Major in Physics

The third year Physics syllabus consists of four theory subjects, one research-based project work and two practical subjects. Apart from that there are two Flexi papers in each semester.

Blended BSc (Physics) in Physics is a three-year undergraduate program comprising of theory and experimental courses mainly from Physics and few interdisciplinary courses from Mathematics Chemistry and Biology.

The program emphasises on the fundamentals of Physics while introducing modern concepts such as Quantum Mechanics and Relativity proceeding over to Classical Mechanics Electrodynamics taking forward the courses like Electricity and Magnetism, Solid State Physics, Digital and analog electronics etc., Statistical Mechanics and Thermodynamics are also essential part of the program to give a good comprehensive picture of classical and modern Physics.

The goal of the programme is to build a strong foundation in classical and modern physics. Through the course curriculum also provide opportunities to conduct individual research as mandatory research project, the students get holistic all-round development. They will also gain expertise in performing experiments through ample hands on practical sessions. This will help them to understand application part of the theory of many concepts.

This undergraduate Physics Major Blended B Sc degree programme Provides a solid ground for students to further acquire mastery in physics concentration areas. This program helps students explore and experiment new and established theories and possess quantitative reasoning and problem-solving skills.

The programme trains graduate to establish entry-level careers in the government and private sectors. The program also prepares the students to qualify in the entrance exams (JAM, JEST) for Master’s program in renowned institutes like IITs, IISERs, IUCAA, TIFR and IISc.

Proposed Curriculum Structure for the B. Sc. (Blended) Course (Semesters V-VI)

1 Credit = 15 Contact hour per week both for theory and lab courses

Semester V

Semester V		
Subject Code	**Title of the Subject**	**Credits**
PHY501	Classical Mechanics	3
PHY502	Quantum Mechanics	3
PHY503	Solid State Physics	3
PHY504	Electrodynamics	3
PHY505	Elective I	2
PHY506	Elective II	2
PHY507	Physics Lab I	2
PHY-508	Physics Lab II(analog and digital)	2
PHY-509	Project work	2
Total Credits		**24**

Semester V- Elective Paper		
Subject Code	**Title of the Subject**	**Credits**
PHY-505	Elective I- Introductory Astrophysics	2
PHY-506	Elective II- Nanotechnology	2

Semester VI

Semester VI		
Subject Code	**Title of the Subject**	**Credits**
PHY601	Statistical Mechanics	3
PHY602	Subatomic Physics	3

PHY603	Atomic and Molecular Spectroscopy and Lasers	3
PHY604	Digital and analog electronics	3
PHY605	Elective III	2
PHY606	Elective IV	2
PHY607	Physics Lab I	2
PHY608	Physics Lab II (analog and digital)	2
PHY609	Project work	2
Total Credits		**24**

Semester VI- Elective Paper		
Subject Code	**Title of the Subject**	**Credits**
PHY-605	Elective III- Introductory Biophysics	2
PHY-606	Elective IV- Renewable energy and Energy harvesting	2

Semester V

PHY501: Classical Mechanics

This course extends knowledge of fundamental thermal physics principles and introduces the powerful and elegant Lagrangian and Hamiltonian formulations of classical mechanics

PHY501: Classical Mechanics	
Central force Problem	**No. of Lectures**
Nature of orbits in an attractive inverse square field	3
Kepler's laws of planetary motion. Rutherford scattering as an example of repulsive potential.	3
Mechanics of Ideal Fluids	**No. of Lectures**
Streamlines and flowlines; Equation of continuity; Euler's equation of motion;	3
Streamline motion - Bernoulli's equation and its applications. Definition of Newtonian and non-Newtonian fluids	3
Lagrangian and Hamiltonian formulation of Classical Mechanics	10
Generalized coordinates, constraints and degrees of freedom; D'Alembart's principle;	2
Lagrange's equation for conservative systems (from D'Alembert's principle; variational principle not required) and its application to simple cases	4
Generalized momentum; Idea of cyclic coordinates, its relation with conservation principles;	4
Definition of Hamiltonian, Hamilton's equation (derivation by Legendre transformation) and its application to simple cases.	4

