
vidual or group research on the chosen area and formal presentation of the research.

SENIOR CAPSTONE for TEACHING OPTION

PHED 411 Issues Seminar in Physical Education

(2, F&S)

Critical analysis and synthesis of student teaching experience and of crucial issues in education. Taken concurrently with PHED 405 and 407. Students must also register for EDUC 203 and 204.

PHED 412 Issues Seminar in Physical Education/Health Education

(2, OD)

Critical analysis and synthesis of student teaching experience and of crucial issues in education. Taken concurrently with PHED 406 and 408. Students must also register for EDUC 203 and 204.

SENIOR CAPSTONE for PHYSICAL FITNESS OPTION

Either four hours of PHED 420 **or** four hours of PHED 423 *and* 424 *and* 426.

PHED 420 Internship: Physical Fitness

(4, F&S)

Observation and practical experience in a public or private agency. Off-campus assignment under the direction of skilled professionals. NOTE: Students choosing this option must complete a total of four hours in PHED 420 or a total of four hours from PHED 423, 424, and 426. The four hours in PHED 420 includes one hour of topics in current issues. Overall GPA of 2.5 required.

PHED 423 Physical Fitness Practicum I

(1, F&S)

Directed observation in off-campus fitness center programs with hands-on practical experience. Requires at least 50 observation hours from two or more agencies; sites to be negotiated. Overall GPA of 2.5 required.

PHED 424 Physical Fitness Practicum II

(1, F&S)

Directed observation in off-campus rehabilitation programs with hands-on practical experience. Requires at least 50 observation hours from two or more agencies; sites to be negotiated. Overall GPA of 2.5 required.

PHED 426 Issues Seminar/Fitness Testing and Prescription

(2, F&S)

Critical analysis and synthesis of critical issues in the area of health and physical fitness. On-campus fitness testing; prescriptions and follow-ups will be conducted by the student. Prerequisites: PHED 423 and 424.

PHED 191, 291, 391, 491 Independent Study

(1, 2, 3 or 4)

PHED 295, 395, 495 Special Topics

(1, 2, 3 or 4)

Depending on interest, demand and faculty availability and expertise courses will be offered to allow students to consider issues and aspects of physical education not covered in other courses.

PHED 496 Honors in Physical Education

(4, OD)

Physics BA, BS (majors and minor)

Department of Physics and Earth Science: Mark E. Yuly, chair. Keith A. Horn, Associate Dean

Faculty: Donell Brandon Hoffman, Mark E. Yuly, Christopher M. Wells

Web site: www.houghton.edu/academics/programs/physics/

Phone: 585.567.9280

Physics Major: BS (35 hours in major; 16 in prerequisites; 12 in co-requisites)

Physics Minor: (12 hours of credit in physics courses numbered 211 or above)

General Information

The BS physics major provides a broad variety of experiences with the theoretical basis of physics, its applications, experimental and mathematical techniques, and its study using computer programming and simulations. It serves as an excellent preparation for graduate work in physics or related fields, such as engineering, astrophysics, biophysics, physical oceanography, geophysics, and meteorology. Students may also use the physics major as preparation for attending professional school in fields such as medicine, dentistry, and law.

The requirements for the BS in physics are as follows:

Prerequisites (16):	
PHYS 151, 152	General Physics I, II 8
MATH 181	Calculus I 4
MATH 182	Calculus II 4
Co-requisites (12):	
MATH 241	Differential Equations 4
MATH 225	Multivariate Calculus 4
CHEM 151	General Chemistry I 4
Required (35) which must include:	
PHYS 251	Mechanics I 4
PHYS 352	Mechanics II 4
PHYS 212	Modern Physics 2
PHYS 275/276	Experimental Physics Lab 2
PHYS 355	Thermal Physics 4
PHYS 356	Quantum Mechanics 4
PHYS 353	Electricity and Magnetism I 4
PHYS 354	Electricity and Magnetism II 4
PHYS 471,472	Physics Project Lab 2
PHYS 482	Senior Capstone: Physics Seminar 1
An additional 4 hours in PHYS courses above 200 level	
Additional recommended supporting courses include:	
MATH 261	Linear Algebra 4
CHEM 152	General Chemistry II 4
CSCI 211	Programming I 4
CSCI 236	Data Structures and Algorithms 4
PHIL 360	History and Philosophy of Science 4

Computational Physics Major: BS (35 hours in major; 16 in prerequisites; 12 in co-requisites)

General Information

Computational physics involves the use of computers in modeling and analyzing complex systems. This major is available to those students interested in studying physics with an emphasis on the use of computers. It provides students with highly sought-after computer and problem-solving skills in a growing area of interdisciplinary study. (See **Computational Physics**)

Applied Physics Major - Engineering Emphasis: BS (31 hours in major; 17 in prerequisites; 15 in co-requisites) See Engineering section in this catalog for details.

