CBCS- Summary (2016-17 onwards)

M. Sc. I Semester from July to December (PHYSICS)

Course Code	Course Title	Credits*	Marks Equivalent allotted
PHY-101 Core	Mathematical Physics	5	50 (40+10CCE)
PHY-102 Core	Statistical Mechanics	5	50 (40+10CCE)
PHY-103 Core	Quantum Mechanics-I	5	50 (40+10CCE)
PHY-104 Core	Electrodynamics and Plasma Physics	5	50 (40+10CCE)
PHY-105	Laboratory Course I (Electrical)	10	100
	Total Credits/Marks	**30**	**300**

M. Sc. II Semester from January to June (PHYSICS)

Course Code	Course Title	Credits*	Marks Equivalent allotted
PHY-201 Core	Atomic and Molecular Physics	5	50 (40+10CCE)
PHY-202 Core	Classical Mechanics	5	50 (40+10CCE)
PHY-203 Core	Quantum Mechanics-II	5	50 (40+10CCE)
PHY-204 Core	Electronics Devices	5	50 (40+10CCE)
PHY-205 Soft Skill	Seminar (Internal Evaluation)	2	25
PHY-206	Laboratory Course II (Non-Electrical)	8	100
	Total Credits/Marks	**30**	**325**

M. Sc. III Semester from July to December (PHYSICS)

Course Code	Course Title	Credits*	Marks Equivalent allotted
[illegible] Core	Condensed Matter Physics-I	5	50 (40+10CCE)
[illegible] Core	Nuclear and Particle Physics-I	5	50 (40+10CCE)
[illegible] Core	Advanced Quantum Mechanics-I	5	50 (40+10CCE)
[illegible] Elective (any one)	A. Advanced Electronics (Digital Electronics) B. Advanced Solid State physics C. Plasma Physics D. Spectroscopy	5	50 (40+10CCE)
PHY-305 Soft skill	Project Proposal formulation (Internal Evaluation)	2	25
PHY-306	Laboratory Course III (General)	8	100
	Total Credits/Marks	**30**	**325**

M. Sc. IV Semester from January to June (PHYSICS)

Course Code	Course Title	Credits*	Marks Equivalent allotted
PHY-401 core	Condensed Matter Physics-II	5	50 (40+10CCE)
PHY-402 Core	Nuclear and Particle Physics - II	5	50 (40+10CCE)
PHY-403 Core	Advanced Quantum Mechanics – II	5	50 (40+10CCE)
PHY-404 Elective (any one)	A. Microprocessor B. Laser & applications C. Fiber optics & integrated optics D. Physics of nano materials	5	50 (40+10CCE)
PHY-405 Soft skill	Research Project work (Internal)	2	25
PHY-406	Laboratory Course- IV (Electronics)	8	100
	Total Credits/Marks	**30**	**325**

Total Credits = I Semester + II Semester + III Semester + IV Semester

120= 30+30+30+30

M. Sc. I Semester

PHY – 101 [Mathematical Physics]

Unit-I

Vector Spaces and Matrices: Vector Spaces; Base. Dimension. Inner product space. Linear transformations. Matrices; Inverse. Orthogonal and Unitary matrices. Independent elements of a matrix. Eigen values and eigenvectors. Diagonalisation of a matrix. Complete Orthogonal sets of functions.

Unit-II

Differential Equations and Special Functions: Second order linear Ordinary Differential Equations with variable coefficients; Solution by series expansion; Legendre. Bessel. Hermite and Lagurre equations; Generating functions; Recursion relations. Physical Applications: Solving one dimensional harmonic oscillator; Schrödinger equation and Hydrogen atom. Schrödinger equation with Lagurre equation.

Unit-III

Integral Transforms: Integral transform; Laplace transform; Inverse LT by partial fractions; Solution of initial value problems by LT.

Unit-IV

Fourier Series and Fourier Transform: Fourier series; FS of arbitrary period; Half-wave expansions; Partial sums; Fourier integral and transforms; FT of delta function; Solution of time dependent problems by FT.