REFERENCE BOOKS:

- Mechanics: C. Kittel, W.D. Knight, M.A. Ruderman, C.A. Helmholz and B.J. Moyer (2008) Berkeley Physics Vol 1, Tata McGraw-Hill Ltd
- Classical Mechanics: N. Rana and P. Joag (2001) Tata McGraw-Hill Education
- Classical Mechanics: J.R. Taylor (2005) University Science Books
- Feynman Lectures in Physics, Vol I , Addison-Wesley.
- Classical Mechanics: H. Goldstein, C. Poole and J. Safko (2002) 3rd edition, Pearson
- Classical Dynamics of Particles and Systems: Thornton and Marion (2003) Thomson Learning EMEA Ltd

PHY502: Quantum Mechanics

Quantum mechanics plays a central role in our understanding of fundamental phenomena, primarily in the microscopic domain. It lays the foundation for an understanding of atomic, molecular, condensed matter, nuclear and particle physics.

PHY502: Quantum Mechanics	
Time dependent and time independent Schrodinger equation	**No. of Lectures**
Eigenstates, normalization and orthonormality.	6
Simple applications of Quantum Mechanics	**No. of Lectures**
One dimensional potential well and barrier, boundary conditions, bound and unbound states.	2
Reflection and transmission coefficients for a rectangular barrier in one dimension – explanation of alpha decay.	4
Free particle in one dimensional box, box normalization, momentum eigenfunctions of a free particle	4
Linear harmonic oscillator, energy eigenvalues from Hermite differential equation, wave function for ground state, parity of wave function.	2
Schrodinger equation in spherical polar coordinates	**No. of Lectures**
Angular momentum operators and their commutation relations;	2
eigenvalues and eigenfunctions of L2 and Lz; theorem of addition of angular momenta [statement with examples].	6
The hydrogen atom problem – stationary state wavefunctions as simultaneous eigenfunctions of H, L2, and Lz;	5
radial Schrodinger equation and energy eigenvalues [Laguerre polynomial solutions to be assumed]; degeneracy of the energy eigenvalues.	5

REFERENCE BOOKS:

- Quantum Physics: S. Gasiorowicz (2003) 3rd edition, Wiley India Edition
- Quantum Physics: E.H. Wichman (2008) Berkeley Physics Course, Vol 4, Tata McGraw-Hill Ltd
- Introduction to Quantum Mechanics, David J. Griffiths, Pearson Education
- Introductory Quantum Mechanics, Richard Liboff, Addison-Wesley; 4 edition
- A Modern Approach to Quantum Mechanics, John Townsend, Viva Books
- Principles of Quantum Mechanics: R. Shankar (2010) 2nd edition, Springer

PHY503: Solid State Physics

Solid State Physics explains how the macroscopic properties of solids result from atomic scale properties. Solid State Physics forms the theoretical basis of Materials Science

PHY503: Solid State Physics	
Crystal Structure	**No. of lectures**
Crystalline and amorphous solids, translational symmetry	2
Elementary ideas about crystal structure, lattice and bases, unit cell, reciprocal lattice	3
fundamental types of lattices, Miller indices, lattice planes, simple cubic, f.c.c. and b.c.c. lattices	5
Laue and Bragg equations. Determination of crystal structure with X-rays.	2
Elementary band theory	**No. of lectures**
Kronig Penny model. Band Gap. Conductor, Semiconductor (Pand N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient. Effect of concentration and temperature on fermi level.	6
Dielectric properties of materials	**No. of lectures**
Electronic, ionic and dipolar polarizability, local fields, induced and oriented polarization – molecular field in a dielectric; Clausius-Mosotti relation.	4
Magnetic properties of materials	**No. of lectures**
Dia, para and ferro-magnetic properties of solids. Langevin's theory of diamagnetism and paramagnetism. Quantum theory of paramagnetism, Curie's law. Ferromagnetism: spontaneous magnetization and domain structure; temperature dependence of spontaneous magnetisation; Curie-Weiss law, explanation of hysteresis.	8
Superconductivity	**No. of lectures**
Introduction (Kamerlingh-Onnes experiment), effect of magnetic field, Type-I and type-II superconductors, Isotope effect. Meissner effect. Heat capacity. Energy gap. Ideas about High-Tc superconductors	5

