M.Sc. Physics (1st Semester)

Total Contact Hrs = 28
Total Credits = 22

Semester 1st								
Course		Contact Hrs.			Marks			Credits
Code	Name	L	T	P	Internal	External	Total	
MPHY1-101	Classical Mechanics	4	0	0	40	60	100	4
MPHY1-102	Statistical Physics	4	0	0	40	60	100	4
MPHY1-103	Mathematical Physics	4	0	0	40	60	100	4
MPHY1-104	Electronics	4	0	0	40	60	100	4
MPHY1-105	Electronics Lab	0	0	6	60	40	100	3
MPHY1-106	Computer Programming Lab	0	0	6	60	40	100	3
Total							600	22

M.Sc. Physics (2nd Semester)

Total Contact Hrs = 30 **Total Credits = 23**

MPHY1-207	Quantum Mechanics –I	4	0	0	40	60	100	4
MPHY1-208	Electrodynamics	4	0	0	40	60	100	4
MPHY1-209	Atomic & Molecular Physics	4	0	0	40	60	100	4
MPHY1-210	Condensed Matter Physics-I	4	0	0	40	60	100	4
MPHY1-211	Advanced Optics and Spectroscopy Lab	0	0	6	60	40	100	3
MPHY1-212	Condensed Matter Lab	0	0	6	60	40	100	3
MPHY1-213	Seminar-I	0	0	2	100	0	100	1
					Total		700	23

M.Sc. Physics (3rd Semester)

Total Contact Hrs = 27 **Total Credits = 23**

MPHY1-314	Nuclear Physics	4	0	0	40	60	100	4
MPHY1-315	Quantum Mechanics –II	4	0	0	40	60	100	4
MPHY1-316	Condensed Matter Physics-II	4	0	0	40	60	100	4
MPHY1-317	Nuclear Physics Lab	0	0	6	60	40	100	3
MPHY1-318	Seminar-II	0	0	2	100	0	100	1
xxxxxxx	Deptt. Elective-I	4	0	0	40	60	100	4
	Open Elective-I**	3	0	0	40	60	100	3
						Total	700	23

M.Sc. Physics (4th Semester)

Total Contact HRs = 17+ Project, Total Credits = 22

MPHY1-419	Particle Physics	4	0	0	40	60	100	4
MPHY1-420	Project***	-	-	-	300		300	6
MPHY1-421	Workshop	0	0	2	60	40	100	1
xxxxxxx	Deptt. Elective-II	4	0	0	40	60	100	4
xxxxxxx	Deptt. Elective-III	4	0	0	40	60	100	4
	Open Elective-II**	3	0	0	40	60	100	3
						Total	800	22
Total Credit During M.Sc Program		Credits earned in Four Semesters (I+II+III+IV)						90
Total Marks During M.Sc Program		Marks earned in Four Semesters (I+II+III+IV)						2800

*Subject to the availability of teacher and minimum 10 students/as per university guidelines.
** Student must choose open elective subject from other department.

*** The student is to carry out literature survey on the topic assigned to him/her by his/her supervisor. The student has to carry out survey 15-20 papers, out of which atleast 10 should be international repute. The student is to write a review paper and present to his/her supervisor in the form of soft and hard copy. He/she will also have to give 15 minutes presentation through power point slides in the front of 3 teachers as decided by Head of department including project supervisor. Evaluation is to be done on his/her performance.

List of Department Elective Subjects

SEMESTER 3rd									
Deptt. Elective-I									
Course		**Contact Hrs.**			**Marks**			**Credits**	
Code	**Name**	**L**	**T**	**P**	**Internal**	**External**	**Total**		
MPHY1-356	**Advanced Mathematical Physics**	4	0	0	40	60	100	4	
MPHY1-357	**Science of Renewable energy sources**	4	0	0	40	60	100	4	
MPHY1-358	**Fibre optics and Laser Technology**	4	0	0	40	60	100	4	
MPHY1-359	**Microprocessor**	4	0	0	40	60	100	4	
SEMESTER 4th									
Deptt. Elective-II, III									
MPHY1-460	**Nuclear Accelerators & Radiation Physics**	4	0	0	40	60	100	4	
MPHY1-461	**Physics of Materials**	4	0	0	40	60	100	4	
MPHY1-462	**Nano Physics**	4	0	0	40	60	100	4	
MPHY1-463	**Soft Matter Physics**	4	0	0	40	60	100	4	

List of Open Elective Subjects

Open Elective Subjects Offered by Physics Deparment								
Course		**Contact Hrs.**			**Marks**			**Credits**
Code	**Name**	**L**	**T**	**P**	**Internal**	**External**	**Total**	
MPHY0-F91	**Physics of Materials**	4	0	0	40	60	100	3
MPHY0-F92	**Science of Renewable Energy Sources**	4	0	0	40	60	100	3

CLASSICAL MECHANICS

Subject Code: MPHY1-101 | **L T P C 4 0 0 4** | **Duration: 48 Hrs.**

UNIT 1

1. Lagrangian and Hamilton's Formulation (12 Hrs)

Mechanics of a system of particles; constraints of motion, generalized coordinates, D'Alembert's Principle and Lagrange's velocity dependent forces and the dissipation function, Applications of Lagrangian formulation, Calculus of variations, Hamilton's principle, Lagrange's equation from Hamilton's principle, extension to non-holonomic systems, advantages of variational principle formulation, symmetry properties of space and time and conservation theorems.

UNIT 2

2. Rigid Body Motion (12 Hrs)

Independent co-ordinates of rigid body, orthogonal transformations, Eulerian Angles and Euler's theorem, infinitesimal rotation, Rate of change of a vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top.

UNIT 3

3. Small Oscillations and Hamilton's Equations (12 Hrs)

Small Oscillations: Eigen value equation, Free vibrations, Normal Coordinates, Vibrations of a triatomic molecule (small oscillation). Legendre Transformation, Hamilton's equations of motion, Cyclic-co-ordinates, Hamilton's equations from variation principle, Principle of least action.

UNIT 4

4. Canonical Transformation and Hamilton-Jacobi Theory (12 Hrs)

Canonical transformation and its examples, Poisson's brackets, Equations of motion, Angular momentum, Poisson's Bracket relations, Infinitesimal canonical transformation, Conservation Theorems. Hamilton-Jacobi equations for principal and characteristic functions, Action-angle variables for systems with one-degree of freedom.

