PHYSICS, ENGINEERING PHYSICS AND ASTRONOMY

Courses

ASTR 101  Astronomy I: Solar System  Units: 3.00
A non-mathematical introduction to the science of astronomy for non-specialist students. Topics to be covered include the fundamentals of astronomy; and introduction to the tools and techniques of modern observational astronomy; the historical development of our understanding of the Earth, Moon, and Solar System; space exploration of Mars, Jupiter, and other planets; the nature of the Sun; and the origin and uniqueness of our Solar System.
NOTE Also offered online. Consult Arts and Science Online.
Learning Hours may vary.
LEARNING HOURS 120 (36L;24O;60P)
EQUIVALENCY PHYS P15/3.0.
Requirements: Prerequisite None.
Offering Faculty: Faculty of Arts and Science

ASTR 102  Astronomy II: Stars, Galaxies, and the Universe  Units: 3.00
This course, intended for non-specialist students, will provide an overview of astronomy beyond the Solar System. Topics will include: the formation, nature, and evolution of the stars; stellar deaths, including novae, supernovae, white dwarfs, neutron stars, pulsars, and black holes; the interstellar medium; the Milky Way Galaxy; normal and active galaxies and large scale structure in the universe; and modern ideas in cosmology and the early universe.
NOTE Also offered online. Consult Arts and Science Online.
Learning Hours may vary.
LEARNING HOURS 120 (36L;24O;60P)
EQUIVALENCY PHYS P16/3.0.
Requirements: Prerequisite (ASTR 101 or PHYS 104 or PHYS 106 or PHYS 117 or PHYS 118) or (APSC 111 and APSC 112) or PHYS P15 or permission of the Department.
Offering Faculty: Faculty of Arts and Science

PHYS P20  Physicists in the Nuclear Age  Units: 3.00
For those interested in the impact of science on our century. Modern physics, especially nuclear physics, will be introduced by emphasizing the personalities, thoughts and writings of key scientists such as Bohr, Einstein and Rutherford and the ways in which they related to and shaped their political, scientific and social environments. Enrolment is limited.
NOTE Also offered online. Consult Arts and Science Online.
Offering Faculty: Faculty of Arts and Science

PHYS P22  Physics Frontiers: From Colliding Black Holes to Disruptive Technologies  Units: 3.00
A descriptive course exploring concepts in physics at the frontiers of active research. Bypassing jargon and mathematical complexities, students will focus on the big questions at the extremes of our understanding of the universe around us. Designed for non-scientists who want to learn how we try to understand our fantastic, physic natural world.
LEARNING HOURS 114 (24L;24Pc;36O;18Oc;12P)
Offering Faculty: Faculty of Arts and Science

PHYS 104  Fundamental Physics  Units: 6.00
Mechanics, including systems of particles and rigid body motion; gravitation; fluids; electricity and magnetism; oscillatory motion and waves; heat, light and sound; topics in modern physics. The material is presented at a more fundamental level appropriate for students who are seeking a deeper appreciation of physics, and who may be considering a concentration in Physics.
LEARNING HOURS 240 (72L;36Lb;36T;96P).
Requirements: Prerequisite None. Corequisite (MATH 120 or MATH 121 or [MATH 123 and MATH 124]). Exclusion PHYS 106; PHYS 117; PHYS 118. Recommended 4U Physics.
Offering Faculty: Faculty of Arts and Science

PHYS 106  General Physics  Units: 6.00
Mechanics, including systems of particles and rigid body motion; fluids; electricity and magnetism; oscillatory motion and waves; heat, light and sound; topics in modern physics. Aspects of physics useful for further work in other sciences will be emphasized.
NOTE Also offered at the Bader International Study Centre. Learning Hours may vary.
LEARNING HOURS 240 (72L;36Lb;36T;96P).
Requirements: Prerequisite None. Corequisite (MATH 120 or MATH 121 or [MATH 123 and MATH 124]). Exclusion PHYS 104; PHYS 117; PHYS 118. Recommended 4U Physics.
Offering Faculty: Faculty of Arts and Science

PHYS 115  Introduction to Physics I  Units: 3.00
Offering Faculty: Faculty of Arts and Science
PHYS 116 Introduction to Physics II Units: 3.00
Offering Faculty: Faculty of Arts and Science

PHYS 118 Basic Physics Units: 6.00
An algebra-based course dealing with basic Physics concepts, including dynamics, fluids, waves, electromagnetism, and basic optics. Emphasis is placed on the development of problem-solving skills through the use of Mastery based course delivery.