REFERENCE BOOKS:

- Solid State Physics: N.W. Ashcroft and N.D. Mermin (1976) College edition, Harcourt College Publishers
- Introduction to Solid State Physics: C. Kittel (2004) 8th edition, John Wiley and Sons
- Atomic and Electronic Structure of Solids, E. Kaxiras; Cambridge University Press.

PHY504: Electrodynamics

Introduction to electrodynamics and a wide range of applications including communications, superconductors, plasmas, novel materials, photonics and astrophysics

PHY504: Electrodynamics	
Generalization of Ampere's Law	**No. of lectures**
Displacement Current, Maxwell's Field Equations, Wave equation for electromagnetic (EM) field and its solution	4
plane wave and spherical wave solutions, transverse nature of field, relation between E and B; energy density of field, Poynting vector and Poynting's theorem, boundary conditions	4
EM Waves in an isotropic dielectric	**No. of lectures**
Wave equation, reflection and refraction at plane boundary, reflection and transmission coefficients	4
Fresnel's formula, change of phase on reflection, polarization on reflection and Brewster's law, total internal reflection.	4
EM waves in conducting medium	**No. of lectures**
Wave equation in conducting medium, reflection and transmission at metallic surface – skin effect and skin depth,	3
propagation of E-M waves between parallel and conducting plates – wave guides (rectangular only)	5
Dispersion	**No. of lectures**
Equation of motion of an electron in a radiation field : Lorentz theory of dispersion – normal and anomalous	2
Sellmeier's and Cauchy's formulae, absorptive and dispersive mode, half power frequency, band width.	6
Scattering	**No. of lectures**
Scattering of radiation by a bound charge, Rayleigh's scattering (qualitative ideas), blue of the sky, absorption.	4

REFERENCE BOOKS:

- Electricity and Magnetism: E.M. Purcell (2008) Berkeley Physics Course, Vol 2, Tata McGraw-Hill Ltd
- Feynman Lectures on Physics: R.P. Feynman, R.B. Leighton and M. Sands (2011) The Millenium edition, Vol 2, Basic Books
- Introduction to Electrodynamics: D.J. Griffths (2012) Pearson Education
- Modern Electrodynamics: A. Zangwill (2013) Cambridge University Press

PHY- 505: ELECTIVE 1-Introduction to Astrophysics

The course defines and analyzes the basic concepts in astronomy. Describes the working principle of the telescope. Identifies important constellations – orient in space. Describes the planets of the solar system and their properties. Interprets the phenomena in the Universe. Describes and understand the physical processes in the Sun and other stars.

PHY505: Introduction to Astrophysics	
Astronomical Scales	**No. of lectures**
Astronomical Distance, Mass and Time, Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature. Astronomical techniques: Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space	4
Telescopes, Detectors and Their Use with Telescopes	**No. of lectures**
(Types of Detectors, detection Limits with Telescopes). The sun (Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere. Corona, Solar Activity, Basics of Solar Magneto-hydrodynamics. Helioseismology). The solar family (Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets.	6
Stellar spectra and classification Structure	**No. of lectures**
(Atomic Spectra Revisited, Stellar Spectra, Spectral Types and Their Temperature Dependence, Black Body Approximation, H R Diagram, Luminosity Classification)	2
The milky way	**No. of lectures**
Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way), Stars and Star Clusters of the Milky Way, Properties of and around the Galactic Nucleus.	6
Galaxies	**No. of lectures**
Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies (The Intrinsic Shapes of Elliptical, de Vaucouleurs Law, Stars and Gas). Spiral and Lenticular Galaxies (Bulges, Disks, Galactic Halo) The Milky Way Galaxy, Gas and Dust in the Galaxy, Spiral Arms	6

