| 1st Semester | | Contact Hrs. | | | Marks | | | Credits |
|---|---|---|---|---|---|---|---|---|
| **Subject Code** | **Subject** | **L** | **T** | **P** | **Internal** | **External** | **Total** | |
| **MPHYS1-101** | Classical Mechanics | 4 | 0 | 0 | 40 | 60 | 100 | 4 |
| **MPHYS1-102** | Statistical Physics | 4 | 0 | 0 | 40 | 60 | 100 | 4 |
| **MPHYS1-103** | Mathematical Physics | 4 | 0 | 0 | 40 | 60 | 100 | 4 |
| **MPHYS1-104** | Electronics | 4 | 0 | 0 | 40 | 60 | 100 | 4 |
| **MPHYS1-105** | Electronics Lab | 0 | 0 | 6 | 60 | 40 | 100 | 3 |
| **MPHYS1-106** | Computer Programming Lab. | 0 | 0 | 6 | 60 | 40 | 100 | 3 |
| **Total** | | **16** | **0** | **12** | **280** | **320** | **600** | **22** |

| 2nd Semester | | Contact Hrs. | | | Marks | | | Credits |
|---|---|---|---|---|---|---|---|---|
| **Subject Code** | **Subject** | **L** | **T** | **P** | **Internal** | **External** | **Total** | |
| **MPHYS1-207** | Quantum Mechanics –I | 4 | 0 | 0 | 40 | 60 | 100 | 4 |
| **MPHYS1-208** | Electrodynamics-I | 4 | 0 | 0 | 40 | 60 | 100 | 4 |
| **MPHYS1-209** | Atomic & Molecular Physics | 4 | 0 | 0 | 40 | 60 | 100 | 4 |
| **MPHYS1-210** | Condensed Matter Physics-I | 4 | 0 | 0 | 40 | 60 | 100 | 4 |
| **MPHYS1-211** | Advanced Optics and Spectroscopy Lab. | 0 | 0 | 6 | 60 | 40 | 100 | 3 |
| **MPHYS1-212** | Condensed Matter Lab. | 0 | 0 | 6 | 60 | 40 | 100 | 3 |
| **MPHYS1-213** | Seminar-I | 0 | 0 | 2 | 100 | 0 | 100 | 1 |
| **Total** | | **16** | **0** | **14** | **380** | **320** | **700** | **23** |

| 3rd Semester | | Contact Hrs. | | | Marks | | | Credits |
|---|---|---|---|---|---|---|---|---|
| **Subject Code** | **Subject** | **L** | **T** | **P** | **Internal** | **External** | **Total** | |
| **MPHYS1-314** | Nuclear Physics | 4 | 0 | 0 | 40 | 60 | 100 | 4 |
| **MPHYS1-315** | Quantum Mechanics –II | 4 | 0 | 0 | 40 | 60 | 100 | 4 |
| **MPHYS1-316** | Condensed Matter Physics-II | 4 | 0 | 0 | 40 | 60 | 100 | 4 |
| **MPHYS1-317** | Nuclear Physics Lab | 0 | 0 | 6 | 60 | 40 | 100 | 3 |
| **MPHYS1-318** | Seminar-II | 0 | 0 | 2 | 100 | 0 | 100 | 1 |
| **Departmental Elective-I (Choose any one)** | | 4 | 0 | 0 | 40 | 60 | 100 | 4 |
| **MPHYS1-356** | Advanced Mathematical Physics | | | | | | | |
| **MPHYS1-357** | Science of Renewable Energy Sources | | | | | | | |
| **MPHYS1-358** | Fibre Optics and Laser Technology | | | | | | | |
| **MPHYS1-359** | Microprocessor | | | | | | | |
| **Open Elective-I** | | 3 | 0 | 0 | 40 | 60 | 100 | 3 |
| **Total** | | **19** | **0** | **8** | **360** | **340** | **700** | **23** |

| 4th Semester | | Contact Hrs. | | | Marks | | | Credits |
|---|---|---|---|---|---|---|---|---|
| **Subject Code** | **Subject** | **L** | **T** | **P** | **Internal** | **External** | **Total** | |
| **MPHYS1-419** | Particle Physics | 4 | 0 | 0 | 40 | 60 | 100 | 4 |
| **MPHYS1-420** | Electrodynamics-II | 4 | 0 | 0 | 40 | 60 | 100 | 4 |
| **Optional# (Choose any one)** | | 0 | 0 | 6 | 60 | 40 | 100 | 3 |
| **MPHYS1-421** | Advanced Physics Lab. | | | | | | | |
| **MPHYS1-422** | Dissertation | | | | | | | |
| **Departmental Elective-II (Choose any one)** | | 4 | 0 | 0 | 40 | 60 | 100 | 4 |
| **MPHYS1-460** | Nuclear Accelerators, Reactors and Detectors | | | | | | | |
| **MPHYS1-461** | Radiation Physics | | | | | | | |
| **Departmental Elective-III (Choose any one)** | | 4 | 0 | 0 | 40 | 60 | 100 | 4 |
| **MPHYS1-462** | Physics of Materials | | | | | | | |
| **MPHYS1-463** | Nano Physics | | | | | | | |
| **MPHYS1-464** | Soft Matter Physics | | | | | | | |
| **Open Elective-II** | | 3 | 0 | 0 | 40 | 60 | 100 | 3 |
| **Total** | | **19** | **0** | **6** | **260** | **340** | **600** | **22** |