NOTE Only offered online. Consult Arts and Science Online.

LEARNING HOURS 228 (132O;96P).
Requirements: Prerequisite None. Exclusion PHYS 104; PHYS 106; PHYS 117. Recommended 4U Physics.

PHYS 118B

PHYS 119 Introductory Physics Laboratory Units: 1.50
This is the laboratory portion of PHYS 117, offered for students who completed the online PHYS 118 Basic Physics course, but would like a laboratory experience. A laboratory class in mechanics, electricity, waves and optics. This course runs 8 experiments through the fall and winter terms.

Requirements: Prerequisite PHYS 118. Exclusion PHYS 104; PHYS 106; PHYS 117.

PHYS 206 Dynamics Units: 3.00
An introductory course in classical dynamics of particles, of rigid bodies and of fluids that sets the foundation for more advanced work. Topics include kinematics of particles and of rigid bodies, central forces, kinetics of systems of particles, planar and three dimensional dynamics of rigid bodies and an introduction to fluid mechanics.

Requirements: Prerequisite ([PHYS 104 or PHYS 106] and [MATH 120 or MATH 121]) or permission of the Department. Recommended A minimum grade of a C in PHYS 104 or PHYS 106.

PHYS 213 Computational Methods in Physics Units: 3.00
Computing environments, algorithms, techniques and programming for solving physics problems. Numerical methods. Code development. Possible topics to be covered include numerical differentiation and integration, root finding and optimization problems, solution of linear systems of equations, Monte Carlo simulation, and symbolic computation.

LEARNING HOURS 120 (24L;24T;72P)

PHYS 216 Introduction to Astrophysics Units: 3.00
Broad overview of basic laws of gravitation, radiation, and relativity: history and evolution of modern astronomy; ground and space-based astronomy; the physics and evolution of stars; the milky way; galaxies in the universe; and cosmology. This course also uses the on-campus observatory at an introductory level.

Requirements: Prerequisite ([PHYS 104 or PHYS 106] and [MATH 120 or MATH 121]) or permission of the Department.

PHYS 212 Vibrations and Waves Units: 3.00
Fundamentals of free, damped and forced vibrations with applications to various mechanical systems. Coupled oscillations and normal modes. Classical wave equation, standing and travelling waves. Continuum mechanics of solid bodies; elasticity theory with applications. Introduction to optics: image formation and optical instruments.

LEARNING HOURS 120 (24L;24T;72P).

Requirements: Prerequisite PHYS 206.

PHYS 229 Electromagnetism Units: 3.00
The experimental basis and mathematical description of electrostatics, magnetostatics and electromagnetic induction, together with a discussion of the properties of dielectrics and ferromagnetics, are presented. Both the integral and vector forms of Maxwell's equations are deduced.

Requirements: Prerequisite (PHYS 104 or PHYS 106) and (MATH 221 or MATH 227 or MATH 280). Recommended A minimum grade of a C in PHYS 104 or PHYS 106.

PHYS 242 Relativity and Quanta Units: 3.00
Evidence for relativistic effects. Kinematics and dynamics in special relativity, space-time diagrams, applications. Evidence for quanta, spectra, Bohr atom. Introduction to the Schroedinger equation.

Requirements: Prerequisite PHYS 104 or PHYS 106. Recommended A minimum grade of a C in PHYS 104 or PHYS 106.

PHYS 235 Eng. Electricity & Magnetism Units: 4.00
Requirements: PHYS113 AND MATH227 OR (PHYS113 AND PHYS114) OR (MATH280 AND PHYS114) OR (MATH280 AND PHYS113) OR (APSC111 AND APSC112) OR (APSC111 AND MATH227) OR (MATH280 AND APSC112) OR (MATH280 AND APSC111)

PHYS 239 Electromagnetism Units: 3.00
Evidence for relativistic effects. Kinematics and dynamics in special relativity, space-time diagrams, applications. Evidence for quanta, spectra, Bohr atom. Introduction to the Schroedinger equation.