REFERENCE BOOKS

- Galaxies in the Universe: An Introduction: L.S. Sparke and J.S. Gallagher III (2000) Cambridge University Press
- Galactic and Extragalactic Radio Astronomy: G.L. Verschuur and K.I. Kellermann (1988) Springer-Verlag
- The Physics of Stars (Manchester Physics Series): A.C. Phillips (1999) John Wiley & Sons

PHY-506: ELECTIVE 2- Nanotechnology

This course will enable students to have the knowledge of syntheses and characterization of nanomaterials. It also highlights the applications and significance of nanotechnology in terms of their properties.

PHY506: Nanotechnology	
Nanoscale systems	**No. of lectures**
Length scales in physics, Nanostructures: 1D, 2D and 3Dnanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences	4
Synthesis and Characterization of nanostructure materials	**No. of lectures**
Top down and Bottom up approach, Photolithography. Ball milling. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunnelling Microscopy.	4
Optical properties	**No. of lectures**
Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasiparticles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostructres and nanostructures.	8
Applications	**No. of lectures**
Applications of nanoparticles. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).	8

REFERENCE BOOKS:

- C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
- S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
- K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
- M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).

PHY507: Physics Lab I (any 4)

1. Verification of Hall Effect.
2. Hysteresis Loop, coercivity, saturation magnetization.
3. Susceptibility of Paramagnetic Materials by Quincke's Tube method.
4. Michelson Interferometer with He-Ne Laser.

PHY508: Physics Lab II (Analog and digital)

1. Characteristics of p-n Junction diode
2. Characteristics of p-n-p transistor in forward and reverse bias.
3. Characteristics of Zener diode.
4. Solar lab.

PHY509: Research Project work

Combination of experimental and theoretical aspects of a problem. Perform experiment, collect data, analyze with various tools and software. Derive conclusion (positive or negative) from the work and summarize the report in form of dissertation in the VI semester

Semester VI

PHY601: Statistical Physics

Statistical mechanics, the microscopic basis of classical thermodynamics, is developed in this subject. It is one of the core areas of physics, finding wide application in solid state physics, astrophysics, plasma physics and cosmology. Using fundamental ideas from quantum physics, a systematic treatment of statistical mechanics is developed for systems in equilibrium

PHY601: Statistical Physics	
Microstates and macrostates	**No. of lectures**
Classical description in terms of phase space and quantum description in terms of wave functions.	1
Hypothesis of equal a priori probability for microstates of an isolated system in equilibrium. Interactions between two systems – thermal, mechanical and diffusive.	3
Statistical definition of temperature, pressure, entropy and chemical potential. Partition function of a system in thermal equilibrium with a heat bath	3
Classical statistical mechanics	**No. of lectures**
Maxwell-Boltzmann distribution law. Calculation of thermodynamic quantities for ideal monoatomic gases. Ergodic hypothesis and Liouville theorem and Ideal gases (monoatomic and diatomic): Translational, rotational, vibrational, electronic partition functions,thermodynamic functions	10
Motivations for quantum statistics	**No. of lectures**
Gibbs' paradox. Identical particle and symmetry requirement. Derivation of MB, FD and BE statistics as the most probable distributions (micro-canonical ensemble). Classical limit of quantum statistics.	6
Quantum statistical mechanics	**No. of lectures**
Bose-Einstein statistics: Application to radiation – Planck's law. Rayleigh Jeans and Wien laws as limiting cases, Stefan's law.	8
Fermi-Dirac statistics: Fermi distribution at zero and non-zero temperatures	7

REFERENCE BOOKS:

