PH - PHYSICS (PH)

PH 090 - College Preparatory Physics 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: None

Topics covered include: Units, significant figures, vectors, 1 and 2 dimensional motion; kinematic equations, objects in free-fall, motion in a circle, projectile motion, Newton's Laws, contact forces, non-contact forces: gravity, Coulomb's Law, magnetic force; centripetal force; collisions, linear momentum, rotational kinematics, torques, angular momentum, mechanical equilibrium - static equilibrium. The credits from this course cannot be counted toward any degree completion at Rose-Hulman.

PH 111 - Physics I 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: F,W
Graduate Studies Eligible: No
Prerequisites: MA 111 (may be taken concurrently) or MA 106 (may be taken concurrently)

Kinematics, Newton's laws of motion, gravitation, Coulomb's law, Lorentz force law, strong and weak nuclear forces, conservation of energy and momentum, relevant laboratory experiments.

PH 111L - Physics I Lab 0 Credits

Hours: 0R-1.5L-0C
Graduate Studies Eligible: No
Prerequisites: None

PH 112 - Physics II 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: F,W,S
Graduate Studies Eligible: No
Prerequisites: PH 111 and (MA 111 or MA 106 or (MA 112 (may be taken concurrently) or MA 107 (may be taken concurrently)) or MA RA100 or MA FTC)

Torque and angular momentum, oscillations, one-dimensional waves, electric fields and potentials, electric current and resistance, DC circuits, capacitance, relevant laboratory experiments.

PH 112L - Physics II Lab 0 Credits

Hours: 0R-1.5L-0C
Graduate Studies Eligible: No
Prerequisites: None

PH 113 - Physics III 4 Credits

Hours: (3.5 - 4)R-(0 - 1.5)L-4C
Term Available: F,W,S
Graduate Studies Eligible: No
Prerequisites: PH 112 and (MA 112 or MA 102 or MA 107 or MA FTC) or MA 113 (may be taken concurrently)

Sources of magnetic fields, Faraday's law, inductance electromagnetic waves, reflection and polarization, geometric and physical optics, introduction to relativity, relevant laboratory experiments.

PH 113L - Physics III Lab 0 Credits

Hours: 0R-(1.5 - 3)L-0C
Graduate Studies Eligible: No
Prerequisites: None

PH 199 - Professional Experience 1 Credit

Hours: 1R-0L-1C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: None

The professional experiences course captures the practical work experiences related to the student’s academic discipline. Students are required to submit a formal document of their reflections, which communicates how their employment opportunity reinforced and enhanced their academic studies.

PH 200 - Career Preparation 1 Credit

Hours: 1R-0L-1C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: None

This course is for physics majors to be taken in the second year. The course addresses career choices, summer opportunities, employment and graduate school preparation, and curriculum vitae and resume preparation.

PH 215 - Introduction to Chaos 2 Credits

Hours: 2R-0L-2C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: None

What constitutes chaotic behavior, detection of chaos in real systems using phase space plots, Poincare sections, bifurcation plots, power spectra, Lyupunov exponents, and computer simulation of chaotic systems.

PH 231 - Observational Astronomy 2 Credits

Hours: 1R-3L-2C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: (MA 111 or MA 106 or MA RA100) and (PH 111 or EM 120)

Celestial coordinates; basics of celestial mechanics; electromagnetic radiation, atomic structure, spectra, blackbody radiation; telescopes and detectors; quantitative observational work using modern telescopes and detectors.

PH 235 - Many-Particle Physics 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: PH 111 and (MA 112 (may be taken concurrently) or MA 107 (may be taken concurrently))

Dynamics of rigid body, harmonic motion; mechanics of fluids; heat, kinetic theory, thermodynamics. Alternate week laboratories.