Requirements: Prerequisite PHYS 104 or PHYS 106. Recommended A minimum grade of a C in PHYS 104 or PHYS 106.

PHYS 242 Relativity and Quanta Units: 3.00
Evidence for relativistic effects. Kinematics and dynamics in special relativity, space-time diagrams, applications. Evidence for quanta, spectra, Bohr atom. Introduction to the Schroedinger equation.

Requirements: Prerequisite PHYS 104 or PHYS 106. Recommended A minimum grade of a C in PHYS 104 or PHYS 106.

PHYS 242 Relativity and Quanta Units: 3.00
Evidence for relativistic effects. Kinematics and dynamics in special relativity, space-time diagrams, applications. Evidence for quanta, spectra, Bohr atom. Introduction to the Schroedinger equation.

Requirements: Prerequisite PHYS 104 or PHYS 106. Recommended A minimum grade of a C in PHYS 104 or PHYS 106.

PHYS 242 Relativity and Quanta Units: 3.00
Evidence for relativistic effects. Kinematics and dynamics in special relativity, space-time diagrams, applications. Evidence for quanta, spectra, Bohr atom. Introduction to the Schroedinger equation.

Requirements: Prerequisite PHYS 104 or PHYS 106. Recommended A minimum grade of a C in PHYS 104 or PHYS 106.
PHYS 250  Foundations of Experimental Physics  Units: 3.00
Laboratory and lecture course that presents techniques and skills that are the foundations of experimental physics. Topics include statistical analysis of data, uncertainties in measurement, propagation of errors, software for data analysis, graphing and reporting. Students will be exposed to techniques in the measurement of electric, magnetic, thermal and mechanical properties. Laboratories also illustrate some principles of quantum physics, mechanics, electromagnetism and thermodynamics learned in other physics courses. Some exposure to computerized data acquisition is included.
LEARNING HOURS 132 (24L;36Lb;72P).
Requirements: Prerequisite PHYS 104 or PHYS 106.
Offering Faculty: Faculty of Arts and Science

PHYS 260  The Physics of Light and Colour  Units: 3.00
Students will develop an appreciation for the physical and chemical processes that control light and colours. Students will learn the basic principles of light emission and propagation, image formation, the workings of optical devices and detectors, colour theory and colour perception, colour in art, colour in nature, and colours in astronomy.
LEARNING HOURS 108 (36L;72P).
Requirements: Prerequisite PHYS 104 or PHYS 106 or PHYS 117 or PHYS 118 or BIOL 102 or BIOL 103 or CHEM 112 or GEOL 102 or GEOL 104 or GEOL 106 or GEOL 107 or PSYC 100.
Offering Faculty: Faculty of Arts and Science

PHYS 316  Methods in Mathematical Physics I  Units: 3.00
Methods of mathematics important for physicists. Complex arithmetic, series expansions and approximations of functions, Fourier series and transforms, vector spaces and eigenvalue problems, ordinary differential equations and Green's functions.
LEARNING HOURS 120 (36L;12T;72P).
Requirements: Prerequisite (MATH 221 or MATH 227 or MATH 280) and (MATH 225 or MATH 231 or MATH 232).
Exclusion MATH 334; MATH 338; PHYS 312.
Offering Faculty: Faculty of Arts and Science

PHYS 317  Methods in Mathematical Physics II  Units: 3.00
A continuation of PHYS 316. Partial differential equations, functions of a complex variable and contour integration, and special topics such as probability and statistics, group theory and non-linear dynamics.
LEARNING HOURS 120 (36L;12T;72P).
Requirements: Prerequisite PHYS 316. Exclusion MATH 228; MATH 326; MATH 338; PHYS 312.
Offering Faculty: Faculty of Arts and Science

