**PHYSICS (PHYS)**

**PHYS 100**  
**Intro to the Profession**  
Introduction to the physical sciences, scientific method, computing tools, and interrelations of physical sciences with chemistry, biology and other professions.  
**Lecture: 2 Lab: 0 Credits: 2**  
**Satisfies:** Communications (C)

**PHYS 120**  
**Astronomy**  
A descriptive survey of observational astronomy, the solar system, stellar evolution, pulsars, black holes, galaxies, quasars, the origin and fate of the universe.  
**Lecture: 3 Lab: 0 Credits: 3**

**PHYS 123**  
**General Physics I: Mechanics**  
**Prerequisite(s):** MATH 151*, An asterisk (*) designates a course which may be taken concurrently.  
**Lecture: 3 Lab: 3 Credits: 4**  
**Satisfies:** Natural Science (N)

**PHYS 200**  
**Introduction to Energy, Waves, Materials, and Forces**  
This course will address the basic physical principles and concepts associated with energy, power, heat, light, sound, circuits, materials, fluids, and forces. Although quantitative at times, the course will stress conceptual understanding and practical applications.  
**Lecture: 4 Lab: 0 Credits: 4**  
**Satisfies:** Natural Science (N)

**PHYS 221**  
**General Physics II: Electricity and Magnetism**  
**Prerequisite(s):** (MATH 149 or MATH 151) and MATH 152*, An asterisk (*) designates a course which may be taken concurrently.  
**Lecture: 3 Lab: 3 Credits: 4**  
**Satisfies:** Communications (C)

**PHYS 223**  
**General Physics III**  
**Prerequisite(s):** PHYS 221  
**Lecture: 3 Lab: 3 Credits: 4**

**PHYS 224**  
**General Physics III for Engineers**  
**Prerequisite(s):** PHYS 123 and MATH 152 and PHYS 221  
**Lecture: 3 Lab: 0 Credits: 3**

**PHYS 240**  
**Computational Science**  
This course provides an overview of introductory general physics in a computer laboratory setting. Euler-Newton method for solving differential equations, the trapezoidal rule for numerical quadrature and simple applications of random number generators. Computational projects include the study of periodic and chaotic motion, the motion of falling bodies and projectiles with air resistance, conservation of energy in mechanical and electrical systems, satellite motion, using random numbers to simulate radioactive decay, the Monte Carlo method, and classical physical models for the hydrogen molecule and the helium atom.  
**Prerequisite(s):** PHYS 221  
**Lecture: 2 Lab: 3 Credits: 3**  
**Satisfies:** Communications (C)

**PHYS 300**  
**Instrumentation Laboratory**  
Basic electronic skills for scientific research. Electrical measurements, basic circuit analysis, diode and transistor circuits. Transistor and integrated amplifiers, filters, and power circuits. Basics of digital circuits, including Boolean algebra and design of logic circuits.  
**Prerequisite(s):** PHYS 221  
**Lecture: 2 Lab: 4 Credits: 4**  
**Satisfies:** Communications (C)

**PHYS 301**  
**Mathematical Methods of Physics**  
**Prerequisite(s):** MATH 252 and MATH 251  
**Lecture: 3 Lab: 0 Credits: 3**

**PHYS 304**  
**Thermodynamics and Statistical Physics**  
Statistical basis of thermodynamics, including kinetic theory, fundamentals of statistical mechanics, fluctuations and noise, transport phenomena and the Boltzmann equation. Thermodynamic functions and their applications, first and second laws of thermodynamics.  
**Prerequisite(s):** PHYS 223 or PHYS 224  
**Lecture: 3 Lab: 0 Credits: 3**
PHYS 308
Classical Mechanics I
Prerequisite(s): MATH 252 and (PHYS 223 or PHYS 224)
Lecture: 3 Lab: 0 Credits: 3

PHYS 309
Classical Mechanics II
Prerequisite(s): MATH 252 and (PHYS 223 or PHYS 224) and PHYS 308
Lecture: 3 Lab: 0 Credits: 3

PHYS 348
Modern Physics for Scientists and Engineers
An introduction to modern physics with the emphasis on the basic concepts that can be treated with elementary mathematics. Subjects covered include Bohr atom, elementary wave mechanics and an introduction to quantum mechanics, atom and molecular spectra, nuclear, and particle physics.
Prerequisite(s): PHYS 223
Lecture: 3 Lab: 0 Credits: 3

