PHYSICS (PHYS)

PHYS105 Calderwood Seminar in Public Writing: Radical Sustainability

The environmental challenges widely known and discussed for the past 50 years not only remain: they have grown. Maybe we haven't worked hard enough, or maybe we've been going about sustainability the wrong way. Radical sustainability explores the intersection of these now-critical challenges--extinction, climate change, and many others--as well as the physical and social constraints on action to address them. Our aim is to identify the pressure points for an effective response within the geo-ecosystem and the human systems embedded within it, and then to focus on making change through writing.

Calderwood Seminars in Public Writing are writing-intensive courses that emphasize writing for general audiences about expert subject matters. Students work with their peers to hone the skills that enable them to translate scientific understanding of sustainability for the public. Using an intensive author/ editor model, students will explore public communication in a variety of forms, including news articles, radio features, and editorials. The goal is prose that is polished and persuasive. Course readings are chosen to highlight the physical nature of human systems as they relate to natural systems. While there is no prerequisite, the course is intended for upper-level students with experience in environmental and sustainability studies.

Offering: Host Grading: OPT Credits: 1.00 Gen Ed Area: NSM-PHYS Identical With: ENVS235, WRCT235 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 course, along with PHYS 112 in the spring semester, is an introduction to the fundamental principles of physics. Employing trigonometry and algebra the goal is to provide tools for the quantitative understanding of a wide variety of phenomena, with many examples taken from the life sciences. The lab PHYS 121 is recommended. Since algebra is an important prerequisite for PHYS 111, we strongly recommend that all students take a diagnostic test prior to the start of the course. It can be found at https://www.khanacademy.org/math/algebra/test/subject-challenge?modal=1

Taking this "Course Challenge" will take 30-45 minutes and leave you with a good idea of where your algebra skills might need review. Follow-up guided lessons can be chosen at this website.

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

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; any student wishing to major in physics should enroll in PHYS124, since it is a requirement for the major.

Offering: Host Grading: OPT Credits: 1.00 Gen Ed Area: NSM-PHYS Prereq: PHYS113

PHYS116P General Physics II Problem Solving

This course in the problem solving session component of General Physics II. All students enrolled in PHYS 116 must register for one section of PHYS 116P. This

course meets weekly for a session focused on direct solving of problems based on material that is covered during General Physics II class time. Students will work in collaboration to develop the problem solving skills that will allow them to succeed in General Physics II and beyond.

Offering: Host Grading: Cr/U Credits: 0.00 Gen Ed Area: None Prereq: None

PHYS121 Introductory 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 Prereq: None

PHYS122 Introductory Physics Laboratory II

This course provides laboratory experiences for students taking PHYS112.

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 calculations with the experiments. Students will get hands-on experience with physical systems that demonstrate the principles being studied in PHYS113. Hands-on experience helps in developing physical intuition, a deeper understanding of the course material, and the world around us. The emphasis in this course is on experimental technique and the proper identification, appreciation, and handling of experimental error.

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

PHYS124 General Physics Laboratory II

This laboratory course is designed to be taken in conjunction with PHYS116. Students will get hands-on experience with physical systems that demonstrate the principles being studied in PHYS116. Hands-on experience helps in developing physical intuition, a deeper understanding of the course material, and the world around us. The emphasis in this course is on experimental technique and the proper identification, appreciation, and handling of experimental error. Offering: Host

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

PHYS170Z Introduction to Design and Engineering

This course will provide a hands-on introduction to design and engineering. Students will engage in individual and team projects in a studio environment where we seek to develop a shared practice and understanding of the engineering design process. We will study biological organisms to find inspiration for design of hoppers, swimmers, and climbers. Students will build skills using computer-aided design (CAD) software and using tools for fabrication and prototyping including laser cutting and 3D printing. We will also hone skills in identifying which scientific and engineering principles need to be understood to achieve design goals.

Offering: Crosslisting Grading: OPT Credits: 1.00 Gen Ed Area: NSM-CIS Identical With: IDEA170Z, CIS170Z Prereq: None

PHYS205 Introduction to Mechanical Design and Engineering

This course will provide a hands-on introduction to design and engineering. Students will engage in individual and team projects in a studio environment where we seek to develop a shared practice and understanding of the engineering design process. We will study biological organisms to find inspiration for design of hoppers, swimmers, and climbers. Students will build skills using computer-aided design (CAD) software and using tools for fabrication and prototyping including laser cutting and 3D printing. We will also hone skills in identifying which scientific and engineering principles need to be understood to achieve design goals.

