SEMESTER I

Course Code	University Course Type	Course Name	Teaching Load			
			L	T	P	C
PHY 201	Core Theory	Classical Mechanics	3	1	0	4
PHY 202	Core Theory	Advanced Electronics	3	1	0	4
PHY 203	Core Theory	Advanced Mathematical Physics	3	1	0	4
PHY 204	Core Theory	Electrodynamics	3	1	0	4
PHY 205	Core Practical	Computational Physics Lab	0	0	6	3
PHY 206	Core Practical	Electronics Lab	0	0	6	3
ENG 101	Skill Enhancement Course	Communicative English	2	0	0	2
Total			14	4	12	24

PHY 201

CLASSICAL MECHANICS

L-T-P-C Structure 3-1-0-4 **Course Type: Core Theory**

MODULE I

LAGRANGIAN FORMULATION**:** Mechanics of a system of particles – constraints, Principle of virtual work, generalized coordinates, D'Alembert's principle and Lagrangian equations – conservation theorems and symmetry properties – applications of Lagrangian formulation: LHO, simple pendulum, particle moving under central force, Atwood machine. (10)

MODULE II

CENTRAL FORCE PROBLEMS**:** Reduction to one body problem, Equation of motion and first integral, Classification of orbits, Kepler's Laws and planetary motion, Scattering in central force field, Transformation to laboratory frames. (9)

MODULE III

RIGID BODY AND VIBRATING SYSTEMS**:** Euler angles – tensor of inertia – kinetic energy of a rotating body – symmetric top and applications. Vibrating string – solution to wave equation – normal modes vibration and coupled oscillation. (9)

MODULE IV

HAMILTONIAN FORMULATION **:** Hamilton's principle, Lagrange's and Hamilton's equations from Hamilton's principle, Hamilton's equation of motion from variational principle, physical significance of Hamiltonian, Principle of least action and applications: LHO, simple pendulum, particle moving under central force, Poisson brackets. (10)

MODULEVI

HAMILTON–JACOBI THEORY AND THEORY OF SMALL OSCILLATIONS**:** Hamilton–Jacobi equations – Linear Harmonic Oscillator Problem by Hamilton – Jacobi method – Action Angle Variables. Oscillatory motion – Theory of small Oscillation –Linear Tri-atomic Molecule – stability of Oscillatory motion – Forced Harmonic Oscillator. (10)

Total 48

Reference Books:

1. Tom W B Kibble, Frank H Berkshire, "Classical Mechanics", Imperial College press. 2004.
2. Srinivasa Rao K N, "Classical Mechanics, University press, 1st Edition, 2003.
3. Gupta S L, Kumar V and Sharma H V, "Classical Mechanics", Pragati Prakashan, Meerut, 2003.
4. Biswas S N, "Classical Mechanics", Books and Allied Ltd., Kolkatta, 1998.
5. Classical Mechanics: H. Goldstein
6. Classical Mechanics: N.C.Rana and P.S.Joag
7. Classical Mechanics : J. C. Upadhyaya (Himalaya Publishing House)

PHY 202

ADVANCE ELECTRONICS

L-T-P-C Structure 3-1-0-4 **Course Type: Core Theory**

MODULE I

OPERATIONAL AMPLIFIER: Concept of input/output impedance, Input bias current, offset input voltage, slew rate, CMMR, Gain, Frequency response, Band Width of OP-AMPs. Applications of Operational Amplifiers as adder, differentiator, integrator, inverter, non-inverter, buffer, etc. (10)

MODULE II

ACTIVE FILTERS : Low Pass Filter, High Pass Filter, Band Pass Filter, Function Generator – Square wave, Triangular, Saw tooth , Sine wave, Half wave and Full wave precision rectifiers, (8)

MODULE III

POWER SUPPLY: Single mode power supply and Dual Mode power supply, Constant Voltage Constant Current (CVCC) power supply using IC-723, Three terminal adjustable regulator, Switching regulator, Introduction to UPS and Inverters. (10)

MODULEIV

COMBINATIONAL LOGIC: Logic Identities, Minimization and Karnaugh map (up to 4 variables), Combinational functions available as ICs, SEQUENTIAL LOGIC: Monostable multivibrator IC555, Counters – BCD, Binary, up-down counter, Shift registers: SISO, SIPO, PISO, PIPO (10)

MODULE V

DATA CONVERTER: Characteristics, Binary type, Analog to Digital Converter: Characteristics, Dual type, Simultaneous type, Successive Approximation and Counter type, Multiplexer and Demultiplexer. Seven Segment display (10)

Total 48

Note :

1. Designing problems are expected to be worked out for respective topics.
2. Student should refer manuals for data specifications.

Reference Books:

1. Operational Amplifiers – G.B.Clayton (5th edition) Newnes
2. Operational Amplifiers Applications – G.B.Clayton
3. Electronic Principles – Malvino (TMH Publication)
4. Operational Amplifiers – Subrahmanyam
5. Op-amps and Linear Integrated circuits – Gayakwad (Prentice Hall)
6. Linear Integrated circuits – D.Roy Choudhury, Shail Jain
9. SMPS Inverters Converters: Gottlib
10. Integrated circuits – Botkar
11. Digital Principles and Applications: Leach and Malvino

PHY 203

ADVANCED MATHEMATICAL PHYSICS

L-T-P-C Structure 3-1-0-4 **Course Type: Core Theory**

MODULE I

COMPLEX ANALYSIS : Analytical functions, Cauchy-Riemann conditions, Line integrals, Cauchy's theorem, Cauchy integral formula, Derivatives of analytical functions, Power Series, Taylor's theorem, Laurent's theorem. (10)

MODULE II

OPERATORS AND MATRIX FORMULATION: Operators, Inverses, Matrix representation, Similarity transformations, Eigenvalues and eigenvectors, Inner product, Orthogonality, Self adjoint and Unitary transformations, Eigenvalues & eigenvectors of Harmitian & Unitary transformations, Diagonalization. (10)

MODULE III

SPECIAL FUNCTIONS: Legendre, Hermite, Laguerre functions and Generating function, Recurrence relations and their differential equations Orthogonality properties, Bessels's function of first kind, Associated Legendre function, Spherical harmonics. (10)

MODULE VI

FOURIER SERIES AND INTEGRAL TRANSFORMS : Fourier Series : Definition, Dirichlet's condition, Convergence, Fourier Integral and Fourier transform, Convolution theorem, Parseral's identity. (10)

MODULE V

LAPLACE TRANSFORM AND ITS APPLICATIONS: Applications to the solution of differential equations, Inverse Laplace transformation, Fourier transform & Laplace transform of Dirac Delta function. (8)

Total 48

Reference Books :

1. Complex Variables and Applications – J.W.Brown, R.V.Churchill – (7th Edition)- Mc-Graw Hill
2. Complex Variables – Seymour Lipschutz
3. Mathematical methods for Physicists – Arfken & Weber – 6th Edition-Academic Press- N.Y.
4. Mathematics for Physical Sciences – Mary Boas, John Wiley & Sons
5. Mathematical Methods of Physics – Mathews & Walker – 2nd Edition- Pearson Edition
6. Fourier Series - Seymour Lipschutz, Schaum Outlines Series
7. Laplace Transform - Seymour Lipschutz, Schaum Outlines Series
8. Mathematical Methods in Classical and Quantum Physics – Tulsi Das, S.K.Sharma- University Press India.
9. Mathematical Methods in Physics – Butkov Addiddion Wesley Publishers.

PHY 204

ELECTRODYNAMICS

L-T-P-C Structure 3-1-0-4 **Course Type: Core Theory**

MODULE I

ELECTROSTATICS: Electrostatic field, Gauss's law, Applications of Gauss's law, Electric Potential, Poisson's equation and Laplace's equation and its applications, Work and energy in electrostatics boundary conditions and uniqueness theorems, Electrostatic fields in matter: Dielectrics, Polarization, Field inside a dielectric. (9)

MODULE II

MAGNETOSTATICS**:** Biot-Savart Law, Divergence and Curl of B, Ampere's law and applications of Ampere's law, Magnetic vector potential, Magnetostatic fields in Matter: Magnetization, field of a magnetized object, magnetic field inside matter, linear and non linear magnetic media. (9)

MODULE III

ELECTRODYNAMICS: Time dependent fields, Faraday's law, Maxwell's displacement current, Differential and integral forms of Maxwell's equations. Gauge transformations, Coulomb and Lorentz Gauge. Maxwell's equations in terms of potentials. Energy and momentum in electrodynamics. (10)

MODULE IV

ELECTROMAGNETIC WAVES: Electromagnetic waves in non conducting media: Monochromatic plane waves in vacuum, propagation through linear media; Boundary conditions, Electromagnetic waves in conductors: Modified wave equation, Guided waves. (10)

MODULE V

ELECTROMAGNETIC RADIATION: Retarded potentials, Electric dipole radiation, Magnetic dipole radiation. Radiation from a point charge: Lienard-Wiechart potentials:, power radiated by a point charge.

