Undergraduate Courses:

PHYS 001 Great Ideas in Physics [3-0-0:3]

For non-Physics students only. Important ideas and developments in physics and their impact on our society. Topics include mechanics, thermodynamics and modern physics. A qualitative, non-mathematical approach will be used. *Exclusion:* AL/AS Physics
References: P. G. Hewitt, *Conceptual Physics*
A. Lightman, *Great Ideas in Physics*

PHYS 002 Introduction to Astrophysics and Astronomy [3-0-0:3]

For non-Physics students only. Origin of modern astronomy, gravity, light and telescope, star light and atoms, stars (binary, formation, evolution, death), neutron stars and black holes, normal galaxies, peculiar galaxies, cosmology, the solar system, life on other world. *Exclusion*: PHYS 340
Reference: Michael A. Seeds, *Foundations of Astronomy*, 3rd edition, 1992

PHYS 007 Physical Phenomena in Everyday Life [3-0-0:3]

For non-Physics students only. Why can't we see stars at daytime? Why toast lands jelly-side down? Why doesn't a bicycle fall? These phenomena, which we observe in everyday life, are all governed by the laws of Physics. In this course, we shall explore how the basic laws of physics work in our everyday life with simple examples and demonstrations.
Reference: Robert Ehrlich, *Turning the World Inside Out and 174 Other Simple Physics Demonstrations*

PHYS 103 Basic Physics [3-0-3:4]

Linear and circular motion, work and energy, fluids, heat and temperature, electricity and magnetism, physical optics, the structure of matter. Laboratory emphasizes instrumentation, measurement and interpretation of data. *Exclusions:* AL/AS Physics, PHYS 104
Reference: Douglas C. Giancoli, *Physics Principles with Applications*

PHYS 104 General Physics [3-0-3:4]

Motion, work and energy; fluids; thermodynamics; electricity and magnetism; electromagnetic waves; physical optics; quantum physics. Laboratory emphasizes instrumentation, measurement and interpretation of data. *Exclusion*: PHYS 103 *Prerequisite*: One of AL/AS Physics, AL Engineering Science, AS Mathematics and Statistics, AL/AS Applied Mathematics, or AL Pure Mathematics
Reference: Halliday, Resnick and Walker, *Fundamental Physics*

PHYS 111 Physics I [3-1-2:4]

Force and motion; work and kinetic energy; conservation of energy and linear momentum; rigid body and angular momentum; oscillations and waves; temperature, kinetic theory and thermodynamics. *Exclusion*: PHYS 121 *Prerequisite*: AS/AL Physics, or AL Engineering Science
Reference: Halliday, Resnick and Walker, *Fundamentals of Physics*, 4th extended edition

PHYS 112 Physics II [2-0-3:3]

Fields and potentials; Gauss's, Ampere's and Faraday's laws; inductance; magnetism and matter; Maxwell's equations. *Exclusion*: PHYS 121 *Prerequisite*: PHYS 111
Reference: Halliday, Resnick and Walker, *Fundamentals of Physics*, 4th extended edition

PHYS 121 Fundamentals of Physics [3-1-2:4]

Ideal gas and kinetic theory, heat, entropy, thermodynamics; Coulomb's law, electric fields, Gauss's, electric potential, capacitance, magnetic field, Lorentz force, Ampere's Faraday's and Lenz's laws. *Exclusions*: PHYS 111, PHYS 112 *Prerequisite*: AL Physics/Engineering Science
Reference: Halliday, Resnick and Walker, *Fundamentals of Physics*, 4th extended edition

PHYS 124 Vibrations and Waves [3-0-3:4]

Topics include harmonic oscillations, transverse and longitudinal waves in gas and solid, voltage and current waves on transmission lines and electromagnetic waves in dielectrics and conductors, Fourier methods, non-linear oscillations, and wave mechanics. *Prerequisite:* AL Physics/Engineering Science or PHYS 112

PHYS 126 Introduction to Modern Physics [3-1-0:3]

