7. SYNOPSIS OF PHYSICS COURSES OFFERED IN THE DEPARTMENT OF PURE AND APPLIED PHYSICS

PHY 101: General Physics I (2-1-0) 3 Units
Fundamental principles of mechanics. Mechanical properties of matter including elasticity, surface tension and viscosity. Mechanical Waves. Thermal Physics: thermal properties including elementary thermodynamics and kinetic theory.

PHY 102: General Physics II (2-1-0) 3 Units
Fundamental laws of electricity and magnetism and their applications. Electron Physics: Introduction to Physics of electronics and some applications. Optics: Principles and applications of geometrical and physical optics.

PHY 105: Physics For Biological Sciences I (2-1-0) 3 Units
Treatment of elementary principles of physics as in PHY 101, but with applications and examples chosen from the life sciences.

PHY 106: Physics For Biological Sciences II (2-1-0) 3 Units
Treatment of elementary principles of physics as in PHY 102 but including elementary modern physics and with examples and applications chosen from the life sciences.

PHY 191/192: General Physics Laboratory I/II (0-0-1) 1Unit Each
These introductory courses are expected to emphasize quantitative measurements, treatment of measurements errors and graphical analysis. A variety of experimental techniques will be employed. The experiments would be designed in such a way that they complement. PHY 101/102; PHY 105/106.

PHY 201: Classical Mechanics (2-0-0) 2 Units
Vectors, Particle: Kinematics, Newtonian mechanics: statics and dynamics, Invariance of Newton's laws (Galilean Relativity); Work. Energy, momentum, angular momentum, conservation laws; Mechanics of systems of particles and rigid bodies; collisions of particles; central forces; theory of gravitation; Fluid mechanics; Special relativity: postulates; Michelson-Morley experiment; Lorentz transformation

PHY 203: Vibrations and Waves (2-0-0) 2 Units
The harmonic oscillator; Aquatic waves, waves on string; Superposition, energy in wave motion; progressive and standing waves, longitudinal and transverse waves; group and phase velocity. Doppler effect; Physical Optics: interference, diffraction, thin films crystal diffraction, holography, dispersion and scattering. Geometrical optics: rays, reflection and refraction at a spherical surface; thin lenses, optical lenses, mirror and prisms. Ultrasound

PHY 204: Modern Physics (2-0-0) 2 Units
The origin of quantum theory – Blackbody radiation, Wien's law, the Rayleigh-Jeans theory, Planck's theory; Electrons and quanta – Cathode rays; the specific charge of electrons, the

charge and mass of electrons. Particle behaviour of electromagnetic radiation: photoelectric effect, x-rays, Compton effect, pair production and annihilation.
The atomic nucleus: Thomson's model; Rutherford's model; the size of the nucleus. Wave behaviour of matter: De Broglie hypothesis; electron diffraction; wave-particle duality. The uncertainty principle of Heisenberg; Bohr's theory of atomic structure: atomic spectra, Wilson-Sommerfeld quantization rules; Sommerfeld's relativistic theory; the correspondence principle. Problems of the old quantum theory – Schrodinger wave equation and simple applications.

PHY 208: Electric Circuits (2-0-0) 2 Units
Elements of circuit theory: Linear circuit elements; network theorems; transient response of linear circuits. Alternating Current circuit theory, electrical resonance; coupled circuits; transformers; A.C. bridges. Electrical instruments

PHY 210: Computational Physics (2-0-1) 3 Units
Use of numerical methods in physics; Various methods of numerical differentiation and integration. Numerical solutions of some differential equations of interest in Physics, Engineering and Finance.

PHY 211: Thermal Physics (2-0-0) 2 Units
Heat Expansion; Heat energy: Heat Capacity and Latent Heat; Heat transfer: conduction, convention, radiation, Zeroth Law of thermodynamics and temperature definition; the first law: work, heat internal energy. Carnot cycles and the second law: entropy and irreversibility; Thermodynamic potential. Qualitative discussion of phase transitions; Elementary kinetic theory of gases; Boltzmann counting, Maxwell-Boltzmann law of distribution of velocities; Simple applications.

PHY 212: Introductory Material Science (2-0-0) 2 Units
Atomic and molecular structure, crystals metallic states, defects in crystals, conductors, semi-conductors and insulators. Alloy theory: application to industrial alloys-steel in particular. Engineering properties: their control. Hot and cold working heat treatment, etc. Creep fatigue and fracture. Corrosion and corrosion control. Non-metallic materials: glass, rubber, concrete, plastics, wood and ceramics. Elastic and plastic deformation; Defects in metals.