Electrodynamics and Relativity: Review of special theory of relativity, Lorentz transformations, Transformation of electric and magnetic fields under Lorentz transformations (10)

Total 48

Reference Books:

1. Introduction to Electrodynamics – David J. Griffiths, Second Edition, Prentice Hall India, 1989.
2. Classical Electrodynamics – J.D. Jackson, Fourth Edition, John Wiley & Sons, 2005.
3. Classical Electromagnetic Radiation – M.A. Heald and J.B. Marion, Saunders, 1983
4. Classical Electromagnetic- Satya Prakash.Pragati Prakashan
5. Classical Electromagnetic- D.C. Tayal, Himalaya publications.

PHY 205

COMPUTATIONAL PHYSICS LAB

L-T-P-C Structure 0-0-6-3 **Course Type: Core Practical**

1. Graphical representation of single ASCII file (experimental data) using origin software
2. Graphical representation of Multiple ASCII file (experimental data) using origin software
3. Merging, Stacking and inset representation of multiple experimental data using origin software
4. Analysis of some dynamic system parameters using tracker program.
5. Linear and Gaussian curve fitting and calculation of linear correlation coefficient.
6. Gaussian distribution analysis by FWHM.
7. XRD Data analysis by powder X software.
8. Solution of first order differential equations using the Rung-Kutta method on C++ Programming.

PHY 206

ELECTRONICS LAB

L-T-P-C Structure 0-0-6-3 **Course Type: Core Practical**

Group –A

1. Study of Inverting and Non-inverting amplifier using OP-AMP IC 741
2. Study of Voltage follower, Summing, Difference using OP-AMP IC 741
3. Study of differentiator and integrator using OP-AMP IC 741.
4. Study of the attenuation characteristics and designing of the phase-shift Oscillator using OP-AMP IC 741.
5. Designing of square wave, sawtooth wave and Triangular wave generators using OP-AMP IC 741.
6. Study of Half adder, Half subtractor, Full adder, Full subtractor using IC 7400 -.

Group –B

1. Study of 4-bit Shift Registers - Ring counter - Twisted Ring counter using standard IC.
2. Study of Arithmetic operations using IC 7483.
3. Study of Astable multivitorator and Voltage Controlled Oscillator using IC 555.
4. Study of Logic gates using combinations of standard ICs on Bread Board
5. Study of Half wave, Full Wave and Bridge rectifier and designing of regulated power supplies.

Note: In Semester students should perform at least 7 experiments taking at least 2 experiments from group A as well as from group B.

SEMESTER II

<table>
<tr><th rowspan="2">Course Code</th><th rowspan="2">University Course Type</th><th rowspan="2">Course Name</th><th colspan="4">Teaching Load</th></tr>
<tr><th>L</th><th>T</th><th>P</th><th>C</th></tr>
<tr><td>PHY 207</td><td>Core Theory</td><td>Quantum Mechanics</td><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>PHY 208</td><td>Core Theory</td><td>Thermal Physics</td><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>PHY 209</td><td>Core Theory</td><td>Advanced Solid State Physics</td><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>PHY 215</td><td rowspan="2">Department Specific Elective Theory</td><td>Instrumentation In Physics</td><td rowspan="2">3</td><td rowspan="2">1</td><td rowspan="2">0</td><td rowspan="2">4</td></tr>
<tr><td>PHY 216</td><td>Biomedical Physics</td></tr>
<tr><td>PHY 210</td><td>Core Practical</td><td>Advanced Solid State Physics Lab</td><td>0</td><td>0</td><td>6</td><td>3</td></tr>
<tr><td>PHY 217</td><td rowspan="2">Department Specific Elective Practical</td><td>Instrumentation In Physics Lab</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">6</td><td rowspan="2">3</td></tr>
<tr><td>PHY 218</td><td>Biomedical Physics Lab</td></tr>
<tr><td colspan="3">Total</td><td>12</td><td>4</td><td>12</td><td>22</td></tr>
</table>

PHY 207

QUANTUM MECHANICS

L-T-P-C Structure 3-1-0-4 **Course Type: Core Theory**

MODULE I

BASIC PRINCIPLES: Hermitian operators, observables; Eigenfunctions, eigenvalues and orthonormalization of eigenfunctions, completeness. State functions as probability amplitude and the principle of superposition. Momentum, Hamiltonian and energy operators, Schrodinger equation. Probability density and probability current density, expectation value, Ehrenfest's theorem; basic postulates of quantum mechanics. (9)

MODULE II

ONE-DIMENSIONAL PROBLEMS: General properties of one-dimensional Schrodinger equation. Particle in a box. Harmonic oscillator. Unbound states; one-dimensional barrier problems. Finite potential well. Schrodinger equation solutions: Three-dimensional Problems: Orbital angular momentum operators in cartesian and spherical polar coordinates, commutation and uncertainty relations, spherical harmonics. TWO-PARTICLE PROBLEM :coordinates relative to the centre of mass; radial equation for a spherically symmetric central potential. Hydrogen atom, eigenvalues and radial eigenfunctions, degeneracy, probability distribution. (10)

MODULE III

ANGULAR MOMENTUM**:** Ladder operators, eigenvalues and eigenfunctions of L2 and Lz using spherical harmonics, angular momentum and rotations. Total angular momentum J; L.S coupling; eigenvalues of J2 and Jz. Addition of angular momentum, Clebsch Gordon coefficients for j1=j2=1/2 and j1= 1, j2 =1/2,coupled and uncoupled representation of eigen functions.Angular momentum matrices; Pauli spin matrices; spin eigenfunctions; free particle wave functions including spin, addition of two spins. Identical particles: symmetric / antisymmetric wavefunctions. (10)

MODULE IV

TIME-INDEPENDENT PERTURBATION THEORY**:** Eigenvalue of energy and eigenfunction in the first-order approximation (the case of a system with non-degenerate energy levels). Application to anharmonic oscillator and to the ground state of Helium atom.

TIME-DEPENDENT PERTURBATION THEORY**:** Transition from one discrete level to the other, to a continuum, another discrete level through an inter-harmonic perturbation, to resonance transitions. Interaction of radiations with a system of atoms, transition dipole moment, selection rules, Einstein's A & B coefficients. (10)

MODULEV

ELASTIC SCATTERING**:** Differential and total cross-section, phase analysis. Significance of the partial waves and phase shifts, S-wave scattering from a square well potential. The Born approximation, derivation of the expression for differential scattering cross-section, condition for validity of the approximation: application to square well potential and screened coulomb potential. (9)

Total 48

Reference Books:

1. Quantum Mechanics – Theory & Applications (3rd Ed): A.K. Ghatak & S. Loknathan, MacMillan India Ltd. 91984)
2. A Text of Quantum Mechanics: P.M. Mathews &K. Venkatesan, Tata McGraw-Hill, New Delhi (1982)
3. Quantum Mechanics (2nd ed): G. Aruldhas, Prentice-Hall India Pvt.Ltd.,New Delhi (2009)
4. Quantum Physics (3rd ed): S. Gasiorowicz, Wiley India (P) Ltd., New Delhi (2007)
5. Introduction to Quantum Mechanics: L. Pauling & E. Bright Wilson, McGraw-Hill, N.Y.(1935)
6. Quantum Mechanics(3rd ed): L.I. Schiff, McGraw-Hill, N.Y.(1968)
7. Quantum Mechanics: E. Merzbacher, 2nd ed., Wiley, N.Y.(1970)
8. Quantum Mechanics (2nd Ed): V.K. Thankappan, new Age International (P) Ltd. (1993)