Text and Reference Books

1. G. Arfken: Mathematical Methods for Physics (Academic Press, INC. (London) Ltd.)
2. A. W. Joshi: Matrices and Tensors in Physics (Wiley Eastern Ltd, New Delhi)
3. E. Kreyszig: Advanced Engineering Mathematics (Wiley Eastern Ltd, New Delhi)
4. E. D. Rainville: Special Functions (The Macmillan Company, NewYork)
5. W. W. Bell: Special Functions (Dover Publication Inc.)
6. K.F. Reily, M.P. Hobson and S.J. Bence: Mathematical Methods for Physicists and Engineers (Cambridge University Press)
7. Mary L Boas: Mathematics for Physicists (John Wiley & Sons)

M. Sc. I Semester
PHY – 102 [Statistical Mechanics]

Unit-I

Foundations of Statistical Mechanics: Specification of states of a system, Statistical interpretation of the basic thermodynamic variables, Classical ideal gas, Entropy of mixing and Gibb's paradox.

Unit-II

Microcanonical ensembles, Phase space, Trajectories and density of states, Liouville's theorem, Canonical and Grand canonical ensembles, Partition function, Calculation of statistical quantities: Energy and Density fluctuations.

Unit-III

Density matrix, Statistics of ensembles, Statistics of indistinguishable particles; Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics, Properties of ideal Bose and Fermi gases,Bose-Einstein condensation.

Unit-IV

Correlation of space-time dependent fluctuations, Fluctuations and transport phenomena; Brownian motion: Langevin theory, Fluctuation dissipation theorem, The Fokker-Plank equation.

Text and Reference Books

1. F. Reif: Fundamentals of Statistical and Thermal Physics (Mcgraw-Hill Series)
2. K. Huang: Statistical Mechanics (Wiley eastern Ltd.)
3. R. K. Patharia: Statistical Mechanics (Pergamon Press)
4. R. Kubo: Statistical Mechanics (North-Holland Publishing Company, Amsterdam Landon)
5. Landau and Lifshitz: Statistical Physics (Pergamon Press, Oxford)
6. B.B. Laud: Fundamentals of Statistical Mechanics (New Age International Publisher)

M. Sc. I Semester

PHY – 103 [Quantum Mechanics-I]

Unit-I

Inadequacy of classical mechanics, Schrödinger equation, Continuity equation, Ehrenfest theorem, Admissible wave function, Stationary states.One-dimensional problems, Wells and barriers, Harmonic oscillator by Schrödinger and by operator method.

Unit-II

Uncertainty relation of x and p, States with uncertainty product, General formalism of wave mechanics, Commutation relations, Representation of states and dynamical variables, Completeness of eigen functions, Dirac-delta function, Bra and Ket notation, Matrix representation of an operator, Unitary transformation.

Unit-III

Angular momentum in QM, Central force problem, solution of Schrödinger equation for spherically symmetric potentials, Hydrogen atom.

Unit-IV

Time independent or stationary perturbation theory; Non-degenerate case; Application such as Stark effect.

Text and reference books

1. L I Schiff: Quantum Mechanics (Mcgaw-Hill Book Company)
2. S Gasiorowicz: Quantum Physics (Wiley, New York)
3. J D Powell and B Craseman: Quantum Mechanics (Addison Wesley Publishing Company)
4. A P Messiah: Quantum Mechanics (North - Holland)
5. J J Sakurai: Modern Quantum Mechanics (Pearson Education, INC.)
6. Mathews and Venkatesan: A text book of Quantum Mechanics (Tata McGraw-Hill Publishing Company Ltd.)
7. A Ghatak & S Loknathan: Quantum Mechanics; Theory and Applications (Macmillan IndiaLtd.)

M. Sc. I Semester

PHY – 104 [Electrodynamics and Plasma Physics]

Unit-I

(i) Review of four-vector and Lorentz transformations in four-dimensional space; Covariance form and transformation equations for Lorentz condition, electromagnetic potentials, Lorentz force law, Continuity equation, electric and magnetic field equations and Maxwell's field equations.