PHY 214: Introduction to Electronics (2-0-0) 2 Units
Physics of active devices: Brief treatment of vacuum tubes. Thermoionic emission e.g., valves and C.R.T., Semiconductors: energy bands, electrons and holes; Junction and Zener diodes, Rectification, Transistors: Bipolar, FET, MOSFET and its static characteristics, Small signal models and parameters, Basic voltage amplifiers, Logic elements and circuits.

PHY 291/292: Experimental Physics I/II (0-0-1) 1 Unit Each
Laboratory experiments which illustrate principles of experimentation and experimental techniques. About 15 carefully selected experiments from all areas of physics including Modern Physics to teach basic experimental techniques. In addition, analysis and eventual demonstration of famous experiments should supplement the students' practical laboratory work.

PHY 293: Workshop Practice (0-0-1) 1 Unit
General Precautions, Engineering drawing, AUTOCAD designs, Woodworks, Metal works/Welding, PCB fabrication.

PHY 301: Analytical Mechanics I (2-0-0) 2 Units
Newtonian mechanics; motion of a particle in one, two and three dimensions, oscillations, forced and damped, resonance; conservation forces and potentials; central force problems. Conservation laws; Collision of particles; moving frames of reference; elementary mechanics of rigid bodies.

PHY 303: Electromagnetic Waves (2-1-0) 3 Units
Electrostatistics and magnetostatics. Laplace's equation and boundary value problems. Multiple expansions; dielectric and magnetic materials, Faraday's Law, A.C. circuits, Maxwell's equations; Lorentz covariance and special relativity.

PHY 305: Statistical Physics (2-1-0) 3 Units
Basic concepts and principles of statistical mechanics. Thermodynamic basis of the thermodynamics and applications of Microsystems. Maxwell-Boltzmann, Bose-Einstein, and Fermi – Dirac statistics; Application to gases, condensed states, phase transformation; Elementary kinetic theory of transport processes and fluctuation.

PHY 309: Electronics (2-0-1) 3 Units
Power supplies, stabilized power supplies and voltage regulation circuits, network analysis, junction transistor, common emitter, feedback and operational amplifier, filters, oscillators, transducers, power feedback instrumentation amplifiers, differential amplifiers circuits.
Transistor as voltage switch, basic switching, circuits, Monostable and Bistable multivibration circuits, binary divider (Eccles-Jordan circuit), Schmitt trigger, Astable multivibrator, current switching FET as a gate, choppers, phase sensitive detection, Noise and Interference in systems. (Note: *1 Unit stands for 3 hours Practical)*

PHY 311: Introductory Reactor Physics (2-0-0) 2 Units
Separation of Isotopes, cross-section of interaction of neutrons, thermal diffusion length, Neutron diffusion theory, homogenous reactors, Fermi Age equation; Types of reactors and their start-up and operations; Effects of radiation on living cells, somatic and genetic damage; Uses of radiation: radiation protection, principles and methods. Personnel monitoring using TLD and film.

PHY 315: Optics (2-0-0) 2 Units
Geometrical Optics: Fermat's principles and applications. Geometric theory of optical systems, Thick lens and lens systems, Aberrations; fibre optics; the wave theory of light; Principle of superposition, Coherent and incoherent disturbances; Group velocity, Huygen's principle
Interference: Interference of two beams by division of wavefront and division of amplitude; Young's experiment, Fresnel's biprism, refractometers utilizing interference phenomena. Interferometers: Michelson, Fabry-Perot.
Diffraction: Fraunhoffer diffraction by single slit, double slit, multiple slit, gratings. Resolving power of various optical systems; Fresnel diffraction; Fresnel integrals and Cornu's spiral; diffraction by apertures and obstacles; zone plates,

Polarization: Analytical description of polarization of electromagnetic waves; production and detection of polarized light. Double refraction in crystals, Nicol prism, retardation plates Babinet compensator. Optical activity and other optical properties of matter; Non-linear phenomena Lasers; holography.

PHY 317: Quantum Mechanics I (2-1-0) 3 Units

Review of Schrodinger wave mechanics and applications. Formulation of quantum mechanics using state vectors, linear operators and matrices. Postulates of quantum mechanics; Quantum theory of measurement; uncertainty principle; commutation relations Angular momentum operator; spin. Central force problems; Applications including one-electron atoms and rigid rotator; Many-particle systems; Distinguishable and identical particles, symmetrisation; Pauli exclusion principle. Spin and statistics; Applications.