PHY 208

THERMAL PHYSICS

L-T-P-C Structure 3-1-0-4 **Course Type: Core Theory**

MODULE I

MATERIAL EQUILIBRIUM**:** Thermodynamic properties of non-equilibrium systems. Entropy and equilibrium. The Gibbs and Helmholtz functions. Gibb's equations for a system of constant composition. Maxwell's relations. Chemical potential. Condition for phase equilibrium and reaction equilibrium. Chemical potentials in an ideal gas mixture. Ideal gas reaction equilibrium. Temperature dependence of the equilibrium constant. Shifts in ideal gas reaction equilibrium (9)

MODULE II

THERMODYNAMICS OF PHASE TRANSITION**:** Thermodynamic classification of phase transitions – Thermodynamic relations at the phase transition – Thermodynamic theories of phase transitions – Landau's theory of second order transitions, Tizza's theory of Lambda transitions – Hysteresis in phase transformations – Irreversible phase transformations and stabilities of polymorphs – Phase transitions in glasses. (9)

MODULE III

PHASE SPACES AND ENSEMBLES**:** phase spaces, Liouville equation; concept of ensembles, postulate of equal *a proiri* probability; canonical ensemble: most probable distribution of energies, thermodynamic relations in canonical ensemble; canonical partition function; micro canonical ensemble; grand canonical ensemble, grand partition function. Partition function for the system and for the particles, translational partition function; Gibbs paradox: Sackur-Tetrode equation; Boltzmann equipartition theorem; rotational partition function; vibrational contribution to thermodynamic quantities; electronic partition function. (10)

MODULE IV

QUANTUM STATISTICS**:** Bose-Einstein and Fermi-Dirac distributions, weak and strong degeneracy of perfect gases; Bose-Einstein condensation, Black body radiation.

FLUCTUATIONS AND BROWNIAN MOTION**:** Fluctuations in canonical, grand canonical and micro canonical ensembles. Brownian motion: Langevin equation, random walk problem. Diffusion: Einstein relation for mobility. Time dependence of fluctuations: power spectrum, spectral density; persistence and correlation of fluctuations; Wiener-Khinchin theorem, Johnson noise, Nyquist theorem; shot noise; Fokker-Planck equation. (12)

MODULE V

IRREVERSIBLE THERMODYNAMICS**:** Onsager reciprocity relations and their derivations; thermoelectric phenomena, linear response theory, Kubo relations, fluctuation dissipation theorem; Saha theory of ionisation. **Liquid helium:** phase diagram, superfluid properties, two-fluid model, thermo-mechanical, fountain and mechano-caloric effects. (8)

Total 48

Reference Books:

1. Rao K J and Rao C N R, "Phase Transitions in Solids", McGraw Hill, 2002.
2. Jena A K and Chaturvedi M C, "Phase Transformations in Materials", Prentice Hall, NJ, 1992
3. Ira N Levine, "Physical Chemistry" , McGraw Hill Book Company, Second Edition, 1988.
4. Nag P K, "Engineering Thermodynamics", Tata McGraw Hill, 1981.
5. Sears F W, "Introduction to Thermodynamics : Kinetic Theory of Gases and Statistical Mechanics", Addison Wesley, 1956.
6. Statistical mechanics and properties of matter: Theory and applications: E.S.R. Gopal, John Wiley & Sons, New York (1974).
7. Statistical mechanics (2nd ed.): B.K. Agarwal and M. Eisner, New Age International (P) Ltd. Publishers, New Delhi (1998).
8. Fundamentals of statistical and thermal Physics: F.Reif, McGrawHill Ltd., New Delhi (1965).
9. statistical Elementary physics: C. Kittel, John Wiley & Sons, New York (1958).
10. Statistical mechanics; Theory and applications; S.K.Sinha, TMH Pub. Ltd., New Delhi

PHY 209

ADVANCED SOLID STATE PHYSICS

L-T-P-C Structure 3-1-0-4 **Course Type: Core Theory**

MODULE I

SEMICONDUCTOR PHYSICS: Classification of Semiconductors; Crystal structure with examples of Si, Ge & GaAs semiconductors; Energy band structure of Si, Ge & GaAs; Extrinsic and compensated Semiconductors; Temperature dependence of Fermi-energy and carrier concentration. Drift, diffusion and injection of carriers; Carrier generation and recombination processes- Direct recombination, Indirect recombination, Surface recombination, Auger recombination; Applications of continuity equation-Steady state injection from one side, Minority carriers at surface, Haynes Shockley experiment, High field effects. Hall effect; Four – point probe resistivity measurement; Carrier life time measurement by light pulse technique. Introduction to amorphous semiconductors, Growth of semiconductor crystals. (12)

MODULE II

THEORY OF METALS AND SEMICONDUCTORS: Free electrons gas in three dimensions - Electronic heat capacity - Wiedmann-Franz law - Hall effect - Band theory of metals and semiconductors - Bloch theorem - Kronig-Penny model - Semiconductors - Intrinsic carrier concentration - Mobility - Impurity conductivity - Fermi surfaces and construction - Experimental methods in Fermi surface studies - de Haas Van Alphen effect. (8)

MODULE III

MAGNETISM: Elementary ideas of dia, para and ferro magnetism - quantum theory of paramagnetism - Rare earth ion - Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization - Quantum theory of ferromagnetism - Curie point - Exchange integral - Heisenberg's interpretation of Weiss field - ferromagnetic domains - Bloch Wall - Spin waves - Quantization - Magnons - thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets - Theory of antiferromagnetism - Neel temperature. (10)

MODULE IV

SUPER CONDUCTIVITY: Experimental facts-occurrence - Effect of magnetic fields - Meissner effect - Entropy and heat capacity - Energy gap - Microwave and infrared properties - Type I and II superconductors - theoretical explanation - thermodynamics of super conducting transition - London equation - Coherence length - BCS Theory - single particle Tunneling - Josephson tunneling - DC and AC Josephson effects - High temperature super conductors - SQUIDS. (10)

MODULE V

SEMICONDUCTOR DEVICES: Metal-semiconductor field effect transistor (MESFET)- Device structure, Principles of operation, Current voltage (I-V) characteristics, High frequency performance. Modulation doped field effect transistor (MODFET); Introduction to ideal MOS device; LEDs: Principles, device structure, device materials. High Intensity LEDs: Characteristics, output spectrum, LEDs for optical fiber communication.

(10)

Reference Books:

1. S.M. Sze; Semiconductor Devices: Physics and Technology, 2nd edition, John Wiley,New York, 2002.
2. B.G. Streetman and S. Benerjee; Solid State Electronic Devices, 5th edition, PrenticeHall of India, NJ, 2000.
3. Donald A. Neamen; Semiconductor Physics and Devices: Basic Principles, 3rd edition,Tata McGraw-Hill, New Delhi, 2002.
4. S.M. Sze; Physics of Semiconductor Devices, 2nd edition, Wiley Eastern Ltd., New Delhi, 1985.
5. C. Kittel, 1996, Introduction to Solid State Physics, 7th Edition, Wiley, New York.
6. M. Ali Omar, 1974, Elementary Solid State Physics-Principles and Applications, Addison-Wesley, London.
7. H.P. Myers, 1998, Introductory Solid State Physics, 2nd Edition, Viva Book, New Delhi.
8. S.O. Pillai, 1997, Solid State Physics, New Age International, New Delhi

PHY 215

INSTRUMENTATION IN PHYSICS

L-T-P-C Structure 3-1-0-4 **Course Type: DSE Theory**

MODULE-I

Transducers, recording electrodes – basic recording system – general electronic recorder – sources of noise in low level recording – Measuring techniques – flow, pressure and temperature.

MODULE-II

Concept of Chromatography – types of Chromatography (paper, gas, liquid) – basic parts of gas Chromatograph – methods of measurement of peak areas – liquid Chromatography and their types.

MODULE-III

Electrophoresis – Electrophoresis techniques – paper electrophoresis – electrophoresis apparatus – microelectrophoresis. Microscopes – electrons probe micro analyser – electrons probe micro analyser – scanning electron microscope.

MODULE-IV

Spectrophotometer (Instrumentation only) – UV-VIS Spectrophotometer – X-ray – X-ray diffractometer - X-ray fluorescence – Amino acid analyser. Baisc Principles of NMR, ESR and AAS

MODULE-V

Calorimeters - PH meters – principle of measurement – electrodes – buffer solution and types of PH meters – Water pollution monitoring instruments.