PH 235L - Many-Particle Physics Lab 0 Credits

Hours: 0R-0L-0C
Graduate Studies Eligible: No
Prerequisites: None

PH 241 - Physics of Stars 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: (MA 111 or MA 106 or MA RA100) and (PH 111 or EM 120)

Binary stars and stellar parameters; stellar spectra; stellar atmospheres; stellar interiors; star formation; stellar evolution; star death; stellar remnants; black holes and binary stars.

PH 250 - Planets and Galaxies 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: (MA 111 or MA 106) and PH 111 or EM 120

Overview of planets and planetary science; origin and evolution of the solar system; structure and evolution of galaxies; origin and evolution of the universe; introduction to cosmology.

PH 255 - Foundations of Modern Physics 4 Credits

Hours: (0 - 4)R-(1.5 - 3)L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: PH 113 and (MA 221 (may be taken concurrently) or MA 211 (may be taken concurrently))

Wave-particle nature of matter and radiation, Bohr model, Schrodinger equation, quantum description of the hydrogen atom, atomic and molecular spectra, and introduction to statistical physics.

PH 265 - Fundamentals of Nuclear Physics & Radiation 4 Credits

Hours: 3R-(0 - 3)L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: PH 112 and (MA 221 or MA 211)

Relativity, black-body radiation, the Bohr model, physics of the nucleus, fission and fusion, reactors, nuclear radiation, radiation damage, medical applications.

PH 265L - Fund Nuclear Phys & Rad Lab 0 Credits

Hours: 0R-0L-0C
Graduate Studies Eligible: No
Prerequisites: None

PH 270 - Selected Topics in Physics 1-4 Credits

Hours: 0R-0L-(1 - 4)C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: None

Lectures on special topics in physics. Maximum of 4 credits per term.

PH 290 - Directed Research 1-4 Credits

Hours: 0R-0L-(1 - 4)C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: None

Research for freshmen and sophomore students under the direction of a physics and optical engineering faculty member. May earn up to a maximum of 2 credits for meeting the graduation requirements. The student must make arrangements with a faculty member for the research project prior to registering for this course.

PH 292 - Physical Optics 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: PH 113

The wave equation; electromagnetic waves; phase and group velocities; complex refractive index; dispersion, interference; interferometers and applications, optical interferometry; coherence; polarized light; Jones vectors/matrices; production of polarized light; birefringence, Fraunhoffer diffraction; diffraction gratings.

PH 292L - Physical Optics Lab 0 Credits

Hours: 0R-0L-0C
Graduate Studies Eligible: No
Prerequisites: None

PH 302 - Biophysics 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: PH 113

Biological examples of the interaction of radiation and matter; medical uses of x-rays, nuclear medicine, magnetic resonance imaging, and current applications in biophysics.

PH 310 - Introduction to Special Relativity 2 Credits

Hours: 2R-0L-2C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: PH 113

Experimental background of the special theory of relativity, the structure of the theory and its consequences in measurements involving space, time and motion. Relativistic mechanics, relativity and electromagnetism, and applications in modern physics.

PH 314 - Theoretical Mechanics I 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: PH 112 and MA 222

Statics and dynamics of particles and systems of particles, including rigid bodies. Conservation of energy, linear and angular momentum. Central forces. Lagrangian and Hamiltonian equations of motion. Vibrations.

PH 315 - Theoretical Mechanics II 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: PH 314

Statics and dynamics of rigid bodies. Lagrangian treatment of rigid body dynamics. Euler method of rigid body dynamics. Small oscillations about positions of equilibrium and about steady motion. Statics and dynamics of deformable bodies. Computational analysis of mechanical systems.

PH 316 - Electric & Magnetic Fields 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: PH 113 and MA 222

Maxwell's equations in integral and point form, vector calculus; electric field and potential, electric fields in matter, boundary conditions; the magnetic field.

PH 317 - Electromagnetism 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: PH 316

Further methods in electrostatics, Poisson's equation; magnetostatics, the vector potential; electromagnetic induction; magnetic properties of matter; further applications of Maxwell's equations, properties of electromagnetic radiation.