PHY 319: Energy Studies (1-0-0) 1 Unit

Energy resources and use; historical survey, use patterns, relative abundance (price and technology as factors). Review of analytical tools. Thermodynamics and chemical reaction kinetics. Combustion of fossils fuels for heat; solid liquid and gaseous fuels. Conversion of heat to power; combined cycles, hydrodynamics, fuel cell. Coals; conversion to environmentally acceptable fuel (Liquefaction and gasification). Solar energy; the biosphere and each energetics. Solar collectors storage and conversion of solar energy. Nuclear energy, nuclear energetics, nuclear reactions, fission, and reactors; Safety, nuclear fusion, Environmental considerations; Air pollution; thermal pollution; Economic, political and social problems; Energy conservation, future energy sources.

PHY 321: Physics of Lower Atmosphere (2-0-0) 2 Units

Geopotential, hydrostatic equation, static stability, distribution of temperature and water vapour, cloud growth, precipitation, electrical charge generation and dissipation, global wind system, geotropic and thermal winds, solar and terrestrial radiation, principles of radiative transfer, vertical fluxes of heat, water supply vapour, methods of atmospheric probing, remote sensing.

PHY 391 Experimental Physics III (0-0-1) 1 Unit Each

Laboratory experiments essential to the development of contemporary physics and illustrating modern experimental techniques including spectroscopy, nuclear radiation techniques and advanced electronic circuits

PHY 398: SIWES (0-0-6) 6 Units

Each Student is attached to some industrial organizations for 6 Months during the rain semester and the long vacations, at the end of which a detailed report will be submitted for grading in the department. Supervision will be jointly done by an academic staff of the department and a supervisor at the organisations.

PHY 399: Physics Seminar (0-0-2) 2 Units

Literature search, presentation of seminar on comprehensive literature reviews of selected topics of research interest.

PHY 401: Quantum Mechanics II (2-1-0) 3 Units

Approximation Methods: Time-independent perturbation theory; applications including Zeeman and Stark effects. Variation methods, WKB method, Methods for Time-dependent problems; magnetic resonance; absorption and emission of radiation; Scattering Theory: Scattering in one dimension and in three dimensions. Bohr approximation; Partial wave analysis; Coulomb scattering; Scattering of identical particles.

PHY 403: Mathematical Physics I (2-1-0) 3 Units

Linear Algebra; Transformation in linear vector spaces and matrix theory; Functional analysis; Halberd space, complete sets of orthogonal functions; linear operations; Special functions; Gamma, hypergeometric, legendre, Bessel, Hermite and Laguerre functions. The Dirac delta function. Integral transforms and Fourier series; Fourier series and Fourier transforms. Application of transform methods to the solution of elementary differential equations in physics and engineering.

PHY 404: Mathematical Physics II (2-1-0) 3 Units

Partial differential equations; solutions of boundary value problems of P.D.E. by various methods (Separation of variables, method of inter-transforms); Sturm-Liouville theory, uniqueness of solutions; Calculus of residues and applications to evaluation of integrals and the summation of series: Kernels; Neumann and Fredholm equations; Applications to various physical situations which may include electromagnetic theory, quantum theory and diffusion-phenomena.

PHY 405: Solid State Physics I (2-0-0) 2 Units

Crystal structure and binding; Elastic properties; lattice vibrations; thermal properties; Electrical properties; conductivity; band theory and application to metals, semiconductors and insulators. Superconductivity; Dielectric properties; Magnetic properties; Magnetic resonance; Imperfections in solids; Superconductivity and superfluidity.

PHY 406: Solid State Physics II (3-0-0) 3 Units

Treatment of a selection of topical areas of condensed matter physics; the following areas are included: crystalline state: Theories and methods of crystal growth. Cohesive energy of crystals; Rigorous treatment of lattice vibrations; Many-electron problems in crystals; Electron lattice interactions; Superconductivity; Theory of recent developments especially high temperature superconductors; Electronic phenomena in nearly perfect crystals. Transport phenomena in solids.

Magnetism: Paramagnetism of incomplete shells; paramagnetic dispersion, absorption and resonance; nuclear magnetism. Topics in ferromagnetism; Topics in crystal lattice defects; the liquid state.