Reference Books:

1. A.K.Sawhney-Electrical and Electronics measurement and Instrumentation-Dhanpath Rai and Co. (Pvt. Ltd) New Delhi,2000
2. Dr.Rajendra Prasad -Electronic measurements and Instrumentation-Khanna Publishers , New Delhi,2002
3. Willard.D. Merrit et.al., -Instrumental methods of analysis- CBS Publishers, New Delhi,2004
4. Gurdeep Chatwal and Sham Anand-Instrumental methods of analysis-Himalaya Publishers,New Delhi,2003.
5. M.Arumugam-Biomedical Instrumentation- Anuradha Publishers, Kumbakonam, 2001.
6. R.S.Khandpur – Hand Book of Biomedical Instrumentation –TMH- New Delhi,2004.
7. B.C.Nakra and K.K.Chawdry-Instrumentation –Mesurement and Analysis- TMH, New Delhi,2004.

PHY 216

BIOMEDICAL PHYSICS

L-T-P-C Structure 3-1-0-4 **Course Type: DSE Theory**

MODULE-I

INTRODUCTION OF PHYSICAL PRINCIPLES RELATED TO LIFE PROCESSES: Electronic structure of atoms, Chemical bonding, Ionization energy, Electron affinity, Electro-negativity, strong bonds and weak bonds, Inter atomic potentials, Non central processes, Bond energy, Free energy, Internal energy, Thermodynamic principles, water, acids, basis and aqueous reactions, Transport process, Diffusion, Viscosity, thermal conduction. (10)

MODULE-II

NEURO-BIOPHYSICS: The Nervous system, Structure & Function of Neuron, Types of synapses, Physics of Membrane Potentials, Resting potential, Local depolarization, Action potential: Generation & propagation, Equivalent circuit of cell, Voltage clamp, Na-K pump, Equivalent circuits.

(8)

MODULE-III

NEUROSCIENCE : Higher functions of brain : Origin of EEG, Signal characteristics, Physiological significance, Auditory, Visual and somato-sensory evoked potentials Nerve communications : (1) Understanding visual system : Visual field, receptive field, receptor response, Response from ganglion, Lateral geniculate, simple, complex, hyper-complex, Cell and their receptive field receptive field formation. (10)

MODULE-IV

BIO-MOLECULES AND ENERGY PATHWAYS IN BIO-SYSTEM: The chemical structure of nucleic acids, double helical structure of DNA, Amino acids and the primary and secondary structure of proteins, virus structure. Energy conversion pathways- oxidation, glycolysis, respiratory chain. (10)

MODULE-V

BIOMECHANICS: Introduction, Strained muscles, contractile proteins, mechanical properties of muscles, contraction mechanism, role of Ca^{2+} ions, Biomechanics of the cardiovascular system, blood pressure, electrical activity during the heart beat, electrocardiography. (10)

TOTAL 48

Reference Books:

1. Biology, a human approach, I. W. Sherman and V. G. Sherman, (Oxford University Press), 1979.
2. Principles of neural science, E. R. Kandel & J. H. Schwaz, (Elsevier, North Holland), 1982.
3. Biophysical plant physiology and exology, P. S. Nobel, (University of California, Los Angeles and W. H. Freeman & Co., Sanfranscisco), 1983.

4. Biophysics : An Introduction by Rodney, M. J. Colteril (John Willey and Sons Ltd.,), 2002.
5. Principles of Biochemistry, Lehninger
6. Molecular Biology of the Cell, Bruce Alberts, Debbis Bary, (Garland Publishing N.Y, London).
7. Biophysics and Physiology of excitable membrane, Adleman (Van Mostrand Rcihold Co.), 1971.

PHY 210

ADVANCED SOLID STATE PHYSICS LAB

L-T-P-C Structure 0-0-6-3 **Course Type: Core Practical**

Group –A

1. Determination of Stefan's constant using hot filament.
2. Determination of energy band gap of semiconductor by four probe method.
3. Determination of Co-efficient of linear expansion of metal rods by Air wedge method.
4. Study of solar cell characteristics and determination of its related parameters.
5. Determination of energy band gap of a semiconductor thin film.
6. Study of polarization by reflection using Laser Spectrometer.
7. Determination of refractive index of a liquid by Newton's ring method.

Group –B

1. Study and analysis of periodic motion/harmonic oscillations by Traker software.
   (i)Circular motion of any object
   (ii)Motion of pendulum (simple/coupled)
   (iii)Electromagnetic induction motor
2. Study and analysis of non-periodic motion /enharmonic oscillation by Traker software.
   (iv)Bouncing of Ball
   (v)Spring oscillations
   (vi)Coupled oscillator

Note: (a) Students must prepare a presentation for group B Experiments.
(b) In End Term Practical Examination students will perform one experiment from group A as well as from group B.

PHY 217

INSTRUMENTATION IN PHYSICS LAB

L-T-P-C Structure 0-0-6-3 **Course Type: DSE Practical**

1. Young's modulus of a specimen plate- by Newton's interference method.
2. Bi-prism on spectrometer- Wavelength (λ) and Refractive index (μ) of a liquid-using Laser source.
3. Charge of an electron- Spectrometer
4. Study of Hall effect in semiconductors.
5. Polarizability of Liquids- Hollow prism on spectrometer.
6. Hg-Cu spectrum- Hartmann's constants and wavelength.
7. Clipping and clamping circuits
8. Power Supply Design

PHY 218

BIOMEDICAL PHYSICS LAB

L-T-P-C Structure 0-0-6-3 **Course Type: DSE Practical**

NOTE: Perform any 8 Experiments

1. Determine size of human RBC of different physiological conditions, using the techniques Laser diffraction and Eriometer. Discuss your results with respect to the physiology of RBC and technique used.
2. Draw V-I characteristics of the given hard tissues and protein samples and determine electrical resistivity of the samples at 100 volt. Determine dielectric parameters such as Dielectric constant, dissipation factor and Dielectric loss of the given samples using LCR meter.
3. Determine Activation energy of the given samples. Discuss your results.
4. Study dielectrophoretic collection rate (DCR) of human erythrocytes suspended in glycine-glucose isotonic solution and subjected to non-uniform electric fields produced by pin-pin electrode configuration. Determine DCR as a function of (a) voltage, and (b) elapsed time of applied electric field. Determine Threshold voltage of human erythrocytes as a function of a) frequency of applied electric field. Calculate excess permittivity of human erythrocytes from the knowledge of DCR
5. Determine Relative viscosity, specific viscosity and Intrinsic viscosity of the given polymer solution using Ostwald viscometer.From the viscometric data, calculate the molecular weight of the given polymer. Discuss your results with respect to polymer and technique used.
6. Determine viscosity and Surface tension of human blood and its serum and plasma at room temperature using Capillary technique. What are the advantages of this technique? Discuss your results with respect to the sample and technique used.
7. Determine Elastic Constants such as Young�s modulus, rigidity modulus, bulk modulus and Poisson�s ratio of horny material using Optical interference technique. What are the advantages of the technique? Discuss your results with respect to material studied and technique used.
8. Study denaturation of glucose. Determine specific rotation of polarized light at the wave length of sodium light, when passed through the glucose solution, using polarimeter. Discuss your results.
9. Estimate Chlorophyll a and Chlorophyll b in the given leaves of different plants using spectrocolorimeter.Discuss your results with respect to species of the given leaves.
10. Study spectroscopically oxyhemoglobin, carboxyhemoglobin and methamoglobin.What inference you draw from the experimental results?
11. Study dielectric properties such as dielectric constant, dielectric loss of hard calcified tissues at microwave frequencies.

12. Determine Auto catalytic ion efflux constant by measuring the conductivity of the medium during the process of germination of seeds of different physiological conditions. Determine velocity and absorption of ultrasound in biofluids using ultrasonic Interferometer.
13. Study osmotic fragility of human blood.
14. Determine specific gravity or density of blood of animals belonging to different Locomotion.
15. Find the HVT of a given biomaterial and hence determine mass absorption coefficient.
16. Study the dependence of back scattering of b particles on the thickness of the back scatterer and hence determine the saturation thickness of the given bio-material.