- Statistical Mechanics: K. Huang (1987) 2nd edition, Wiley
- Fundamental of Statistical and Thermal Physics: F. Reif (2008) Waveland Pr Inc
- Statistical Physics of Particles: Mehran Kardar (2007) Cambridge University Press
- Statistical Physics- Reif-(2008)) Berkeley Physics Course, Vol 5, Tata McGraw-Hill Ltd

PHY602: Subatomic Physics

This course intends to develop familiarity with the vast areas of nuclear and particle physics as well as develop an interest in these subjects. It also helps students acquire knowledge in the content areas of nuclear and particle physics, focusing on concepts that are commonly used in this area

REFEENCE BOOKS:

- Nuclear Physics – Cottingham and Greenwood (Cambridge University Press).
- Concepts of Nuclear Physcics – R. Cohen (Tata-Mc Graw Hill).
- Paramanu o Kendrak Gathan Parichay – S. N. Ghoshal (WBSBB).
- Atomic and Nuclear Physics – S. N. Ghoshal (S. Chand).

PHY602: Subatomic Physics	
Bulk properties of nuclei and Nuclear structure	**No. of lectures**
Nuclear mass, charge, size, binding energy, spin and magnetic moment. Isobars, isotopes and isotones; mass spectrometer. Nature of forces between nucleons, nuclear stability and nuclear binding, the liquid drop model (descriptive) and the Bethe-Weizsacker mass formula, application to stability considerations, extreme single particle shell model (qualitative)	2
Unstable nuclei and Nuclear Reactions	**No. of lectures**
Alpha decay : alpha particle spectra – velocity and energy of alpha particles. Geiger-Nuttal law. Beta decay : nature of beta ray spectra, the neutrino, energy levels and decay schemes, positron emission and electron capture, selection rules, beta absorption and range of beta particles, Kurie plot. Gamma decay : gamma ray spectra and nuclear energy levels, isomeric states. Gamma absorption in matter – photoelectric process, Compton scattering, pair production (qualitative)	2
Conservation principles in nuclear reactions. Q-values and thresholds, nuclear reaction cross-sections, examples of different types of reactions and their characteristics. Bohr's postulate of compound nuclear reaction, Ghoshal's experiment.	2
Nuclear fission and fusion	**No. of lectures**
Discovery and characteristics, explanation in terms of liquid drop model, fission products and energy release, spontaneous and induced fission, transuranic elements. Chain reaction and basic principle of nuclear reactors. Nuclear fusion: energetics in terms of liquid drop model.	6
Elementary particles	**No. of lectures**
Four basic interactions in nature and their relative strengths, examples of different types of interactions. mass, charge, spin, isotopic spin, intrinsic parity, hypercharge. Charge conjugation. Conservation laws. Classifications of elementary particles – hadrons and leptons, baryons and mesons, elementary ideas about quark structure of hadrons – octet and decuplet families. Particle Accelerator and Detector Cyclotron – basic theory, synchrotron, GM counter	18

PHY603: Atomic and Molecular Spectroscopy and Lasers

This course intends to throw light on the phenomenon of the interaction of light with matter in terms of the relationship with the molecular structure. The course will enable students to select molecular spectroscopy methods suitable for solving given scientific problem.

REFERENCE BOOKS:

- Eisberg, R. and Resnick, R., Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles, II Edition, John Wiley, 1985
- Banwell, C.N., Fundamentals of Molecular Spectroscopy, III Edition, Tata-McGraw Hill, 1972
- Wilson, J. and Hawkes, J. F. B., Optoelectronics- An Introduction, Prentice Hall, 1983