General Information

This major is for students interested in the engineering applications of physics and is preparation for an engineering-related career or graduate school in engineering or physics. (See **Engineering**)

Physics Major: BA (25 hours in major; 12 in prerequisites; 8 in co-requisites)

The BA major is particularly appropriate for students interested in a double major with another field or for students completing a major in inclusive childhood or secondary education.

Students interested in working toward certification to teach Physics at the elementary level can do so by double-majoring in Physics and Inclusive Childhood Education. Students interested in working toward certification to teach Physics at the middle and high school levels can do so by double-majoring in Physics and Adolescence Education (ADE). Please see the Education Department section of this catalog for details.

The requirements for the BA in physics are as follows:

Prerequisites (12):	
PHYS 151	General Physics I 4
MATH 181	Calculus I 4
MATH 182	Calculus II 4
Co-requisites (8):	
MATH 241	Differential Equations 4
MATH 225	Multivariate Calculus 4
Required (25) which must include:	
PHYS 152	General Physics II 4

PHYS 251	Mechanics I	4
PHYS 212	Modern Physics	2
PHYS 275/276	Experimental Physics Lab	2
PHYS 355	Thermal Physics	4
PHYS 353	Electricity and Magnetism I	4
PHYS 482	Senior Capstone: Physics Seminar	1
	An additional 4 hours in PHYS courses above 200 level.	

Additional recommended supporting courses include:

CHEM 151, 152	General Chemistry I, II	4, 4
CSCI 211	Programming I	4
PHIL 360	History and Philosophy of Science	4

COURSE DESCRIPTIONS

PHYS 102 **General Astronomy** (4, F12)

A survey of modern astronomy with emphasis on the structure and dynamics of stars, galaxies and the universe. Current theories of cosmic origins. Three lecture, three laboratory hours each week. Lab Science or 2nd Science.

PHYS 130 **How Things Work** (4, F12)

Introduction to the science behind a variety of modern technological advancements. Possible topics may include rockets, musical instruments, plasma screens, hybrid automobiles and nuclear reactors. The physical principles relevant to each technology will be explored. Three lecture, three laboratory hours each week. Lab science or 2nd science.

PHYS 140 **Physics of Music** (2, May, 12)

This course will focus on the physics of various phenomena associated with music. A quantitative, mathematical approach will be used, and students will apply the methods of science to gain a greater understanding of music. Topics will include harmonics, frequency and tone, overtones, spectral analysis and the physics of scales. 2nd Science.

PHYS 151, 152 **General Physics I, II** (4/4, F/S)

Introduction to physics focusing on central concepts and problem solving. Topics: mechanics, energy and waves (I) and thermodynamics, electricity, magnetism, optics and modern physics (II). Prerequisite: MATH 181 (or evidence of adequate math preparation) for PHYS 151; PHYS 151 for PHYS 152. Lab Science or 2nd Science: PHYS 151 only.

PHYS 212 **Modern Physics** (2, F12)

Exploration of the implications of Special Relativity using the Lorentz transformation and conceptual introduction to General Relativity. Elementary quantum mechanics using the Schrödinger equation applied to atoms, molecules, solids, nuclei, and elementary particles. 3 lecture hours/week. Prerequisite: PHYS 152.

PHYS 215 **Statics & Engineering Design** (4, S12)

Introduction to engineering design in the context of the basic mechanics of static structures and machines. Topics: multidimensional vector analysis of particles and rigid bodies in equilibrium, structural analysis of trusses and frames, friction, center of gravity, and moment of inertia. Introduction, by design project, to topics of technical drawing using CAD software, MATLAB, and machine shop skills. 3 lecture & 3 lab hrs/week. Prerequisite: PHYS 151.

PHYS 251 **Mechanics I** (4, F12)

A development of classical Newtonian mechanics focusing on the dynamics of particles and rigid bodies in one, two, and three dimensions. Topics covered will include work and energy, central forces, collisions, non-inertial frames of reference, and oscillations. Prerequisites: PHYS 151 and MATH 182; pre/co-requisite: MATH 241.