SEMESTER III

Course Code	University Course Type	Course Name	Teaching Load			
			L	T	P	C
PHY 211	Core Theory	Advanced Spectroscopy	3	1	0	4
PHY 212	Core Theory	Materials Science	3	1	0	4
PHY 213	Core Theory	Advanced Nuclear and Particle Physics	3	1	0	4
PHY 219	Department Specific Elective Theory	Advanced Quantum Mechanics	3	1	0	4
PHY 220		Electronic Devices and Circuits				
PHY 214	Core Practical	Material Science and Nuclear Physics Lab	0	0	6	3
PHY 221	Department Specific Elective Practical	Advanced Quantum Mechanics Lab	0	0	6	3
PHY 222		Electronic Devices and Circuits Lab				
Total			12	4	12	22

PHY 211

ADVANCED SPECTROSCOPY

L-T-P-C Structure 3-1-0-4 **Course Type: Core Theory**

MODULE I

MICROWAVE SPECTROSCOPY: Pure rotational spectra of diatomic molecules - Polyatomic molecules - Study of linear molecules and symmetric top molecules - Hyperfine structure and quadruple moment of linear molecules - Experimental techniques - Molecular structure determination Stark effect - inversion spectrum of ammonia - Applications to chemical analysis. (10)

MODULE II

INFRARED SPECTROSCOPY: Vibrational spectroscopy of diatomic and simple ployatomic molecules - Harmonic Oscillator - Anharmonic Oscillator - Rotational vibrators - Normal modes of vibration of Polyatomic molecules - Experimental techniques - Applications of infrared spectroscopy- H2O and N2O molecules - Reflectance spectroscopy. (8)

MODULE III

RAMAN SPECTROSCOPY: Classical theory of Raman Scattering - Raman effect and molecular structure - Raman effect and crystal structure - Raman effect in relation to inorganic, organic and physical chemistry - Experimental techniques - Coherent anti-Stokes Raman Spectroscopy - Applications of infrared and Raman spectroscopy in molecular structural confirmation of water and CO2 molecules. (10)

MODULE IV

NMR AND NQR TECHNIQUES: Theory of NMR - Bloch equations - Steady state solution of Bloch equations - Theory of chemical shifts - Experimental methods - Single Coil and double coil methods - Pulse Method - High resolution method - Applications of NMR to quantitative measurements. Quadruple Hamiltonian of NQR - Nuclear quadruple energy levels for axial and non-axial symmetry - Experimental techniques and applications. (10)

MODULE V

ESR AND MOSSBAUER SPECTROSCOPY: Quantum mechanical treatment of ESR - Nuclear interaction and hyperfine structure - Relaxation effects - Basic principles of spectrographs - Applications of ESR method. Mossbauer effect - Recoilless emission and absorption - Mossbauer spectrum - Experimental methods - Massbauer spectrometer - Hyperfine interactions - Chemical Isomer shift - Magnetic hyperfine interactions - Electric quadruple interactions - Simple biological applications. (10)

Total 48

Reference Books:

1. C.N. Banwell and E.M. McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw-Hill Publications, New Delhi.
2. G. Aruldas, 2001, Molecular Structure and Spectorscopy, Prentice - Hall of India Pvt.Ltd., New Delhi.
3. D.N. Satyanarayana, 2004, Vibrational Spectroscopy and Applications, New Age International Publications, New Delhi.

PHY 212

MATERIALS SCIENCE

L-T-P-C Structure 3-1-0-4 **Course Type: Core Theory**

MODULE I

THERMAL ANALYSIS: Introduction – thermogravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)- cooling curves - differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermomechanical parameters . (9)

MODULE II

MICROSCOPIC METHODS: Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy – Dispersion staining microscopy - phase contrast microscopy -differential interference contrast microscopy - fluorescence microscopy - confocal microscopy - scanning probe microscopy (STM, AFM) - scanning new field optical microscopy - digital holographic microscopy - oil immersion objectives -quantitative metallography - image analyzer. (10)

MODULE III

ELECTRON MICROSCOPY AND OPTICAL CHARACTERISATION SEM, EDAX, EPMA, TEM: working principle and Instrumentation – sample preparation – data collection, processing and analysis- Photoluminescence – light – matter interaction – instrumentation – electroluminescence – instrumentation – Applications. (10)

MODULE IV

ELECTRICAL METHODS: Two probe and four probe methods- van der Pauw method – Hall probe and measurement – scattering mechanism – C-V characteristics – Schottky barrier capacitance – impurity concentration – electrochemical C-V profiling – limitations. (9)

MODULE V

SPECTROSCOPY: Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, ESR, NMR,NQR, XPS, AES and SIMS-proton induced X-ray Emission spectroscopy (PIXE) –Rutherford Back Scattering (RBS) analysis-application. (10)

Total 48

Reference Books:

1. Stradling, R.A; Klipstain, P.C; Growth and Characterization of semiconductors, Adam Hilger, Bristol,1990.
2. Belk, J.As; Electron microscopy and microanalysis of crystalline materials, Applied Science Publishers, London, 1979.
3. Lawrence E.Murr, Electron and Ion microscopy and Microanalysis principles and Applications, Marcel Dekker Inc., New York, 1991

PHY 213

ADVANCED NUCLEAR AND PARTICAL PHYSICS

L-T-P-C Structure 3-1-0-4 **Course Type: Core Theory**

MODULE - I:

BASIC PROPERTIES OF NUCLEUS**:** Charge distribution in nuclei and nucleons by electron scattering experiment.
Electric quadrupole moment: Expression for exial quadruple moment, Quadruple moment of spheroidal nucleus. Quadruple moment due to single nucleon is a state J.
Magnetic dipole moment : Nuclear g factor for neutron and proton, expression for g factor for a nucleon in a state J in special cases for odd proton and odd neutron on extreme single particle model, Schmidt limits. (10)

MODULE - II

DEUTERON PROBLEM: Basic properties, ground state of deuteron for square well potential, relation between the range and depth of potential. Non existence of excited states, Basic properties of the central force, deuteron in mixture of S and D states using magnetic moment. Range of tensor interaction using quadruple moment. Meson Theory of Nuclear force : Yukawa potential. (9)

MODULE - III

INTERACTION OF RADIATION WITH MATTER: Photo electric effect , Compton scattering & pair production. Absorption and attenuation coefficient. Cross-section.
Radiation Detection: Principle, G.M. Counter, Scintillation Counter and Solid state detector, Energy Resolution and linearity, Coincidence Counting Systems. (9)

MODULE - IV

ELEMENTARY PARTICLES**:** Pion – nucleon scattering and its resonances. Strange particles : Associated production-strangeness quantum number, Gell –Mann and Nishijima formula, Kaons, lamda, sigma, omega hyperons. Symmetry classification of elementary particles- Eight Fold Symmetry- Weight diagram, discovery of Ω- particle
Interactions and their Unification**:** Fundamental interactions conservation laws, quark model, experimental support for quark model, quark structure of mesons and baryons. colour quark and gluons, quark dynamics, charm, beauty and truth quarks, GUT. (10)

MODULE - V

SHELL MODEL: Shell model for one nucleon outside core : Energy levels according to the infinite square well potential and harmonic oscillator potential, effect of spin orbit interaction, prediction of ground state spin – parity of odd A nuclei and odd-odd nuclei – Nordhiem's rules magnetic moment of odd A nuclei Configuration for excited states for two nucleons outside the core-18 O spectrum (qualitative) for two particles in d5/2 orbit and in the d5/2 –S ½ orbits, configuration mixing. (10)

Total 48

Reference Books:

1. Introductory Nuclear Physics : Kenneth S. Krane, John Wiley and sons (1988)
2. Subatomic Physics : Nuclei and Particles (Volume II) : Luc Valentin North Holland (1981)
3. Physics of Nuclei and Particles : P. Marmier and E. Sheldon Academic press (1970)
4. Introduction to Particle Physics : M. P. Khanna Prentice Hall of India (1990)
5. Subatomic Physics (Second Edition) : Hans Frauenfelder and E. M. Henley, Prentice Hall (1991)
6. Introduction Nuclear Physics : Herald. A. Enge., Addison-Wesley (1983)
7. Introductory Nuclear Physics : Samuel S. M. Wong, Prentice – Hall (1996)
8. Atomic Nucleus : R. D. Evans, Tata Mc Graw –Hill (1982)
9. Theoretical Nuclear Physics Volume I : Nuclear structure : Amosde Shalit and Herman Feshbach, John Wiley (1974)
10. Nuclear and particle Physics : W. Burcham and M. Jobes, Addision-wesley (1998)
11. Theoretical Nuclear Physics : J. M. Blatt and V. F. Weisskoff, Wiley (1962)
12. Inroduction to quantum electrodynamics and particle physics: Deep Chadra Joshi,
13. Modern Atomic and Nuclear Physics: A.B. Gupta- Books and Allied (2009)

