

and existence of God, the problem of evil, miracles, and the significance of religious experience. PREREQ: PHIL 101.

PHIL 337 AESTHETICS (3-0-3)(Offered as justified). The philosophy of the fine arts covering such topics as the existence and nature of works of art, aesthetic experience, artistic creativity, the species of aesthetic value, and the nature of beauty.

PHIL 406 PHILOSOPHY OF SCIENCE (3-0-3)(Offered as justified). A study of philosophical issues raised by reflection on the nature of science and the results of scientific inquiry. PREREQ: PHIL 101 and either PHIL 201 or MATH 187.

PHIL 410 PHILOSOPHY OF MIND (3-0-3)(Offered as justified). An examination of various solutions to the mind/body problem, the problem of other minds, as well as related mental concepts. Problems of action theory may be explored. PREREQ: PHIL 101.

PHIL 413 ANALYTIC PHILOSOPHY (3-0-3)(S). A critical examination of the development of the analytic method in Anglo-American philosophy with attention to such selected figures as Frege, Russell, Moore, Wittgenstein, and Austin. PREREQ: PHIL 101 and either PHIL 201 or MATH 187.

PHIL 433 METAPHYSICS (3-0-3)(F). An investigation of basic problems about the nature of reality. Possible topics include personal identity, the nature of mind, freedom and determinism, and the problems of universals. PREREQ: PHIL 101.

PHIL 435 EPISTEMOLOGY (3-0-3)(Offered as justified). An investigation of basic problems concerning knowledge and the justification of belief. Possible topics include attempts to define knowledge and related concepts, the problem of skepticism, and the problem of other minds. PREREQ: PHIL 101.

PHIL 441 (POLS 441) CLASSICAL POLITICAL THOUGHT (3-0-3)(F)(Odd years). Development of political philosophy from Socrates to Machiavelli. May be taken for either POLS or PHIL credit, but not both. PREREQ: POLS 101, 141 or PHIL 101.

PHIL 442 (POLS 442) MODERN POLITICAL THOUGHT (3-0-3)(S)(Even years). Development of political thought since Machiavelli. May be taken for either POLS or PHIL credit, but not both. PREREQ: POLS 101, 141 or PHIL 101.

PHIL 443 (POLS 443) CONTEMPORARY POLITICAL THOUGHT (3-0-3)(F)(Even years). Major trends in political thought from the post-French Revolutionary era, which may include German idealism, historicism, existentialism, nihilism, and Marxism. May be taken for either POLS or PHIL credit, but not both. PREREQ: POLS 101, 141 or PHIL 101.

PHIL 489 SENIOR TUTORIAL (3-0-3)(F). Directed research culminating in the writing of a senior essay to be approved by the members of the philosophy faculty. PREREQ: Senior standing in philosophy major and approval by the department chair of a Tutorial Project Proposal by April 1 of the semester preceding the semester when the Tutorial is taken.

PHIL 495 SENIOR COMPREHENSIVE EXAMINATION (1-0-1)(F/S). Capstone experience culminating in a four-part examination over the fundamental areas developed within the major: history of philosophy; metaphysics and epistemology/philosophy of science; moral philosophy; logic. Exam questions are drawn from a pool of candidate questions made available to the examinee beforehand. PREREQ: Senior standing in philosophy major and PERM/INST.

Physical Education—see Department of Kinesiology

Physical Therapy, Pre-Professional Program—see Department of Community and Environmental Health

Physician Assistant, Pre-Professional Program—see Department of Community and Environmental Health

Department of Physics

College of Arts and Sciences

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Fax: (208) 426-4330

Chair and Professor: C. D. Hanna. *Professor:* Dykstra. *Associate Professors:* Km, Maccomb. *Assistant Professors:* Tenne, Zhang.

Degrees Offered

- B.S. and Minor in Physics
- B.S. in Physics, Secondary Education

Department Statement

The scope of the program is applied physics. However, flexibility is maintained in order to direct students toward their desired objectives. If the student is interested in going on into graduate physics, more math would be recommended. Depending on the particular field of interest in physics, the student could select electives in biology, chemistry, engineering, math, or geophysics.

