Courses Offered in the Physics Department

PHYS 009 – Energy and the Environment
Forms of energy as defined in physics; sources, uses, and transformations of energy; introductory seminar and laboratory will place emphasis on environmental issues. Prerequisites: High-school algebra and trigonometry. Credits: 3.

PHYS 011 - Elementary Physics
Algebra-based survey of mechanics, oscillations, waves and thermal physics. Appropriate for students in health and life sciences. Accompanying lab: PHYS 021. Prerequisites: High-school algebra and trigonometry. Credits: 4.

PHYS 012 - Elementary Physics
Algebra-based survey of electricity, magnetism, optics and modern physics. Appropriate for students in health and life sciences. Accompanying lab: PHYS 022. Prerequisites: High-school algebra and trigonometry. One of PHYS 011, 031, 051. Credits: 4.

PHYS 013 - Conceptual Physics
One-semester conceptual survey. Topics selected from mechanics, electricity, magnetism and modern physics. For students in the College of Nursing and Health Sciences only. Credits: 3.

PHYS 021 - Introductory Lab I
Prerequisite: Concurrent enrollment or credit in 011. Credits: 1.

PHYS 022 - Introductory Lab II
Prerequisite: Concurrent enrollment or credit in 012 or 125. Credits: 1.

PHYS 030 - Physics Problem Solving I
Problem-solving techniques for first semester physics with calculus. Accompanies 031. Pre/co-requisites: Concurrent enrollment in 031. Credits: 1.

PHYS 031 - Physics for Engineers I
Mechanics including oscillations and waves. With lab. Accompanying optional problem-solving session: 030. Pre/co-requisites: Math 021, secondary school trigonometry. Credits: 4.

PHYS 044 - The Physics of Music
Basic physical principles underlying the production, transmission and perception of musical sound. Vibrations, waves, elementary acoustics with applications to a wide range of musical topics. Pre-requisites: High School Algebra. Credits: 3.

PHYS 051 - Fundamentals of Physics I
Calculus-based introduction to kinematics, dynamics, oscillations, thermal physics. For students in the natural sciences. With lab. Credit not given for both 051 and 031. Pre/co-requisites: Credit or concurrent enrollment in MATH 021. Credits: 4.

PHYS 095, 096 - Special Topics Credits: 0-4.

PHYS 123 - Physics Problem Solving II
Problem-solving techniques for second semester physics with calculus. Accompanies 125. Pre/co-requisites: Concurrent enrollment in 125. Credits: 1.

PHYS 122 - Biological Physics
Physical laws, processes, and interactions pertaining to biological systems. Prerequisites: 012 or 152, Math. 121. Credits: 3.

PHYS 125 - Physics for Engineers II
Electricity, magnetism, electromagnetic waves, optics. Appropriate for students in engineering and physical sciences. Without lab. Accompanying optional problem- solving session: 123. Pre/co-requisites: 031, Math 022, concurrent enrollment in Math 121 or 123. Credits: 3.

PHYS 128 - Waves and Quanta
Classical and electromagnetic waves, physical optics, wave-particle phenomenology, wave mechanics, and applications of the Schrodinger equation. With lab. Prerequisites: 152, Math. 121. Credits: 4.

PHYS 152 - Fundamentals of Physics II
Calculus-based introduction to electricity, magnetism and optics. For students in the natural sciences. With lab. Credit not given for both 125 and 152. Pre/co-requisites: PHYS 031 or 051; credit or concurrent enrollment in MATH 022. Credits: 4.

PHYS 195, 196 - Intermediate Special Topics
See Schedule of Courses for specific titles. Prerequisite: 128, department permission. Credits: 1-6.

PHYS 197, 198 - Readings & Research
Prerequisite: 128, department permission. Credits: 1-6.

PHYS 201, 202 - Experimental Physics
Experiments in classical and modern physics. May be entered at beginning of either semester and repeated for credit up to a maximum of four semesters. Prerequisites: 152 or 128, Math. 121, junior standing. Credits: 3.