PHYS 318  Electromagnetism  Units: 3.00
This course relates observable quantities to the physical properties of astronomical sources thereby deciphering the varied nature of the cosmos. Basic physical processes in astrophysics are discussed and applied to diverse systems including planets, stars, the interstellar medium and distant galaxies. Topics include radiative transfer and the perturbation of the signal by instruments, the atmosphere, and the interstellar medium. The main astrophysical emission processes, both continuum and line, are also presented. An observing project will be carried out during the term.
LEARNING HOURS 120 (36L;84P).
Requirements: Prerequisite (PHYS 216 and PHYS 242) or permission of the Department.
Offering Faculty: Faculty of Arts and Science
PHYS 335  Semiconductor Physics  Units: 3.00
An examination of the basic phenomena of semiconductor physics and their application in diodes, transistors, optical detectors, and lasers. The laboratory illustrates the use of semiconductor devices in electronic circuits. (0/10/2/28/8)~
Requirements: PHYS231 OR PHYS235 OR PHYS239
Course Equivalencies: PHYS335, PHYS380
Offering Faculty: Faculty of Arts and Science

PHYS 336  Solid State Devices  Units: 3.25
This course deals with the fundamental concepts of solid state materials and the principles of operation of modern electronic and optoelectronic devices. Topics in materials include crystal structure, energy bands, carrier processes and junctions. Topics in device operation include p-n junction diodes, bipolar junction transistors, field-effect junction transistors, metal-oxide-semiconductor field-effect transistors, and double heterojunction lasers. (0/18/0/21/0)
Requirements: (ELEC252 AND ELEC280) OR (ELEC252 AND PHYS231)
Offering Faculty: Faculty of Arts and Science

PHYS 344  Introduction to Quantum Mechanics  Units: 3.00
Requirements: Prerequisite PHYS 212 and PHYS 242 and (MATH 221 or MATH 280) and (MATH 225 or MATH 231 or MATH 232). Equivalency PHYS 343.
Course Equivalencies: PHYS343, PHYS344
Offering Faculty: Faculty of Arts and Science

PHYS 345  Quantum Physics of Atoms, Nuclei and Particles  Units: 3.00
Spin. Addition of angular momentum. Many electron atoms and the periodic table. Introduction to perturbation theory and Fermi's golden rule. Time dependent perturbations, including stimulated emission. Introduction to nuclear and particle physics.
Requirements: Prerequisite PHYS 344. Equivalency PHYS 424.
Course Equivalencies: PHYS345, PHYS424
Offering Faculty: Faculty of Arts and Science

PHYS 350  General Laboratory  Units: 6.00
Experiments in heat, optics, electron physics, quantum physics, and radioactivity are performed. A substantial part of the course is an experimental project during the Winter Term. A topic for the experimental physics, or observational astronomy project will be assigned after discussion with the student.
LEARNING HOURS 222 (72Lb;60;144P).
Requirements: Prerequisite PHYS 239 and PHYS 242 and PHYS 250.
Offering Faculty: Faculty of Arts and Science

PHYS 352  Measurement Experiment Design  Units: 3.00
Measurement of a variety of quantities with particular reference to techniques used in current physics and engineering practice, including optics, X-rays in crystallography and analysis, vacuum practice, nuclear techniques, signal-to-noise enhancement, the use of digital computers for instrumentation purposes, and the statistical analysis of data.
Requirements: PHYS 239 PHYS344
Offering Faculty: Faculty of Arts and Science

PHYS 372  Thermodynamics  Units: 3.00
Temperature, equations of state, internal energy, first and second laws, entropy and response functions. Application to heat engines and refrigerators. Free energies, Legendre transformations, changes of phase. Introduction to the Boltzmann factor and statistical mechanics.
Requirements: PHYS242
Offering Faculty: Faculty of Arts and Science

PHYS 380  Electrical & Optical Properties  Units: 3.00
An introduction to the electrical and optical properties of insulators, semiconductors and metals. Introduction to Fermi-Dirac statistics, crystal and band theory and electron transport. Topics covered include the physics behind diodes, field effect and bipolar junction transistors, and electro-optical discrete devices.
Requirements: (PHYS231 AND PHYS344) OR (PHYS239 AND PHYS344)
Course Equivalencies: PHYS335, PHYS380
Offering Faculty: Faculty of Arts and Science