PHY603: Atomic and Molecular Spectroscopy and Lasers	
Atomic Spectroscopy	**No. of lectures**
LS and JJ coupling schemes. Terms for equivalent and non-equivalent electron atom. Spectra of one and two electron systems. Electron spin, spin orbit interaction, fine structure, relativistic correction and radiation correction (Lamb Shift). Electric dipole selection rules. Intensity rules. Alkali type spectra. Zeeman effect. Paschen-Back effect. Stark effect. Hyperfine structure and isotopic shifts. Complex Spectra: Vector model for three or more valence electrons. Inverted terms.Compound doublet. Inner-Shell Excitation and Autoionization, Line intensities, Transition probabilities, oscillator strength. Forbidden transitions.	15
Molecular Spectroscopy	**No. of lectures**
Rotational spectra of diatomic molecules. Vibrational spectra of diatomic molecules. Rotation- Vibration spectra of diatomic molecules. Classification of electronic states. Electronic spectra of diatomic molecules. Franck-Condon principle. Rotational spectra of linear polyatomic molecules: Coriolis interaction and effect of l-type doubling in linear molecules. Nuclear spin statistical weights and their effect on intensities. Rotational spectra of symmetric (prolate and oblate) molecules. Vibration-rotation spectra of polyatomic molecules: Parallel and perpendicular bands of linear molecules and symmetric top (prolate and oblate) molecules.	15
Spectroscopy (elementary and qualitative)	**No. of lectures**
Experimental techniques in spectroscopy: FTIR Raman, Stoke's antiStoke's.	3
Laser Physics Spectroscopy	3

PHY604: Digital and Analog Electronics

This course is designed for students to know the operation and the structure of switching circuits, use and working of diodes and transistors as a switching circuits, logic families, TTL, ECL, and MOSFET and amplifiers etc.

PHY604: Digital and Analog Electronics	
Digital Circuits	**No. of lectures**
Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion, AND, OR and NOT Gates (Realization using Diodes and transistors)	4
De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Minterms and	5

Maxterms. Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.	
Binary Addition. Binary Subtraction using 2's Complement Method). Half Adders and Full Adders and Subtractors, 4-bit binary Adder-Subtractor.	4
Semiconductor Devices and Amplifiers:	**No. of lectures**
Semiconductor Diodes: P and N type semiconductors. Barrier Formation in PN Junction Diode. Qualitative Idea of Current Flow Mechanism in Forward and Reverse Biased Diode. PN junction and its characteristics. Static and Dynamic Resistance. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell.	5
Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Active, Cutoff & Saturation regions Current gains α and β. Relations between α and β. Load Line analysis of Transistors. DC Load line & Q-point. Voltage Divider Bias Circuit for CE Amplifier. h-parameter Equivalent Circuit. Analysis of single-stage CE amplifier using UGC Document on LOCF Physics 233 hybrid Model. Input & output Impedance. Current, Voltage and Power gains. Class A, B & C Amplifiers	12
Operational Amplifiers (Black Box approach):	**No. of lectures**
Characteristics of an Ideal and Practical Op-Amp (IC 741), Open-loop and closed-loop Gain. CMRR, concept of Virtual ground. Applications of Op-Amps: (1) Inverting and non-inverting Amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Zero crossing detector. Sinusoidal Oscillators: Barkhausen's Criterion for Self-sustained Oscillations. Determination of Frequency of RC Oscillator	6

- REFERENCE BOOKS:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronic devices & circuits, S. Salivahanan & N.S. Kumar, 2012, Tata Mc-Graw Hill
- Microelectronic Circuits, M.H. Rashid, 2nd Edn., 2011, Cengage Learning.
- Modern Electronic Instrumentation and Measurement Tech., Helfrick and Cooper, 1990, PHI Learning
- Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7th Ed., 2011, Tata McGraw Hill
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., OxfordUniversity Press.

PHY605: ELECTIVE 3- Renewable Energy and Energy Harvesting

This course enables the students to outline the principles of energy harvesting systems as well as methods of electro-mechanical conversion, principle of photovoltaic cells and thermoelectric generators. They will be able to describe the physical principles of energy

harvesting methods mainly electro-mechanical conversion and simulation modeling of such mechatronic systems.