| **Sem.** | **Marks** | **Credits** |
|---|---|---|
| I | 600 | 22 |
| II | 700 | 23 |
| III | 700 | 23 |
| IV | 600 | 22 |
| **Total** | **2600** | **90** |

**Departmental Elective:** Subject to the availability of teacher and minimum 10 students as per university guidelines.
**Open Elective:** Student must choose open elective subject offered by other department.
# **Optional: Dissertation-** Maximum 20% of the sanctioned strength of the students will be allotted dissertation on the basis of **their option** and **percentage of marks** (Merit) in M.Sc.1st year examination subject to the consent of the faculty in the Department. Maximum students guided by each faculty cannot be more than two.
**Advanced Physics Lab-** The students who have not been allotted dissertation, will be offered Advanced Physics Lab.

## CLASSICAL MECHANICS

**Subject Code: MPHYS1-101** **L T P C** **Duration: 45 Hrs.**
**4 0 0 4**

### 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: (11 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: (11 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: (11 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.
6. S.L. Gupta; V. Kumar; H.V. Sharma, 'Classical Mechanics', Pragati Parkashan, Meerut.


## STATISTICAL PHYSICS

**Subject Code: MPHYS1-102** **L T P C** **Duration: 45 Hrs.**
**4 0 0 4**

### UNIT--1

**Statistical Basis of Thermodynamics: (10 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, 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: (12 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, dynamical model of phase transition, Ising model in the zeroth approximation, Diffusion equation, random walk and Brownian motion.

**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: MPHYS1-103** | **L T P C**<br>**4 0 0 4** | **Duration: 45 Hrs.** |

**UNIT-1**

**Linear Algebra and Vector Space: (11 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: (11 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 Singularpoints, 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: MPHYS1-104** | **L T P C 4 0 0 4** | **Duration: 45 Hrs.**

### UNIT- 1

**Electronic Devices: (11 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(11Hrs.)**

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: (11 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 McGraw 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 McGraw Hill, New Delhi, **1986.**
5. Millman, 'Microelectronics', Tata McGraw Hill, London, **1979**.
6. W.H. Gothmann, 'Digital Electronics', Prentice Hall, New Delhi, **1980**.

## ELECTRONICS LAB.

**Subject Code: MPHYS1-105** **L T P C** **Duration: 72 Hrs.**
**0 0 6 3**

### EXPERIMENTS

**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: MPHYS1-106** **L T P C** **Duration: 72 Hrs.**
**0 0 6 3**

**Note:** 1. One Lab Class will be of 3 Hr duration in which theory concept will be cleared in 1 Hr and 2 Hr practice session to develop related program on PC.
2. The final external examination will be Lab exam only.

### Section A

**BASIC THEORY INTRODUCTION FOR DOING NUMERICAL PROBLEMS**

1. **Introduction to Numerical Methods:** Computer algorithms, Interpolations – Langrage,
2. Newton divided difference, system of linear equations – Gauss elimination & Gauss Jordan method, Numerical differential equations by Euler method, modified Euler's method, Runge-Kutta method.
3. **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++.

OR

4. **Programming with Fortran 77:** 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.

### Section B

**LIST OF NUMERICAL PROBLEMS**

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

### EXPERIMENTS

1. Arithmetic operations of integers, mensuration (area of circle, rectangle).

2. Data handling: find standard deviation, mean, variance, moments etc. of at least 25 entries.
3. Choose a set of 10 values and find the least squared fitted values.
4. Implementation of newton's divided difference formula to find tabulated values.
5. To calculate solution of system of linear equations by Gauss elimination OR Gauss Jordan method.
6. To evaluate the integrals by using Simpson methods.
7. To find differential equation using modified Euler method.
8. To compute the solution of ordinary differential equation by using Euler's method.

   OR

   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.
9. To compute the solution of ordinary differential equation by using Runge-Kutta method.

