq: None

PHYS577 Lab Pedagogy
This course is taken by graduate students teaching PHYS121 or PHYS123.
Offering: Host
Grading: Cr/U
Credits: 0.25
Gen Ed Area: None
Prereq: None

PHYS578 Lab Pedagogy
This course is taken by graduate students teaching PHYS122.
Offering: Host
Grading: OPT
Credits: 0.50
Gen Ed Area: None
Prereq: None

PHYS587 Seminar in Chemical Physics
Weekly seminars presented jointly with the Department of Physics under the auspices of the Chemical Physics Program. These informal seminars will be presented by students, faculty, and outside visitors on current research and other topics of interest.
Offering: Crosslisting
Grading: Cr/U
Credits: 0.25
Gen Ed Area: None
Identical With: CHEM547
Prereq: None

PHYS588 Seminar in Chemical Physics
Weekly seminars presented jointly with the Chemistry Department under the auspices of the Chemical Physics Program. These informal seminars will be presented by students, faculty, and outside visitors on current research and other topics of interest.
Offering: Host
Grading: Cr/U
Credits: 0.25
Gen Ed Area: None
Identical With: CHEM548
Prereq: None

PHYS222 AND PHYS223 AND PHYS313 AND PHYS315 AND PHYS324