Recommended Books

1. H. Goldstein, C. Poole and J. Safko, 'Classical Mechanics', Pearson Education Asia, New Delhi.
2. K.C. Gupta, 'Classical Mechanics of Particles and Rigid Bodies', Wiley Eastern, New Delhi.
3. L.N. Hand and J.D. Finch, 'Analytical Mechanics', Cambridge University Press, Cambridge.
4. L.D. Landau and E.M. Lifshitz, 'Mechanics', Pergamon, Oxford.
5. N.C. Rana and P.J. Joag, 'Classical Mechanics', Tata McGraw Hill, New Delhi.

STATISTICAL PHYSICS

Subject Code: MPHY1-102 | **L T P C 4 0 0 4** | **Duration: 48 Hrs.**

UNIT 1

Statistical Basis of Thermodynamics (12 Hrs)

Foundation of statistical mechanics, macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Entropy of mixing and Gibbs paradox, Phase space and Liouville's theorem.

UNIT 2

Ensemble Theory (12 Hrs)

Micro-canonical ensemble theory and its application to ideal gas of monatomic particles; Canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations, equipartition and virial theorems, a system of quantum harmonic oscillators as canonical ensemble, statistics of paramagnetism; The grand canonical ensemble and significance of statistical quantities, classical ideal gas in grand canonical ensemble theory, density and energy fluctuations

UNIT 3

Quantum Statistics of Ideal Systems (13 Hrs)

Quantum states and phase space, an ideal gas in quantum mechanical ensembles, statistics of occupation numbers; Ideal Bose systems: basic concepts and thermodynamic behavior of an ideal Bose gas, Bose-Einstein condensation, discussion of gas of photons (the radiation fields) and phonons (the Debye field); Ideal Fermi systems: thermodynamic behaviour of an ideal Fermi gas, discussion of heat capacity of a free-electron gas at low temperatures, Pauli paramagnetism.

UNIT 4

Theory of Phase Transition (11 Hrs)

First and Second order transition, Diamagnetism, paramagnetism and ferromagnetism, Ising model, Diffusion equation, random walk and Brownian motion, introduction to nonequilibrium processes.

Recommended Books:

1. R.K. Pathria, 'Statistical Mechanics', 2nd Edn., Butterworth-Heinemann, Oxford.
2. K. Huang, 'Statistical Mechanics', Wiley Eastern, New Delhi.
3. B.K. Agarwal and M. Eisner, 'Statistical Mechanics', Wiley Eastern, New Delhi.
4. C. Kittel, 'Elementary Statistical Physics', Wiley, New York.
5. S.K. Sinha, 'Statistical Mechanics', Tata McGraw Hill, New Delhi.

MATHEMATICAL PHYSICS

Subject Code: MPHY1-103 **L T P C** **Duration: 48 Hrs.**

4 0 0 4

UNIT 1

Linear Algebra and Vector space (13 Hrs)

Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Rank of matrix, Guass Jordan method to find inverse of matrix,reduction to normal form, Consistency and solution of linear algebraic equations, Eigenvalues and eigenvectors, Cayley-Hamilton theorem, Reduction to diagonal form, Contour Integration.

UNIT 2

Integral Transform (12 Hrs)

Fourier series of periodic functions, even and odd functions, half range expansions and Fourier series of different wave forms, Fourier transforms: Infinite and Finite Fourier transform (General, Sine, Cosine Fourier transform).

Laplace transforms of various standard functions, properties of Laplace transforms, inverse Laplace transforms and Solve Differential Equation using Inverse Laplace.

UNIT 3

Partial Differential Equations (12 Hrs)

Formation of PDE, Linear PDE, Homogeneous PDE with constant coefficients, Classification of PDE, Application of PDE: Wave equation and Heat conduction equation in one dimension. Two dimensional Laplace equation in Cartesian Coordinates, solution by the method of separation of variables, Gamma function, Beta function.

UNIT 4

Special Functions (11 Hrs)

Ordinary and Singular points, Power series solution of differential equations, Frobenius method. Bessel functions of first and second kind, Generating function, integral representation and recurrence relations for Bessel's functions of first kind, orthogonality. Legendre functions: generating function, recurrence relations and special properties, orthogonality.

Recommended Books

1. Anil Makkar, Abstract Algebra, Sharma Publications.
2. M.D. Raisinghania, 'Advanced Differential Equation', S. Chand.
3. M.L. Boas, 'Mathematical Methods in the Physical Sciences', Wiley, NewYork.
4. E.D. Rainville, 'Special Functions', MacMillan, New York.
5. B.S. Grewal, 'Higher Engineering Mathematics', Khanna Publishers.

ELECTRONICS

Subject Code: MPHY1-104 **L T P C** **Duration: 48 Hrs.**

4 0 0 4

UNIT 1

Electronic Devices (12 Hrs)

Semiconductor Devices (diode, transistors), MESFETs and MOSFETs, Charge Coupled (CCDs) devices, Unijunction transistor (UJT), four layer (PNPN) devices, construction and working of PNPN diode, Semiconductor controlled rectifier (SCR) and Thyristor, Transducers.

UNIT 2

Electronic Circuits (12 Hrs)

Multivibrators (Bistable Monostable and Astable), Differential amplifier, Operational amplifier (OP-AMP), OP-AMP as inverting and non-inverting, scalar, summer, integrator, differentiator. Schmitt trigger and logarithmic amplifier, Electronic analog computation circuits.

UNIT 3

Digital Principles (12 Hrs)

Binary and Hexadecimal number system, Binary arithmetic, Logic gates, Boolean equation of logic circuits, Karnaugh map simplifications for digital circuit analysis, and design, Encoders & Decoders, Multiplexers and Demultiplexers, Parity generators and checkers, Adder-Substractor circuits.

UNIT 4

Sequential Circuits and Microprocessor (12 Hrs)

Flip Flops, Registers, Up/Down counters, Basics of semiconductor memories: ROM, PROM, EPROM, and RAM,D/A conversion using binary weighted resistor network, Ladder, D/A converter, A/D converter using counter, Successive approximation A/D converter, Microprocessor INTEL 8085 basic.