PHYS 414  Introduction to General Relativity  Units: 3.00
Einstein's theory of gravity is developed from fundamental principles to a level which enables the student to read some of the current literature. Includes an introduction to computer algebra, an essential element of a modern introduction to Einstein's theory.
Requirements: Prerequisite PHYS 321 and (PHYS 312 or PHYS 317 or MATH 334).
Offering Faculty: Faculty of Arts and Science
PHYS 432  Electromagnetic Theory  Units: 3.00
Electromagnetic theory and applications. Topics include: Maxwell's equations, gauge theory, relativistic transformations of Maxwell's equations, properties of waves in free space, dielectrics, conductors and ionized media, reflection and refraction at the surfaces of various media, propagation in metallic and dielectric waveguides, radiation of electromagnetic waves from charged particles and antennae.
Requirements: Prerequisite PHYS 239 and (MATH 221 or MATH 280) and (MATH 225 or MATH 231 or MATH 232). Equivalency PHYS 332.
Course Equivalencies: PHYS332, PHYS432
Offering Faculty: Faculty of Arts and Science

PHYS 434  Extragalactic Astronomy  Units: 3.00
Requirements: PHYS315
Offering Faculty: Faculty of Arts and Science

PHYS 435  Stellar Structure and Evolution  Units: 3.00
This course provides a detailed account of the formation, structure, evolution and endpoints of stars. Topics include the HR diagram, nuclear energy generation, radiative transport and stellar model building, supernovae, white dwarfs, neutron stars, pulsars and black holes.
Requirements: Prerequisite PHYS 315.
Offering Faculty: Faculty of Arts and Science

PHYS 444  Advanced Quantum Physics  Units: 3.00
This course covers perturbation theory, scattering theory and the addition of angular momentum. Special topics may include: many-electron systems, path integral formulation of quantum mechanics, entanglement and quantum computing, quantum optics.
Requirements: Prerequisite PHYS 345. Equivalency PHYS 426.
Course Equivalencies: PHYS426, PHYS444
Offering Faculty: Faculty of Arts and Science

PHYS 450  Adv Physics Lab & Proj  Units: 6.00
This course provides advanced physics and engineering physics students with experience in a wide range of modern experimental techniques. Experiments encompass measurements in applied physics, quantum solid state physics, low temperature physics, nuclear physics and optics. The course has set experiments in the Fall Term and group projects in the Winter Term.
Requirements: (PHYS350 AND PHYS343) OR (PHYS350 AND PHYS350) OR (PHYS350 AND CHEM331) OR (PHYS343 AND PHYS351) OR (PHYS342 AND PHYS343) OR (PHYS344 AND PHYS350) OR (PHYS342 AND PHYS351) OR (PHYS350 AND CHEM313) OR (PHYS344 AND PHYS351) OR (PHYS350 AND CHEM313)
Offering Faculty: Faculty of Arts and Science

PHYS 453  Advanced Physics Laboratory  Units: 3.00
Advanced physics laboratory course providing students with experience in a range of experimental techniques and analysis. A selection of experiments are performed from fields including nuclear physics, applied physics, fluid mechanics, solid state physics, low-temperature physics and optics.
LEARNING HOURS 132 (76Lb;60P)
Requirements: (PHYS350 AND PHYS343) OR (PHYS350 AND CHEM331) OR (PHYS350 AND PHYS343) OR (PHYS350 AND CHEM313) OR (PHYS350 AND CHEM313) OR (PHYS343 AND PHYS351) OR (PHYS344 AND PHYS350) OR (PHYS344 AND PHYS351)
Offering Faculty: Faculty of Arts and Science

PHYS 454  Advanced Physics Design Project  Units: 3.00
Groups of students in physics and engineering physics undertake a large design project of their choice that reflects and further develops their knowledge of physics. The students then build a prototype of their design to demonstrate the feasibility of the project within the design constraints.
Requirements: Prerequisite PHYS 350.
Offering Faculty: Faculty of Arts and Science

PHYS 460  Laser Optics  Units: 3.00
Topics and applications in modern physical optics, culminating with the development of the laser and its current applications. Topics include: Gaussian beam propagation, optical resonators, Fourier optics, fiber optics, holography, light-matter interaction using classical and semi-classical models, and the basic theory and types of lasers.
Requirements: Prerequisite PHYS 239 and (PHYS 344 or CHEM 313). Corequisite PHYS 432.
Offering Faculty: Faculty of Arts and Science

