

Philosophy—PHL

485 Philosophy of Social Science
Spring. 3(3-0) RB: Three courses in social science or two PHL courses.

Explanations, theories, and concepts in social science. Such topics as historicism; reductionism; rationality and relativism; comparison of logical empiricist, interpretive, and critical theory approaches.

486 Biotechnology in Agriculture: Applications and Ethical Issues
Fall of even years. 3(3-0) Interdepartmental with Horticulture; Crop and Soil Sciences; Forestry. Administered by Department of Horticulture. P:M: (BOT 105 or BS 111) RB: (CSS 350 or ZOL 341) R: Not open to freshmen or sophomores.

Current and future roles of biotechnology in agriculture: scientific basis, applications. Environmental, social, and ethical concerns.

487 Philosophy of Mathematics
Fall of odd years. 3(3-0) RB: (PHL 330) or three courses in mathematics.

Nature of mathematical truth and knowledge. Thesis of logicism, formalism, intuitionism, and conventionalism.

490 Independent Study
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Approval of department.

Supervised special projects arranged by an individual student and a faculty member in areas supplementing regular course offerings.

491 Special Topics in Philosophy
Fall, Spring, Summer. 3 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course.

Special topics supplementing regular course offerings, proposed by faculty on a group study basis.

492 Seminar for Majors (W)
Fall. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. P:M: Completion of Tier I writing requirement. RB: 16 credits in Philosophy. R: Open only to juniors or seniors in the Department of Philosophy or approval of department.

Advanced, variable topic seminar for undergraduate majors. Seminar presentations. Substantial paper.

499 Senior Thesis Research (W)
Fall, Spring. 3(3-0) P:M: Completion of Tier I writing requirement. R: Open only to juniors or seniors in the Department of Philosophy. Approval of department.

Individual research project supervised by a faculty member that demonstrates the student's ability to do independent research and submit or present a major paper.

102 Physics Computations I
Spring. 1(0-3) P:M: (PHY 183 or concurrently or PHY 183B or concurrently or PHY 193H or concurrently or PHY 181B or concurrently) RB: (CSE 101 or CSE 231)

Use of Mathematics to solve, analyze and graph equations and data from mechanics.

170 Investigations in Physics
Fall. 3(0-6) R: Approval of department.
Experiments in optics, electronics, sound and mechanics; analysis of data using computers, library research and oral presentations.

181B Basic Physics I
Fall, Spring, Summer. 3 credits. P:M: (MTH 132 or MTH 152H or LBS 118) Not open to students with credit in LBS 271 or PHY 183 or PHY 183B or PHY 193H or PHY 231 or PHY 231B or PHY 231C, PHY 233B.

Newton's laws of motion, conservation of momentum and angular momentum, energy conservation, thermal physics, waves, and sound. This course is given in the competency based instruction format.

182B Basic Physics II
Fall, Spring, Summer. 3 credits. P:M: (PHY 183 or PHY 183B or PHY 181B or LBS 271 or PHY 193H) or (PHY 231 or concurrently and PHY 233B) or (PHY 231B or concurrently and PHY 233B) and (MTH 133 or MTH 153H or LBS 119) Not open to students with credit in LBS 272 or PHY 184 or PHY 184B or PHY 232 or PHY 232B or PHY 294H.

Electricity and magnetism, optical phenomena, interference and diffraction of light, atomic and subatomic topics. This course is given in the competency based instruction format.

183 Physics for Scientists and Engineers I
Fall, Spring. 4(5-0) P:M: (MTH 132 or MTH 152H or LBS 118) Not open to students with credit in LBS 164 or PHY 181B or PHY 183B or PHY 193H or PHY 231 or PHY 231B.

Mechanics, Newton's laws, momentum, energy conservation laws, rotational motion, oscillation, gravity, waves.

183A Physics I
Fall, Spring, Summer. 1 credit. P:M: (PHY 181B) Not open to students with credit in LBS 271 or PHY 183 or PHY 183B or PHY 193H or PHY 231 or PHY 231B or PHY 231C.