(ii) Wave equation for vector and scalar potential and solution, Retarded potential and Leinard- Wiechert Potential, Electric and magnetic fields due to a uniformly moving charge.

Unit-II

(i) Reaction force of radiation: Abraham-Lorentz equation of motion.

(ii) Motion of charged particles in electromagnetic field: Uniform E and B fields, Time varying E and B fields.

Unit-III

(i) Elementary concept: Plasma oscillations, Debye shielding, Plasma parameters.

(ii)Hydrodynamical description of plasma: Fundamental equations, Hydromagnetic waves: Magneto sonic and Alfven waves.

Unit-IV

(i) Wave phenomena in magneto plasma: Polarization, Phase velocity, Group velocity, Cut-offs and Resonance for electromagnetic waves propagating parallel and perpendicular to the magnetic field.

(ii) Propagation through ionosphere and magnetosphere.

Text and reference books

1. Panofsky and Philips: Classical electricity and magnetism (Addison – Wesley Publishing Company).
2. J.D. Jackson: Classical electrodynamics (Berkley, California, 1974)
3. J.A. Bittencourt: Fundamentals of Plasma Physics (Springer, III Edition)
4. F.F. Chen: Introduction to Plasma Physics (Plenum Press, III Print)

M. Sc. I Semester

PHY – 105 Laboratory Course –I (Electrical)

At least 10 Practicals based on electricity and general electronics.

M. Sc. II Semester

PHY - 201 [Atomic and Molecular Physics]

Unit-I

Raman Spectroscopy: Introduction: Characteristic properties of Raman Lines: Difference between Raman and Infrared Spectra: Mechanism of Raman Effect: Classical theory of Raman Effect. (a) Effect of vibrations. (b) Effect of Rotation: Quantum theory of Raman Effect. Pure Rotational Raman Spectra. Polarization of light and Raman Effect. Structure determination form Raman and Infrared Spectroscopy. Instrumentation of Raman Spectroscopy.

Unit -II

Electronic Spectroscopy: Electronic Spectra of Diatomic Molecules. The Born-Oppenheimer Approximation. Vibrational Coarse Structure, Frank-Condon Principle. Dissociation energy and Dissociation Products. Rotational Fine Structure of Electronic-Vibration Transitions. Fortrat Diagram, Predissociation, Applications of Electronic Spectra to Transition Metal Complexes.

Unit-III

Nuclear Magnetic Spectroscopy: Nuclear Magnetic Resonance, Quantum Description of Nuclear Magnetic Resonance, Instrumentation, Chemical Shift, Spin-Spin Coupling, Applications of NMR Spectroscopy, Limitations of NMR Spectroscopy.

Unit-IV

Electron Spin Resonance Spectroscopy: Electron Spin Resonance, Types of Substances, Comparison between NMR and ESR, Instrumentation, Presentation of ESR spectrum, Hyperfine Splitting, Determination of g value, Line width, Applications of ESR Spectroscopy.

Text and References books

1. Gurdeep Chatwal and Sham Anand, *Spectroscopy* (Atomic and Molecular) (Himalaya Publishers)
2. C. N. Banwell, Fundamentals of Molecular Spectroscopy. (Tata Mcgraw-Hill Publishers Company Ltd.)
3. Gerhard Herzberg, Infrared and Raman Spectra (D. Vannostrand Company, New York)

M. Sc. II Semester
PHY II – 202 [Classical Mechanics]

Unit-I
Constraints and their classifications, D'Alembert's principle, Generalized coordinates; Lagrange's equations, Gauge invariance, Generalized coordinates and momenta; Integrals of motion; Symmetries of space and time with conservation laws.

Unit-II
Rotating frames; Inertial forces; Terrestrial and astronomical applications of Coriolis force, Central force; Definition and characteristics, Two-body problem; Kepler's laws and equations, Artificial satellites; Rutherford scattering.

Unit-III
The Hamiltonian function, Hamilton's equation of motion, Hamilton's principle, modified Hamilton's principle, Derivation of Hamilton's equation from variational principle, principle of least action.