Offering: Crosslisting Grading: Cr/U Credits: 1.00 Gen Ed Area: NSM-CIS Identical With: IDEA170, CIS170 Prereg: None

PHYS206 Introduction to Electrical Design & Engineering

Students will learn about engineering mechanics, electronic control systems, and physical actuators (e.g., for movement) using a microprocessor platform, sensors and motors. The final project will require a student team to ideate, design, analyze, and optimize a mechatronic system. This course will allow students to better understand components, methods, and challenges in mechatronics systems commonly found in automation and robotics.

Offering: Crosslisting Grading: Cr/U Credits: 1.00 Gen Ed Area: NSM-CIS Identical With: IDEA175, CIS175 Prereg: None

PHYS207 Introduction to Biophysics

This course will introduce students to major topics in biophysics with an emphasis on the statistical physics of biological systems at the microscopic or molecular level. Topics covered will include molecular motors, self-assembly, and single-molecule manipulation. Students will learn how physical arguments and reasoning can provide significant insight into the design and function of biological systems. While this course is geared toward students who have had a full year of calculus-based physics, relevant concepts in biology and chemistry will be introduced as needed. No detailed knowledge of biology or chemistry beyond the high-school level is required for this course.

Offering: Crosslisting Grading: A-F Credits: 1.00 Gen Ed Area: NSM-PHYS Identical With: MB&B207 Prereq: PHYS116

PHYS210 How Things Fail: Mechanics and Materials

This lab/lecture engineering course is a foundational cornerstone of structural analysis and mechanical design. It will provide students with a theoretical and practical understanding of static equilibrium force systems, material response to loading, and analysis of failure modes for each of the fundamental types of stress and strain (axial, flexural, and torsional). These skills are vital for students from a range of disciplines, including mechanical engineering and architecture. The final project will require the design, implementation, and performance testing of an optimized structural system model, such as a truss bridge, building, or other structure.

Offering: Crosslisting Grading: A-F Credits: 1.00 Gen Ed Area: NSM-IDEA Identical With: IDEA210, CIS210 Prereq: IDEA170 AND (PHYS111 OR PHYS113)

PHYS213 Waves and Oscillations

The properties of periodic motion recur in many areas of physics, including mechanics, quantum physics, and electricity and magnetism. The ubiquity of oscillatory motion in biological and chemical systems, as well as engineering, provides interdisciplinary importance for developing the formal description of periodic motion. 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: OPT Credits: 1.00 Gen Ed Area: NSM-PHYS Prereq: PHYS116

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 AND MATH221) OR (PHYS213 AND MATH223)

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: None

PHYS217 Nonlinear Dynamics and Chaos

Why is it often very difficult to predict the behavior of systems even when we know the interactions between the constituent parts? When the interactions are nonlinear, the tools of linear mathematics are inadequate. When nonlinear systems have more than three dimensions in their state space, they are often chaotic with fundamental limits on predictability. This course systematically addresses one and two dimensional nonlinear systems, analyzing fixed points,

bifurcations, and limit cycles. We then explore chaos in continuous systems and discrete maps. The course balances mastery of mathematical tools for analyzing nonlinear systems, development of physical intuition, and practical problem-solving.

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

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: Cr/U Credits: 0.50 Gen Ed Area: NSM-PHYS Prereq: (PHYS113 AND PHYS116)

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: OPT Credits: 1.00 Gen Ed Area: NSM-PHYS Identical With: PHYS513 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. Offering: Host Grading: A-F Credits: 1.00 Gen Ed Area: NSM-PHYS Identical With: PHYS515 Prereq: (PHYS214 AND MATH223) OR (PHYS214 AND MATH221)

PHYS316 Thermal and Statistical Physics

Thermodynamics and statistical mechanics are pillars of physics. Thermodynamics provides a framework through which we can understand the rules for the conversion of energy and matter from one form to another. As we will learn, every transfer of energy results in the conversion of some energy into an unusable form. Using the tools of thermodynamics, we can establish limits for the amount of useful work that can be extracted from any process. These limits have important implications for the quest to achieve sustainability in our use of energy and materials. As we learn about thermodynamics, we will spend some time exploring this real-world application of the material covered.