Topics from: frames of reference, special relativity, rocket equation, forced oscillations, resonances, fluid motion, numerical solutions, moments of inertia, gyroscopic motion. This course plus PHY 181B is equal to PHY 183B. This course is given in the competency based instruction format.

183B Physics for Scientists and Engineers I
Fall, Spring, Summer. 4 credits. P:M: (MTH 132 or MTH 152H or LBS 118) Not open to students with credit in LBS 271 or PHY 181B or PHY 183 or PHY 193H or PHY 231 or PHY 231B or PHY 231C.

Mechanics, Newton's laws, momentum, energy conservation laws, rotational motion, oscillation, gravity, waves. This course is given in the competency based instruction format.

184 Physics for Scientists and Engineers II
Fall, Spring. 4(5-0) P:M: (PHY 183 or PHY 183B or PHY 193H or PHY 233B or PHY 183A) or (LBS 164 and PHY 233B) and (MTH 133 or MTH 153H or LBS 119) Not open to students with credit in LBS 267 or PHY 182B or PHY 184B or PHY 232 or PHY 232B or PHY 294H.

Electricity and magnetism, electromagnetic waves, light and optics, interference and diffraction.

184A Physics II
Fall, Spring, Summer. 1 credit. P:M: (PHY 182B) Not open to students with credit in PHY 184 or PHY 184B or PHY 232 or PHY 232B or PHY 294H, PHY 232C or LBS 272.

Topics from: standing wave phenomena, atoms, electromagnetic fields, alternating currents, optics, quantum mechanics, elementary particles. This course plus PHY 182B is equivalent to PHY 184B. 182B is exactly 3/4 of 184B and 184A is the other 1/4. This course is given in the competency based instruction format.

184B Physics for Scientists and Engineers II
Fall, Spring, Summer. 4 credits. P:M: (PHY 183 or PHY 183B or PHY 193H) or (PHY 181B and PHY 183A) or (PHY 231B and PHY 233B) or (LBS 271 and PHY 233B) RB: (MTH 133 or MTH 153H or LBS 119) Not open to students with credit in LBS 272 or PHY 182B or PHY 184 or PHY 232 or PHY 232B or PHY 294H.

Electricity and magnetism, electromagnetic waves, light and optics, interference and diffraction. This course is given in the competency based instruction format.

191 Physics Laboratory for Scientists, I
Fall. 1(0-3) P:M: (PHY 183 or concurrently or PHY 183B or concurrently or PHY 193H or concurrently or PHY 231 or concurrently or PHY 231B or concurrently or LBS 271 or concurrently or PHY 181B or concurrently) Not open to students with credit in PHY 251 or LBS 271L.

Error analysis, exercises in motion, forces, conservation laws and some electricity and magnetism studies.

192 Physics Laboratory for Scientists, II
Spring. 1(0-3) P:M: (PHY 191 or MSM 211 or MSM 250) and (PHY 184 or concurrently or PHY 182B or concurrently or PHY 184B or concurrently or PHY 294H or concurrently or PHY 232 or concurrently or PHY 232B or concurrently or LBS 272 or concurrently) Not open to students with credit in PHY 252 or LBS 272L.

Electric and magnetic fields, circuits, wave optics, modern physics.

193H Honors Physics I-Mechanics
Spring. 3(4-0) P:M: (MTH 133 or concurrently or MTH 153H or concurrently or LBS 119 or concurrently) Not open to students with credit in PHY 183 or PHY 183B or PHY 231 or PHY 231B or LBS 164 or PHY 181B.

Mechanics and waves.

201 Physics Computations II
Fall. 1(0-3) P:M: (PHY 184 or concurrently or PHY 184B or concurrently or PHY 294H or concurrently) RB: (MTH 133 and PHY 102)

Computer methods to analyze and visualize physics problems. Tools used will include programming languages (Fortran) and mathematical software (Mathematica, etc).