Degree Requirements

| Physics Bachelor of Science | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| Course Number and Title | Credits |
| ENGL 101-102 Introduction to College Writing and Research | 6 |
| Area I—see page 44 for list of approved courses | |
| Area I core course in one field | 3 |
| Area I core course in a second field | 3 |
| Area I core course in a third field | 3 |
| Area I core course in any field | 3 |
| Area II—see page 44 for list of approved courses | |
| Area II core course in one field | 3 |
| Area II core course in a second field | 3 |
| Area II core course in a third field | 3 |
| Area II core course in any field | 3 |
| Area III | |
| Area III requirements are automatically met by specific courses included in the major requirements below. | |
| CHEM 111, 111L-112, 112L General Chemistry I & II with Labs | 8 |
| MATH 170 Calculus I | 4 |
| MATH 175 Calculus II | 4 |
| MATH 275 Multivariable and Vector Calculus | 4 |
| MATH 333 Differential Equations with Matrix Theory | 4 |
| One or more of the following: MATH 301 Introduction to Linear Algebra MATH 360 Engineering Statistics MATH 361 Probability and Statistics I MATH 436 Partial Differential Equations MATH 462 Probability and Statistics II MATH 465 Numerical Analysis I | 3-4 |

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Chapter 12—Academic Programs and Courses

Department of Physics

| <i>Physics (continued)</i> | |
|---------------------------------------------------------------------|------------|
| PHYS 211, 211L Physics I with Calculus and Lab | 5 |
| PHYS 212, 212L Physics II with Calculus and Lab | 5 |
| PHYS 301 Analog Electronics | 4 |
| PHYS 304 Transducers and Instrumentation | 3 |
| PHYS 309, 310 Introductory Modern Physics with Applications and Lab | 4 |
| PHYS 311 Modern Physics | 3 |
| PHYS 325 Scientific Computing | 4 |
| PHYS 330 Optics | 3 |
| PHYS 334 Optics Laboratory | 1 |
| PHYS 341 Mechanics | 4 |
| PHYS 381 Electromagnetic Theory | 3 |
| PHYS 382 Electrodynamics | 3 |
| PHYS 412 Introductory Quantum Mechanics | 3 |
| PHYS 432 Thermal Physics | 3 |
| PHYS 481 Advanced Physics Lab | 3 |
| PHYS 499 Physics Seminar | 1 |
| Electives to total 128 credits | 18-19 |
| Total | 128 |

The Physics, Secondary Education program combines content knowledge, theories of learning and human development, study of curriculum, and methodology, to help students develop the knowledge, skills and dispositions essential for success in secondary school teaching. The program is grounded in the conceptual framework of the Professional Educator. Professional educators adjust their teaching approaches and learning environment to the needs and backgrounds of their students. Candidates who complete this program have demonstrated evidence of meeting the Idaho Beginning Teacher Standards and are eligible for recommendation for state certification.

Students wishing to pursue this degree must meet the requirements and standards for admission to teacher education, which are described fully under the Department of Curriculum, Instruction, and Foundational Studies or at <http://education.boisestate.edu>. Students must meet all knowledge, skill, and disposition requirements to remain in the program.

| Physics, Secondary Education Bachelor of Science | |
|-----------------------------------------------------------------------------------------------------------|----------------|
| Course Number and Title | Credits |
| ENGL 101-102 Introduction to College Writing and Research | 6 |
| Area I—see page 44 for list of approved courses | |
| Area I core course in one field | 3 |
| Area I core course in a second field | 3 |
| Area I core course in a third field | 3 |
| Area I core course in any field | 3 |
| Area II—see page 44 for list of approved courses | |
| ED-CIFS 201 Foundations of Education | 3 |
| Area II core course in a second field | 3 |
| Area II core course in a third field | 3 |
| Area II core course in any field | 3 |
| Area III | |
| Area III requirements are automatically met by specific courses included in the major requirements below. | |
| BIOL 191-192 General Biology I and II | 8 |
| CHEM 111, 111L-112, 112L General Chemistry I & II with Labs | 8 |