Introduction to relativity; introduction to quantum theory: particle-wave duality and Schrodinger equation; atoms, molecules; and statistical physics: Maxwell, Bose and Fermi distributions. *Prerequisite*: AL Physics/Engineering Science or PHYS 112/121
Reference: Taylor and Zafiratos, *Modern Physics for Scientists and Engineers*

PHYS 127 Introduction to Modern Physics Laboratory [0-0-3:1]

Laboratory accompanying PHYS 126. *Prerequisite*: AL Physics/Engineering Science or PHYS 112 or PHYS 121

PHYS 140 Black Holes and the Early Universe [3-0-0:3]

An introduction to the exciting discoveries of black holes and the early universe, and through them some basic theories in general relativity, field theory, thermodynamics and cosmology. *Exclusion:* PHYS 340 *Prerequisite:* AL Physics or any 000-level physics course

PHYS 180 Physics Seminar and Tutorial I [0-1-0:1]

For Physics students only. All undergraduate Physics students are required to take PHYS 180, PHYS 280 and PHYS 380 in sequence. About five physics seminars by faculty or invited speakers and small group tutorial under the supervision of a faculty member. Course duration is one year. Graded P or F.

PHYS 211 Experimental Physics [1-0-3:2]

About six experiments selected in the areas of electronics, optics, materials science and computational physics. Focuses on skills and techniques of instrumentation relevant to careers in teaching, engineering and postgraduate research.

PHYS 214 Mathematical Methods in Physics [4-0-0:4]

Physical applications of analytic and numerical methods are studied in such topics as differential equations, Fourier series, Laplace transforms, matrices and vectors.
Reference: Mary L. Boa, *Mathematical Methods in the Physical Sciences*, Second Edition

PHYS 221 Intermediate Classical Mechanics [4-0-0:4]

Newtonian mechanics, including rigid bodies; oscillating systems; gravitation and planetary motion; Lagrange equations; Hamilton's equations; normal modes and small oscillations. *Prerequisite:* PHYS 112 or PHYS 121
Reference: Marion, *Classical Dynamics,* or
Davis, *Classical Mechanics*

PHYS 222 Continuum Physics [4-0-0:4]

Properties of solids and liquids; conservation laws; stress and strain tensors; elastic and viscons response; waves in solids and fluids; ideal fluids, Bernouli's equation; viscous incompressible flow and the Navier-Stokes equations, boundary layers, flow instabilities, introduction to turbulent flow. *Prerequisite:* PHYS 221

PHYS 223 Intermediate Electricity and Magnetism I [4-1-0:4]

A physics core course. Electrostatics: electric charge and fields, multipoles, Laplace equation, dielectrics; magnetostatics: currents, magnetic fields and vector potential, magnetic materials; Maxwell's equations. *Prerequisite:* PHYS 112 or PHYS 121
Reference: David J. Griffiths*, Introduction to Electrodynamics*, Second Edition

PHYS 224 Intermediate Electricity and Magnetism II [3-0-0:3]

Electrodynamics: applications of Maxwell's equations, propagation in various media, radiation, relativistic electrodynamics, transmission lines and wave guides. *Prerequisite:* PHYS 223
Reference: Marion and Heald, *Classical Electromagnetic Radiation*

PHYS 225 Selected Problems in Electricity and Magnetism [1-1-0:1]

This course is intended for students who want to understand deeper the application of electricity and magnetism to more advanced situations. Selected problems in electricity and magnetism will be discussed in detail in this course. *Pre-/Co-requisite:* PHYS 223
Reference: D. J. Griffiths, *Introduction to Electrodynamics, Second Edition*

PHYS 226 Introduction to Relativity and Quantum Mechanics [1-1-0:1]

Space-time approach to special relativity, introduction to general relativity, Schrodinger-Equation and examples. *Pre-/Co-requisite:* PHYS 126

PHYS 234 Elementary Quantum Mechanics I [4-0-0:4]

Basic properties of Schrodinger equation, simple examples, angular momentum and hydrogen atom, electrons, spin and statistics, multi-electron atoms, stationary state and time-dependent perturbation theories, Fermi golden rule, simple applications. *Prerequisite*: PHYS 126
Reference: D.J. Griffiths, *Introduction to Quantum Mechanics*