PHYSICS

PHY

Department of Physics and Astronomy College of Natural Science

101 Concepts in Physics
Fall. 1(1-0)
Conceptual foundations of physics emphasizing key experiments.

- 205 Directed Studies**
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 3 credits in all enrollments for this course. R: Approval of department.
Guided individualized study in an area of physics.
- 213H Navigating the Universe**
Fall. 3(3-0) Interdepartmental with Integrative Studies in Physical Science. Administered by Center for Integrative Studies in General Science. P:M: (MTH 103 or MTH 110 or MTH 116 or MTH 106 or MTH 124 or MTH 132 or MTH 201 or LBS 117 or STT 200 or STT 201) or designated score on Mathematics placement test. RB: High school physics, high school algebra, and high school trigonometry
Aspects of classical physics, relativity, quantum mechanics, and standard models of elementary particle physics and cosmology. How notions of reality and standards for forming acceptable knowledge claims have changed.
- 215 Thermodynamics and Modern Physics**
Fall, Spring. 3(4-0) P:M: (PHY 184 or concurrently or PHY 184B or concurrently or PHY 294H or concurrently or LBS 272 or concurrently or PHY 234B or concurrently) and (MTH 234 or concurrently or MTH 254H or concurrently or LBS 220 or concurrently) Not open to students with credit in PHY215B.
Thermodynamics, atomic physics, quantized systems, nuclear physics, solids, elementary particles.
- 215B Thermodynamics and Modern Physics**
Fall, Spring, Summer. 3 credits. P:M: (PHY 184 or concurrently or PHY 184B or concurrently or LBS 272 or concurrently or PHY 294H or concurrently or PHY 234B or concurrently) and (MTH 234 or MTH 254H or LBS 220) Not open to students with credit in PHY 215.
Thermodynamics, atomic physics, quantized systems, nuclear physics, solids, elementary particles. This course is given in the competency based instruction format.
- 231 Introductory Physics I**
Fall, Spring. 3(4-0) P:M: (MTH 103 or MTH 116 or LBS 117 or MTH 124 or MTH 132 or concurrently) Not open to students with credit in LBS 164 or PHY 181B or PHY 183 or PHY 183B or PHY 193H or PHY 231B or PHY 231C.
Mechanics, Newton's Laws, momentum, energy, conservation laws, thermodynamics, waves, sound.
- 231B Introductory Physics I**
Fall, Spring, Summer. 3 credits. P:M: (MTH 103 or MTH 116 or LBS 117 or MTH 124 or MTH 132 or concurrently) Not open to students with credit in LBS 271 or PHY 181B or PHY 183 or PHY 183B or PHY 193H or PHY 231 or PHY 231C.
Mechanics, Newton's laws, momentum, energy, conservation laws, thermodynamics, waves, sound. This course is given in the competency based instruction format.
- 231C Introductory Physics I**
Fall, Spring. 3 credits. RB: (MTH 116) Not open to students with credit in PHY 181B or PHY 183 or PHY 183B or PHY 193H or PHY 231 or PHY 231B or LBS 271.
Mechanics, Newton's Laws, momentum, energy, conservation laws, thermodynamics, waves, sound. This course is an internet based course.
- 232 Introductory Physics II**
Fall, Spring. 3(4-0) P:M: (PHY 231 or PHY 231B or PHY 181B or PHY 183 or PHY 183B or LBS 271 or PHY 193H or PHY 231C) Not open to students with credit in PHY 184 or PHY 184B or PHY 232B or LBS 272 or PHY 182B.
Electricity and magnetism; optics; atomic, nuclear, and subnuclear physics.
- 232B Introductory Physics II**
Fall, Spring, Summer. 3 credits. P:M: (PHY 231 or PHY 231B or PHY 231C or PHY 181B or PHY 183B or PHY 193H or LBS 271) Not open to students with credit in PHY 184 or PHY 184B or PHY 232 or PHY 232C or PHY 294H or PHY 182B or LBS 272.
Electricity and magnetism; optics; atomic, nuclear, and subnuclear physics. This course is given in the competency based instruction format.
- 232C Introductory Physics II**
Fall, Spring. 3 credits. P:M: (PHY 182B or PHY 183 or PHY 183B or PHY 193H or PHY 231 or PHY 231B or PHY 231C or LBS 271) Not open to students with credit in PHY 184 or PHY 184B or PHY 232 or PHY 232B or PHY 294H or LBS 272.
Electricity and magnetism; optics; atomic, nuclear, and subnuclear physics. This course is an internet based course.
- 233B Calculus Concepts in Physics I**