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| Physics, Secondary Education (continued) | |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| *ED-CIFS 301 Teaching Experience I | 1 |
| *ED-CIFS 302 Learning and Instruction | 4 |
| *ED-CIFS 401 Professional Year—Teaching Experience II | 2 |
| *ED-CIFS 404 Teaching Secondary Science | 3 |
| *ED-LTCY 444 Content Literacy for Secondary Students | 3 |
| *ED-SPED 350 Teaching Students with Exceptional Needs at the Secondary Level | 3 |
| *Teaching Experience III/IV | 16 |
| NOTE: *You must apply for admission to secondary teacher education in order to enroll in these upper-division education courses. Completion of all requirements for graduation with a secondary education option may require more than 128 credit hours. See "Department of Curriculum, Instruction, and Foundational Studies" for more information. | |
| EDTECH 202 Educational Technology: Classroom Applications | 3 |
| MATH 170 Calculus I | 4 |
| MATH 175 Calculus II | 4 |
| MATH 275 Multivariable and Vector Calculus | 4 |
| MATH 333 Differential Equations with Matrix Theory | 4 |
| PHYS 105 Stars and Cosmology | 4 |
| PHYS 211, 211L Physics I with Calculus and Lab | 5 |
| PHYS 212, 212L Physics II with Calculus and Lab | 5 |
| PHYS 309 Introductory Modern Physics with Applications | 3 |
| PHYS 310 Introduction to Modern Physics Lab | 1 |
| PHYS 311, Modern Physics | 3 |
| PHYS 330 Optics | 3 |
| PHYS 334 Optics Laboratory | 1 |
| PHYS 400 Conceptions in Physics for Teachers | 3 |
| PHYS 481 Advanced Physics Lab | 3 |
| Computer programming course, such as COMPSCI 125 | 2-5 |
| Possible earth science elective | 4 |
| Total | 134-137 |

| Physics Minor | |
|----------------------------------------------------------------------------|----------------|
| Course Number and Title | Credits |
| *PHYS 211, 211L Physics I with Calculus and Lab | 5 |
| PHYS 212, 212L Physics II with Calculus and Lab | 5 |
| *PHYS 309, 310 Introductory Modern Physics with Applications and Lab | 4 |
| *Math or other prerequisite | |
| Upper-division physics courses (May take only 3 credits of Special Topics) | 6-7 |
| Total | 20-21 |

| Physical Science Teaching Endorsement | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Course Number and Title | Credits |
| CHEM 111, 111L-112, 112L General Chemistry I & II with Labs | 8 |
| PHYS 111-112 General Physics OR PHYS 211, 211L-212, 212L Physics I & II with Calculus and Labs | 8 |
| A minimum of two courses beyond the introductory level in Chemistry or Physics, not including those in their Major Certification Endorsement. | 8 |
| Total | 24 |
| Students pursuing this minor certification endorsement are required to hold a major certification endorsement in: Biology, Chemistry, Earth Science Education or Physics. | |

Course Offerings

See page 63 for a definition of the course-numbering system.

PHYSCI—Physical Science

PHYSCI 100 FOUNDATIONS OF PHYSICS – IMAGES AND COLOR (3-2-4)(F/S)(Area III). An inquiry approach to constructing understanding of physical phenomena. Image formation and color are explored to deepen conceptual understanding of the phenomena and how we explain our physical environment. For non-science majors only.

PHYSCI 101 FOUNDATIONS OF PHYSICS – MOTION AND FORCE (3-2-4)(F/S)(Area III). An inquiry approach to constructing understanding of physical phenomena. Motion and force are explored to deepen conceptual understanding of the phenomena and how we explain our physical environment. For non-science majors only.

PHYSCI 102 FOUNDATIONS OF PHYSICS – ELECTRICAL AND THERMAL PHENOMENA (3-2-4)(F/S)(Area III). An inquiry approach to constructing understanding of physical phenomena. Electrical circuits and thermal phenomena are explored to deepen conceptual understanding of the phenomena and how we explain our physical environment. For non-science majors only.