Likewise, statistical mechanics provides us with a set of tools for understanding how the behavior of individual atoms and molecules impacts the properties and behavior of materials that can be observed in our daily lives. Our approach to this material differs from many previous physics courses and requires a mixture of statistical and counting skills, coupled with physical intuition for the nature of matter. In addition to explaining phase transitions, critical phenomena, and the statistical nature of fermions and bosons, the tools of statistical mechanics are essential for understanding phenomena like evaporative cooling and the greenhouse effect. We will explore the conditions that lead to these phenomena and discuss the role they may play in a comprehensive approach to sustainability.

Offering: Host Grading: OPT Credits: 1.00 Gen Ed Area: NSM-PHYS Identical With: PHYS516 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 iln 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: MB&B507, MB&B307, CHEM507, CHEM307, PHYS517 Prereq: None

PHYS318 Molecular Biophysics Journal Club II

Presentation and active discussion of a series of current research articles in the field of molecular biophysics and biophysical chemistry from 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: MB&B508, MB&B308, CHEM508, PHYS518, CHEM308 Prereg: None

PHYS320 Introduction to Tensors and General Relativity

Students will learn the basics of physics in curved spacetime and the use of tensors to describe physical quantities and laws. Geodesics in curved spacetimes and how space and time change in general relativity will be a particular focus. Offering: Host

Grading: OPT Credits: 1.00 Gen Ed Area: NSM-PHYS Prereq: PHYS215

PHYS321 Undergraduate Physics Research Seminar I

This seminar introduces undergraduate students to the exciting and diverse research conducted within the physics department. Faculty members from various research areas will give talks showcasing their work, providing insight into both fundamental and applied physics. The goal is to help students explore different research topics, understand what physics research entails, and discover potential opportunities to get involved in faculty-led projects. This seminar is open to all students with an interest in physics, particularly first and second year students who are curious about research but have not yet chosen a specific focus. The course is structured as a series of faculty presentations, followed by discussions where students can engage with researchers, ask questions, and explore potential research pathways.

Offering: Host Grading: Cr/U Credits: 0.50 Gen Ed Area: None

Prereq: None

PHYS322 Physics Colloquium with Journal Club II

Students will review and discuss materials in preparation for attending the physics colloquium. Attendance at the colloquium is also required. Offering: Host Grading: Cr/U Credits: 0.50 Gen Ed Area: None 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: PHYS524 Prereq: PHYS116 AND PHYS124 AND PHYS213 AND MATH222

PHYS339 Molecular and Cellular Biophysics

This course is an integration of the physical and chemical principles underlying biological systems from molecules to cells. The objectives are to develop an understanding of the underlying biological and physical principles that inform biophysical methods (e.g., protein-protein interaction studies, enzyme kinetics, spectroscopy, structural biology), how these concepts and techniques can be used to address open scientific questions, and how to critically evaluate their use in scientific literature. Particular emphasis will be placed on the biophysical concepts underlying studies of proteins, enzymes, and metalloproteins.

Offering: Crosslisting Grading: A-F Credits: 1.00 Gen Ed Area: NSM-CHEM Identical With: MB&B309, CHEM309, CHEM509, MB&B509, PHYS539 Prereq: None

PHYS340 Computational Physics

Most modern problems in physics cannot be analytically solved, making numerical solution necessary. This course introduces students to vital numerical methods used in modern computational physics. Students will develop code to calculate exact numerical solutions to a range of physics problems, such as N-body motion, the solution of Schrödinger's equation, and phase transitions. Methods covered include root finding, numerical integration of initial and boundary value problems, Monte Carlo techniques, and an introduction to machine learning methods. Code will be developed using Python and there will be opportunities to gain experience in the C programming language as well. Previous programming experience is strongly encouraged but not required. Offering: Host Grading: OPT 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: A-F Credits: 0.50 Gen Ed Area: NSM-PHYS Identical With: PHYS545 Prereq: (PHYS116 AND PHYS213)

PHYS358 Condensed Matter

This calculus-based course is an introduction to the physics of the solid state. It includes topics such as the reciprocal lattice, elastic constants, band structure, and Fermi surfaces.

Offering: Host Grading: OPT Credits: 1.00 Gen Ed Area: NSM-PHYS Identical With: PHYS558 Prereq: PHYS316 AND PHYS315 AND PHYS324

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 threedimensional 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: MB&B395, CHEM395 Prereq: (CHEM142 OR CHEM142Z OR CHEM144) AND (CHEM325 OR MB&B208 OR PHYS207)

PHYS401 Individual Tutorial, Undergraduate Topic to be arranged in consultation with the tutor.

Topic to be arranged in consultation with the tu 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

PHYS465 Education in the Field, Undergraduate

Students must consult with the department and class dean in advance of undertaking education in the field for approval of the nature of the responsibilities and method of evaluation.