Fall, Spring, Summer. 2 credits. P:M: (PHY 231) and (MTH 132 or MTH 152H or LBS 118) Not open to students with credit in PHY 183 or PHY 193H.
Kinematics, dynamics, applications of Newton's laws. PHY 231B plus PHY 233B is equivalent to PHY 183B. This course is given in the competency based instruction format.
- 234B Calculus Concepts in Physics II**
Fall, Spring, Summer. 2 credits. P:M: (PHY 232 or PHY 232B) and (MTH 133 or concurrently or MTH 153H or concurrently or LBS 119 or concurrently)
Electricity and magnetism. PHY 232B plus PHY 234B equals PHY 184B. This course is given in the competency based instruction format.
- 251 Introductory Physics Laboratory I**
Fall, Spring, Summer. 1(0-3) P:M: (PHY 231 or concurrently or PHY 231B or concurrently or LBS 271 or concurrently or PHY 181B or concurrently or PHY 183 or concurrently or PHY 183B or concurrently or PHY 231C or concurrently or PHY 193H or concurrently) RB: (MTH 103) Not open to students with credit in PHY 191 or LBS 271L.
Laboratory exercises involving simple mechanical systems.
- 252 Introductory Physics Laboratory II**
Fall, Spring, Summer. 1(0-3) P:M: (PHY 251 or PHY 191 or LBS 271L) and (PHY 232 or concurrently or PHY 232B or concurrently or PHY 232C or concurrently or PHY 182B or concurrently or PHY 184 or concurrently or PHY 184B or concurrently or PHY 294H or concurrently or LBS 272 or concurrently) Not open to students with credit in PHY 192 or LBS 272L.
Laboratory exercises involving simple electromagnetic and optical systems.
- 294H Honors Physics II-Electromagnetism**
Fall. 3(4-0) P:M: (PHY 193H) and (MTH 234 or concurrently or MTH 254H or concurrently or LBS 220 or concurrently) Not open to students with credit in PHY 184 or PHY 184B or PHY 232 or PHY 232B or PHY 232C or PHY 182B or LBS 267.
Electricity and magnetism, electromagnetic waves and optics.
- 301 Physics Computations III**
Spring. 1(0-3) P:M: (PHY 471) RB: (CSE 232)
Use of computer software to solve, analyze and graph equations and data from physics problems. Tools include Mathematica, Fortran 90 and C++.
- 305 Directed Studies**
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 3 credits in all enrollments for this course. P:M: (PHY 184 or PHY 184B or PHY 232 or PHY 232B or PHY 294H or PHY 294H or LBS 272) R: approval of department.
Guided individualized study in an area of physics.
- 321 Classical Mechanics I**
Spring, Summer. 3(3-0) P:M: (PHY 184 or PHY 184B or PHY 294H or LBS 272) and (PHY 215 or concurrently or PHY 215B or concurrently) and (MTH 234 or concurrently or MTH 254H or concurrently or LBS 220 or concurrently)
Newtonian point particles. Oscillations. One-particle chaos. Central-force motion. Systems of particles.
- 351B Computational Physics**
Fall, Spring, Summer. 3 credits. P:M: (PHY 215 or PHY 215B) RB: (CSE 131 or CSE 231)
Computer applications in physics research: printer graphics, Schroedinger equation solution, physics-symbol processing, physics information retrieval. Analysis of typical research data. This course is given in the competency based instruction format.
- 357B Topics in Contemporary Physics**
Fall, Spring, Summer. 3 credits. P:M: (PHY 215 or PHY 215B) RB: (PHY 184 or PHY 184B or PHY 294H or PHY 234B or LBS 272) R: Not open to students in the Department of Physics and Astronomy.
Atoms and nuclei, weak decay interaction, weak bosons, strong interaction, conservation laws, quarks and gluons. This course is given in the competency based instruction format.
- 390 Physics Journal Seminar**
Spring. 1(3-0) P:M: Completion of Tier I writing requirement. R: Open only to juniors or seniors in the Department of Physics and Astronomy or Lyman Briggs School.
Written and oral reports on selected articles in the current literature. Critique of presentations by peers.
- 405 Directed Studies**
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 5 credits in all enrollments for this course. P:M: (PHY 184 or PHY 184B or PHY 232 or PHY 232B or PHY 232C or PHY 294H or LBS 272) R: Approval of department.
Guided independent study of special topics.
- 410 Thermal and Statistical Physics**
Spring. 3(3-0) P:M: (PHY 471)
Equilibrium statistical mechanics and thermodynamics, kinetic theory, phase transformations.