PHYS 211 - Mechanics
Newtonian dynamics of particles and systems of particles, with applications to problems of special importance, such as driven and coupled harmonic oscillators and central field trajectories. Prerequisites: 152, Math. 121. Credits: 3.

PHYS 213 - Electricity & Magnetism
Fundamental principles of electricity and magnetism; electrostatic fields, and magnetic fields of steady currents. Electric and magnetic properties of matter and electromagnetic energy. Prerequisites: 152, Math. 121. Credit not given for more than one of 213 or Electrical Engineering 141. Credits: 3.

PHYS 214 - Electromagnetism
Introduction to time dependent electromagnetic fields. Maxwell's equations in vacuum and in matter. Electromagnetic waves and radiation. Prerequisite: 213. Credit not given for more than one of 214 or Electrical Engineering 142. Credits: 3.

PHYS 242 - Intro to Solid State Physics
Introduction to crystal structures, reciprocal lattices, lattice vibrations. Thermal properties of solids and free electron theory of metals and semiconductors. Elementary band theory and introduction to electronic transport theory. Prerequisite: 128. Credits: 3.

PHYS 257 - Modern Astrophysics
(Same as ASTR 257.) Stellar structure and evolution, compact objects, the interstellar medium, galactic structure, gravitational theory, and cosmology, the formation of our solar system and terrestrial life. Prerequisite: One 100-level course in physical science or engineering. Credits: 3.

PHYS 258 - Relativity
Development of Einstein's theory of special relativity. Lorentz transformation, time dilation, length contraction, mass variation, relative velocities. Introduction to four-dimensional space. Concepts of general relativity. Applications selected from astrophysics, elementary particles, etc. Prerequisite: 128. Credits: 3.

PHYS 264 - Nuclear & Elementary Particle Physics
Introduction to theoretical and experimental aspects of nuclear and elementary particle physics. Prerequisites: 128, junior standing. Credits: 3.

PHYS 265 - Thermal Physics
Thermodynamics, kinetic theory, statistical mechanics. Prerequisites: 152; Math. 121. Credits: 3.

PHYS 273 - Quantum Mechanics I
Introduction to nonrelativistic quantum mechanics. Schrodinger equation and applications to simple systems. Prerequisites: 128, 211. Credits: 3.

PHYS 274 - Applications of Quantum Mechanics
Applications of Quantum Mechanics including Quantum Statistical Mechanics, Time-Independent and Time- Dependent Perturbation Theory, WKB Approximation, Variational Principle and Scattering. Pre/co-requisites: PHYS 273 Credits: 3.

PHYS 295, 296 - Advanced Special Topics
See Schedule of Courses for specific titles. Credits: 1-6.

PHYS 301 - Mathematical Physics
Introduction to basic mathematical methods of theoretical physics; vector and tensor analysis, partial differential equations, orthogonal functions, complex variables and variational techniques. Prerequisites: 211, 214. Alternate years. Credits: 3.

PHYS 305 - Teaching of College Physics
Instructional strategies and techniques with application to the teaching of laboratories and recitations. Prerequisites: Undergraduate degree in physics and permission. Credits: 1.

PHYS 311 - Advanced Dynamics
Classical mechanics presented as the basis of the concepts and methods of modern physics. Variational, Lagrangian, and Hamiltonian formulations, canonical transformations, continuous systems. Prerequisite: 211. Alternate years. Credits: 3.

PHYS 313 - Electromagnetic Theory
Development of Maxwell's theory of electromagnetism emphasizing its physical basis and the modes of mathematical description. Prerequisite: 214. Alternate years. Credits: 3.

PHYS 321 - Theoretical Physics
For research students interested in pursuing topics of general and departmental research interest in theoretical physics. Prerequisite: Permission. Offered as occasion warrants. Credits: 1-6.