Recommended Books

1. Millman and Halkias, 'Electronic Devices and Circuits', Tata Mc Graw Hill, **1983**.
2. Ben G. Streetman, 'Solid State Electronic Devices', Prentice Hall, New Delhi, **1995**.
3. A.P. Malvino and D.P. Leach, 'Digital Principles and Applications', Tata McGraw Hill, New Delhi, **1986**.
4. A.P. Malvino, 'Digital Computer Electronics', Tata Mc Graw Hill, New Delhi, **1986.**
5. Millman, 'Microelectronics', Tata Mc Graw Hill, London, **1979**.
6. W.H. Gothmann, 'Digital Electronics', Prentice Hall, New Delhi, **1980**.

ELECTRONICS LAB

Subject Code: MPHY1-105 **L T P C** **Duration: 72 Hrs.**
0 0 6 3

Note: Students will be required to perform at least ten experiments from the given list of experiments

1. Design of Regulated power supply and study of its characteristics.
2. To Study the various gates and verify their truth tables using IC's.
3. To study the Encoder and decoder circuits.
4. To study the INTEL 8085 Microprocessor and WAP to addition and subtraction of two 8 bit numbers.
5. WAP to addition and Subtraction of two 16 bit numbers.
6. WAP to multiply and divide of two 8 bit numbers.
7. To study the use of digital to analog and analog to digital converter.
8. Plot VI characteristics of depletion and enhancement type MOSFET.
9. Design 2:1 MUX circuit using basic gates and verify.
10. To study the construction of thyristor and plot VI characteristics of SCR.
11. Plot the frequency response of op-amp on semi-log graph paper.
12. Application of op-amp as inverting and non-inverting Amplifier.
13. To use the op-amp as summing, scalling and averaging amplifier.
14. Design differentiator and integrator using op-amplifier.

COMPUTER PROGRAMMING LAB

Subject Code: MPHY1-106 **L T P C** **Duration: 72 Hrs.**
0 0 6 3

Note: Students will be required to perform at least ten experiments from the given list of experiments.

1. Introduction to Numerical methods: Computer algorithms, interpolations cubic spline fitting, Numerical differentiation – Lagrange interpolation, Numerical integration by Simpson and Weddle's rules, random generators, Numerical solution of differential equations by Euler, predictor-corrector and Runge-Kutta methods, problems.

2. Computer hardware, software, programming languages, Fortran 77, classification of data, variables, dimension and data statement, input/output, format, branching, IF statements, DO statements, subprograms, operations with files.

or

2. Programming with C++: Introduction to the Concept of Object Oriented Programming; Advantages of C++ over conventional programming languages; Introduction to Classes, Objects; C++ programming syntax for Input/Output, Operators, Loops, Decisions, simple and inline functions, arrays, strings, pointers; some basic ideas about memory management in C++.

3. List of Numerical Problems:

Section A

1. Data handling: find standard deviation, mean, variance, moments etc. of at least 25 entries.
2. Choose a set of 10 values and find the least squared fitted curve.
3. Generation of waves on superposition like stationary waves and beats.
4. Fourier analysis of square waves.
5. Wave packet and uncertainty principle.

Section B

6. Study the charging and discharging of a capacitor in RC circuit with a DC source using Euler method. Graphically demonstrate the variation of charge with time for two values of time step size.

Modify the program to include AC source instead of D.C. Source.

7. Study the growth and decay of current in RL circuit containing (a) DC source and (b) AC source using Runge Kutta method. Draw graphs between current and time in each case. Perform power analysis in the circuit for two values of time step size for the case.

8. Study graphically the path of a projectile with and without air drag, using FN method. Find the horizontal range and maximum height in either case. Write your comments on the findings.

9. Motion of artificial satellite.

10. Study of motion of a one-dimensional harmonic-oscillator without and with damping effect (use Euler method). Draw graphs showing the relations (a) velocity vs time (b) acceleration vs time (c) position vs time.

Recommended Books

1. J.B. Scarborough, ‘Numerical Mathematical Analysis’, 4th Edn., Oxford Book Co.
2. P.L. DeVries, ‘A first course in Computational Physics’, 2nd Edn., Wiley, **2011**.
3. ‘Computer Applications in Physics’, 2nd Edn., S. Chandra (Narosa), **2008**.
4. R.C. Verma, P.K. Ahluwalia and K.C. Sharma, ‘Computational Physics’, 1st Edn., New Age, **2005**.
5. ‘Object Oriented Programming with C++: Balagurusamy’, 2nd Edn., Tata McGraw Hill, **2002**.

QUANTUM MECHANICS –I

Subject Code: MPHY1-207 **L T P C 4 0 0 4** **Duration: 48 Hrs.**

UNIT 1

Basic Formulation and quantum Kinematics (11 Hrs)

Stern Gerlach experiment as a tool to introduce quantum ideas, analogy of two level quantum system with polarisation states of light. Complex linear vector spaces, ket space, bra space and inner product, operators and properties of operators. Eigenkets of an observable, eigenkets as base kets, matrix representations. Measurement of observable, compatible vs. incompatible observable, commutators and uncertainty relations. Change of basis and unitary transformations. Diagonalisation of operators. Position, momentum and translation.

UNIT 2

Quantum Dynamics (11 Hrs)

Time evolution operator and Schorodinger equation, energy eigen kets, time dependence of expectation values, Schrodinger vs. Heisenberg picture, unitary operator, Heisenberg equations

Unit 3

One Dimenstional Systems (11 Hrs)

Potential Step, potential barrier, potential well. Scattering vs. Bounds states. Simple harmonic oscillator, energy eigen states, wave functions and coherent states.

Unit 4

Theory of Angular momentum (15 Hrs)

Orbital angular momentum commutation relations. Eigen value problem for L^2, Angular momentum algebra, commutation relations. Introduction to the concept of representation of the commutation relations in different dimensions. Eigen vectors and eigen functions of J^2 and J_z. Addition of angular momentum and C.G. coefficients.