PHY605: Renewable Energy and Energy Harvesting	
Fossil fuels and Alternate Sources of energy	**No. of lectures**
Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity	3
Solar energy	**No. of lectures**
its importance, storage of solar energy, solar pond, no convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption	3
Ocean Energy, Hydro Energy and Geothermal Energy	**No. of lectures**
Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. (3 Lectures) Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. (2 Lectures) Geothermal Resources, Geothermal Technologies. Hydropower resources, hydropower technologies, environmental impact of hydro power sources	6
Piezoelectric Energy harvesting	**No. of lectures**
Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modelling piezoelectric generators, Piezoelectric Energy harvesting applications, Human power	4
Electromagnetic Energy Harvesting	**No. of lectures**
Electromagnetic Energy Harvesting	2
Linear generators, physics mathematical models, recent applications	2
Environmental issues and Renewable sources of energy, sustainability.	2

REFERENCE BOOKS:

- Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
- Solar energy - M P Agarwal - S Chand and Co. Ltd.
- Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
- Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.
- Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
- J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
- http://en.wikipedia.org/wiki/Renewable_energy

PHY606: ELECTIVE 4 -Introductory Biophysics

This course will enable students to define the fundamental concepts of biophysics. The course explains the integration of physical theory into biological processes

PHY606: Renewable Energy and Energy Harvesting	
Thermodynamics of living systems	**No. of lectures**
Conservation of energy in living systems, Entropy and Life, Gibbs and Standard free energy, Equilibrium constant, Coupled reactions.	2
Dynamics of biomolecules	**No. of lectures**
Diffusion, Laws of diffusion, Active transport, facilitated diffusion, Osmosis, Osmotic pressure, Osmoregulation, Viscosity and biological importance, Surface tension, Factors influencing surface tension, Biological importance.	4
Atomic & Molecular structure	**No. of lectures**
Structure of atom-Models & theories, Periodic table, Concept of bonding; valence of carbon; hybridizations of carbon; hybridizations of nitrogen & oxygen; molecular orbital theories, polar & non polar molecules; inductive effect; Secondary bonding: weak interactions, hydrogen bonding; dipole-dipole & dipole induced dipole interactions; London dispersion forces. Bonds within molecules-Ionic, covalent, Hydrogen, Electrostatic, Disulphide & peptide bonds, Van-der Waals forces Bond lengths & Bond energies , Bond angles, Structural isomerism; optical isomerism & optical activity.	8
Physico-chemical Foundations	**No. of lectures**
Biophysics of Water: Physicochemical properties of water, Molecular structure, Nature of hydrophobic interactions, Water Structure. Small-Molecule Solutes: Hydrophiles, Hydrophobes, Large Hydrophobic Solutes and Surfaces, Aqueous Environment of the Cell, State of water in bio- structures & its significance, Protein Hydration-Nonspecific Effects, The Hydration Shell. Acid	12

& Bases: Acid-Base theories, Mole concept, Molarity, Molality & Normality, Ampholyte, concept of pH,measurements of pH , Henderson–Hasselbatch equation , Titration curve & pK values, Buffers & Stability of their pH , numerical problems. Redox potential : Oxidation –Reduction, examples of redox potential in biological system	

REFERENCES BOOKS:

- Biochemistry by Voet and Voet
- Biological Thermodynamics by Donald T. Haynie
- Introductory Biophysics by J. R. Claycomb and J.Q.P. Tran
- Molecular and Cellular Biophysics by Meyer B. Jackson

PHY607- Physics Lab I

1. Determine Planck's Constant using Photo Vacuum Tube.
2. Refractive index of transparent material.
3. Study of Zeeman Effect.
4. G M counting set up for radioactive experiments.

PHY608- Physics Lab II (Analog and digital)

1. verification of Logic Gates.
2. Charging and Discharging of Capacitor.
3. Verification of Kirchhoff's law.
4. Verification of DeMorgan’s Theorem

PHY609- Research Project work

Combination of experimental and theoretical aspects of a problem. Perform experiment, collect data, analyze with various tools and software. Derive conclusion (positive or negative) from the work and summarize the report in form of dissertation in the VI semester