PHYSCI 111 LABORATORY ONLY (0-V-1)(F/S). For transfer students who need a laboratory experience to gain Area III Core credit for a lecture-only PHYS course taken elsewhere but includes a weekly 2 or 3 hour lab at Boise State. (Pass/Fail.) PREREQ: PERM/INST.

PHYSCI 200 FOUNDATIONS OF PHYSICS: THE LEARNING CONTEXT (1-0-1)(F/S). An investigation of the theory behind the approach used in the Foundations of Physics courses and its impact on the students and their learning in the course. This study is at the interface between physics and the learning of physics. (Pass/Fail.) CO-REQ: PHYSCI 100 or PHYSCI 101 or PHYSCI 102 or PERM/INST.

PHYS—Physics

PHYSICS LABORATORY FEES: A \$40 laboratory fee is charged to all students enrolling in a physics course with an associated laboratory or a physics laboratory.

Lower Division

PHYS 101 INTRODUCTION TO PHYSICS (3-2-4)(F/S)(Area III). A broad survey of basic physics concepts and principles including motion, energy, electricity, magnetism, light, relativity, atoms, fission and fusion. Some examples will be related to social applications. A one-semester core course that uses some basic algebra.

PHYS 104 PLANETS AND ASTROBIOLOGY (3-2-4)(F/S)(Area III). Emphasis is on our solar system, the origin of chemical abundances, and astronomical requirements for the development of life; extra-solar planetary systems, and the search for life in the universe. Requires evening labs and/or planetarium visits.

PHYS 105 STARS AND COSMOLOGY (3-2-4)(F/S)(Area III). An exploration of star formation and evolution, black holes, galaxies, and cosmology. Explores how the ideas of Albert Einstein, Stephen Hawking, and others form our understanding of the universe. Requires evening labs and/or planetarium visits.

PHYS 106 RADIATION PHYSICS (2-0-2)(F). Fundamental concepts involving electricity, magnetism, formation of electromagnetic radiation and radioactivity. Includes basic circuitry of x-ray machine and introduction to radiation dose. COREQ: RADSCI 226 or PERM/INST.

PHYS 109 INTRODUCTION TO COMPUTERS (3-2-4). The potential and limitations of computers and their impact on society. The course includes an introduction to computer hardware and programming. Designed for non-science majors.

PHYS 111–112 GENERAL PHYSICS (3-3-4)(F/S)(Area III). Mechanics, sound, heat, light, magnetism and electricity. This course satisfies the science requirement for the bachelor of arts and bachelor of science curricula and may be taken by forestry, pre-dental and pre-medical students. PREREQ: for PHYS 111: MATH 144 or MATH 147 or satisfactory placement score into MATH 170. PREREQ: for PHYS 112: PHYS 111.

PHYS 125 INTRODUCTORY PHYSICS COLLOQUIUM (1-0-1). Informal seminars introducing current areas of interest in physics, introduction to the physics faculty, requirements for graduation, jobs and graduate school. Intended for new physics majors, but open to all interested students. (Pass/Fail.)

PHYS 211 PHYSICS I WITH CALCULUS (4-1-4)(F/S)(Area III). Kinematics, dynamics of particles, statics, momentum, rotational motion, gravitation, introductory wave motion, heat and thermodynamics. PREREQ: MATH 170, COREQ: MATH 175, PHYS 211L.

PHYS 211L PHYSICS I WITH CALCULUS LAB (0-3-1)(F/S)(Area III). Lab to be taken with PHYS 211. Basic experiments in mechanics, wave motion, and heat. COREQ: PHYS 211.

PHYS 212 PHYSICS II WITH CALCULUS (4-1-4)(F/S)(Area III). Coulombs law, fields, potential, magnetism, induced emf, simple circuits, geometrical optics, interference, diffraction, and polarization. PREREQ: PHYS 211. COREQ: PHYS 212L

PHYS 212L PHYSICS II WITH CALCULUS LAB (0-3-1)(F/S)(Area III). Lab to be taken concurrently with PHYS 212. Basic experiments in electricity, magnetism, and optics. COREQ: PHYS 212.