Offering: Host

Grading: OPT

PHYS466 Education in the Field, Undergraduate

Students must consult with the department and class dean in advance of undertaking education in the field for approval of the nature of the responsibilities and method of evaluation.

Offering: Host Grading: A-F Credits: 1.00 Gen Ed Area: None Prereq: None

PHYS470 Independent Study, Undergraduate

Credit may be earned for an independent study during a summer or authorized leave of absence provided that (1) plans have been approved in advance, and (2) all specified requirements have been satisfied.

Offering: Host Grading: OPT Credits: 0.50 Gen Ed Area: None Prereq: None

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, CHEM500, BIOL500, E&ES500, MB&B500, MUSC500, PSYC500, 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

Presentation and discussion 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 Grading: Cr/U Credits: 0.25 Gen Ed Area: None Prereq: PHYS214 PHYS508 Atomic and Molecular Physics Seminar II

Presentations and discussions of material at the forefront of the discipline, emphasizing current research at Wesleyan. Offering: Host Grading: Cr/U Credits: 0.25 Gen Ed Area: None Prereq: None

PHYS509 Theoretical 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: ([PHYS313 or PHYS513] AND PHYS214 AND [PHYS315 or PHYS515] AND [PHYS316 or PHYS516])

PHYS510 Theoretical Physics Seminar II

Presentations and discussions of material at the forefront of the discipline, emphasizing emerging, novel physics topics. Offering: Host

Grading: OPT Credits: 0.25 Gen Ed Area: None Prereq: ([PHYS315 or PHYS515] AND [PHYS324 or PHYS524] AND [PHYS316 or PHYS516])

PHYS511 Group Tutorial, Graduate

Topic to be arranged in consultation with the tutor. Offering: Host Grading: OPT

PHYS512 Group Tutorial, Graduate

Topic to be arranged in consultation with the tutor. Offering: Host Grading: OPT

PHYS513 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: Crosslisting Grading: OPT Credits: 1.00 Gen Ed Area: NSM-PHYS Identical With: PHYS313 Prereq: (PHYS213 AND MATH221 AND MATH222 AND MATH122)

PHYS515 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.

Offering: Crosslisting Grading: A-F Credits: 1.00 Gen Ed Area: NSM-PHYS Identical With: PHYS315 Prereq: (PHYS214 AND MATH223) OR (PHYS214 AND MATH221)

PHYS516 Thermal and Statistical Physics

Thermodynamics and statistical mechanics are pillars of physics.

Thermodynamics provides a framework through which we can understand the rules for the conversion of energy and matter from one form to another. As we will learn, every transfer of energy results in the conversion of some energy into an unusable form. Using the tools of thermodynamics, we can establish limits for the amount of useful work that can be extracted from any process. These limits have important implications for the quest to achieve sustainability in our use of energy and materials. As we learn about thermodynamics, we will spend some time exploring this real-world application of the material covered.

Likewise, statistical mechanics provides us with a set of tools for understanding how the behavior of individual atoms and molecules impacts the properties and behavior of materials that can be observed in our daily lives. Our approach to this material differs from many previous physics courses and requires a mixture of statistical and counting skills, coupled with physical intuition for the nature of matter. In addition to explaining phase transitions, critical phenomena, and the statistical nature of fermions and bosons, the tools of statistical mechanics are essential for understanding phenomena like evaporative cooling and the greenhouse effect. We will explore the conditions that lead to these phenomena and discuss the role they may play in a comprehensive approach to sustainability.

Offering: Crosslisting Grading: OPT

Credits: **1.00** Gen Ed Area: **NSM-PHYS** Identical With: **PHYS316** Prereq: **PHYS214**

PHYS517 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 iln 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: MB&B507, MB&B307, CHEM507, CHEM307, PHYS317

Prereq: None

PHYS518 Molecular Biophysics Journal Club II

Presentation and active discussion of a series of current research articles in the field of molecular biophysics and biophysical chemistry from 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: MB&B508, MB&B308, CHEM508, PHYS318, CHEM308 Prerea: None

PHYS521 Physics Colloquium I

Presentations by outside experts and discussion 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

PHYS522 Physics Colloquium II

Presentations by outside experts and discussion 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: ([PHYS315 or PHYS515] AND [PHYS313 or PHYS513])

PHYS524 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: Crosslisting Grading: OPT Credits: 1.00 Gen Ed Area: NSM-PHYS Identical With: PHYS324 Prereq: PHYS116 AND PHYS124 AND PHYS213 AND MATH222

PHYS531 Graduate Physics Methods Seminar I

This seminar focuses on presenting general methods used in current theoretical and experimental research performed in the Physics Department. The exposition will be done by student participants, guided by the instructing faculty.