PHY 219

ADVANCED QUANTUM MECHANICS

L-T-P-C Structure 3-1-0-4 **Course Type: DSE Theory**

MODULE I

APPROXIMATION METHODS FOR STATIONARY PROBLEMS: Time independent perturbation theory***:*** Time independent perturbation theory for a non degenerate energy level, time independent perturbation theory for a degenerate energy level, Applications: (1) one dimensional harmonic oscillator subjected to a perturbing potential in x, x^2 and x^3 (2) the fine structure of the hydrogen atom (3) Zeeman effect. (8)

MODULE II

VARIATIONAL METHOD*:* Bound states (Ritz Method), Expectation value of the energy. Applications: (1) ground state of Helium (2) van de Waals interaction. WKB approximation: the classical region, connection formulae, tunneling. Time dependent perturbation theory: Statement of the problem, approximate solution of the Schrodinger equation, constant perturbation, harmonic perturbation, transition to a continuum, the Fermi golden rule. (10)

MODULE III

SCATTERING THEORY: The scattering experiment, relationship of the scattering cross section to the wave function, scattering amplitude and scattering cross-section, Born approximation, scattering by a spherically symmetric potential, cross-section for scattering in a screened coulomb potential, validity of Born's approximation. Method of partial waves: Expansion of a plane wave in terms of partial waves, scattering by a central potential, optical theorem. (10)

MODULE IV

SYMMETRY PRINCIPLES AND CONSERVATION LAWS: Continuous symmetries: Spatial translation symmetry and conservation of linear momentum, time translation symmetry and conservation in energy, Rotations in Space: Conservation of angular momentum, Discrete symmetries: Parity, Time reversal, Permutation symmetry, symmetric and antisymmetric wave functions, Slater determinant, scattering of identical particles, ortho and para helium. (10)

MODULE V

RELATIVISTIC QUANTUM MECHANICS: Klein-Gordan equation for a free relativistic particle, Plane wave solutions, probability density and probability current density. Dirac Hamiltonian for a free relativistic particle, properties of alpha and beta matrices, probability density and probability current, positive and negative energy solutions, orthogonality and completeness of the solutions, intrinsic spin of the Dirac particle, Negative energy sea, gamma matrices, covariant form of Dirac equation, Non-relativistic approximation of Dirac equation in the presence of central potential and spin-orbit energy, Dirac particle in an external magnetic field, magnetic moment. (10)

TOTAL 48

References Books:

1. Introduction to Quantum Mechanics – David J. Griffiths, Second Edition, Pearson Prentice Hall 2005.
2. Quantum Mechanics – V.K. Thankappan, Second Edition, Wiley Eastern Limited, 1993.
3. Quantum Mechanics Vol I & II – C. Cohen-Tannoudji, B. Diu and F. Laloe, Second Edition, Wiley Interscience Publication, 1977.
4. Quantum Mechanics- L.I. Schiff, Third Edition, Mc Graw Hill Book Company, 1955
5. Quantum Mechanics – B.H. Bransden and C.J. Joachain, Second Edition, Pearson Education, 2007.
6. Modern Quantum Mechanics – J.J. Sakurai, Revised Edition, Addison-Wesley, 1995.
7. Principles of Quantum Mechanics - R. Shankar, Second Edition, Springer, 1994.
8. Quantum Mechanics – E. Merzbacher, John Wiley and Sons, 1998.
9. Quantum Physics – S. Gasiorowicz, John Wiley and Sons.

PHY 220

ELECTRONIC DEVICES AND CIRCUITS

L-T-P-C Structure 3-1-0-4 **Course Type: DSE Theory**

MODULE I:

FABRICATION OF IC AND LOGIC FAMILIES: Fabrication of IC - Monolithic integrated circuit fabrication - IC pressure transducers - Monolithic RMS - Voltage measuring device - Monolithic voltage regulators - Integrated circuit multipliers - Intergrated circuit logic - Schottky TTL - ECL - I2L - P and NMOS Logic - CMOS Logic - Tristate logic circuits (10)

MODULE II:

OPTO ELECTRONIC DEVICES: Light sources and Displays - Light emitting diodes - Surface emitting LED - Edge Emitting LED - Seven segment display - LDR - Diode lasers - Photo detectors - Basic parameters - Photo diodes - p-i-n Photo diode - Solar cells - Photo transistors - IR and UV detectors. (9)

MODULE III:

555 TIMER AND APPLICATIONS: 555 Timer - Description - Monostable operation - Frequency divider - Astable operation - Schimitt trigger - Phase Locked Loops - Basic principles - Analog phase detector - Voltage Controlled Oscillator - Voltage to Frequency conversion - PLL IC 565 - Description - Lock-in range - Capture range - Application - Frequency multiplication. (10)

MODULE IV:

OP-AMP APPLICATIONS: Instrumentation amplifier - V to I and I to V converter - Op-amp circuits using diodes - Sample and Hold circuits - Log and Antilog amplifiers - Multiplier and Divider - Electronic analog Computation - Schimitt Trigger - Astable, Monostable Multivibrator - Triangular wave generators - Sine wave generators - Rc Active filters. (9)

MODULE V:

PULSE AND DIGITAL COMMUNICATION: Pulse communications - Introduction - Types - Pulse-Amplitude Modulation (PAM) - Pulse Time Modulation - Pulse Width Modulation (PWM) - Pulse Position Modulation (PPM) - Pulse Code Modulation (PCM) - Principles of PCM - Quantizing noise - Generation and Demodulation of PCM - Effects of Noise - Advantages and applications of PCM - Pulse systems - Telegraphy - Frequency-Shift keying - Telemetry - Digital communication - Modem classification - Modes of modem operation - Modem interconnection - Modem interfacing. (10)

Total 48

Reference Books:

1. S.M. Sze, 1985, Semiconductor Devices - Physics and Technology, Wiley, New York.
2. Millman and Halkias, Integrated Electronics, McGraw-Hill, New Delhi.
3. R.A. Gaekwad, 1994, Op-Amps and intergrated circuits EEE.

4. Taub and Shilling, 1983, Digital Integrated Electronics, McGraw-Hill, New Delhi.
5. J. Millman, 1979, Digital and Analog Circuits and Systems, McGraw-Hill, London.
6. George Kenndy, 1987, Electronic communication systems 3rd Edition, McGraw-Hill, London.

PHY 214

MATERIAL SCIENCE AND NUCLEAR PHYSICS LAB

L-T-P-C Structure 0-0-6-3 **Course Type: Core Practical**

Group –A

1.. To study the characteristics of a Geiger-Muller counter and to determine the operating voltage of the given GM counter.
2. To Study the Inverse Square Law of Radiation distribution using GM counter.
3. To Study Beta absorption in different metal foils and finding of end point energy.
4. To Study Gamma Attenuation Coefficient.
5. To study statistical distribution in nuclear events.

Group –B

1. Determination of magnetic susceptibility – Quinke's method.
2. Determination of band gap of silicon and its Hall co-efficient.
3. Determination of dielectric constant of liquids and solids.
4. To study dielectric behaviour of ferroelectric materials during the phase transition.
5. To study the growth of a crystal using thermal evaporation technique
6. Determination of corrosion rate using micro balance.

PHY 221

ADVANCED QUANTUM MECHANICS LAB

L-T-P-C Structure 0-0-6-3 **Course Type: DSE Practical**

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

$$\frac{d^2y}{dr^2} = A(r)u(r),\ A(r) = \frac{2m}{\hbar^2}\,[V(r) - E] \text{ where } V(r) = -\frac{e^2}{r}$$

Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 $(eVÅ)^{1/2}$, ħc = 1973 (eVÅ) and m = 0.511×10^6 eV/c^2.