PHYS 241 Optics [3-0-0:3]

Ray tracing, matrix optics, wave optics, superposition of waves and interference, coherence, Fresnel and Fraunhofer diffraction, polarisation, Fourier optics, holography, phase and group velocity, material dispersion, propagation of Gaussian beams. *Exclusion*: ELEC 308

PHYS 242 Fibre Optics [3-0-0:3]

Electromagnetic wave propagation in waveguide, fabrication of optical fibres, step index fibre, fields, modes, propagation and dispersion in monomode and multimode fibres, couplers and connectors, fibre optics communication system, and fibre optic sensors. *Exclusion*: ELEC 342

PHYS 250 Introduction to Materials Science [3-0-0:3]

An integrated study of the nature and behavior of metals, ceramics and polymers. Topics include crystal structures, phase diagrams, microstructures and microscopy, defects, phases and interfaces in materials systems, phase transformations, deformation, annealing and failure of materials.

PHYS 251 Introduction to Materials Processing [3-1-0:4]

Phase transitions and phase diagrams, crystal growth, vacuum physics and technology, thin film preparation by physical vapor deposition, sputtering and sol-gel. Chemical processing such as chemical vapor deposition, oxidation, wet and plasma etching. Lithography and patterning techniques. *Pre-/Co-requisite:* PHYS 250

PHYS 280 Physics Seminar and Tutorial II [0-1-0:1]

Continuation of PHYS 180. For Physics students only. All undergraduate Physics students are required to take PHYS 180, PHYS 280 and PHYS 380 in sequence. Physics seminars by faculty or invited speakers and small group tutorial under the supervision of a faculty member. Each student must lead one discussion session. Course duration is one year. Graded P or F. *Prerequisite*: PHYS 180

PHYS 311 Advanced Experimental Physics [1-0-6:3]

Four to six diverse experiments selected from optics, spectroscopy, electrical circuits, magnetic resonance, x-rays, solid state, cosmic rays, nuclear physics. Formal reports and oral presentations are required. *Prerequisite:* PHYS 211 or PHYS 223 or PHYS 234

PHYS 321 Thermodynamics and Statistical Physics [4-0-0:4]

Laws of thermodynamics, entropy, thermodynamic relations, free energy; elementary statistical mechanics: Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics; elementary transport theory; applications to physical systems. *Prerequisite*: PHYS 126
Reference: Kittel and Morse, *Thermal Physics*

PHYS 331 Elementary Quantum Mechanics II [4-0-0:4]

Foundations of quantum mechanics, states, operators and observables, Hilbert space, Schrodinger and Heisenberg pictures, symmetry, periodic potentials and crystals, formal perturbation theories, scattering. *Prerequisites*: PHYS 214/MATH 352 (prior to 2000-01), plus PHYS 234
Reference: J.J. Sakurai, *Modern Quantum Mechanics*

PHYS 332 Introductory Solid State Physics [3-0-0:3]

An introduction to modern solid state physics, including lattice structure, lattice vibrations, thermal properties, electron theory of metals and semiconductors, magnetic properties, and superconductivity. *Prerequisite:* PHYS 234
Reference: Kittel, *Introduction to Solid State Physics*, Sixth Edition

PHYS 335 Lasers and Optical Electronics [3-0-0:3]

Propagation of Gaussian beams, optical cavity and cavity modes, blackbody radiation and stimulated emission, laser principles and rate equations, examples of solid state, liquid, gas and semiconductor lasers, laser Q-switching and mode-locking, detection of optical radiation.