   OR

   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 for the case.
10. Generation of waves on superposition like stationary waves and beats.
11. Fourier analysis of square waves.
12. Wave packet and uncertainty principle.
13. Modify the program to include AC source instant of D.C. Source.
14. 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.
15. Motion of artificial satellite.
16. 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', $4^{th}$ Edn., Oxford Book Co.
2. P.L. DeVries, 'A First Course in Computational Physics', $2^{nd}$ Edn., Wiley, **2011**.
3. S. Chandra, 'Computer Applications in Physics', $2^{nd}$ Edn., Narosa, **2008**.
4. R.C. Verma, P.K. Ahluwalia and K.C. Sharma, 'Computational Physics', $1^{st}$Edn., New Age, **2005**.
5. 'Object Oriented Programming with C++: Balagurusamy', $2^{nd}$ Edn., Tata McGraw Hill, **2002**.

## QUANTUM MECHANICS –I

**Subject Code: MPHYS1-207** **L T P C** **Duration: 45 Hrs.**
**4 0 0 4**

### UNIT- 1

**Basic Formulation and Quantum Kinematics: (12 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. Eigen kets of an observable, Eigen kets as base kets, matrix representations. Measurement of observable, compatible vs. incompatible observable, commutators and uncertainty relations. Change of basis and Unitary transformations. Diagonalization of operators.

**UNIT- 2**

**Quantum Dynamics: (11 Hrs.)**

Time evolution operator and Schrodinger equation, Schrodinger vs. Heisenberg picture, Unitary operator, state kets and observable in Schrodinger and Heisenberg pictures, Heisenberg equations of motion, Ehrenfest's theorem.

**UNIT- 3**

**One Dimensional Systems: (10 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: (12 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 Mechanics', Pearson Education 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**.



## ELECTRODYNAMICS-1

**Subject Code: MPHYS1-208** **L T P C 4 0 0 4** **Duration: 45 Hrs.**

**UNIT- 1**

**Electrostatics: (12 Hrs.)**

Review of basic concepts 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.

**UNIT- 2**

**Magnetostatics: (11 Hrs.)**

Review of basic concept of Magnetostatics and Electromagnetic induction (Biot and Savart's law, Ampere's law, Gauss law, Faraday's Law) vector potential and magnetic field of a localized current distribution. Magnetic moment, force and torque on a magnetic dipole in an external field. Magnetic materials, Magnetization and microscopic equations. Boundary Conditions for the field vectors B, H.

**UNIT- 3**

**Time-varying fields (11 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- 4**

**Electromagnetic Waves: (11 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.

**Recommended Books:**


1. J.D. Jackson, 'Classical Electrodynamics', John & Wiley Sons Pvt. Ltd. New York, **2004**.
2. D.J. Griffiths; Introduction to Electrodynamics; Pearson Education Ltd., New Delhi, **1991**.
3. J.B. Marion; Classical Electromagnetic Radiation; Academic Press, New Delhi, **1995**.
4. M.N.O. Sadiku,' Elements of Electromagnetics', Oxford University Publication, **2014**.
5. A. Pramanik, 'Electromagnetism - Theory and Applications', PHI Learning Pvt. Ltd, New Delhi, **2009**.
6. W.J. Duffin, 'Electricity and Magnetism', McGraw Hill Publication, **1980**.


## ATOMIC AND MOLECULAR PHYSICS

**Subject Code: MPHYS1-209** **L T P C 4 0 0 4** **Duration: 45 Hrs.**

### UNIT- 1

**One and Two Valance Electron Atoms (14Hrs.)**

Bohr's model of one electron atom, Magnetic dipole moments, Larmor Precession, Space quantization of orbital angular momentum and electron spin, Vector model of one electron atom, Spin-orbit coupling and Relativistic correction, Hydrogen fine structure, Lamb Shift, Spectroscopic terms and selection rules for LS and JJ couplings, Vector model for two valance electron atom, Interaction energy in LS and JJ couplings for atoms with two valance electrons.

### UNIT-2

**Atom in Magnetic and Electric Field (10 Hrs.)**

Zeeman effect, Magnetic moment of a bound electron, Lande-g factor, Magnetic interaction energy in weak field, Intensity rules for Zeeman effect, Determinations of Zeeman patterns, Paschen-Back effect and its spin-orbit correction, Weak and strong field Stark effect in hydrogen, Hyperfine structure: Isotope effect, hyperfine splitting, interaction energy.



### UNIT-3

**Infra-Red and Microwave Spectroscopy (10 Hrs.)**

Introduction to pure rotational spectra, Rotational spectra of a diatomic molecule as rigid and non-rigid rotator, Isotope effect on rotational spectra, Microwave spectrum of Linear molecules, Microwave oven, Vibrational diatomic molecule as a simple harmonic and anharmonic oscillator, Diatomic vibrating rotator: Born-Oppenheimer approximation, Vibrational-rotational spectrum of CO, Breakdown of Born-Oppenheimer approximation.

### UNIT- 4

**Electronic and Raman Spectroscopy: (11 Hrs.)**

Classical and Quantum theories of Raman effect, Vibrational Raman spectra, Pure rotational Raman spectra of linear molecules, Raman and infra-red spectroscopy for structure determination, Electronic spectra, Vibrational coarse structure, Franck-Condon principle, Dissociation energy, Rotational fine structure of electronic-vibration transitions. Spin Resonance Spectroscopy: Electron spin resonance and nuclear magnetic resonance spectroscopy.