PH 322 - Celestial Mechanics 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: PH 112 and MA 221

Dynamics of point masses; the two-body problem; the restricted three-body problem; orbital position as a function of time; orbits in three dimensions; preliminary orbit determination; orbital maneuvers; interplanetary trajectories.

PH 325 - Adv Physics Laboratory I 4 Credits

Hours: 2R-6L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: PH 113

Introduction to the methods of experimental physics; topics may include error analysis, component fabrication, transducers, ac circuits, operational amplifiers, electrical signal conditioning, and automated data acquisition.

PH 325L - Adv Physics Laboratory I Lab 0 Credits

Hours: 0R-3L-0C
Graduate Studies Eligible: No
Prerequisites: None

PH 326 - Adv Physics Laboratory II 4 Credits

Hours: 2R-6L-4C
Graduate Studies Eligible: No
Prerequisites: PH 325

PH 327 - Thermodynamics & Statistical Mechanics 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: PH 235 or (ES 202 and ES 204)

First, second, and third laws of thermodynamics. Ideal gases, real gases, liquids, solids, change of phase. The Joule-Thompson effect, adiabatic demagnetization. Kinetic theory of gases, classical and quantum statistical mechanics.

PH 401 - Introduction to Quantum Mechanics 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: PH 255 or (PH 113 and PH 265)

Review of wave-particle experiments, atomic model, Bohr theory, deBroglie's hypothesis. Uncertainty principle, Schroedinger equation, quantum mechanical operators and stationary states, quantization and role of angular momentum.

PH 402 - Intro to Atomic Physics 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: No
Prerequisites: PH 401

Solutions of Schroedinger equation, perturbation theory, applications to one electron system. Quantum numbers, spin and magnetic moments, multi-electron systems including LS coupling. Zeeman effect, transition rates, hyperfine structure, X-rays.

PH 404 - Acoustics 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: No
Prerequisites: PH 113 and (MA 222 or MA 212)

Harmonic motion, waves on strings, membranes, eigenfunctions and eigenvalues; waves in rods and fluids; behavior of waves at interfaces; radiation from vibrating piston; resonators, absorption.

PH 405 - Semiconductor Materials & Applications 4 Credits

Hours: 3R-3L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: PH 255 or PH 113 or PH 265

Material structure electronic levels and energy bands; semiconductor doping; optical and electronic material characteristics; p-n junction and diode characteristics; bipolar junction transistor; basics of device fabrication. Laboratories on X-ray and Scanning Electron Microscope investigations, device characteristics and a three-week design project on production and testing of thin films. Cross-listed with PH 505.

PH 405L - Semicond Materials & Apps Lab 0 Credits

Hours: 0R-3L-0C
Graduate Studies Eligible: Yes
Prerequisites: None

PH 407 - Solid State Physics 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: PH 255 or PH 265

Selected topics in the field are discussed in detail; e.g., crystal structures, lattice vibrations and electronic band structure; electrical, optical and thermal properties of solids and semi-conductors; and the properties of materials at very low temperatures.

PH 410 - General Relativity 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: MA 421 and PH 310

An in-depth study of Einstein's theory of General Relativity. Gravity as geometry and curved space-time, metrics, and geodesics. Orbits and light paths around spherical masses. Detailed study of Einstein's equation in vacuum and with sources of space-time curvature.

PH 425 - Advanced Physics Lab II 4 Credits

Hours: 1R-9L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: PH 325

Selected experiments in various areas of physics and a significant independent student project

PH 431 - Advanced Observational Astronomy 2 Credits

Hours: 1R-3L-2C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: PH 231 and (PH 241 or PH 250)

Students will conduct astronomical observations with telescopes and learn to process and interpret astronomical data.They will learn astronomical data processing, statistical analysis, image processing, observational bias, data interpretation, and scientific writing skills.