PHYS 323 - Contemporary Physics
Topics of current interest in physics to be offered as student and faculty interest warrants. May be repeated for credit with departmental approval. Prerequisite: Permission. Credits: 0-6.

PHYS 331 - Biological Physics
For research students in the field of biological physics. Lectures, reports, and directed readings related to the research of the Department and the field generally. May be repeated for credit with departmental approval. Prerequisite: Permission. Offered as occasion warrants. Credits: 1-3.

PHYS 341 - Condensed Matter Physics
Introduction to crystal symmetry and the reciprocal lattice. Crystal binding and lattice vibrations. Thermal, electrical, and magnetic properties of solids, free electron theory of metals, and band theory. Prerequisites: 214, 265, 273 or their equivalents; permission. Credits: 3.

PHYS 351 - Seminar: Physics of Materials
For research students in the field of the physics of materials. Lectures, reports, and directed readings related to the research for the department and the field generally. May be repeated for credit with departmental approval. Prerequisite: Permission. Offered as occasion warrants. Credits: 1-3.

PHYS 362 - Quantum Mechanics II
Mathematical and physical foundations of nonrelativistic quantum mechanics from the unifying point of view of Dirac. Symmetry operations and the algebraic structure of quantum mechanics are emphasized. Prerequisite: 273. Alternate years. Credits: 3

A GUIDE FOR PHYSICS MAJORS AND MINORS

The University of Vermont

A Guide for Physics Majors and Minors

UVM Physics (http://physics.uvm.edu) offers courses that develop and refine skills that are of a broad interest to practitioners in a wide variety of fields and disciplines. A physics major or minor indicates that you have the ability to solve a wide variety of problems and that you are comfortable in a technical setting. It tells employers that you have breadth to your technical background. Students who major in physics usually have a very broad scientific interest in a multitude of different fields. If your post-UVM plans involve professional schools such as medical school, law school or MBA programs, the problem-solving skills that come with a physics degree will get you noticed!

Physics is the discipline that describes how Nature behaves and uses observations of the world around us to make this description possible. A student of physics will be able to take a real world problem, break it apart into its components, translate each into a mathematical expression, manipulate that expression to get new results, and then translate the mathematical results back into a statement of physical reality. This skill is important for a wide variety of careers in the sciences, engineering, economics and the social sciences. Many majors require their students to take at least an elementary course in physics if only so the students can hone their skills in analytical thinking.

Academic Requirements

Bachelor of Science, Bachelor of Arts in Physics

The department offers both a Bachelors of Science (B.S.) and a Bachelors of Arts (B.A.) degree. The B.A. allows students to acquire a broad liberal arts education whereas the B.S. has a traditional Physics focus. Both degree options prepare students for graduate school or employment in industry. Students pursuing the B.S. may opt for the Astrophysics track in preparation for graduate studies in Astronomy or Astrophysics.

Bachelor of Science tracks in Applied Physics

The purpose of these tracks is to offer students the opportunity to take a series of engineering courses in addition to the core physics courses. Majors in the Applied Physics program have the breadth of knowledge generally identified with a physics degree combined with a strong foundation in one of the engineering disciplines. They will be prepared to sit the Fundamentals Exam (FE) for engineering and be very attractive prospects for entry-level applied science positions. This program is designed for those considering graduate work in one of the engineering disciplines. The various options for the Applied Physics program include Electrical Engineering (Electronic Circuits and Devices or Signal Processing), Mechanical Engineering and Civil and Environmental Engineering.

Accelerated Masters Program

The Accelerated Masters Program allows students to receive an M.S. in Physics in one year, following their B.S. degree by allowing students to apply some of their undergraduate course work towards the completion of their M.S. degree. This program is open by invitation only; students are considered for the AMP during their junior year.

Honors and Awards

University Honors such as *cum laude*, *magna cum laude*, and *summa cum laude* awarded, respectively, to the top 10%, 4%, and 1% students of each graduating class.