PHYS 295/395 RESEARCH IN PHYSICS (1-4 credits)(F/S). Individual research project carried out by the student in collaboration with a supervising member of the physics faculty. May be repeated for up to 5 credits maximum.

Upper Division

PHYS 301 ANALOG ELECTRONICS (2-6-4)(F)(Odd years). An introduction to basic electronic test instrumentation and to some of the more common discrete semiconductor devices and integrated circuits. Included are diodes, silicon controlled rectifiers, transistors, operational and instrumentation amplifiers, voltage regulators, timers, and analog-to-digital converters. The devices will be utilized in simple electronic circuits for rectification, amplification, waveform creation, and other applications. PREREQ: PHYS 212L.

PHYS 304 TRANSDUCERS AND INSTRUMENTATION (1-6-3)(S)(Even years). An introduction to some common devices used to convert energy forms into electrical signals and their appropriate signal conditioning. Included are photomultiplier tubes, photoconductive cells, photodiodes, phototransistors, linear variable differential transformers, thermocouples, thermistors, Hall Effect devices, strain gauges, and piezoresistive elements. The IEEE-488 BUS Controller will be introduced and used throughout the course for data acquisition from the transducers. PREREQ: PHYS 301.

PHYS 307 INTRODUCTION TO BIOPHYSICS (3-3-4)(S). Application of physical principles and techniques to the study of biological systems. Stresses examples relevant to cellular and molecular biology and to biomedical research. PREREQ: BIOL 191, CHEM 112, MATH 160, and PHYS 112 or 212 with labs; or PERM/INST.

PHYS 309 INTRODUCTORY MODERN PHYSICS WITH APPLICATIONS (3-0-3)(S). Key concepts and applications of quantum physics, with examples from chemistry, materials science, engineering, applied physics and nanotechnology, plus a short survey of special relativity. PREREQ: PHYS 212, MATH 275. COREQ: PHYS 310.

PHYS 310 INTRODUCTORY MODERN PHYSICS LAB (0-3-1)(S). Lab to be taken concurrently with PHYS 309. Hands-on experiments and computer simulations applying the principles of modern physics. PREREQ: PHYS 212L, MATH 275. COREQ: PHYS 309.

PHYS 311 MODERN PHYSICS (3-0-3)(F)(Even years). Further topics in modern physics, such as relativity, Schroedinger's equation, nuclear physics and elementary particles. PREREQ: MATH 333 and PHYS 309.

PHYS 325 SCIENTIFIC COMPUTING (3-3-4)(F)(Odd years). Methods and practice of computing and computer modeling with emphasis on science and engineering. Topics include scientific visualization, simulation of complex systems, numerical solutions of systems of differential equations, supercomputing and parallel processing. Computer programming experience required. PREREQ: PHYS 212.

PHYS 330 OPTICS (3-0-3)(S)(Odd years). Geometrical and physical optics, including lenses, fiber optics, Fourier optics, polarization, interference,

Chapter 12—Academic Programs and Courses

Department of Physics

diffraction, lasers, and holography. PREREQ: MATH 333, PHYS 212, PHYS 381. COREQ: PHYS 334.

PHYS 334 OPTICS LABORATORY (0-3-1)(S)(Odd years). Laboratory to be taken concurrently with PHYS 330. Experiments in optics, including optical systems, thick lenses, interference, diffraction, Fourier optics, image processing, and holography. COREQ: PHYS 330.

PHYS 341 MECHANICS (4-0-4)(S)(Odd years). An upper-division course which approaches classical mechanics with the aid of vector calculus and differential equations. Numerical techniques and computer applications will be used. PREREQ: MATH 333 and PHYS 211.