Recommended Books:
1. J.J. Sakurai, 'Modern Quantum Mechnics', Pearson Education Pvt. Ltd., New Delhi, **2002**.
2. L.I. Schiff, 'Quantum Mechanics', Tokyo Mc Graw Hill, **1968**.
3. 'Feynmann lectures in Physics', Vol. III, Addison Wesly, **1975**.
4. Powel and Craseman, 'Quantum Mechanics', Narosa Pub., New Delhi, **1961**.
5. Merzbacher, 'Quantum Mechanics', John Wiley & Sons, New York, **1970**.

ELECTRODYNAMICS

Subject Code: MPHY1-208 **L T P C** **Duration: 48 Hrs.**
4 0 0 4

Unit 1

Electrostatics and Magnetostatics (12 Hrs)

Review of basic concept of Electrostatics (Coulomb's law, Guass's law, Poisson's equation, Laplace equation), Solution of boundary value problem: Green's function, method of images and calculation of Green's function for the image charge problem in the case of a sphere, Laplace equation, uniqueness theorem. Electrostatics of dielectric media, multipole expansion, Boundary value problems in dielectrics; molecular polarizability, electrostatic energy in dielectric media.

Magnetostatics: Review of basic concept of Magnetostatics and Electromagnetic induction (Biot and Savart's law, Ampere's law, Gauss law, Faraday's Law) Boundary Conditions for the field vectors D, E, B, H.

Unit 2

Time-varying fields (12 Hrs)

Physical Significance of Maxwell's equations, vector and scalar potential, Gauge transformations; Lorentz gauge and Coulomb gauge. Poynting theorem. conservation laws for a system of charged particles and electromagnetic field, continuity equation

Unit 3

Electromagnetic Waves (14 Hrs)

Plane wave like solutions of the Maxwell equations. Polarisation, linear and circular polarisation. Superposition of waves in one dimension. Group velocity. Reflection and refraction of electromagnetic waves at a plane surface between dielectrics. Polarisation by reflection and total internal reflection. Fresnal Law, Waves in conductive medium. EM wave guides, TE, TM and TEM waves, Rectangular wave guides. Energy flow and attenuation in wave guides, Cavity resonators.

Unit 4

Relativistic formulation of electrodynamics (10 Hrs)

Postulate of Special theory of relativity, Review of Lorentz's transformations for length contraction and time dilation, Structure of space-time, four scalars, four vectors and tensors, Relativistic electrodynamics, Magnetism as a relativistic phenomenon and field transformations, Recasting Maxwell equations in the language of special relativity, covariance and manifest covariance, field tensor. Lagrangian formulation for the covariant Maxwell equations.

Recommended Books:
1. Classical Electrodynamics - J.D. Jackson-John & Wiley Sons Pvt. Ltd. New York, **2004**.
2. Introduction to Electrodynamics - D.J. Griffiths-Pearson Education Ltd., New Delhi, **1991**.
3. Classical Electromagnetic Radiation - J.B. Marion-Academic Press, New Delhi, **1995**.

ATOMIC AND MOLECULAR PHYSICS

Subject Code: MPHY1-209 **L T P C** **Duration: 48 Hrs.**
4 0 0 4

Unit 1

One Electron Atom (12 Hrs)
Vector model of a one electron atom, Quantum states of an electron in an atom, Hydrogen atom spectrum, Spin-orbit Coupling, Relativistic correction, Hydrogen fine structure, Spectroscopic terms, Hyperfine structure.

Unit 2

Two valance Electron Atom (10 Hrs)
LS coupling, Pauli exclusion principle, Interaction energy for LS coupling, Lande interval rule, jj coupling, interaction energy for jj coupling.

Unit 3

Atom in Magnetic and Electric Field (10 Hrs)
Zeeman effect, Magnetic moment of a bound electron, Magnetic interaction energy in weak field. Paschen-Back effect, Magnetic interaction energy in strong field. Stark effect, First order Stark effect in hydrogen.

Unit 4

Molecular Spectroscopy (16 Hrs)
Rotational and vibrational spectra of diatomic molecule, Raman Spectra, Electronic spectra, Born-Oppenheimer approximation, Vibrational coarse structure, Franck-Condon principle, Rotational fine structure of electronic-vibration transitions. Spin Resonance Spectroscopy: Electron spins resonance and nuclear magnetic resonance spectroscopy.

Recommended Books:

1. H.E. White, 'Introduction to Atomic Spectra', McGraw Hill, **1934**.
2. C.N. Banwell and E.M. McCash, 'Fundamentals of Molecular Spectroscopy', Tata McGraw Hill, **1994**.

CONDENSED MATTER PHYSICS-I

Subject Code: MPHY1-210 **L T P C** **Duration: 48 Hrs.**
4 0 0 4

Unit 1

Crystallography and Defects in Solids (15 Hrs)
Crystal structure, Bravais lattices and its classification, Miller Indices, X-Ray Diffraction, Braggs law of Crystallography, Braggs spectrometer, Ordered Phase of matter: kinds of liquid crystalline order, Quasi Crystals.
Defects: Point defects, Impurities, Vacancies- Schottky and Frankel vacancies, Color centres and coloration of crystals, F-centres, Line defects (dislocations), Edge and screw dislocations, Berger Vector, Planar (stacking) Faults, Grain boundaries.

Unit 2

Lattice Dynamics and Phonons (12 Hrs)
Concept of photons and phonons, Quantization of lattice vibrations, Energy and momentum of phonons, inelastic scattering of photons by phonons, Dispersion relation for lattice waves in monoatomic linear lattice, Vibration modes of diatomic linear lattice.

Unit 3

Specific Heat for solid (12 Hrs)
Molar Specific heat at constant pressure and volume, Dulong Petit's Law, Eienstein model of specific heat-low and high temperature, Failure of Dulong Petit's Law at low temperature,

Drawback of Eienstein model, Debye model of specific heat and its comparison with Einstein model, Debye T^3 law, Drude Model of Electrical and Thermal Conductivity.

Unit 4

Diffusion Phenomenon in solids (9 Hrs)

Diffusion in solids, Classification of diffusion process, Mechanism of atomic diffusion, Fick's law, Factor affecting diffusion and applications, Kirkendal law.