College Honors involves an independent research project within the Department of Physics that is directed by a faculty member. The research project, which requires 6 credits of independent research, culminates in an Honors Thesis. The student receives 6 credits of HONORS-PHYSICS on his/her transcript as well as receiving recognition at Honors Day in May. Eligible students are invited by the department to participate in this program. Interested students should inquire about possible research opportunities at the end of their junior year.

Albert D. Crowell Award - for outstanding undergraduate experimental research in physics. The Crowell award is awarded to students that have exceptional ability to participate in experimental work under the direction of a faculty member.

David W. Juenker Prize - for outstanding senior physics major. The Juenker prize is awarded to those who have performed outstanding service to the department and their fellow majors as well as to those who have achieved an outstanding academic record. Recent recipients have gone on to graduate schools (often after completing their Master's degree at UVM) like M.I.T., Stanford, Cornell, RPI, and the University of Illinois at Champaign-Urbana.

Research

Undergraduate Research Projects

Students have the opportunity to conduct a research project under the direction of a faculty member. Such projects can be carried out as part of their honors work to receive College Honors, or as a Special Topics course (Readings). Recent undergraduate research projects include:

- Isabel Kloumann, "Dynamics, Stability, and Applications of Neutron Star Radio Frequency Emission" (Honors)
- Mateus Teixeira, "Geometry, Polarimetry, and Stabilization Applications of Pulsar Radio Frequency Emission: An 'Anthropology' of Neutron Stars" (Honors)
- Stephanie Young, "Core Emission and Nulling Phenomena in Pulsars" (Honors)
- Jacob Wahlen-Strothman, "Low-Temperature Magnetic Studies of Meso-Tetraphenylporphyrin Crystalline Films" (Honors)

Typical Bachelor of Science in Physics Course Scheduling

Year 1:
Fall: PHYS 051; MATH 021; CHEM 031, CS 021
Spring: PHYS 152; MATH 022; CHEM 032

Year 2:
Fall: PHYS 128; MATH 121
Spring: PHYS 211, PHYS elective; MATH 271/230/124

Year 3:
Fall: PHYS 201, 213; MATH 272/230/124
Spring: PHYS 202, PHYS 265 and/or PHYS electives;

Year 4:
Fall: PHYS 273 and/or PHYS elective;
Spring: PHYS 265 or PHYS elective; PHYS 274/214

Major and Minor Requirements

Bachelor of Science

- Physics: PHYS 051, 152 (or PHYS 031 and PHYS 125 with PHYS 022), PHYS 128, PHYS 201, PHYS 202, PHYS 211, PHYS 213, PHYS 265, PHYS 273; PHYS 214 or PHYS 274; PHYS 265, twelve hours of approved physics electives at level 100 or above.
- Mathematics: MATH 021, MATH 022, MATH 121; MATH 271 or MATH 230; MATH 124 or MATH 272;
- Chemistry: CHEM 031 and one additional course in Chemistry (CHEM 032 recommended);
- Computer Science: CS 021.

Bachelor of Arts

- Physics Department Requirements: PHYS 051, 152 (or PHYS 031 and PHYS 125 with PHYS 022), PHYS 128 with 130, PHYS 201 or PHYS 202, PHYS 211, PHYS 213, PHYS 273; nine additional hours of approved physics electives at level 100 or above;
- Mathematics: Mathematics through MATH 121 and three hours of approved mathematics electives above 121.
- An additional laboratory science is strongly recommended.

Minor in Physics

- PHYS 051, 152 (or PHYS 031 and PHYS 125 with PHYS 022), PHYS 128 with 130; three additional hours at the PHYS 200 level excluding PHYS 201 and PHYS 202. Note: Mathematics through 121 is needed for 128.

Minor in Astronomy

- Sixteen hours in Astronomy including ASTR 005 and one of ASTR 023, 024; three courses selected from ASTR 153, 155, 157, 177; three additional hours in ASTR. Three hours of Special Topics in ASTR may count towards the minor with departmental approval.