Offering: Host Grading: Cr/U Credits: 0.25 Gen Ed Area: NSM-PHYS Prereq: None

PHYS532 Graduate Physics Methods Seminar II

This seminar focuses on presenting general methods used in current theoretical and experimental research performed in the Physics Department. The exposition will be done by student participants, guided by the instructing faculty.

Offering: Host Grading: Cr/U Credits: 0.25 Gen Ed Area: NSM-PHYS Prereq: None

PHYS533 Graduate Physics Research Seminar I

This course consists of weekly meetings for students to practice their scientific presentation and listening skills. Students will each claim responsibility for one or two meetings. Presentations may consist of research-relevant papers, practice talks for conferences, or research updates for the general graduate audience. Offering: Host

Grading: Cr/U Credits: 0.25 Gen Ed Area: NSM-PHYS Prereq: None

PHYS534 Graduate Physics Research Seminar II

This course consists of weekly meetings for students to practice their scientific presentation and listening skills. Students will each claim responsibility for one or two meetings. Presentations may consist of research-relevant papers, practice talks for conferences, or research updates for the general graduate audience. Offering: Host

Grading: Cr/U Credits: 0.25 Gen Ed Area: NSM-PHYS Prereq: None

PHYS539 Molecular and Cellular Biophysics

This course is an integration of the physical and chemical principles underlying biological systems from molecules to cells. The objectives are to develop an understanding of the underlying biological and physical principles that inform biophysical methods (e.g., protein-protein interaction studies, enzyme kinetics, spectroscopy, structural biology), how these concepts and techniques can be used to address open scientific questions, and how to critically evaluate their use in scientific literature. Particular emphasis will be placed on the biophysical concepts underlying studies of proteins, enzymes, and metalloproteins. Offering: **Crosslisting**

Grading: A-F Credits: 1.00 Gen Ed Area: NSM-CHEM Identical With: MB&B309, CHEM309, CHEM509, MB&B509, PHYS339 Prereq: None

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)

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: **A-F** 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 calculus-based course is an introduction to the physics of the solid state. It includes topics such as the reciprocal lattice, elastic constants, band structure, and Fermi surfaces.

Offering: Crosslisting Grading: OPT Credits: 1.00 Gen Ed Area: NSM-PHYS Identical With: PHYS358 Prereq: PHYS316 AND PHYS315 AND PHYS324

PHYS563 Analytical Mechanics

Advanced classical mechanics: multidimensional motion, rigid bodies and rotational dynamics, chaotic dynamics, and applications. Offering: Host

Grading: A-F Credits: 1.00 Gen Ed Area: None

Prereq: (PHYS213 AND PHYS217 AND PHYS313) OR (PHYS213 AND PHYS217 AND PHYS513)

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.

Grading: A-F Credits: 1.00 Gen Ed Area: None

Prereq: MATH222 AND MATH223 AND PHYS313 AND PHYS315 AND PHYS324

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: PHYS324

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 concepts of quantum mechanics. Offering: Host Grading: A-F Credits: 1.00 Gen Ed Area: None Prereq: [PHYS315 or PHYS515] AND [PHYS313 or PHYS513]

PHYS571 Advanced Topics in Atomic and Molecular Physics

Fundamentals of plasma physics will be discussed. We will investigate theoretical and experimental aspects related to the production and diagnostic of such plasmas, in particular low temperature plasmas. Offering: Host

Grading: OPT Credits: 0.50 Gen Ed Area: None Prereq: PHYS315

PHYS572 Advanced Topics in Atomic and Molecular Physics

Several plasma applications will be discussed, for example, in fusion, chemical analysis, surface treatment, and medicine.

Offering: Host Grading: OPT Credits: 0.50 Gen Ed Area: None Prereq: PHYS515

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: PHYS324 OR PHYS524

PHYS574 Advanced Topics in Condensed Matter

The course will cover advanced topics in condensed-matter physics, with emphasis on current research problems within the department. This course may be repeated for credit. Offering: Host Grading: OPT Credits: 0.50 Gen Ed Area: None

Prereg: PHYS324 OR PHYS524

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

PHYS588 Seminar in Atomic and Molecular/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