**Recommended Books:**


1. H.E. White, 'Introduction to Atomic Spectra', 5th Edn., McGraw Hill, **1934**,
2. C.N. Banwell and E.M. McCash, 'Fundamentals of Molecular Spectroscopy', 4th Edn., Tata McGraw Hill, **1994**.
3. R. Kumar, 'Atomic and Molecular Spectra: Laser', Kedar Nath Ram Nath Publication.

## CONDENSED MATTER PHYSICS-I

**Subject Code: MPHYS1-210** **L T P C** **Duration: 48 Hrs.**
**4 0 0 4**

### UNIT- 1

**Crystallography and Defects in Solids (15Hrs.)**

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: (10 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: (11 Hrs.)**

Molar Specific heat at constant pressure and volume, Dulong Petit's Law, Einstein Model of specific heat-low and high temperature, Failure of Dulong Petit's Law at low temperature, Drawback of Einstein 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: MPHYS1-211** **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: MPHYS1-212** | **L T P C 0 0 6 3** | **Duration: 72 Hrs.**

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

### 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.



## SEMINAR-I

**Subject Code: MPHYS1-213** | **L T P C 0 0 2 1** | **Duration: 24 Hrs.**

**Guidelines for the Seminar I (MPHY1-213) for 2nd Semester**

1. In the beginning of the semester, a teacher will be allocated maximum 30 students. The latter will guide/teach them how to prepare/present 15 minutes Power Point Presentation for the Seminar.
2. If there are more than 30 students in the class, then class will be divided into two groups having equal students. Each group may be allocated to a different teacher.
3. Each student will be allotted a topic by the teacher at least one week in advance for the presentation. The topic for presentation may be from the syllabus or relevant to the

syllabus of the program.

4. During the presentation being given by a student, all the other students of his/her group will attend the Seminar. The assessment/evaluation will be done by the teacher. However, Head of Department and other faculty members may also attend the Seminar, ask questions and give their suggestions.
5. This is a turn wise continuous process during the semester and a student will give minimum two presentations in a Semester.
6. For the evaluation, the following criteria will be adopted,
   (a) Attendance in Seminar: 25 Marks
   (b) Knowledge of Subject along with Q/A handling during the Seminar: 25 Marks
   (c) Presentation and Communication Skills: 25 Marks
   (d) Contents of the Presentation: 25 Marks.

## NUCLEAR PHYSICS

**Subject Code: MPHYS1-314** **L T P C** **Duration: 45 Hrs.**
**4 0 0 4**

### UNIT- 1

**Nuclear Interactions: (12Hrs.)**
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: (10 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, Reading, A.**1975**.
7. Kenneth S. Krane, 'Introductory Nuclear Physics', Wiley, New York, **1988**.
8. G.N. Ghoshal, 'Atomic and Nuclear Physics', Vol.-2, S. Chand and Co., **1997.**

## QUANTUM MECHANICS-II

**Subject Code: MPHYS1-315** **L T P C** **Duration: 45 Hrs.**
**4 0 0 4**

### UNIT- 1

**Identical Particles: (10 Hrs.)**
Brief introduction to identical particles in quantum mechanics, symmetrisation postulates-symmetric and antisymmetric wave functions, Particle exchange operator, 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: (12 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, 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 Mechanics', Pearson Education Pvt. Ltd., New Delhi, **2002**.
2. L.I. Schiff, 'Quantum Mechanics', Tokyo McGraw Hill, **1968**.
3. 'Feynmann Lectures in Physics', Vol. III, Addison Wesley, **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: MPHYS1-316** **L T P C** **Duration: 45 Hrs.**
**4 0 0 4**

### UNIT- 1

**Theory of Magnetic Materials: (12 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: MPHYS1-317** **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:

## 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.

## SEMINAR-II

**Subject Code: MPHYS1-318** **L T P C 0 0 2 1** **Duration: 24 Hrs.**

**Guidelines for the Seminar II (MPHY1-318) for 3rd Semester**

1. In the beginning of the semester, a teacher will be allocated maximum 30 students. The latter will guide/teach them how to prepare/present 15 minutes Power Point Presentation for the Seminar.
2. If there are more than 30 students in the class, then class will be divided into two groups having equal students. Each group may be allocated to a different teacher.
3. Each student will be allotted a topic by the teacher at least one week in advance for the presentation. The topic for presentation may be from the syllabus or relevant to the syllabus of the program.
4. During the presentation being given by a student, all the other students of his/her group will attend the Seminar. The assessment/evaluation will be done by the teacher. However, Head of Department and other faculty members may also attend the Seminar, ask questions and give their suggestions.
5. This is a turn wise continuous process during the semester and a student will give minimum two presentations in a Semester.
6. For the evaluation, the following criteria will be adopted,
   a) Attendance in Seminar: 25 Marks
   b) Knowledge of Subject along with Q/A handling during the Seminar: 25 Marks
   c) Presentation and Communication Skills: 25 Marks
   d) Contents of the Presentation: 25 Marks.