Unit-IV
Canonical transformation, Generating function, Poisson bracket and their properties, Invariance of Poisson bracket with respect to canonical transformation, equation of motion in Poisson bracket form, Hamilton-Jacobi equation, Hamilton's characteristics or principle function, Hamilton-Jacobi equation for Hamilton's characteristic function, Jacobi's identity, Small oscillation, Normal modes and coordinates.

Text and Reference Books

1. N. C. Rana and P. S. Joag: Classical Mechanics (Mcgraw-Hill Education (India) (P) Ltd.)
2. H. Goldstein: Classical Mechanics (Narosa Publishing House, New Delhi)
3. A. Sommerfeld: Mechanics (Lectures on theoretical Physics Vol.1, Acadmic Press)
4. I. Peroceival and D. Richards: Introduction to Dynamics (Cambridge University Press)
5. J. C. Upadhyaya: Classical Mechanics (Ramprasad and Sons)

M. Sc. II Semester
PHY III – 203 [Quantum Mechanics-II]

Unit-I

Variation method, Ground state of helium, Vander wall's interaction, Polarizability of hydrogen, Exchange degeneracy.

Unit-II

Time-dependent perturbation theory, WKB method, □-decay of radioactive nucleus, Penetration of barrier, Adiabatic approximation, Sudden approximation.

Unit-III

Identical particles: Symmetric and anti-symmetric wave functions, Collision of identical particles, Spin angular momentum, Spin functions for a many-electron system.

Unit-IV

Semi classical theory of radiation: Transition probability for absorption and induced emission, Electric dipole and forbidden transitions: Selection rules.

Text and reference books

1. L I Schiff: Quantum Mechanics, (Mcgraw-Hill Education (India) (P) Ltd.)
2. S Gasiorowicz: Quantum Physics
3. B Craseman and JD Powell: Quantum Mechanics, (Addison – Wesley Publishing Company)
4. A P Messiah: Quantum Mechanics, (North - Holland)
5. J J Sakurai: Modern Quantum Mechanics, (Pearson Education, Singapore)
6. Mathews and Venkatesan: Quantum Mechanics, (Tata Mcgraw-Hill Publishers Company Ltd.)

M. Sc. II Semester

PHY – 204 [Electronic Devices]

Unit-I

(i) Transistors: JFET, BJT, MOSFET and MESFET: Structure, working, derivations of equations for I-V characteristics under different conditions, High frequency limits.

(ii) Microwave devices: Tunnel diode, Transfer electron devices (Gunn diode), Avalanche transit time devices, Impatt diodes and parametric devices.

Unit-II

(i) Memory devices: Static and dynamic random access memories SRAM and DRAM, CMOS and NMOS, NON-volatile-NMOS, Magnetic, Optical and Ferroelectrics memories, Charge coupled devices (CCD).

(ii) Transistor as a switch, OR, AND and NOT gates; NOR and NAND gates, Boolean algebra, Demorgan's theorem; Exclusive OR gates; Decoder/Demultiplexer data selector multiplexer; Encoder.

Unit-III

Oscillators: The phase shift oscillator, Wein bridge oscillator, LC-tunable oscillators, Multivibrator: Monostable and Astable, Comparators, Square wave and triangle wave generators.

Unit-IV

Voltage regulators: Fixed voltage regulators, Adjustable voltage regulators, Switching regulators.

Text and reference books

1. S M Sze: Semiconductor devices, (John Wiley & Sons)
2. M S Tyagi: Introduction to semiconductor materials and devices, (John Wiley & Sons)
3. M Sayer and A Mansingh: Measurement, instrumentation and experimental design in physics and engineering, (Prentice Hall of India, New Delhi)
4. Ajoy Ghatak and K Thyagarajan: Optical electronics, (Cambridge University Press)
5. J Millmann and C C Halkias: Integrated electronic: Analog and digital circuits and systems, (Tata Mcgraw-Hill Education, New Delhi)
6. G K Mithal: Electronic devices and circuits, (Khanna Publishers)

M. Sc. II Semester
PHY – 205 Seminar

A student has to deliver a seminar on syllabus or research topic chosen by the student with the consent of the faculty. All the students are encouraged to attend and participate in the seminar.