2. Solve the s-wave radial Schrodinger equation for an atom:

$$\frac{d^2y}{dr^2} = A(r)u(r),\ A(r) = \frac{2m}{\hbar^2}\,[V(r) - E]$$

where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

$$V(r) = -\frac{e^2}{r}e^{-r/a}$$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 $(eVÅ)^{1/2}$, m = 0.511×10^6 eV/c^2, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

$$\frac{d^2y}{dr^2} = A(r)u(r),\ A(r) = \frac{2m}{\hbar^2}\,[V(r) - E]$$

For the anharmonic oscillator potential

$$V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$$

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2, k = 100

MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3}In these units, cħ = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

   $$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2\mu}{\hbar^2}[V(r) - E]$$

   Where μ is the reduced mass of the two-atom system for the Morse potential

   $$V(r) = D\left(e^{-2\alpha r'} - e^{-\alpha r'}\right), \qquad r' = \frac{r - r_o}{r}$$

   Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.

Take: m = $940 \times 10^6 eV/C^2$, D = 0.755501 eV, α = 1.44, r_o = 0.131349 Å

Laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
7. To show the tunneling effect in tunnel diode using I-V characteristics.
8. Quantum efficiency of CCDs

PHY 222

ELECTRONIC DEVICES AND CIRCUITS LAB

L-T-P-C Structure 0-0-6-3 **Course Type: DSE Practical**

1. To study the Zener diode as a voltage regulator at various loads.
2. To study the Input/output characteristics of a Transitor in common - emitter configuration.
3. To study half -wave rectifier with and without filter.
4. To study full - wave rectifier with and without filter.
5. To study h-parameters of CE-configuration.
6. To study frequency response curves of a CE-amplifier.
7. To study frequency response curves of CC-amplifier.
8. To study frequency response of FET amplifier.
9. To study of silicon-controlled rectifier (SCR) characteristics.
10. To study the input/output characteristics of UJT.

SEMESTER IV

Course Code	University Course Type	Course Name	Teaching Load			
			L	T	P	CREDIT
PHY 223	Department Specific Elective Theory	Physics for Nano Materials	3	1	0	4
PHY 224		Digital Electronics, Microprocessor and Microcontroller				
PHY 225	Department Specific Elective Theory	Thin Film Techniques	3	1	0	4
PHY 226		Microwaves				
PHY 227	Department Specific Elective Practical	Physics for Nano Materials Lab	0	0	8	4
PHY 228		Digital Electronics, Microprocessor and Microcontroller Lab				
PHY 229		Thin Film Techniques Lab				
PHY 230		Microwaves Lab				
PHY 231	Core Practical	Project	0	0	16	8
PHY 232	Core Practical	Seminar	0	0	4	2
Total			6	2	28	22

PHY 223

PHYSICS FOR NANOMATERIALS

L-T-P-C Structure 3-1-0-4 **Course Type: DSE Theory**

MODULE I

Introduction to Nanoscience: Free electron theory (qualitative idea) and its features, Idea of band structure, Density of states for zero, one, two and three dimensional materials, Quantum confinement, Quantum wells, wires, dots, Factors affecting to particle size, Structure property relation, Size dependence properties. (10)

MODULE II

Determination of particle size, Increase in width of XRD peaks of nano-particles, Shift in photoluminescence peaks, Variation on Raman spectra of nano-materials.

Synthesis of Nanomaterials: Physical methods: High energy Ball Milling, Melt mixing, Physical vapour deposition, Ionised cluster beam deposition, Laser ablation, Laser pyrolysis, Sputter deposition, Electric arc deposition, (10)

MODULE III

Photolithography. Chemical methods: Chemical vapour deposition, Synthesis of metal & semiconductor nanoparticles by colloidal route, Langmuir-Blodgett method, Microemulsions, Sol-gel method, Combustion method, Wet chemical method. (10)

MODULE IV

Nanomaterials Characterizations: X-ray diffraction, UV-VIS spectroscopy, Photoluminescence spectroscopy, Raman spectroscopy, Transmission Electron Microscopy, Scanning Electron Microscopy, Scanning Tunnelling Electron Microscopy, Atomic Force Microscopy, Vibration Sample Magnetometer, Spintronics. (9)

MODULE V

Special Nanomaterials and Properties: Carbon nanotubes, Porous silicon, Aerogels, Core shell structures. Self assembled nanomaterials. Metal and semiconductor nanoclusters Mechanical, Thermal, Electrical, Optical, Magnetic, Structural properties of nanomaterials Text (9)

Total 48

Reference Books:

1. Nanotechnology: Principles & Practicals. Sulbha K. Kulkarni ,Capital Publishing Co.New Delhi.
2. Nanostructures & Nanomaterials Synthesis, Properties & Applications. Guozhong Cao, Imperials College Press London.
3. Nanomaterials: Synthesis, Properties & Applications. Edited by A.S. Edelstein & R.C.Commorata. Institute of Physics Publishing, Bristol & Philadelphia.
4. Introduction to Nanotechnology. C.P. Poole Jr. and F. J.Owens, Wiley Student Edition.
5. Nano: The Essentials. T.Pradeep , McGraw Hill Education.
6. Handbook of Nanostructures: Materials and Nanotechnology. H. S. Nalwa Vol 1- 5, Academic Press, Bostan.

PHY 224

DIGITAL ELECTRONICS, MICROPROCESSOR AND MICROCONTROLLER

L-T-P-C Structure 3-1-0-4 **Course Type: DSE Theory**

MODULE I

Digital circuits: Flip-flops – R-S, D, J-K and T Flip-flops. Shift registers – Shift left and Shift right registers- Synchronous and Asynchronous counters (Construction and working only). Basic concepts of Multiplexing and Demultiplexing- Encoder-decoder. (10)

MODULE II

A/D and D/A converters: Sampling theorem – Time division multiplexing – quantization – DAC – Weighted resister method – Binary ladder network – ADC- Successive approximation, Dual slope and counter methods. Operating principles and pin configurations of IC s 0809 and 0800. (10)

MODULE III

Architecture and programming of 8085 microprocessor: Architecture of 8085 – Data bus- Address bus- Control bus – General Purpose Registers – Special purpose registers – Addressing modes of 8085 – register, immediate, direct-indirect and implicit – Instruction set – Data transfer, Arithmetic, Logical, Branching, Stack and I/O instructions – Assembly language programming: Simple programs using arithmetic and logic operations – Interrupt structure.(10)

MODULE IV

Interfacing devices of 8085 microprocessor: Types of interfacing devices – Programmable peripheral interface (PPI 8255) – Universal synchronous asynchronous receiver transmitter (USART 8251). Timer/counter (8253), DMA controller (8257). (9)

MODULE V

Architecture and programming of 8051 microcontroller: Differences between a microprocessor and microcontroller – Key features (808051) – Memory organization – Data memory – Program memory – Internal RAM organization – Special function Registers – Control Registers – I/O ports – Counters and Timers – Interrupt structure. Instruction set – Addressing modes in 8051. Simple programs. (9)

Total 48

Reference Books:

1. R.P. Jain- Modern Digital Electronics- Tata Mc Graw Hill.
2. Aditya P.Mathur-Introduction to microprocessors- Tata Mc.Graw Hill-II R
3. Ramesh S.Gaonkar- Microprocessor Architecture, Programming and Applications with 8085- Wily Eastern
4. Douglas V.Hall- Microprocessor and Interfaces- Tata Mc Graw Hill
5. A.K.Mukho Padhayay- Microprocessor, Micro Computer and their Applications- Narosa Publishing House
6. Kenneth J -The 8051 Micro Controller – Ayala Penram internationals-India.
7. Lance A.Leventhal-Introduction to Microprocessor Software, Hardware programming- Prentice Hall of India.
8. Kenneth L.Shot-Microprocessors and Programmed Logic- Prentice Hall of India.