PHYS 360
Introduction to Astrophysics
This course provides an overview of astrophysics and introduces the student to the many conventions, units, coordinate systems, and nomenclature used in astrophysics. The course will survey observational, stellar, and extragalactic astrophysics as well as cosmology. The course will also include planetary astronomy including extrasolar planets.
Prerequisite(s): PHYS 221 and (CHEM 122 or CHEM 124)
Lecture: 3 Lab: 0 Credits: 3
Satisfies: Natural Science (N)

PHYS 361
Observational Astrophysics
This lecture/lab class covers the basics of multiwavelength observational astrophysics. Topics covered include statistical analysis techniques, multi-wavelength telescope design, instrument design (including CCDs, spectrographs and PMTs), and best practices applicable in different observational bands.
Prerequisite(s): PHYS 221 and PHYS 360 and (CHEM 122 or CHEM 124)
Lecture: 3 Lab: 1 Credits: 4
Satisfies: Natural Science (N)

PHYS 403
Relativity
Introduction to the special and general theories of relativity. Lorentz covariance. Minkowski space. Maxwell's equations. Relativistic mechanics. General coordinate covariance, differential geometry, Riemann tensor, the gravitational field equations. Schwarzschild solution, astronomical and experimental tests, relativistic cosmological models.
Prerequisite(s): PHYS 308 and MATH 251
Lecture: 3 Lab: 0 Credits: 3

PHYS 404
Subatomic Physics
Historical introduction; general survey of nuclear and elementary particle physics; symmetries and conservation laws; leptons, quarks, and vector bosons; unified electromagnetic and weak interactions; the parton model and quantum chromodynamics.
Prerequisite(s): PHYS 348
Lecture: 3 Lab: 0 Credits: 3

PHYS 405
Fundamentals of Quantum Theory I
A review of modern physics including topics such as blackbody radiation, the photoelectric effect, the Compton effect, the Bohr model of the hydrogen atom, the correspondence principle, and the DeBroglie hypothesis. Topics in one-dimensional quantum mechanics such as the particle in an infinite potential well, reflection and transmission from potential wells, barriers, and steps, the finite potential well and the quantum harmonic oscillator. General topics such as raising and lowering operators, Hermitian operators, commutator brackets and the Heisenberg Uncertainty Principle are also covered. Many particle systems and the Pauli Exclusion Principle are discussed. Three-dimensional quantum mechanical systems, orbital angular momentum, the hydrogen atom.
Prerequisite(s): PHYS 348 and MATH 252
Lecture: 3 Lab: 0 Credits: 3

PHYS 406
Fundamentals of Quantum Theory II
Zeeman and Stark Effects. Addition of spin and orbital angular momenta, the matrix representation of quantum mechanical operators, the physics of spin precession and nuclear magnetic resonance. Time independent and time dependent perturbation theory, Fermi's Golden Rule and the physics of radiation emitted in the course of atomic transitions. Indistinguishable particles in quantum mechanics, the helium atom. Scattering theory, using partial wave analysis and the Born approximation.
Prerequisite(s): PHYS 405
Lecture: 3 Lab: 0 Credits: 3

PHYS 410
Molecular Biophysics
The course covers thermodynamic properties of biological molecules, irreversible and open systems, information theory, biophysical measurements, the structure and properties of proteins, enzyme action, the structure and properties of nucleic acids, genetics at the molecular level, and molecular aspects of important biological systems.
Prerequisite(s): CHEM 343 or PHYS 348
Lecture: 3 Lab: 0 Credits: 3
PHYS 412
Modern Optics and Lasers
Prerequisite(s): PHYS 348 and CS 105
Lecture: 3 Lab: 0 Credits: 3

PHYS 413
Electromagnetism I
Differentiation and integration of vector fields, and electrostatics and magnetostatics. Calculation of capacitance, resistance, and inductance in various geometries.
Prerequisite(s): PHYS 221 and MATH 252
Lecture: 3 Lab: 0 Credits: 3

PHYS 414
Electromagnetism II
Prerequisite(s): PHYS 413
Lecture: 3 Lab: 0 Credits: 3

PHYS 415
Solid State Electronics
Energy bands and carrier transport in semi-conductors and metals. Physical principles of p-n junction devices, bipolar junction transistors, FETS, Gunn diodes, IMPATT devices, light-emitting diodes, semiconductor lasers.
Prerequisite(s): PHYS 348
Lecture: 3 Lab: 0 Credits: 3

PHYS 418
Introduction to Lasers
Prerequisite(s): PHYS 348
Lecture: 3 Lab: 0 Credits: 3