PHY 407: Nuclear Physics I (2-0-0) 2 Units

Nuclear structure; nuclear size, shapes and masses. Nuclear forces: Characteristic features; binding and separation energies; charge symmetry and independence of nuclear forces. Nuclear models: Liquid-drop model; shell model. Radioactive decay: Alpha, Beta, Gamma decays; decay law.

PHY 408: Nuclear Physics II (2-0-0) 2 Units
Interaction of radiation with matter; nuclear reactions; Radiation detection techniques; nuclear instrumentation; Neutron physics: Production and detection of neutrons; neutron activation. Fission: fission reactors. Fusion: fusion reactors. Elementary particles: conservation laws and symmetry; sub-atomic particle classification; particle interactions; particle properties measurement, e.g., quarks, gluons, etc. Resonances.

PHY 409: Solid Earth Physics I (2-0-0) 2 Units
Introduction to potential field theory, Gravimetry, reduction and interpretation of gravity data; Seismology including elastic waves in unbounded media, seismology and the planetary interior; analysis of seismic records and interpretation; seismic and heat flows

PHY 410: Solid Earth Physics II (2-0-0) 2 Units
Electrical conduction and electromagnetic induction methods; Geomagnetism and geo-thermometry; radioactivity and geochronology, geothermics and planetary heat budget, geodesy and global gravity, palaeomagnetism, techtonophysics, palaogeophysics and geodynamics, methods of geophysical survey: Radiometric survey and remote sensing.

PHY 411: Imperfections in Crystalline Solids (2-0-0) 2 Units
Electronic defects; vacancies and interstitials; non-stoichiometry; Experimental techniques on point defect formation and migration; Dislocation mechanics including stress field and stress-energy; extended dislocations; interfacial and bulk defects. Interaction between the various defects. Selected applications to physical behaviour of solids.

PHY 412: Crystallography and Electron Microscopy (2-0-0) 2 Units
Production of X-ray, lattices, crystal systems, planes and directions, symmetry and point groups, stereographic projection. Bragg's law and diffraction methods, structure factor, Laue and powder methods, optical microscope and its limitations, electron microscope in transmission and scanning modes, analytical and high transmission voltage electron microscopy.

PHY 413: Relativistic Physics (3-0-0) 3 Units
Review of historical and experimental background Relativistic mechanics: Postulates of special relativity; Lorentz transformation and kinematic consequences. Successive Lorentz transformation; Graphical representation; four dimensional formulations: Four vector; energy momentum four vectors; Minkowski force; Collision of particles. Invariants, applications; Relativistic electrodynamics; covariant formulation of the Maxwell-Lorentz equations; Gauge in variance; Transformation laws for electromagnetic fields; The stress-energy; tensor conservation laws.

PHY 415: General Relativity (2-0-0) 2 Units
Matrix tensor; covariant differentiation; Christoffel symbols Curvature tensor Gravitational fields: Principles of covariance and equivalence; constant or stationary fields Particle motion in a gravitational field Equations of electrodynamics in a gravitational field. Gravitational field equation: Einstein's equations. Cosmological problems.

PHY 417: Analytical Mechanics II (2-0-0) 2 Units
Newtonian mechanics of systems of particles. D'Alembert's principles; degree of freedom, generalized coordinates and Legrange's Formulation of mechanics; simple applications. The calculus of variations and the action principle. Hamiltonian mechanics. Invariance and conservation laws. Small oscillations and normal modes.

PHY 421: Modelling Complex Systems (2-1-0) 3 Units
Covers the theory of computational modelling techniques used by Physicists, chemists and material scientists to study large systems.

PHY 422: Simulation of Dynamic Systems (2-0-1) 3 Units
Introduces the basic principles of modelling real world systems in Engineering, Science and Commerce.

PHY 423: Modelling Fields, Flows & Structures (2-1-0) 3 Units
Provides an overview of methods used for the solution of differential and integral equation problems in modelling fields, flows, and structure in Physics and Engineering.

PHY 424: Modelling of Molecules, Solids & Liquids (2-0-1) 3 Units
The course focuses on the modelling of high temperature superconductors, crystalline materials and simple as well as non-simple liquids using Monte Carlo and Molecular Dynamics simulation, other topics in computer simulation of Physical systems.