PHYS 340 Introduction to Astrophysics [3-0-0:3]

Light spectrum and telescope, the Sun, gravitation and relativity, stellar masses and evolution, interstellar medium, star formation, galaxies, clusters of galaxies, active galaxies and quasars, cosmology, solar system. *Prerequisite*: MATH 151 or PHYS 126
Reference: Marc L. Kutner, *Astronomy, A Physical Perspective*, 1987

PHYS 342 Nuclear and Particle Physics [3-0-0:3]

Nuclear and elementary particles, general symmetries and conservation laws, behavior of high energy particles and radiations, basic properties of detectors, brief introduction to cosmology.
References: H. Frauenfelder and E.M. Henley, *Substomic Physics*
A. Das and T. Ferbel, *Introduction to Nuclear and Particle Physics*
S. Weinberg, *The First Three Minutes*

PHYS 346 Atomic and Molecular Physics [3-0-0:3]

Atomic models, Radiation and matter, Wave equations for simple quantum systems, Perturbation theory and radiative transitions, Quantum theory of one-electron atoms, Many-electron atoms, Molecular structure, Approximation methods for many-electron systems, Atomic and molecular spectroscopy.
Reference: Banwell & McCash, Fundamentals of Molecular Spectroscopy

PHYS 351 Structure and Defects of Materials [4-0-0:4]

Real and reciprocal lattice, atomic structure of crystalline and amorphous solids, dislocations and other crystal defects, determination of structure and defects by x-ray diffraction and transmission electron microscopy. *Exclusion:* PHYS 551 *Prerequisite:* PHYS 250

PHYS 354 Electronic Materials [3-0-0:3]

Physical properties of elemental and compound semiconductors, optoelectronic and display materials, and dielectrics; their preparation techniques such as single crystal and thin film growth, physical and chemical vapor deposition, molecular beam epitaxy, etching, and dopant incorporation; oxidation and metallization as applied to device fabrication and integrated circuit technology. *Prerequisites:* PHYS 250 and PHYS 251

PHYS 361 Materials Characterization [3-0-0:3]

Basic principles and instrumentation of modern materials analysis techniques. Emphasis will be placed on structural and chemical determinations by diffraction techniques, optical and electron spectroscopies, surface analysis techniques, optical and electron microscopies. *Exclusion: PHYS 561 Prerequisites:* PHYS 126 and PHYS 250

PHYS 370 Information Physics [3-0-0:3]

Probability theory, entropy in information theory, relative entropy and mutual information, Second Law of thermodynamics, instantaneous code and Kraft inequality, optimal code and block code, data compression: Huffman code, portfolio management. *Prerequisite:* PHYS 214 or PHYS 321

PHYS 373 Applied Magnetism and Magnetic Materials [3-0-0:3]

Role of magnetic materials in magnetic disk/tape recording systems. Basic physics of magnetism, magnetic measurement techniques, soft and hard magnetic materials and their applications, and advanced topics that are of concern to modern magnetic recording devices. *Exclusion*: PHYS 573 *Prerequisites*: PHYS 223 and PHYS 234

PHYS 380 Physics Seminar and Tutorial III [0-1-0:1]

Continuation of PHYS 280. For Physics students only. All undergraduate Physics students are required to take PHYS 180, PHYS 280 and PHYS 380 in sequence. Attend regular physics colloquia and seminars and small group tutorial under the supervision of a faculty member. Each student must lead one discussion session. Course duration is one year. Graded P or F. *Prerequisite*: PHYS 280

PHYS 381 Computational Physics I [3-0-3:4]

This course introduces the use of computer to solve problems and to simulate physical phenomena. It covers the numerical solution of ordinary differential equations, linear systems, stochastic processes, and Monte Carlo methods. Visualization tools will be used to interpret results of the calculations. *Prerequisite:* COMP 102 *Pre-/Co-requisite:* PHYS 214
Reference: Numerical Recipes*, The Art of Scientific Computing*

PHYS 382 Computational Physics II [3-0-3:4]

A continuation of PHYS 381. It covers the numerical solution of partial differential equations, and the simulation of models which may include traffic flow, earthquake, option pricing, etc. *Prerequisite:* PHYS 381

PHYS 398 Independent Study Project [0-2-6:4]

Undergraduate research conducted under the supervision of a faculty member. A written report is required and one of the following activities is expected: identify a non-textbook problem and suggest approaches to its solution, solve a non-textbook problem, or acquire a specific research skill. Course duration is one-year.