## ADVANCED MATHEMATICAL PHYSICS

**Subject Code: MPHYS1-356** **L T P C 4 0 0 4** **Duration: 45 Hrs.**

### 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**.

## SCIENCE OF RENEWABLE ENERGY SOURCES

**Subject Code: MPHYS1-357** | **L T P C 4 0 0 4** | **Duration: 45 Hrs.**

### UNIT- 1

**Introduction: (6 Hrs.)**

Production and reserves of energy sources in the world and in India, need for alternatives, renewable energy sources.

### UNIT- 2

**Energy: (15 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: (14 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: (10 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.

## FIBRE OPTICS AND LASER TECHNOLOGY

**Subject Code: MPHYS1-358** **L T P C** **Duration: 45 Hrs.**
**4 0 0 4**

### UNIT- I

**Fibre Optics: (12 Hrs.)**
Optical fibre and its properties: Introduction, basic fibre construction, propagation of light, modes and the fibre, refractive index profile, types of fibre, dispersion, data rate and band width, attenuation, leaky modes, bending losses, cut-off wavelength, mode field diameter, other fibre types, Fibre fabrication and cable design: Fibre fabrication, mass production of fibre, comparison of the processes, fibre drawing process, coatings, cable design requirements, typical cable design, testing.

### UNIT- II

**Basics of Lasers: (12 Hrs.)**
Population Inversion, Einstein Coefficients and Light Amplification, Laser Rate Equations; Two-level, Three-level, and Four-level Laser Systems, Optical Resonators, Axial and Transverse Modes, Q-switching and Mode Locking in Lasers, Coherence Properties of Laser Light, Temporal Coherence, Monochromaticity, Spatial Coherence, Directionality, Linewidth, Brightness, Focusing Properties of Laser Radiation & Tunability.

### UNIT- III

**Types of Lasers: (10 Hrs.)**
Doped-insulator Lasers: Ruby Laser, Nd: YAG and Nd: Glass Laser; Gas Lasers: Atomic Lasers – He Ne Laser, Ion Lasers: Argon Laser, Molecular Lasers: Carbon Dioxide Laser, Nitrogen Laser, and Excimer Laser; Liquid Dye Laser; Semiconductor Laser.

### UNIT- IV

**Applications of Lasers: (11 Hrs.)**
Measurement of distance – Interferometric methods, Beam modulation telemetry, Pulse echo techniques; Laser Tracking, LIDAR, Holography, Applications of Holography: Holographic Interferometry – Double Exposure, Real Time, and Time Average; Laser Cooling, Material Processing -Lasers in Welding, Drilling, and Cutting, Medicine, Laser-induced Fusion, Resistor Trimming, Laser Soldering, Laser Heat Treatment; Information Storage, Bar Code Scanner.

**Recommended Books:**

1. Wymer and Meardon, 'The Elements of Fibre Optics', S.L. Regents/Prentice Hall, **1993**.
2. K. Thyagarajan and A.K. Ghatak, 'Lasers Theory and Applications', Macmillan India Ltd., **1995**.
3. Ajoy Ghatak and K. Thyagarajan, 'Fiber Optics and Lasers', Macmillan India Limited, **2006**.
4. B.B. Laud, 'Laser and Non Linear Optics', New Age International Publisher, **2011**.
5. M. N. Avadhanui and P. S. Hemne, 'An Introduction to Laser: Theory and Applications', S. Chand & Company Ltd.


## MICROPROCESSOR

**Subject Code: MPHYS1-359** **L T P C** **Duration: 45 Hrs.**
**4 0 0 4**

### UNIT- 1

**Introduction: (10 Hrs.)**
Introduction to Microprocessor, General Architecture of Microcomputer System, Microprocessor UNIT-s, Input UNIT-, Output UNIT-, Memory UNIT- and auxiliary storage Unit.

### UNIT-II

**Architecture of 8086/8088 Microprocessor: (11 Hrs.)**

Description of various pins, configuring the 8086/8088 microprocessor for minimum and maximum mode systems, internal architecture of the 8086/8088 microprocessor, system clock, Bus cycle, Instruction execution sequence.

### UNIT-III

**Memory Interface of 8086/8088 Microprocessor: (11 Hrs.)**

Address space and data organization, generating memory addresses hardware organization of memory address space, memory bus status code, memory control signals, read/write bus cycles, program and data storage memory, dynamic RAM system.