PHY 431: Ionospheric Physics (2-0-0) 2 Units
Composition and height distribution of the neutral atmosphere, formation of the ionosphere, regular characteristics, irregularities, radio wave propagation in homogeneous ionised gas, measurements, geomagnetism and the ionosphere.

PHY 432: Introduction to Solar Energy Physics (2-0-0) 2 Units
Solar interior, solar constant, calculation and measurement, solar radiation intensity reaching the earth's surface under clear sky condition and under cloud and aerosol covers, solar energy harnessing, natural solar conversion systems, methods of solar collection and thermal and electrical conversion systems, economics of solar conversion systems.

PHY 433: Communications Physics (2-0-0) 2 Units
Analysis of linear systems, analysis in frequency and time domains, Fourier and Laplace transforms, delta and step functions, amplitude modulation, power spectrum, D.S.B., S.S.B. phase and frequency modulations, demodulation, stereo broadcasting, multiplexing of signals, in TDM and FDM, digital modulation, noise, noise sources in electronic systems, power spectrum and measurements, t and π networks, Radar.

PHY 434: Geomagnetism (2-0-0) 2 Units
Development of geomagnetism, the earth's main magnetic fields, the central and eccentric dipoles, harmonic analysis, geomagnetic field variations – secular, solar and lunar, the equatorial electrojet, magnetic disturbances and storms, solar wind.

PHY 436: Introduction to Astrophysics (2-0-0) 2 Units

An introduction to the physics of stars, galaxies and the universe based on observational data on stellar electromagnetic radiation, Stellar parameters: mass, radius luminosity. Stellar systems and classification, Stellar interior and models, Energy generation and transport, Stellar pulsation: inter-stellar space, Stellar evolution, Galaxies: intergalactic space, Introduction to Solar physics: solar atmosphere, solar activity and radiation, The solar system: Planets, moons, comets, and meteors, Cosmology.

PHY 451: Radiation Effects and Protection (2-0-0) 2 Units

A review of the interaction of radiation with matter. Radiation effects in chemical and biological systems biological response. Radiation dosimetry, theory and practice. Principles of radiation protection; shielding of nuclear installations; shield design and safety standards. Radioactive waste management and radiological emergencies.

PHY 452: Biophysics (2-0-0) 2 Units

Forces and equilibrium, muscle force, heat transfer, energy from metabolism, athletic performance, fluid statics, elastic blood vessels, the circulatory system, ballistocardiography, electrocardiography, feedback and control, body temperature, nerve cells, the Hodgkin-Huxle equations, sound, anatomy of the ear, theories of hearing, physiological optics, visual acuity.

PHY 461: Digital Electronics (2-0-1) 3 Units

The transistor as a switch, power dissipation, base over drive storage drive and switching speed, logic gates: AND, OR, NAND,NOR,EX-OR,X-NOR. Truth tables, noise margin, totem pole, open collector and tristate outputs, TTL, CMOS, NMOS, ECL. Combinational systems, Boolean algebra, identities, De-Morgan's law, Karnaugh maps, Quinne McChusky Minimization by computer aided techniques. The half and full adder, Flip-flop: R-S, J-K and D types. Edge and level trigger, master- slave types, the shift register. Circuit techniques, Oscillators: sine wave amplitude control, sequencing, frequency stability, waveform discrimination. Practical ramp generators Conversion techniques, frequency to voltage, staircase generation, analogue to digital, Digital to Analogue Termination of pulsed lines, Beageron diagram. Low noise amplifier design, Use to discrete components for minimum noise (Note: *1 Unit stands for 3 hours Practical).*

PHY 462: Semiconductor & IC Technology (2-0-1) 3 Units

The chemical physics of semiconductors, preparation, purification, growth of simple crystals evaluation of chemical structural properties, doping effects, mechanical and metallurgical properties. Thermodynamic and kinetic consideration in crystal growth from met and by chemical vapour transport techniques. Scanning and transmission electron microscopy, X-ray Photograph, photo luminescence and mass spectroscopy, Si, Ge, GaAs, GaP, InSo and other common compound semiconductors, their preparation and measurements of electrical properties. Processing of semiconductors material for device fabrication. Formation of p.n junction luminescence and luminescent materials, Photoemissive and photoconductive materials. Materials for IC's and their fabrication (Note: *1 Units stands for 3 hours Practical)*

PHY 499: Research Project (0-0-6) 6 Units

An independent thesis project selected on the basis of student interest will be carried out under the supervision of Staff. Each student shall give a seminar and produce a written report of the selected project.