M. Sc. II Semester
PHY – 206 Laboratory Course –II (Non-Electrical)

At least 10 Practicals based on Optics, mechanics etc. (other than electrical based)

M. Sc. III Semester
PHY – 301 [Condensed Matter Physics-I]

Unit-I

(1) Crystal structure and reciprocal lattice: Crystal structure and Bravais lattice, Primitive unit cell, Wigner Seitz cell, Reciprocal lattice, Brillouin zone.
(2) X-ray diffraction: Bragg formulation, Van Laue formulation of X-ray diffraction, Ewald construction, Laue method, Debye-Scherrer method.

Unit-II

Lattice vibration, Normal modes of a one-dimensional mono-atomic lattice, Normal modes of one-dimensional diatomic lattice, Two ions per cell, The acoustic and optical modes of vibrations, Connection with the theory of elasticity.

Unit-III

Band theory-I: Periodic potential and Bloch's theorem, Proof of Bloch theorem, Born-Von-Karman boundary condition, Fermi surface, Density of levels, Schrödinger equation in a weak periodic potential (nearly free electron), Energy bands in one dimension, Construction of Fermi surface.

Unit-IV

Band theory-II: Tight binding method, Cellular method, Muffin-Tin potential, Augmented Plane wave (APW) method, Orthogonalised plane wave (OPW) method, de Haas- Van-Alphen effect.

Text and References Books

1. Solid State Physics: N. W. Ashcroft and N. D. Mermin (Harcourt Asia PTE Ltd.)
2. Introduction to Solid State Physics: C. Kittel (John Wiley and Sons, II and III Ed.)
3. Intermediate Quantum theory of Crystalline Solids: A. E. Animalu (Prentice Hall of India Pvt. Ltd.)
4. Principles of Condensed Matter Physics: Chaikin and Lubensky (Cambridge University Press)

M. Sc. III Semester

PHY – 302 [Nuclear and Particle Physics -I]

Unit-I

Introduction to the Nucleus: Mass, Charge and constitution of the nucleus, nuclear size and the distribution of nucleus. Energies of nucleus, angular momentum. Miscellaneous aspects of nuclear structure, masses and binding energies of nuclei. The liquid drop model and semiempirical mass formula, magnetic dipole moments, electric quadrupole moments

Unit -II

Experimental nuclear physics: Accelerators, Synchrocyclotron, proton synchrotron, variable energy cyclotron. Detectors: GM counters, scintillation detectors, semiconductor radiation detector, magnetic Beta-ray spectrometer scintillation, Gamma-ray spectrometer.

Unit-III

The nuclear force: the deuteron problem, spin states of two nucleon system effects of pauli's exclusion principle. Magnetic dipole and electric quadrupole memonets of a deuteron. The tensor force, exchange forces, meson theory of nuclear force, the nuclear force as we know it.

Unit-IV

Nuclear structure: the independent particle model, empirical rules for the ground states of the model, the shell model. The unified model. Vibrational and rotational states.

Text and Reference Books:

1. Introductory nuclear physics by Y.R. Waghmare (oxford and IBH)
2. Concepts of nuclear physics by B.L. Cohen (TMH)
3. Experimental Nuclear Physics by R.M. Singru (Wiley- Eastern)

M. Sc. III Semester

PHY – 303 [Advanced Quantum Mechanics -I]

Unit-I: Angular Momentum

Angular Momentum: Time displacement symmetry and conservation of energy. Angular momentum and rotation. Rotational Symmetry and conservation of angular momentum. Degeneracy. Reflection invariance and parity. Eigen values of angular momentum operators. Angular momentum matrices. Pauli's spin matrices. Addition of angular momentum. The possible values of J-Clebsh-Gordan coefficients for 1/ 2 1, 1/ 2 1 2 1 2 *j* □□*j* □□*and j* □□*j* □□.