Recommended Books

1. C. Kittel, 'Introduction to Solid State Physics'.
2. N.W. Ashcroft and N.D. Mermin, 'Solid State Physics'.
3. J.M. Ziman, 'Principles of the Theory of Solids'.
4. A.J. Dekker, 'Solid State Physics'.
5. G. Burns, 'Solid State Physics'.
6. M.P. Marder, 'Condensed Matter Physics'.
7. B.D. Cullity, 'Elements of X-Ray Diffraction'.
8. L.V. Azaroff, 'Introduction to Solids'.

ADVANCED OPTICS AND SPECTROSCOPY LAB.

Subject Code: MPHY1-211 **L T P C** **Duration: 72 Hrs.**

0 0 6 3

Note: Students will be required to perform at least ten experiments from the given list of experiments.

1. To find the wavelength of monochromatic light using Febry Perot interferometer.
2. To find the wavelength of sodium light using Michelson interferometer.
3. To calibrate the constant deviation spectrometer with white light and to find the wavelength of unknown monochromatic light.
4. To find the grating element of the given grating using He-Ne laser light.
5. To find the wavelength of He-Ne laser.
6. To verify the existence of Bohr's energy levels with Frank-Hertz experiment.
7. To determine the charge to mass ratio (e/m) of an electron with normal Zeeman Effect.
8. To determine the velocity of ultrasonic waves in a liquid using ultrasonic interferometer.
9. Laboratory spectroscopy of standard lamps.
10. To study the Kerr effect using Nitrobenzene.
11. To study polarization by reflection - Determination of Brewester's angle.
12. To measure numerical aperture and propagation loss and bending losses for optical fibre as function of bending angle and at various wavelengths.
13. To study the Magnetorestriction effect using Michelson interferometer.
14. Experiments with microwave (Gunn diode): Young's double slit experiment, Michelson interferometer, Febry-Perot interferometer, Brewester angle, Bragg's law, refractive index of a prism.
15. To measure (i) dielectric constant of solid/liquid; (ii) Q of a cavity. Use of Klystron-based microwave generator.

CONDENSED MATTER LAB

Subject Code: MPHY1-212 **L T P C** **Duration: 72 Hrs.**

0 0 6 3

Note: Students will be required to perform at least ten experiments from the given list of experiments

1. To study the characteristics of a LED and determine activation energy.

2. To study magneto-resistance and its field dependence.
3. To trace hysteresis loop and calculate retentivity, coercivity and saturation magnetization
4. To prepare the thin films of ferroelectric material/ composite films in laboratory by using solvent cast and spin cast method.
5. To prepare electrical contacts on thin films through vacuum/sputtering technique.
6. To study dielectric permittivity of different polymer/ composites as a function of frequency.
7. To study dielectric losses (Tan Delta) spectra of different polymer/ composites as a function of frequency.
8. To study the temperature dependence of dielectric losses (Tan Delta) of different polymer/ composites at different frequencies.
9. To study of ferro-electricity in a ferroelectric material/ composite film
10. To study the dielectric behavior of PZT ceramic by determining Curie temperature, dielectric strength & dielectric constant.
11. Determination of crystal structure & lattice parameters using X-rays diffraction technique.
12. Sizing nano-structures (UV-VIS spectroscopy).
13. DSC/DTA/TGA studies for thermal analysis of materials.

NUCLEAR PHYSICS

Subject Code: MPHY1-314 **L T P C** **Duration: 48 Hrs.**
4 0 0 4

UNIT 1

Nuclear Interactions (13 Hrs)

Two nuclear system, deuteron problem, binding energy, nuclear potential well, pp and pn scattering experiments at low energy, Nucleon- nucleon interaction, Exchange forces and tensor forces, meson theory of nuclear forces, Nucleon- nucleon scattering, Effective range theory, Spin dependence of nuclear forces, independence and charge symmetry of nuclear forces, Yukawa interaction.

UNIT 2

Nuclear Reactions (12 Hrs)

Direct and compound nuclear reaction mechanisms, Cross section in terms of partial wave amplitude, Compound nucleus, Scattering matrix, Reciprocity theorem, Breit-Wigner one-level formula-Resonance Scattering.

UNIT 3

Nuclear Methods (11 Hrs)

Liquid Drop Model-Bohr-Wheelar theory of fission- Experimental evidence for shell effects- Shell Model- spin- Orbit coupling-Magic numbers-Angular momenta and parities of nuclear ground states- Qualitative discussion and estimates of transition rates- Magnetic moments and Schmidt lines- Collective model of Bohr and Mottleson.

UNIT 4

Nuclear Decay (12 Hrs)

Beta decay, Fermi theory of beta decay, Shape of beta spectrum, Total decay rate, Angular momentum and parity selection rules, Comparative half-lives, Allowed and forbidden transitions, Two component theory of neutrino decay, Detection and properties of neutrino, Gamma decay, Multiple transitions in nuclei, Angular momentum and parity selection rules, Internal conversion, Nuclear isomerism.

Recommended Books:

1. R.R. Roy & B.P. Nigam, 'Nuclear Physics', New Age International Ltd., **2001**.
2. M.A. Preston and R.K. Bhaduri, 'Structure of Nucleus', Addison-Welsey, **2000**.

3. M.K. Pal, 'Theory of Nuclear Structure', East-West Press, Delhi, **1983**.
4. 'Kaplan Irving Nuclear Physics', Narosa Publishing House, **2000**.
5. D.C. Tayal, 'Nuclear Physics', Himalaya Publication home, **2007.**
6. A. Bohr and B.R. Mottelson, 'Nuclear Structure', Vol. 1 (1969) and Vol.2 Benjamin,
7. Reading, A.**1975**.
8. Kenneth S. Krane, 'Introductory Nuclear Physics', Wiley, New York, **1988**.
9. G.N. Ghoshal, 'Atomic and Nuclear Physics', Vol.2, S. Chand and Co., **1997.**

QUANTUM MECHANICS-II

Subject Code: MPHY1-315 | **L T P C 4 0 0 4** | **Duration: 48 Hrs.**

Unit 1

Identical Particles (10 Hrs)

Brief introduction to identical particles in quantum mechanics (based on Feynmann Vol. III) symmetrisation postulates-symmetric and antisymmetric wave functions, Pauli Exclusion Principle, Spin statistic Connections-Bose Einstein and Fermi Dirac Statistics, Application to 2-electron systems.