PHYS 420
Bio-Nanotechnology
In this multidisciplinary course, we will examine the basic science behind nanotechnology and how it has infused itself into areas of nanofabrication, biomaterials, and molecular medicine. This course will cover materials considered basic building blocks of nanodevices such as organic molecules, carbon nanotubes, and quantum dots. Top-down and bottom-up assembly processes such as thin film patterning through advanced lithography methods, self-assembly of molecular structures, and biological systems will be discussed. Students will also learn how bionanotechnology applies to modern medicine, including diagnostics and imaging and nanoscale, as well as targeted, nanotherapy and finally nanosurgery.
Prerequisite(s): PHYS 348
Lecture: 3 Lab: 0 Credits: 3

PHYS 425
High Energy Astrophysics
High-energy astrophysics covers interactions in the most extreme physical conditions across the cosmos. Included in this course are the physics of black holes, neutron stars, large scale jets, accretion, shocks, and particle acceleration. Emission mechanisms resulting from relativistic particle acceleration are covered including synchrotron radiation and Bremsstrahlung and Compton processes. Recent observations of X-ray to TeV gamma-ray energies have contributed significantly to understanding these phenomena and will be highlighted.
Prerequisite(s): PHYS 348 and MATH 251 and MATH 252
Lecture: 3 Lab: 0 Credits: 3

PHYS 427
Advanced Physics Laboratory I
Experiments related to our present understanding of the physical world. Emphasis is on quantum phenomena in atomic, molecular, and condensed matter physics, along with the techniques of measurement and data analysis. The second semester stresses project-oriented experiments on modern topics including spectroscopy, condensed matter physics, and nuclear physics.
Prerequisite(s): PHYS 348
Lecture: 3 Lab: 2 Credits: 3
Satisfies: Communications (C)

PHYS 428
Advanced Physics Laboratory II
Experiments related to our present understanding of the physical world. Emphasis is on quantum phenomena in atomic, molecular, and condensed matter physics, along with the techniques of measurement and data analysis. The second semester stresses project-oriented experiments on modern topics including spectroscopy, condensed matter physics and nuclear physics.
Prerequisite(s): PHYS 348
Lecture: 2 Lab: 3 Credits: 3
Satisfies: Communications (C)

PHYS 437
Solid State Physics
Crystal structure and binding, lattice vibrations, phonons, free electron model, band theory of electrons. Electrical, thermal, optical, and magnetic properties of solids. Superconductivity.
Prerequisite(s): PHYS 348
Lecture: 3 Lab: 0 Credits: 3
PHYS 440  
Computational Physics  
Root finding using the Newton-Raphson method; interpolation using Cubic Splines and Least Square Fitting; solving ordinary differential equations using Runge-Kutta and partial differential equations using Finite Difference and Finite Element techniques; numerical quadrature using Simpson's Rule, Gaussian Quadrature and the Monte Carlo method; and spectral analysis using Fast Fourier Transforms. These techniques are applied to a wide range of physics problems such as finding the energy levels of a finite quantum well using a root finding technique, solving the Schrodinger equation using the Runge-Kutta-Fehlberg method, using random numbers to simulate stochastic processes such as a random walk, using the Fast Fourier Transform method to perform a spectral analysis on non-linear chaotic systems such as the Duffing oscillator, and using auto-correlation functions to simulate sonar or radar ranging problems.  
Prerequisite(s): PHYS 240 and PHYS 348  
Lecture: 1 Lab: 4 Credits: 3  
Satisfies: Communications (C)

PHYS 460  
Stellar Astrophysics  
This course will cover the formation, structure, and evolution of stars. Stellar remnants (white dwarfs, neutron stars, and black holes) will also be covered. Aspects of the interstellar medium relevant to star formation will be covered as well.  
Prerequisite(s): PHYS 360  
Lecture: 3 Lab: 0 Credits: 3

PHYS 461  
Extragalactic Astrophysics  
This course will cover galaxy morphology, dynamics, and structure. This course will also cover cosmology including dark matter, dark energy, and fate of the universe.  
Prerequisite(s): PHYS 360  
Lecture: 3 Lab: 0 Credits: 3

PHYS 465  
Electrical, Magnetic, and Optical Properties  
Lecture: 3 Lab: 0 Credits: 3

PHYS 485  
Physics Colloquium  
Lectures by prominent scientists. This course exposes students to current and active research in physics both within and outside the IIT community. It helps prepare students for a career in research. It is complementary to our academic courses and provides examples of professional/scientific presentations. This course may not be used to satisfy the natural science general education requirement.  
Prerequisite(s): PHYS 223 or PHYS 224  
Lecture: 1 Lab: 0 Credits: 1