Unit-II: Bose, Fermi and Particle and Parastatistics

Identical particles in quantum mechanics and permutation symmetry. Symmetrization postulate. Algebraic approach to Bose and Fermi statistics. Parastatistics. Quantization and spin statistics connection.

Unit-III: Radiation Theory

The quantum theory of radiation. The Hamiltonian quantization of the radiation field (second quantization). Creation and Annihilation operator.

Unit-IV: Relativistic Theory

The Klein-Gordon equation. The Dirac equation, Probability and Current densities. Covariance of Dirac equation, Plane wave solutions. The electron in electric and magnetic field. Dirac equation in central potential, Energy levels of hydrogen atom. The hole theory and positrons, Prediction of the spin angular momentum.

Text and Reference Books:

1. A.K. Ghatak and S. Loknathan: Quantum Mechanics; Theory and Applications (Macmillan India Ltd.)
2. S. N. Biswas: Quantum Mechanics (Books & Allied (P) Ltd.)
3. Messiah: Quantum Mechanics (Dover Publications)

M. Sc. III Semester

PHY – 304(A) [Advanced Electronics (Digital Electronics)]

Unit-I: Operational Amplifiers and Gates

OP-Amp: Operational amplifier. Inverting and non-inverting amplifier. Difference amplifier. Analog Integration and differentiation. Gates: Binary. Decimal. Hexadecimal numbers. BCD. ASCII codes. Inverter. Diode OR and AND gates. Boolean algebra. De Morgen's Theorems. NOR. NAND. ex-OR and ex-NOR gates. Controlled inverter.

Unit-II: TTL circuits and Karnaugh Maps

TTL circuits: 7400 devices. TTL characteristics. TTL overview. Encoders and Decoders. AND-OR-INVERT gates. Multiplexer. Karnaugh maps and Karnaugh simplification.

Unit-III: Digital Electronics and system

Arithmetic logic unit: Half adder. Binary adder, 2's compliment, 2's compliment adder and subtracter. Flip-Flops: RS-latches. Level clocking, D-latches and flip-flops, JK master slave flip-flops.

Unit-IV: Registers and Memories

Registers and counters: Buffer registers, Shift register, Ripple counters, Synchronous counters. Ring counters. other counters and Bus-organized computer.

Memories: ROMS. PROMS, EPROMS, RAMS, A small TTL memory, Hexadecimal addresses.

Text and Reference Books:

1. Digital Principles and Application: A. P. Melvino & D. P. Leech (Tata McGraw-Hill Education (P) Ltd.)
2. Op-Amps & Linear Integrated circuits: R. A. Gayakwad (Prentice Hall, 2000)
3. Electronics: D. S. Mathur (S. Chand Publishing)
4. Digital Communications: W. Tomasi (Prentice Hall)
5. Digital Computer Electronics: A. P. Malvino and Brown (Tata McGraw-Hill Education (P) Ltd.)

M. Sc. III Semester
PHY – 304(B) [Advanced Solid State Physics]

Unit-I

Elastic constants and elastic waves: Analysis of elastic stains, Elastic compliance and stiffness constants, Central and non-central forces, velocity of sound and crystal elasticity, Dynamical equations of sound wave propagation in crystal of cubic symmetry. Experimental determination of elastic constants.

Unit-II

Optical Properties: Electronic properties of alkali halides, Optical and thermal electronic excitation, Ultravoilet spectrum of the alkali halides, Exciton, Influence of lattice defects on electronic levels, ionic polarizability, Restrahlen, polarization waves in ionic crystals. Lyddane- Sachs-Teller relation. Optical effects in semiconductors, Direct and indirect transitions, Free carrier absorption

Luminescence, Excitation and emission, Decay mechanisms, Traps, Thermoluminescence, Electroluminescence, Luminescence in semiconductors and ionic solids.