Unit 2

Time-independent and dependent Approximation Methods (15 Hrs)

Non-degenerate perturbation theory & its applications, degenerate case, variational methods, WKB approximation. Time-dependent perturbation theory, transition probability calculations, Fermi-golden rule, adiabatic approximation, sudden approximation.

Unit 3

Scattering Theory (12 Hrs)

Partial wave analysis, Diffraction and Scattering Cross-sections, unitarity and phase shifts. Determination of phase shift, Optical theorem. Born approximation, extend to higher orders. Validity of Born approximation.

Unit 4

Relativistic Quantum Mechanics (11 Hrs)

Klein Gordon equation. Dirac Equation, Lorentz covariance of Dirac equation. Positive and negative energy solutions of Dirac equation, positrons. Properties of gamma matrices. Parity operator and its action on states. Semi-classical theory of radiation.

Recommended Books:

1. J.J. Sakurai, 'Modern Quantum Mechnics', Pearson Educaton Pvt. Ltd., New Delhi, **2002**.
2. L.I. Schiff, 'Quantum Mechanics', Tokyo McGraw Hill, **1968**.
3. 'Feynmann lectures in Physics', Vol. III, Addison Wesly, **1975**.
4. Powel and Craseman, 'Quantum Mechanics', Narosa Pub., New Delhi, **1961**.
5. Merzbacher, 'Quantum Mechanics'. John Wiley & Sons, New York, **1970**.

CONDENSED MATTER PHYSICS-II

Subject Code: MPHY1-316 | **L T P C 4 0 0 4** | **Duration: 48 Hrs.**

Unit 1

Theory of Magnetic Materials (15 Hrs)

Classification of magnetic materials, the origin of permanent magnetic dipoles, diamagnetic susceptibility, classical and quantum theory of paramagnetism, Quenching of orbital angular momentum, Paramagnetic susceptibility of conduction electrons, Ferro magnetism, Weiss molecular theory, Ferromagnetic domains, super exchange interaction, the structure of ferrites, saturation magnetisation, Neel's theory of ferrimagnetism, Curie temperature and susceptibility of ferrimagnets.

Unit 2

Superconductivity (12 Hrs)

Superconductivity, Superconductors as ideal diamagnetic materials, Signatures of Superconducting state, Meissner Effect, Type I & II superconductors, London Equations, London penetration depth, Isotope effect, BCS Theory of superconductivity, Josephson Effect (DC & AC), Applications of Superconductors.

Unit 3

Dielectric Properties and Ferro Electrics (11 Hrs)

Macroscopic field, local field, Lorentz field, Claussius-Mossotti relations, Different contribution to polarization: dipolar, electronic and ionic polarizabilities, Response and Relaxation Phenomenon, General properties of ferroelectric materials, dipole theory of ferroelectricity, Ferroelectric Domains, thermodynamics of ferroelectric transitions.

Unit 4

Free Electrons Theory of Metal (10 Hrs)

Difficulties of the classical theory, the free electron model, The Fermi-Dirac distribution, electronic specific heat, Paramagnetism of free electrons, Thermionic emission from metals, energy distribution of the emitted electrons, Field-enhanced electron emission from metals, Changes of work function due to adsorbed atoms, contact potential between two metals, photoelectric effect of metals.

Recommended Books

1. C. Kittel, 'Introduction to Solid State Physics'.
2. N.W. Ashcroft and N.D. Mermin, 'Solid State Physics'.
3. J.M. Ziman, 'Principles of the Theory of Solids'.
4. A.J. Dekker, 'Solid State Physics'.
5. G. Burns, 'Solid State Physics'.
6. M.P. Marder, 'Condensed Matter Physics'.
7. B.D. Cullity, 'Elements of X-Ray Diffraction'.
8. L.V. Azaroff, 'Introduction to Solids'.

NUCLEAR PHYSICS LAB

Subject Code: MPHY1-317 **L T P C** **Duration: 72 Hrs.**

0 0 6 3

Note: Students will be required to perform at least ten experiments from the given list of experiments

1. Analysis of pulse height of gamma ray spectra.
2. To study absorption of beta rays in Al and deduce end-point energy of a beta emitter.
3. To study the dead time and other characteristics of G.M. counter.
4. To study Gaussian distribution and Source strength of a beta-source using G.M. counter.
5. Recording and calibrating a gamma ray spectrum by scintillation counter.
6. Detecting gamma radiation with a scintillation counter.
7. Identifying and determining the activity of weakly radioactive samples.
8. To calibrate the given gamma-ray spectrometer and determine its energy resolution.
9. Energy resolution and calibration of a gamma-ray spectrometer using multi-channel analyzer.
10. Time resolution and calibration of a coincidence set-up using a multi- channel analyzer.
11. Formation and Counting of alpha particle tracks on Solid State Nuclear Track

12. Detectors using Optical Microscope/ spark counter.
13. Determination of Ionization Potential of Lithium.
14. Determination of Lande's factor of DPPH using Electron-Spin resonance (E.S.R.) Spectrometer.

PARTICLE PHYSICS

Subject Code: MPHY1-419 **L T P C** **Duration: 48 Hrs.**
4 0 0 4

UNIT 1

Elementary Particles and Their Properties (12 Hrs)

Historical survey of elementary particles and their classification, determination of mass, life time, decay mode, spin and parity of muons, pions, kaons and hyperons. Experimental evidence for two types of neutrinos, production and detection of some important resonances and antiparticles.

UNIT 2

Symmetries and Conservation Laws (13 Hrs)

Conserved quantities and symmetries, the electric charge, baryon number, leptons and muon number, particles and antiparticles, hypercharge (strangeness), the nucleon isospin, isospin invariance, isospin of particles, parity operation, charge conservation, time reversal invariance, Elementary ideas of CP and CPT invariance, unitary symmetry SU(2), SU (3) and the quark model.

UNIT 3

Week Interaction (12 Hrs)

Classification of weak interactions, Fermi theory of beta decay, matrix element, classical experimental tests of Fermi theory, Parity non conservation in beta decay, Weak decays of strange-particles and Cabibbo's theory.