PHYS 258 **Analog Electronics** (4, S13)

A study of analog circuits comprised of resistors, capacitors, inductors, op-amps and DC and AC voltage and current sources. Methods of analyses: Kirchoff's Laws, node/mesh, network theorems, bode plots, Laplace transforms, two-port networks. Some software tools explored. 3 lecture & 3 lab hrs/week. Prerequisite: PHYS 152; pre/coreq: MATH 241.

PHYS 259 **Digital Electronics** (4, S12)

An introduction to digital circuits including Boolean algebra, logic gates, Karnaugh maps, decoders, flip-flops, registers, microcomputers, and interface devices. Characteristics and operation of digital integrated circuits will be covered. Some software tools will also be explored. 3 lecture and 3 laboratory hours each week.

Prerequisite: PHYS 152.

PHYS 260 Optics (4, OD)

Introduction to the study of light. Topics from geometrical optics, such as optical system analysis and aberration theory, and topics from physical optics, including interference, diffraction, and Fourier optics. Special topics from quantum optics will also be included. 3 lecture & 3 lab hrs/week. Prerequisites: PHYS 152 and MATH 182. Pre/co-requisite: MATH 241.

PHYS 275, 276 Experimental Physics Laboratory (1, 1 F12 & S13)

Selected experiments in mechanics, electricity and magnetism, and modern physics.

PHYS 352 Mechanics II (4, S13)

Newton's Laws and conservation laws will be reviewed, followed by an examination of Hamilton's Principle and the Lagrangian formulation of mechanics. Using these tools, topics such as central force motion, dynamics of systems of particles and rigid bodies, and coupled oscillations and normal modes will be explored. Prerequisite: PHYS 251.

PHYS 353 Electricity and Magnetism I (4, F11)

An introduction, with applications, to the classical theory of electric and magnetic fields. The course will begin with an overview of vector calculus for electromagnetic theory and will develop Maxwell's equations. 3 lecture hrs/week. Prerequisite: PHYS 152; Pre/co-requisite: MATH 321.

PHYS 354 Electricity and Magnetism II (4, S12)

An examination of the role of special relativity in electromagnetic phenomena. Maxwell's equations introduced in a relativistic manner, and used to investigate the properties of electromagnetic waves. Includes techniques for solving the equations of Laplace and Poisson in electrostatics. Prerequisite: PHYS 353; pre/co-requisite: MATH 261 recommended.

PHYS 355 Thermal Physics (4, F11)

Analysis of laws of thermodynamic equilibria in solid, liquid, and gaseous phases; introduction to statistical mechanics in terms of the microcanonical, canonical and grand canonical ensembles. Prerequisites: PHYS 152, MATH 241.

PHYS 356 Quantum Mechanics (4, S13)

Modern quantum mechanics with an emphasis on matrix methods. Topics to be covered include time evolution of wave functions, harmonic oscillators, angular momentum, central potentials, the hydrogen atom and perturbation theory. Prerequisites: PHYS 212, MATH 241; pre/co-requisites: MATH 261 recommended.

PHYS 471, 472 Physics Project Laboratory (1/1, F/S)

Participation with a faculty member in an individual research project. May be repeated for credit.

PHYS 482 Senior Capstone: Physics Seminar (1, S)

Written and oral presentation of work completed in PHYS 471/472 (for Physics BS) or on a topic of current interest in physics journals (for Physics BA).

PHYS 295, 395, 495 Special Topics in Physics (1, 2, 3 or 4)

Introduction to areas of physics not treated in other courses.

PHYS 391, 392, 491, 492 Independent Study (1, 2, 3, or 4)

PHYS 393 Summer Collaborative Research in Physics (1, 2, 3 or 4, Summer)

Research in collaboration with a physics faculty member focusing on a current area of physics research. Students work individually or in small teams reviewing literature, designing and building apparatus, collecting and analyzing data, and describing their work in written form. This course usually involves travel to other laboratories such as Los Alamos National Laboratory or Cornell University. May be repeated for credit. Prerequisite: Permission from instructor.

PHYS 480 General Science Seminar (1, S)

Written thesis and oral presentation on a topic selected for interdisciplinary breadth describing current scientific research in the area of the student's concentration based on a thorough review of scientific literature.

PHYS 496 Honors in Physics (4, OD)