Unit-III

Transport Properties: Boltzmann transport equation, its application for the study of transport phenomena due to electric and magnetic fields, density and temperature gradients. Solution of Boltzmann equation under relaxation time approximation, Transport coefficients, Scattering mechanisms, Calculation of the relaxation time for scattering due to impurity and thermal vibrations of lattice.

Unit-IV

Ferroelecticity: Classification and general properties of ferroelectrics, Dipole theory. Thermodynamics of ferroelectric transitions, Low frequency optical phonons, Exprinents with strontium titanate. Ferroelectric domains antiferroelectricity. Piezo and pyroelectricity.

Text and Reference Books:

1. Introduction to solid state physics- C. Kittel (John Wiley 5th edition).
2. Solid state physics- A.J. Dekkar (MachMillan).
3. Solid State Physics- Ed Seitz and Turnbull (Academic Press) Vol. 2 and 4.

4. The use of Thin Films in Physical Investigation- Ed. J.C. Anderson (Academic Press).
5. Energy Band Theory- J. Callaway (Academic).
6. Wave Mechanics of Crystalline Solids- R.A. Smith (Chapman and Hall).
7. The Theory and Properties of Metals and Alloys- M.F. Mott and Jones (Dover).

M. Sc. III Semester
PHY – 304(C) [Plasma Physics]

Unit-I

Occurrence of Plasmas in nature: Defination of plasma, Concept of temperature, Debye shielding, The plasma parameter, Criteria for plasma, Applications of plasma physics with elementary idea about gas discharges, Controlled thermonuclear fusion, Space physics, Astro-physical Plasma, MHD energy conversion and ion propulsion, Solid state plasma, Laser and laser fusion.

Single particle motions: Uniform E and B fields, Gravitational fields, Non uniform B field, Grade B drift, curvature drift, Non uniform E field, Time varying E field, Time varying B field, Guiding center drifts. The first adiabatic invariant, second adiabatic invariant.

Unit-II

Plasma as fluids: Relation of plasma physics to electromagnetic, classical treatment of magnetic materials and dielectrics. Dielectric constants of plasma fluids, equations of motion, stress tensor collisions, equations of continuity, equation of state, Complete set of fluid equations.

Equilibrium and Stability: Hydromagnetic equilibrium, Concept of diffusion of magnetic field into a plasma, Classification of instability, Resistive drift waves.

Unit-III

Waves in plasmas: Representation of waves group velocity, Plasma oscillations, Electron plasma waves, Sound waves, ion waves, Comparision of electron and ion waves, Electrostatic electron oscillations perpendicular to B. Electrostatic ion waves perpendicular to B, The lower hybrid frequency electromagnetic waves. Experimental applications, Electromagnetic wave perpendicular to B, Cut off and resonances, Electromagnetic wave parallel to magnetic field. Experimental consequences of Magnetosonic waves. The C.M.A. diagram.

Unit-IV

Kinetic theory: Meaning of distribution function, equation of Kinetic theory, Derivation of fluid equation, Landau damping without contour integrations, Meaning of Landau damping. The Kinetic energy of a beam of electrons, Experimental verification.

Solid state plasma: Introduction, parameters and physical laws, Passive electro kinetic wave propagation in an infinite and in a finite medium, Macroscopic model of piezoelectric media, Longitudinal Phonon-Plasmon interactions, Transverse Phonon-Helicon interactions, Solid state plasma technology, Travelling wave amplifiers, High frequency isolator, the oscillator, the madistor.

Text and Reference Books:

1. Introduction to Plasma Physics- F.F. Chen, Plenum Press, III Print.
2. Principles of Plasma Mechanics- B.B. Charkraborty, Wiley Eastern Limited.
3. Solid State Plasmas- M.F. Hoyaux, Pion Limited, London, 1970.
4. Wave Interactions in solid state plasmas- M.C. Steele and B. Vural, McGraw Hill, New York, 1969.

M. Sc. III Semester
PHY – 304(D) [Spectroscopy]

Unit-I

Atomic Spectra: Coupling schemes, LS and JJ couplings in spectra of two valence electron systems.