UNIT 4

Gauge theory and GUT (11 Hrs)

Gauge symmetry, field equations for scalar (spin 0), spinor (spin ½), vector (spin-1) and fields, global gauge invariance, local gauge invariance, Feynmann rules, introduction of neutral currents. Spontaneously broken symmetries in the field theory, standard model.

Recommended Books:

1. H. Fraunfelder and E.M. Henley, 'Subatomic Physics', N.J. Prentice Hall.
2. D. Griffiths, 'Introduction to Elementary Particles', Wiley-VCH, **2008**.
3. D.H. Perkins, 'Introduction to High Energy Physics', Cambridge University Press, **2000**.
4. I.S. Hughes, 'Elementary Particles', Cambridge University Press, Cambridge, **1996**.
5. F.E. Close, 'Introduction to Quarks and Partons', Academic Press, London, **1981**.
6. M.P. Khanna, 'Introduction to Particle Physics', Prentice Hall of India, New Delhi, **2004**.

ADVANCED MATHEMATICAL PHYSICS

Subject Code: MPHY1-356 **L T P C** **Duration: 48 Hrs.**
4 0 0 4

Unit 1

Complex Analysis (12 Hrs.)

Limits, Continuity and Derivative of the function of Complex variable, Analytic Function, Cauchy- Riemann Equations, Harmonic Function, Orthogonal System, Conjugate Function, Taylor and Laurent series, Complex integration: Line Integral, Singularities, Cauchy integration Theorem, Cauchy's Integral formula, residues and evaluation of integrals, Contour Integration.

Unit 2

Group Theory (12 Hrs.)

Definition of a group, Composition table, Conjugate elements and classes of groups, directs product, Isomorphism, homeomorphism, permutation group, Definitions of the three dimensional rotation group and SU(2), O(3).

Unit 3

Sampling and Probability Distribution (12 Hrs.)

Random Variables: Definition, Probability Distribution-Binomial, Poisson and Normal distributions. Sampling Distributions: Population and samples, Concept of sampling Distributions-Student's t test, F-test and Chi-square test, Curve Fitting, Least square fitting.

Unit 4

Tensors (12 Hrs.)

Review of tensor, Equality of Tensors - Symmetric and Skew – symmetric tensors - Outer multiplication, Contraction and Inner Multiplication - Quotient Law of Tensors - Reciprocal Tensor of Tensor - Relative Tensor - Cross Product of Vectors, Riemannian Space - Christoffel Symbols and their properties.

Recommended Books

1. J.N. Sharma, 'Complex Analysis', Krishna Publishers.
2. S.C. Gupta & V.K. Kapoor, 'Mathematical Statistics', S. Chand.
3. Josaph A. Gallian, 'Contemporary Abstract Algebra', Narosa.
4. A.R. Vasishtha, 'Modern Algebra', Krishna Prakashan.
5. Erwin Kreyszig, 'Advanced Mathematical Physics'.
6. J.L. Synge and A. Schild, 'Tensor Calculus', Toronto, **1949**.

PHYSICS OF MATERIALS

Subject Code: MPHY1-461 **L T P C** **Duration: 48 Hrs.**
4 0 0 4

Unit 1

Polymer Materials (12 Hrs)

Polymer Structure: Molecular Weight, Shape, Structure and Configuration; Thermoplastic and Thermosetting, Mechanical Behavior of Polymers-stress strain behavior, Macroscopic and Viscoelastic deformation, Fracture of polymers, Mechanical charachteristics-Fatigue, Tear Strength and Hardness, Mechanisms of Deformation and strengthening of polymers. Crystallization, Melting and Glass Transition Phenomena in Polymers.

Unit 2

Composite Materials (12 Hrs)

Introduction, Particle-Reinforced Composites-Large, Fiber-Reinforced Composites: Influence of Fiber Length, Influence of Fiber Orientation and Concentration, The Fiber Phase, The Matrix Phase, Polymer-Matrix Composites, Metal-Matrix Composites, Ceramic-Matrix Composites.

Unit 3

Nano-Materials (11 Hrs)

Emergence of Nanotechnology, Micro to Nanoscale materials, Characteristics of Nanomaterials- Band gap, surface to volume ratio, Electron confinement for zero, one and two dimensional nanostructures, synthesis of nanomaterials with top down and bottom up approach, Methods of Synthesis- ball milling, sol-gel, Electro-spinning and Lithography techniques, Carbon nanotubes (synthesis and properties), applications of nanomaterials.

Unit 4

Electrical, Magnetic and Thermal Properties of Materials (13 Hrs)

Electrical properties of materials: Conduction in ionic materials, Dielectric behavior, Field vectors and polarization types, Frequency dependent dielectric constant, Other Electrical characteristics of materials and its applications: Ferroelectricity, Piezoelectricity.

Magnetic Properties of Materials: Magnetic materials and its classifications, Domain and Magnetic Hysteresis, Magnetic storage, Magnetic Anisotropy, Soft and Hard magnetic materials.

Thermal properties of materials: Heat capacity, Thermal expansion, Thermal conductivity and Thermal stresses.

Recommended Books:

1. William D. Callister, 'Materials Science and Engineering: An Introduction', John Wiley & Sons, Inc.
2. G.M. Chow & K.E. Gonsalves, 'Nanotechnology - Molecularly Designed Materials', American Chemical Society.
3. K.P. Jain, 'Physics of Semiconductor Nanostructures', Narosa Publishing House, **1997**.
4. G. Cao, 'Nanostructures and Nanomaterials: Synthesis, Properties and Applications', Emperial College Press, **2004**.

NUCLEAR ACCELERATORS & RADIATION PHYSICS (NARP)

Subject Code: MPHY1-460 **L T P C** **Duration: 48 Hrs.**

4 0 0 4

Unit 1

Interactions of Nuclear Radiations and Neutron Detection (12 Hrs)

Introduction to radiations, types of radiations, Radiation dose, units, safety limits, Biological effects of radiation, radiation monitoring.

Neutron discovery, neutron classification, neutron sources, Neutron detectors, Diffusion of thermal neutrons.