### UNIT-IV

**Input/output Interface of the 8086/8088 Microprocessor: (13 Hrs.)**

I/O interface, I/O address space and data transfer, I/O instructions, I/O bus cycles, Output ports, 8255A Programmable Peripheral, Interface (PPI), Serial communication interface (USART and UART) – the RS- 232 C interface. Interface of 8086/8088 Microprocessor, Types of Interrupt, Interrupt Vector Table (IVT).

**Recommended Books:**

1. Walter Triebel, 'The 8086 Microprocessor – Architecture, Software and Interfacing Techniques', PHI, Delhi.
2. Douglas V. Hall, 'Microprocessors and Interfacing – Programming and Hardware', Tata McGraw Hill Publishing Company Ltd., New Delhi.
3. Peter Abel, 'IBM PC Assembly Language and Programming', PHI, Delhi.

## PARTICLE PHYSICS



**Subject Code: MPHYS1-419** | **L T P C 4 0 0 4** | **Duration: 45 Hrs.**

### UNIT- 1

**Elementary Particles and Their Properties: (11 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: (12Hrs.)**

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, UNIT-ary symmetry SU (2), SU (3) and the quark model.

### UNIT- 3

**Week Interaction: (11 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**.

## ELECTRODYNAMICS-II

**Subject Code: MPHYS1-420** | **L T P C 4 0 0 4** | **Duration: 45 Hrs.**

### UNIT-1

**Electromagnetic Wave Guides: (11 Hrs.)**
Field at the surface of and within a conductor, EM wave guides, Cylindrical cavities and waveguides, transverse electric, transverse magnetic and transverse electric and magnetic modes in waveguides, Rectangular wave guides, energy flow and attenuation in wave guides, cavity resonators, power loss in cavity and quality factor.

### UNIT- 2

**Relativistic Formulation of Electrodynamics: (12 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.

### UNIT- 3

**Radiating Systems: (10 Hrs.)**
Fields of radiation of localized oscillating sources, electric dipole fields and radiation, magnetic dipole and electric quadrupole fields, central fed antenna, brief introduction to radiation damping and radiation reaction.



### UNIT- 4

**Charged Particle Dynamics: (12 Hrs.)**
**Fields of Moving Charges:** Lienard Wiechert potential, field of a moving charge. Non-relativistic motion in uniform constant fields: Constant uniform electric field, Constant uniform magnetic field, Crossed uniform and constant electric and magnetic fields. Non-relativistic motion of a charged particle in a slowly varying magnetic field. Relativistic motion of a charged particle: Constant magnetic field, Constant electric field Electromagnetic Field of a plane wave. Radiated power from an accelerated charge at low velocities, Larmour's power formula and its relativistic generalization; Angular distribution of radiation emitted by an accelerated charge.

**Recommended Books:**
1. J.D. Jackson, 'Classical Electrodynamics', John & Wiley Sons Pvt. Ltd. New York, **2004**.
2. D.J. Griffiths, 'Introduction to Electrodynamics', Pearson Education Ltd., New Delhi, **1991**.
3. J.B. Marion, 'Classical Electromagnetic Radiation', Academic Press, New Delhi, **1995**.
4. W.J. Duffin, 'Advanced Electricity and Magnetism', McGraw Hill Publication, **1968**.
5. R.K. Shevgaonker, 'Electromagnetic Waves', McGraw Hill Publication, **2005**.
6. D.K. Chen,' Field and Wave Electromagnetics', Addision-Wesley,**1989**.
7. M.N.O. Sadiku, 'Elements of Electromagnetics', Oxford University Publication, **2014**.

## ADVANCED PHYSICS LAB.

**Subject Code: MPHYS1-421** **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.

### Nuclear Physics Experiments

1. To study p-p interaction and find the cross-section of a reaction using a bubble chamber film.
2. To study n-p interaction and find the cross-section using a bubble chamber film.
3. To study k-d interaction and find its multiplicity and moments using a bubble chamber film.
4. To study a πμ event using emulsion track film.
5. To study the energy resolution of Cs-137.
6. To identify the unknown γ-source using energy calibration.
7. To study the alpha spectrum from natural sources Th and U.
8. To study calibration of a beta-ray spectrometer.
9. To study scattering of gamma rays from different elements.
10. To determine range of Alpha/Beta-particles in air at energy loss in thin foils.
11. To determine strength of alpha particles using SSNTD.

### Computational Physics Experiments

Programming software: Fortran/C++/Monte Carlo Method.