PH 440 - X-rays & Crystalline Materials 4 Credits

Hours: 2R-6L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: PH 255 or PH 265

X-ray emission, absorption, fluorescence, and diffraction. Methods of analyzing crystalline solid materials. Applications in solid-state physics, materials science, chemistry, metallurgy, and biology.

PH 460 - Directed Study 1-4 Credits

Hours: 0R-0L-(1 - 4)C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: None

Permits study in an area of physics not available in regular course offerings. Maximum of 4 credits per term.

PH 470 - Special Topics in Physics 1-4 Credits

Hours: 0R-0L-(1 - 4)C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: None

Lectures on special topics in physics.

PH 490 - Directed Research 1-4 Credits

Hours: 0R-0L-(1 - 4)C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: None

Research for junior and senior students under the direction of a physics and optical engineering faculty member. May earn a maximum of 8 credits between PH 290 and PH 490 for meeting graduation requirements. Maximum of 2 credits per term. The student must make arrangements with a physics and optical engineering faculty member for the research project prior to registering for this course.

PH 496 - Senior Thesis 1-4 Credits

Hours: 0R-0L-(1 - 4)C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: None

Literature search, research proposal preparation, and laboratory project work with a total number of 8 credit hours over the three quarter sequence. This sequence is designed to result in a completed senior thesis.

PH 497 - Senior Thesis 2-4 Credits

Hours: 0R-0L-(2 - 4)C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: None

Literature search, research proposal preparation, and laboratory project work with a total number of 8 credit hours over the three quarter sequence. This sequence is designed to result in a completed senior thesis.

PH 498 - Senior Thesis 2-4 Credits

Hours: 0R-0L-(2 - 4)C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: None

Literature search, research proposal preparation, and laboratory project work with a total number of 8 credit hours over the three quarter sequence. This sequence is designed to result in a completed senior thesis.

PH 499 - Physics Ethics & Communication 1 Credit

Hours: 1R-0L-1C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: (PH 497 and PH 498) or PH 425

Guidelines will be discussed to encourage ethical reporting and conduct of research performed by individuals.Situations in physics research and publication will be presented and discussed in regards to ethical reporting and conduct.

PH 505 - Semiconductor Materials & Devices I 4 Credits

Hours: 3R-3L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: PH 113 or PH 255 or PH 265

Material structure electronic levels and energy bands; semiconductor doping; optical and electronic material characteristics; p-n junction and diode characteristics; bipolar junction transistor; basics of device fabrication. Laboratories on X-ray and Scanning Electron Microscope investigations, device characteristics and a three-week design project on production and testing of thin films. Students must do additional project work on a topic selected by the instructor. Cross-listed with PH 405.

PH 505L - Semiconductor Mat & App Lab 0 Credits

Hours: 0R-3L-0C
Graduate Studies Eligible: Yes
Prerequisites: None

PH 512 - Methods of Mathematical Physics 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: None

Ordinary and partial differential equations, linear vector spaces, matrices, tensors. Strum-Liouville theory and eigenvalue problems, special functions, function of a complex variable, theory of groups, linear integral equations.

PH 514 - Quantum Mechanics 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: None

Development of quantum mechanical theory to the present time. Examples from spectroscopy, chemistry, nuclear physics.

PH 530 - Advanced Acoustics 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: PH 404

Waves in solids, electrodynamics and piezoelectric sound transducers, ultrasonics. Architectural acoustics. Underwater sound.

PH 538 - Introduction to Neural Networks 4 Credits

Hours: 3R-3L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: None

Classifiers, linear separability. Supervised and unsupervised learning. Perceptrons. Back-propagation. Feedback networks. Hopfield networks. Associative memories. Fuzzy neural networks. Integral laboratory.

PH 540 - Computer Physics 4 Credits

Hours: 3R-3L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: None

Exploration of physics by simulation including planetary motion, waves, chaos, cellular automata and fractals; application of numerical methods of differentiation and integration; computer hardware and machine language as it affects laboratory use; curve fitting and smoothing of data.