UNIT 2

Nuclear Radiation Detectors (12 Hrs)

Detection of nuclear radiation, classification of detectors, Gas filled detectors, multiplicative regions, ionization chamber, Proportional counter, Geiger-Muller counter, Solid state detectors, Cerenkov detector, Wilson cloud chamber, Bubble chamber, Spark chamber, Nuclear emulsions, Solid state nuclear track detectors, Semiconductor detectors.

Unit 3

Nuclear Accelerators (10 Hrs)

Introduction of accelerators of charged particles: Classification and performance characterstics of accelerator, ion sources, Electrostatic accelerators (Cockroft---Walton accelerators), Cyclotron, Betatron, principle of phase stability, Synchro-cyclotron, Electron and Proton synchrotron, Microtron, Linear accelerator, drift tube and wave guide accelerator.

Unit 4

Nuclear reactors (14 Hrs)

Nuclear chain reactor, Four factor formula, reactor design, classification of reactors, research reactor: graphite moderator, water boiler, swimming pool, light water-moderator, tank type; Heavy water-moderator: tank type, production reactor, power reactor: pressurized water reactor, Boiling water reactors, heavy water moderated reactors, organic moderated reactors, Gas cooled reactors, Sodium graphite reactors, Liquid fuel reactor, Fast reactor, breeder reactors.

Recommended Books

1. Edward J.N. Wilson "Ann introduction to Paricle Accelerators", Oxford University

Press,2003.
2. James Rosenzweig "Fundamantal of Beam Physics", Oxford University Press,2001.
3. P N Cooper "Introduction to Nuclear Radiation Detectors", Cambridge University press, 1986.
4. Kapoor S S and Ramamurthy V S "Nuclear Radiation Detectors", Wiley Eastern, new Delhi, 1986.
5. Knoll G. F., Radiation Detection and Measurement, John Wiley & Sons (1989).
6. Krane K. S., Introductory Nuclear Physics, John Wiley & Sons (1975).
7. 7.Singuru R. M., Introduction to experimental nuclear physics, Wiley Eastern Publications (1987).

NANO-PHYSICS

Subject Code: MPHY1-462 **L T P C** **Duration: 48 Hrs.**
4 0 0 4

UNIT 1

Introduction to the Nanoscience (6 Hrs)

Nano scale, Surface to volume ratio, Electron confinement in infinitely deep square well, Confinement in one and two-dimensional wells, Idea of quantum well, quantum wire and quantum dots, Comparison of Density states for 0D, 1D and 2D confined nanostructured materials with the bulk.

UNIT 2

Synthesis of Nanostructures (15 Hrs)

Top down and Bottom up approach for synthesis of nanoparticles, growth of nuclei, Growth controlled by diffusion and surface process in Zero Dimensional nanostructures.

Synthesis of One-Dimensional Nanostructures: Template-Based Synthesis, Electrochemical deposition, Electrophoretic deposition, Electrospinning and Lithography.

Synthesis of two-Dimensional Nanostructures: Fundamentals of Film Growth, Physical Vapor Deposition, Molecular beam epitaxy, Sputtering, Chemical Vapor Deposition, Atomic Layer Deposition, Self-Assembly, Sol-Gel Films, Langmuir-Blodgett Films.

UNIT 3

General Characterization Techniques (15 Hrs)

Determination of particle size, Structural Characterization: X-ray diffraction, Small angle X-ray scattering, Morphological Characterization: Scanning electron microscopy, Transmission electron microscopy, Atomic Force Microscopy, Scanning probe microscopy.

Optical Characterization: photo luminescence (PL), Raman and FTIR spectroscopy of nanomaterials.

Special Nanomaterials and its Applications (12 Hrs)

Structure of Fullerene, Methods of synthesis of Carbon Nanotubes, Properties of CNT; Electrical, Optical, Mechanical, Vibrational properties etc., Applications: Molecular Electronics and Nanoelectronics, Carbon Nanotube Emitters, Solar cells, Fuel Cells, Display devices.

Recommended Books:

1. Chow G-M & K.E. Gonsalves, 'Nanotechnology - Molecularly Designed Materials', American Chemical Society.
2. K.P. Jain, 'Physics of Semiconductor Nanostructures', Narosa Publishing House, **1997**.
3. G. Cao, 'Nanostructures and Nanomaterials: Synthesis, Properties and Applications', Emperial College Press, **2004.**

SCIENCE OF RENEWABLE ENERGY SOURCES

Subject Code: MPHY0-F92 **L T P C** **Duration: 36 Hrs.**
3 0 0 3

Unit 1

Introduction (5 Hrs)
Production and reserves of energy sources in the world and in India, need for alternatives, renewable energy sources.

Unit 2

Energy (12 Hrs)
Thermal applications, solar radiation outside the earth's atmosphere and at the earth's surface, fundamentals of photovoltaic energy conversion. Direct and indirect transition semi-conductors, interrelationship between absorption coefficients and band gap recombination of carriers.

Types of solar cells, p-n junction solar cell, Transport equation, current density, open circuit voltage and short circuit current, description and principle of working of single crystal, polycrystalline and amorphous silicon solar cells, conversion efficiency. Elementary ideas of Tandem solar cells, solid-liquid junction solar cells and semiconductor-electrolyte junction solar cells. Principles of photoelectrochemical solar cells. Applications.

Unit 3

Hydrogen Energy (12 Hrs)
Environmental considerations, solar hydrogen through photo electrolysis and photocatalytic process, physics of material characteristics for production of solar hydrogen. Storage processes, solid state hydrogen storage materials, structural and electronic properties of storage materials, new storage modes, safety factors, use of hydrogen as fuel; use in vehicles and electric generation, fuel cells, hydride batteries.

Unit 4

Other sources (7 Hrs)
Nature of wind, classification and descriptions of wind machines, power coefficient, energy in the wind, wave energy, ocean thermal energy conversion (OTEC), system designs for OTEC.

Recommended Books:

1. S.P. Sukhatme, 'Solar Energy', Tata McGraw-Hill, New Delhi, **2008**.
2. Fonash, 'Solar Cell Devices', Academic Press, New York, **2010**.
3. Fahrenbruch and Bube, 'Fundamentals of Solar Cells, Photovoltaic Solar Energy', Springer, Berlin, **1983**.
4. Chandra, 'Photoelectrochemical Solar Cells', New Age, New Delhi.