12. Obtain the energy eigen values of a quantum oscillator using Runge-Kutta method.
13. Study the motion of a charged particle in (a) uniform electric field (b) in uniform magnetic field (c) in combined electric and magnetic fields (cyclotron). Draw graphs in each case.
14. Monte-Carlo technique to simulate phenomenon of nuclear radioactivity. Modify your program to a case when daughter nucleus is also unstable.
15. Study the motion of two coupled harmonic oscillators. Compare the numerical results with analytic results.
16. To calculate the Radioactivity and disintegration rate of a given radioisotopes.
17. To calculate the half and mean life of radioactive isotopes.
18. To calculate the absorbed dose and Radiation Exposure for a given situation.
19. Estimation of Photon attenuation coefficient in high and low Z material.
20. Calculate the range of alpha particle.
21. Calculation of thicknesses of lead and concrete needed to reduce the gamma ray intensity to a particular value.
22. Calculation of binding energy of a given nucleus.

### Miscellaneous Experiments

23. The student has to fabricate at least one experimental set up using integrated chips and other semiconductor devices.
24. To configure various shift registers and digital counters. Configure seven segment displays and drivers.
25. Use of timer IC 555 in astable and monostable modes and applications involving relays, LDR
26. To study temperature-dependence of conductivity of a given semiconductor crystal using four probe method.
27. To determine the Hall coefficient for a given semi-conductor.
28. To study the potential energy curve of the magnet-magnet interaction using air-track setup along with the simple experiments in mechanics.
29. To study the power dissipation in the SSB and DSB side bands of AM wave. To study the demodulation of AM wave.

30. To study various aspects of frequency modulation and demodulation.

## DISSERTATION

**Subject Code: MPHYS1-422** **L T P C**
**0 0 6 3**

M.Sc. 4th Semester will carry the dissertation work under the supervision of the assigned project guide as per following scheme:
**Format for writing dissertation work:** The students will write the report in Times New Roman, with font size 12 and 1.5 spacing.

| | |
|---|---|
| 1. Title of the M.Sc. Dissertation Work | 7. Introduction |
| 2. Self-Declaration Certificate of Original Work | 8. Methodology |
| 3. Acknowledgement | 9. Results and Discussion |
| 4. Content | 10. Conclusion |
| 5. List of Tables | 11. References |
| 6. List of Figures | 12. Student's Bio data |

**Evaluation Criteria:** The maximum marks allotted for the dissertation will be 100 which comprises of internal evaluation of 60 marks and external evaluation of 40 marks. The details of internal and external evaluation are given below:
(A) **Internal Evaluation: (MM: 60)**
The students will be evaluated based on regular performance, attendance and presentation. He/She should give power point presentation of their detail work during the mid-semester (1st and 2nd) examinations.
**Final Submission Report:**
The student will submit the final report as hard bound copies (03) and soft copy on CD/DVD. The internal awards will be given to the students after final submission of the report by the dissertation supervisor.
**(B) External Evaluation: (MM:40)**
Evaluation will be done based on originality and quality of work, knowledge and presentation skills etc. The students should give 30minutes' presentation through power point slides in the front of a internal panel of three examiners including dissertation Supervisor, Head/Nominee and other faculty member of the Department as constituted by Head of the Department.



## NUCLEAR ACCELERATORS, REACTORS AND DETECTORS (NARD)

**Subject Code: MPHYS1-460** **L T P C** **Duration: 45 Hrs.**
**4 0 0 4**

### UNIT- 1

**Interactions of Nuclear Radiations and Neutron Detection: (11 Hrs.)**
Introduction to radiations, types of radiations, Statistics of Counting, Nuclear electronics, Pulse shaping, Neutron discovery, neutron classification, neutron sources, Neutron detectors, slowing down of neutrons in matter, slowing down power and moderating ratio, 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 characteristics 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: (12 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, 'An Introduction to Paricle Accelerators', Oxford University Press, **2003**.
2. James Rosenzweig, 'Fundamentals of Beam Physics', Oxford University Press, **2001**.
3. P.N. Cooper, 'Introduction to Nuclear Radiation Detectors', Cambridge University Press, **1986**.
4. S.S. Kapoor and V.S. Ramamurthy, 'Nuclear Radiation Detectors', Wiley Eastern, New Delhi, **1986**.
5. G.F. Knoll, 'Radiation Detection and Measurement', John Wiley & Sons, **1989**.
6. K.S. Krane, 'Introductory Nuclear Physics', John Wiley & Sons, **1975**.
7. R.M. Singuru, 'Introduction to Experimental Nuclear Physics', Wiley Eastern Publications, **1987**.



## RADIATION PHYSICS

**Subject Code: MPHYS1-461** **L T P C** **Duration: 45 Hrs.**
**4 0 0 4**

**UNIT--I**

**Radiations and Radiation Quantities: (12 Hrs.)**

Sources and properties of α, β and γ - radiations, Interaction processes of α, β and γ - radiations with matter, Lambert-Beer Law, Linear and mass attenuation coefficients, Build-up factor: Exposure and energy absorption. Fluence, energy fluence, KERMA, Linear energy transformation (LET), exposure rate and its measurement. Absorbed dose and its measurement; Bragg Gray Principle, Radiation dose UNIT-s- rem, rad, Gray and Sievert, dose commitment, dose equivalent and quality factor.