PHY 225

THIN FILM TECHNIQUES

L-T-P-C Structure 3-1-0-4 **Course Type: DSE Theory**

MODULE I

PREPARATION OF THIN FILMS: Study of thin film vacuum coating unit - Construction and uses of vapour sources-wire, sublimation, crucible and electron bombardment heated sources. Physical vapour deposition – Thermal evaporation – electron beam evaporation – Sputtering - Study of glow Discharge - Physical nature of sputtering - Sputtering yield - Experimental set up for DC and RF magnetron sputtering, Pulsed laser deposition and Ion beam assisted deposition. Chemical vapour deposition – Thermodynamics of CVD - Atmospheric pressure CVD – MOCVD and PECVD processes. (10)

MODULE II

CHEMICAL METHODS: Qualitative study of preparation of thin films by Electroplating, vapour phase growth and anodization.**NUCLEATION AND GROWTH:** Nucleation and growth of thin films – four stages of film growth - Directionality of evaporation molecules - Cosine law of emission. Emission from a point source. Mass of material condensing on the substrate. (9)

MODULE III

DEPOSITION MONITORING AND CONTROL: Microbalance, Crystal oscillator thickness monitor, optical monitor, Resistance Monitor. Thickness measurement**:** Multiple Beam Interferometer, Fizeau (Tolansky) technique - Fringes of equal chromatic order (FECO) method - Ellipsometry (qualitative only)**ELECTRICAL PROPERTIES:** Sheet resistance - size effect - Electrical conduction in thin metallic films. Effect of ageing and annealing - Oxidation - Agglomeration. (10)

MODULE IV

DIELECTRIC PROPERTIES: DC conduction mechanism - Low field and high field conduction. Breakdown mechanism in dielectric films - AC conduction mechanism. Temperature dependence of conductivity.**STRUCTURE AND OPTICAL PROPERTIES:** Study of structure of thin films using x-ray diffraction method, **O**ptical constants of thin films – spectrophotometer- Transmittance, absorption, determination of band gap. (10)

MODULE V

APPLICATION OF THIN FILMS: Thin film resistors: Materials and Design of thin film resistors (Choice of resistor and shape and area) - Trimming of thin film resistors - sheet resistance control - Individual resistor trimming. Thin film capacitors: Materials - Capacitor structures - Capacitor yield and capacitor stability. Thin film field effect transistors: Fabrication and characteristics - Thin film solar cells – antireflection coatings. (9)

Total 48

References Books:

1. Milton Oring, “Materials Science of Thin Films”, Academic Press, 2002.
2. Icha Elshabini-Riadaud Fred D Barlow III "Thin Film Technology Hand book", Mc Graw Hill Company, 1997.
3. Goswami A, "Thin Film Fundamentals", New Age International (P) Ltd., 1996.
4. Donald Smith, “Thin Film Deposition ”, McGraw –Hill, 1995.

PHY 226

MICROWAVES

L-T-P-C Structure 3-1-0-4 **Course Type: DSE Theory**

MODULE I

MICROWAVE FUNDAMENTALS: Microwave frequency spectrum, Types and characteristics of transmission line, Transmission line equation solution, Reflection coefficient and transmission coefficient, Standing wave and standing wave ratio, Line impedance and admittance. (8)

MODULE II

WAVEGUIDES: Rectangular wave guide- waves in rectangular waveguide, TE and TM modes, solution of TE mode in rectangular waveguide, Dominating mode and degenerate mode in rectangular waveguide, mode excitations, Circular wave guide-TEM mode, advantages, disadvantages and applications, Power losses in waveguides. (10)

MODULE III

WAVEGUIDE COMPONENTS: Scattering matrix, Microwave circular cavities, Q-factor of a cavity resonator, frequency meters, Basic principles of Directional coupler, Tow hole directional couplers Circulators, Attenuators, Isolators. (10)

MODULE IV

MICROWAVE ACTIVE DEVICES: Limitations of conventional tubes at high frequencies , Velocity and density modulation of electron beam, Two cavity Klystron amplifier, multi cavity klystron, Reflex Klystron, , Basic of Transfer electron devices: Gunn diode. (10)

MODULE V

MICROWAVE MEASUREMENTS: Attenuation measurement, Frequency measurement, Power measurement, Reflection coefficient and VSWR measurement, Microwave detection, Point contact diode, Schottly barrier diode, Impedance measurement. (10)

Total 48

References Books:

1. Microwave Devices and Circuits- Samull Y. Lio, Prentice Hall of India Pravate Limited, New Delhi.
2. Microwave Communications Components and Circuits- Hunds, Mc Graw Hill, International Edition.
3. Microwave Techniques- D.C. Agarwal, S. Chand and Company.
4. Microwave Engineering- David M. Pozar, John Wiley and Sons, New York.
5. Microwave Principles- Herbert S. Reich, C.B.S. Publications.
6. Microwave Propagation and Techniques- D.C. Sarkar, S. Chand and Company.
7. Microwave Fundamental- Sanjeeva, Gupta and Others, Khanna Publications.
8. Microwave Circuits and Passive Devices- Sisodia and Raghuvanshi, Wiley Easter Ltd.

PHY 227

PHYSICS FOR NANOMATERIALS LAB

L-T-P-C Structure 0-0-4-2 **Course Type: DSE Practical**

1. Synthesis of metal oxide nanoparticles by wet chemical method.
2. Synthesis of inorganic nanomaterials by combustion method.
3. Synthesis of nanomaterials by sol-gel method.
4. Synthesis of conducting polymer nanocomposites by in-situ polymerization.
5. Study of optical absorption of nanomaterials.
6. Determination of particle size of nanomaterials from x-ray diffraction.
7. Deposition of thin films by dip coating technique.
8. Electrical characterization of nanostructured materials.
9. Deposition of thin film in vacuum.
10. Electrical resistivity of nanomaterials using four probe method

PHY 228

DIGITAL ELECTRONICS, MICROPROCESSOR AND MICROCONTROLLER LAB

L-T-P-C Structure 0-0-4-2 **Course Type: DSE Practical**

8086 programming (Any six of the following)

1. Addition / subtraction of 32-bit integers
2. Hexadecimal to ASCII and vice versa
3. Search for character sequence in a string
4. Addition of an array of integers
5. Bubble sorting of an array of integers
6. Counting no. of 1's in a word using shift and rotate instructions
7. Packed and unpacked BCD arithmetic
8. Counting positive values, zeros and negative values in an array of integer
9. 64 bit Addition

8086 Interfacing (Any six of the following)

1. Interfacing of 8255 I/O Programming.
2. Interfacing of 8253 programmable Interval Timer
3. Interfacing of Stepper motor
4. Interfacing of Seven Segment Display
5. Interfacing of 8279 Programmable Keyboard
6. A/D converter interface
7. D/A converter interface
8. Traffic Controller interface
9. Square wave generator

8051 Microcontroller (Any six of the following)

1. Addition, subtraction (8bit and multi Bytes)
2. Multiplication, Division of 8-bit and 16-bit.
3. Temperature measurement
4. Ascending and descending order and alphabetical order.
5. Real time clock.
6. LED Interface.
7. Interfacing A/D converter
8. Interfacing D/A Converter
9. Interfacing Logic controller
10. Interfacing Traffic Controller
11. Interfacing Keyboard
12. Interfacing seven segment display

PHY 229

THIN FILM TECHNIQUES LAB

L-T-P-C Structure 0-0-4-2 **Course Type: DSE Practical**

1. To Study the Doctor blade method
2. To Study the Vacuum evaporation method
3. To Study the Spin coating method
4. To Study the Spectrophotometer method
5. To Study the Photoluminescence method
6. To Study the 4-point probe method

PHY 230

MICROWAVES LAB

L-T-P-C Structure 0-0-4-2 **Course Type: DSE Practical**

1. To determine the velocity of ultrasonic wave in non-conducting medium
2. Studying Kerr effect of non conducting liquid.
3. To study the characteristics of the reflex Klystron tube
4. To measure the transverse and longitudinal field distribution of microwaves received by horn antenna.
5. Determination of dielectric constant of benzene at X band frequency.
6. Determination of dielectric constant of liquids and solids.

PHY 231

PROJECT

L-T-P-C Structure 0-0-16-8 **Course Type: Core Practical**

1. All students of IV semester will be allotted a project by the department at the commencement of the semester.

2. Each faculty member will guide at least two students in completing the project work by the student.

3. Project work will be regularly assessed by the faculty concerned and submission of the report to HOD on monthly basis.

4. The project submission process must be completed by each student at least 10 days ahead of end term practical exams.

PHY 232

SEMINAR

L-T-P-C Structure 0-0-4-2 **Course Type: Core Practical**

- Individual student is required to choose a topic of their interest for final research area.
- Research related topics can be downloaded from IEEE, Elsevier, Springer etc. Topics preferably from outside the M.Sc. syllabus
- Each student has to give a seminar on that topic for about 30 minutes.
- A committee consisting of at least two faculty members specialized in respective area of research shall assess the presentation of the seminar.
- Marks are awarded to the students by head of department in consultancy with faculty.
- Each student shall submit two copies of a write up of his/her seminar topic. One copy shall be returned to the student after duly certifying it by the Head of department and the other will be kept in the departmental library.
- Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.