PHYS 472  Statistical Mechanics  Units: 3.00
Phase space, the ergodic hypothesis and ensemble theory. Canonical and grand canonical ensembles. Partition functions. Ideal quantum gases. Classical gases and the liquid-vapour transition. Introduction to techniques for interacting systems, including Monte Carlo simulations.
Requirements: Prerequisite (PHYS 213 or PHYS 313) and PHYS 434 and PHYS 372. Exclusion CHEM 412.
Offering Faculty: Faculty of Arts and Science
PHYS 479  High Performance Computational Physics  Units: 3.00
This course teaches students how to use the tools of high performance computing facilities, including communications protocol for parallel computations. Students will employ these facilities and tools and use various numerical algorithms in the solution of physics problems. LEARNING HOURS 120 (24L;24T;72P).
Requirements: Prerequisite (PHYS 213 or PHYS 313) and PHYS 344. Corequisite PHYS 432.
Offering Faculty: Faculty of Arts and Science

PHYS 480  Solid State Physics  Units: 3.00
A fundamental treatment of the properties of solids. Topics include: crystal structure, X-ray and neutron scattering, the reciprocal lattice, phonons, electronic energy bands, and the thermal, magnetic, optical and transport properties of solids.
Requirements: Prerequisite PHYS 345 or CHEM 313.
Offering Faculty: Faculty of Arts and Science

PHYS 483  Nanoscience and Nanotechnology  Units: 3.00
An examination of the key ideas, techniques and technologies in the fields of nanoscience and nanotechnology. Emphasis will be placed on the physics involved, measurement techniques, and technological applications. Topics covered are selected from the following: electrical and optical properties of quantum dots, quantum wires and nanotubes; quantum information technology; mesoscopic electronics; nanostructures on surfaces; and scanning-probe and optical microscopy.
Requirements: Prerequisite ([PHYS 345 or CHEM 313] and PHYS 480) or permission of the Department.
Offering Faculty: Faculty of Arts and Science

PHYS 490  Nuclear and Particle Physics  Units: 3.00
A systematic introduction to nuclear and particle physics for advanced physics students. Topics include basic nuclear properties: size, mass, decay and reactions; shell model of nuclear structure; magnetic moments; gamma and beta decay; quark model of elementary particles; and strong, electromagnetic and weak interactions.
Requirements: Prerequisite PHYS 345.
Offering Faculty: Faculty of Arts and Science

PHYS 491  Physics of Nuclear Reactors  Units: 3.00
The objective of this course is the understanding of the fundamental physics associated with a nuclear reactor. Topics include a brief review of basic nuclear physics, neutron interactions and cross-sections, neutron diffusion, neutron moderation, theory of reactors, changes in reactivity, control of reactors. Offered in alternate years.
LEARNING HOURS 120 (36L;12T;72P).
Requirements: Prerequisite Level 3 or above and registration in a (PHYS, ASPH or MAPH Plan).
Offering Faculty: Faculty of Arts and Science

PHYS 495  Introduction to Medical Physics  Units: 3.00
Topics include: the production and measurement of X-rays and charged particles for radiation therapy and nuclear medicine; interactions of radiation with matter and biological materials; interaction coefficients and radiation dosimetry; radiation safety; physics of medical imaging with examples from nuclear medicine, ultrasound and magnetic resonance imaging.
Requirements: Prerequisite Level 3 or above and registration in a (PHYS, ASPH or MAPH Plan).
Offering Faculty: Faculty of Arts and Science

PHYS 590  Research Thesis  Units: 6.00
Investigation of a contemporary research topic in physics or astronomy under the supervision of a faculty member, and leading to a written thesis and an oral presentation of results.
Requirements: Prerequisite Level 4 or above and registration in a (PHYS, ASPH or MAPH Plan).
Offering Faculty: Faculty of Arts and Science

PHYS 594  Independent Study  Units: 3.00
Offering Faculty: Faculty of Arts and Science