**UNIT--II**

**Dosimeters: (12 Hrs.)**

**Active and Passive Dosimeters, Pocket Dosimeter:** film badges, thermo-luminescent dosimeters, optically stimulated luminescent dosimeters, solid state nuclear track detectors, chemical detectors, simple numerical problems on dose estimation.

**UNIT– III**

**Applications: (10 Hrs.)**

**Archaeological Applications:** Carbon dating; limitations and accuracy. Industrial Applications: Smoke detection, blockage/leakage detection of buried pipelines, thickness gauge, non-destructive testing. Agricultural Applications: benefits of radiation processing of food items, sterilization. Medical Applications: sterilization of medical equipment's, diagnosis and radiotherapy: in-vivo and in-vitro. Space Exploration: nuclear batteries/RTG.

**UNIT-– IV**

**Radiation Effects and Protection: (12 Hrs.)**

Biological effects of radiation, acute and delayed effects, stochastic and non-stochastic effects, Dose response characteristics, Relative Biological Effectiveness (RBE). Permissible dose to occupational and non-occupational workers, safe handling of radioactive materials. ALARA, ALI and MIRD concepts, Rad waste and its disposal. Radiation Shielding: The point kernal technique, radiation attenuation from a uniform plane source. The exponential point-Kernal. Radiation attenuation from a line and plane source. Thermal and biological shields, shielding materials, shielding requirement for medical, industrial and accelerator facilities, Practical applications and some simple numerical problems.

**Recommended Books:**


1. G.F. Knoll, 'Radiation Detection and Measurement', 3rd Edn., John Wiley & Sons Inc., **2000**.
2. E.B. Podgorsak, 'Radiation Physics for Medical Physicists', Springer, **2006**.
3. R.M. Singru, 'Introduction to Experimental Nuclear Physics', Wiley Eastern Pvt. Ltd., **1974.**
4. S.N. Ahmed, 'Physics and Engineering of Radiation Detection', Academic Press, **2007**.


## PHYSICS OF MATERIALS

**Subject Code: MPHYS1-462** **L T P C** **Duration: 45 Hrs.**

**4 0 0 4**



**UNIT- 1**

**Polymer Materials: (11 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 Characteristics-Fatigue, Tear Strength and Hardness, Mechanisms of Deformation and strengthening of polymers. Crystallization, Melting and Glass Transition Phenomena in Polymers.

**UNIT- 2**

**Composite Materials: (10 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', 4th Edn., John Wiley & Sons, Inc.
2. G.M. Chow& K.E. Gonsalves, 'Nanotechnology - Molecularly Designed Materials', 2nd Edn., 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', Imperial College Press, **2004**.


## NANO-PHYSICS

**Subject Code: MPHYS1-463** **L T P C** **Duration: 45 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: (12 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.

### UNIT- 4

**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. G.M. Chow& K.E. Gonsalves, 'Nanotechnology - Molecularly Designed Materials', 1st Edn., 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', Imperial College Press, **2004**.

## SOFT MATTER PHYSICS

**Subject Code: MPHYS1-464** **L T P C** **Duration: 45 Hrs.**
**4 0 0 4**

### UNIT-1

**Introduction to Soft Materials and the Glass Transitions: (8 Hrs.)**
Classification in terms of their thermal, mechanical and often unusual physical properties. The glass transition: General phenomenon and theoretical models, experimental determination.

### UNIT-2

**Introduction to Polymers: (8 Hrs.)**
Terminology and nomenclature, polymerisation mechanisms, molar masses and distributions, chain-dimensions and structures. Polymers in solution: Ideal solutions, Flory-Huggins theory, conformation entropy, dilute solutions.

### UNIT- 3

**Mechanical Properties of Polymers and Phase Separation: (8 Hrs.)**
Energy-elasticity, entropic spring, visco-elastic behaviour. **Phase Separation:** Mixing, de-mixing, simple fluid model, spinodal decomposition, metastability, fluctuations.

### UNIT-4

**Liquid Crystals and Collides: (11 Hrs.)**
Thermotropic, lyotropic, orientational order, order parameters, Landau description of the Isotropic to nematic phase transition, optical retardation, Freederiksz transition. Colloids:Stability, fluctuations and forces, Stokes-Einstein, gels, emulsions and foams.



**Recommended Books:**

1. P.J. Collings& M. Hird, ‘Introduction to Liquid Crystals’, **1997**.
2. K.A. Dill & S. Bormberg, ‘Molecular Driving Forces Garland’, **2003**.
3. I.W. Hamley, ‘Introduction to Soft Matter’, Wiley Chichester, **2000**.
4. R.A.L. Jones, ‘Soft Condensed Matter (OUP)’, Oxford, **2002**.
5. D. Tabor, ‘Gases, liquids & solids CUP’, **1991**.