Physics—PHY

- 422 Classical Mechanics II**
Fall. 3(3-0) P:M: (PHY 321)
Hamiltonian and Lagrangian mechanics. Non-inertial frames. Coupled oscillations. Continuous systems.
- 423B Special Relativity**
Summer. 3 credits. P:M: (PHY 321) RB:
Some understanding about electric and magnetic fields.
Concepts of special relativity applied to coordinate transformations, mechanics, and electrodynamics. This course is given in the competency based instruction format.
- 425B Mathematical Physics**
Summer. 3 credits. RB: Calculus through differential equations. Some experience with complex variables.
Fourier series and complex variables as applied to problems in quantum mechanics, electrodynamics, and mechanics. This course is given in the competency based instruction format.
- 431 Optics I**
Fall. 3(2-3) P:M: (PHY 192) and (PHY 184 or PHY 184B or PHY 234B or PHY 183A or PHY 294H) and (PHY 215 or PHY 215B) and completion of Tier I writing requirement. SA: PHY 331
Lenses, aberrations, apertures, and stops. Diffraction, interferometry, spectroscopy, fiber optics.
- 440 Electronics**
Spring. 4(3-3) P:M: (PHY 192) and (MTH 235 or concurrently or MTH 255H or concurrently or LBS 220 or concurrently) and (PHY 184 or concurrently or PHY 184B or PHY 294H or LBS 272)
Concepts of electronics used in investigating physical phenomena. Circuits, amplifiers, diodes, LEDs, transistors.
- 451 Advanced Laboratory**
Fall. 3(1-6) P:M: (PHY 440) and completion of Tier I writing requirement. R: Completion of Tier I writing requirement.
General research techniques, design of experiments, and the analysis of results based on some historical experiments in modern physics.
- 471 Quantum Physics I**
Fall. 3(3-0) P:M: (PHY 215 or PHY 215B) and (PHY 321 or concurrently) and (MTH 235 or MTH 255H or LBS 220)
Schrödinger equation, hydrogen atom, harmonic oscillator, and other one-dimensional systems.
- 472 Quantum Physics II**
Spring. 3(3-0) P:M: (PHY 471) RB: A Mathematics course on Boundary-Value Problems
Matrix formulation of quantum mechanics, perturbation theory, scattering.
- 480 Computational Physics**
Spring of even years. 3(3-0) RB: (CSE 131 or CSE 230)
Applications of scientific computational techniques to solutions of differential equations, matrix methods, and Monte Carlo methods used in physics.
- 481 Electricity and Magnetism I**
Fall. 3(3-0) P:M: (MTH 234 or MTH 254H or LBS 220) R: Open only to juniors or seniors or graduate students.
Electrostatics, dielectrics, magnetic fields of steady state currents, Faraday law of induction.

- 482 Electricity and Magnetism II**
Spring. 3(3-0) P:M: (PHY 481) RB: A Mathematics course on Boundary-Value Problems.
Maxwell's equations, scalar and vector potentials, electromagnetic plane waves.
- 490 Senior Thesis**
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 5 credits in all enrollments for this course. P:M: (PHY 390) and completion of Tier I writing requirement.
Design, carry out, and analyze an original experiment or computation. A written and oral report is required.
- 491 Atomic, Molecular, and Condensed Matter Physics**
Fall. 3(3-0) P:M: (PHY 471 and PHY 410) and completion of Tier I writing requirement.
Many-electron atoms. Molecules, crystal structure, lattice dynamics. Band models of metals and semiconductors. Transport properties.
- 492 Nuclear and Elementary Particle Physics**
Spring. 3(3-0) P:M: (PHY 471) and completion of Tier I writing requirement. RB: (PHY 472)
Properties of nuclei, nuclear models, nuclear reactions. High-energy accelerators. Weak, electromagnetic and strong interactions. Symmetries and conservation laws. Elementary particle spectrum, quarks, gluons.