PHYS 381 ELECTROMAGNETIC THEORY (3-0-3)(F)(Even years). Electrostatic and magnetostatic fields including potentials, Gauss's law, solutions of Laplace's equation, dielectrics, vector potentials, magnetization, and introduce Maxwell's equations. PREREQ: MATH 275, MATH 333, PHYS 212.

PHYS 382 ELECTRODYNAMICS (3-0-3)(S)(Odd years). Application of Maxwell's equations to electrodynamics including the stress tensor, wave equation, guided waves, radiation, and special relativity. PREREQ: PHYS 381 or PERM/INST.

PHYS 400 CONCEPTIONS IN PHYSICS FOR TEACHERS (3-0-3)(S). Nature of the conceptions of physical phenomena today's students bring to physics/physical science classes and implications of these conceptions for developing new understandings from the research in physics learning. Attention given to evidence concerning how, why, and under what circumstances students develop new understandings of the phenomena. PREREQ: PHYS 309 or PERM/INST.

PHYS 405 ASTROPHYSICS (3-0-3)(S)(Offered on demand, even years). Techniques and topics of modern astrophysics. Material is selected from the interaction of light with matter, solar system formation, main sequence star structure and evolution, degenerate stars and black holes, galaxy formation, and cosmology. PREREQ: PHYS 104 or 105, PHYS 309; or PERM/INST.

PHYS 412 INTRODUCTORY QUANTUM MECHANICS (3-0-3)(S)(Offered on-demand, odd years). Fundamentals including Schroedinger equation, energy levels, angular momentum, electron spin, perturbations, and scattering. Applications, such as tunneling, orbitals, magnetic resonance, and nanoscale effects. PREREQ: PHYS 309.

PHYS 415 SOLID STATE PHYSICS (3-0-3)(Offered on demand).

Quantum physics applied to understanding the properties of materials, including semiconductors, metals, superconductors, and magnetic systems. PREREQ: PHYS 309.

PHYS 422 ADVANCED TOPICS (1-4 credits)(F/S)(Offered on demand). Selected advanced topics from physics and applied physics, such as astrophysics, biophysics, device physics, magnetic materials, nanoscale physics, or medical physics. May be repeated for credit. PREREQ: Upper-division standing and PERM/INST.

PHYS 423 PHYSICAL METHODS OF MATERIALS

CHARACTERIZATION (3-0-3)(S). Physical principles and practical methods used in determining the structural, electronic, optical, and magnetic properties of materials. Optical, electron, and scanning microscopies, diffraction, surface analysis, optical spectroscopy, electrical transport, and magnetometry. PREREQ: PHYS 309 or PERM/INST.

PHYS 432 THERMAL PHYSICS (3-0-3)(F)(Odd years). Discussion of temperature, work, specific heat, and entropy. The laws of thermodynamics are discussed and applied to physical problems. Ideal gases, statistics, Gibbs free energy, and cryogenics. PREREQ: MATH 333, PHYS 212.

PHYS 436 SOFT MATTER (3-0-3)(S)(Even years). Introduction to the physical principles underlying the properties and behaviors of soft matter, including polymers, gels, colloids, and liquid crystals. Examples of soft matter include glues, paints, soaps, rubber, foams, gelatin, milk, and most materials of biological origin. (Recommended preparation: PHYS 309.) PREREQ: MATH 275, PHYS 212, and either CHEM 322 or MSE 308 or PHYS 432.

PHYS 481 ADVANCED PHYSICS LAB (1-6-3)(F)(Even years). An advanced laboratory course designed to acquaint students with the concepts of modern physics, laboratory techniques, and measurements. PREREQ: PHYS 310.

PHYS 482 SENIOR PROJECT (0-6-2)(S). 1 or 2 credits depending on the project. Elective. A sophisticated library or laboratory project in some area of physics. PREREQ: PHYS 481.

PHYS 495 RESEARCH IN PHYSICS (1-4 credits)(F/S). Individual research project carried out by the student in collaboration with a supervising member of the physics faculty. May be repeated for up to 5 credits maximum.

PHYS 499 PHYSICS SEMINAR (1-0-1)(S). Individual reports on selected topics. PREREQ: Senior status.