PHYSIOLOGY PSL

Department of Physiology College of Natural Science

- 101 Current Issues in Physiology**
Fall. 2(2-0) Not open to students with credit in PSL 250 or PSL 431 or PSL 432.
Physiological bases of health issues of broad social significance, and new approaches for the treatment of specific disorders.
- 250 Introductory Physiology**
Fall, Spring. 4(4-0) R: Not open to students in Physiology.
Function, regulation and integration of organs and organ systems of higher animals emphasizing human physiology.
- 323 Physiology and Hygiene of the Eye**
Fall of odd years. Summer of even years. 3(3-0) R: Not open to Physiology majors.
Basic anatomy, physiology, and hygiene of the visual system: normal and abnormal visual function, methods of correction, and educational implications.
- 331 Cell Physiology: Function of Specialized Cells**
Fall. 3(3-0) P:M: (BS 111 or LBS 145)
Functions of differentiated cells, including mechanisms of cell communication, excitable membranes, contraction, motility, transport, secretion, and extra cellular matrix.
- 410 Computational Problem Solving in Physiology**
Fall, Spring. 3(3-0) RB: (PSL 432) R: Approval of department.
Quantitative analysis of physiological data: mathematical models, curve fitting, data analysis and interpretation. Problem solving involving exponential and logistic growth. Cerebral blood flow, convective cooling, oxygen consumption, thermoregulation, other applications.
- 420 Membrane Biophysics: An Introduction**
Fall, Spring. 2(2-0) RB: One year of college physics or chemistry, and one year of college mathematics.
Biophysical and chemical aspects of biomembranes. Experimental model membrane systems including planar lipid bilayers and liposomes. Biotechnological applications of lipid bilayer sensors.
- 431 Human Physiology I**
Fall. 3(3-0) RB: (BS 111 and CEM 142)
Neural function including autonomic nervous system, physiological control systems, endocrinology, reproduction and digestive function.
- 432 Human Physiology II**
Spring. 3(3-0) RB: (PSL 431)
Continuation of PSL 431. Function and regulation of the cardiovascular, respiratory, and renal systems. Control of tissue blood flow, blood pressure, blood gases, body fluid volume and electrolytes.
- 440 Topics in Cell Physiology**
Fall, Spring. 2(2-0) RB: (PSL 432) R: Open only to Physiology majors. Completion of Tier I writing requirement.
Critical discussion and evaluation of a selected problem of mammalian cell physiology including cell biophysics, molecular biology of the cell.
- 441 Topics in Endocrinology**
Fall, Spring. 2(2-0) RB: (PSL 432) R: Open only to Physiology majors. Completion of Tier I writing requirement.
Selected topic on the role of hormones in the regulation of growth, metabolism, differentiation.
- 442 Topics in Cardiovascular Physiology**
Fall. 2(2-0) RB: (PSL 432) R: Open only to Physiology majors. Completion of Tier I writing requirement.
Selected topic in blood flow physiology.
- 443 Topics in Respiratory Physiology**
Fall of odd years. 2(2-0) RB: (PSL 432) R: Open only to Physiology majors. Completion of Tier I writing requirement.
Selected topic in the physiology of gas exchange and lung mechanics.
- 445 Topics in Environmental Physiology**
Spring of odd years. 2(2-0) RB: (PSL 432) R: Open only to Physiology majors. Completion of Tier I writing requirement.
Selected topic in environmental physiology with an emphasis on thermoregulation.
- 446 Topics in Visual Physiology**
Fall of even years. 2(2-0) RB: (PSL 432) R: Open only to Physiology majors. Completion of Tier I writing requirement.
Selected topic in the functioning of the visual system in health and disease.