Hyperfine structure: Hyperfine multiplets, Magnetic interaction in single electron spectra, Basic relation Hydrogen like atoms: Relativistic and volume correction.

Width of spectral lines: the different causes of line width, The natural or radiation width, Doppler width, External effects.

Molecular Orbitals: Spectroscopic designations for molecules, The unified atom model, separated atom model, Molecular orbitals, United-separated atom. Correlation diagrams.

Unit-II

Microwave spectroscopy: Theory of microwave spectroscopy, Linear Molecules, spherical top molecules, symmetric top molecules, Asymmetric top molecules, The stark effect, Instrumentation for Microwave spectroscopy, Applications of microwave spectroscopy.

Infrared spectroscopy: Theory of IR absorption spectroscopy, Linear Molecules, Symmetric top molecules, Asymmetric molecules, Instrumentation, Single beam and double beam, spectrophotometers, Modes of vibration of atoms in polyatomic molecules, Applications of infrared spectroscopy to organic and inorganic compounds and complexes.

Unit-III

Ultraviolet spectroscopy: Origin and theory of ultraviolet spectra, choice of solvents, Instrumentation, Application of UV absorption spectroscopy.

Unit-IV

X-Ray spectroscopy: Theory of emission spectra-classical, semiclassical and quantum theory of emission of X-ray lines, X-ray energy level diagrams, selection rules of electric and magnetic dipole and higher multipole transitions, Spin doubles, The T-sum and permanence rules Screening doublets and screening constants, Relative intensities in X-ray spectra, Non-diagram lines (theory). Structure of absorption edges and chemical effects in X-ray absorption spectra. Theory of EXAFS; experimental details and its uses.

Text and Reference Books:

1. Spectroscopy part I & II – Strughan and S. Walkar, Chapman and ...
2. Spectra of Diatomic molecules- G. Herzberg, Vannostrand.
3. Atomic spectra- H.E. White, McGraw Hill.
4. X-ray spectroscopy- B.K. Agrawal, Springer Verlag.
5. Elements of diatomic molecular spectra- H. Brian Dunford, Addission Wesley.

M. Sc. III Semester

PHY – 305 [Project Proposal Formulation]

A student has to prepare a project proposal and submit a write up on a working model.

M. Sc. III Semester

PHY – 306 Laboratory Course –III (General)

At least 10 Practicals based on Solid State, Spectroscopy, Nuclear Physics etc (other than electronics)

M. Sc. IV Semester

PHY – 401 [Condensed Matter Physics-II]

Unit-I

Electron dynamics: The semi-classical model: Motion in a DC electric field, the holes. Motion in a uniform magnetic field. Motion in perpendicular uniform electric and magnetic fields. Hall effect and magneto-resistance.

The semi-classical theory of conduction in metals: The relaxation time approximation. DC electric conductivity. AC electric conductivity. Thermal conductivity.

Unit-II

Defects in Solid: Number of vacancies and interstitial as a function of temperature. Diffusion: Self-diffusion and chemical diffusion. Fick's law. Edge and screw dislocation. Slip. Burger vector. Dislocation mobility and density. Interaction between dislocations. Color center. Excitons. Elementary idea about luminescence.

Unit-III

Semiconductors: Typical semiconductor band structures. effective mass in semiconductors. Cyclotron resonance. Number of carriers in thermal equilibrium: Intrinsic and extrinsic cases. Population of impurity levels in thermal equilibrium: Thermal equilibrium carrier density of impure semiconductors. p-n junction in equilibrium.

Unit-IV

Superconductivity: Experimental surveys. Meissner effect. Heat capacity. Energy gap. Microwaves and infrared properties. Thermodynamics of superconducting transition. London equation. Qualitative idea of BCS theory. Type-I and Type-II superconductors. Super conducting devices. isotope effect. Flux quantization. Single particle tunneling. Josephson tunneling. High Tc superconductors.

Text and References Books:

1. Solid State Physics: Neil W. Ashcroft and N. David Mermin (Harcourt college Publishers)
2. Solid State Physics: C. Kittel (John Wiley and Sons. VII Ed.)
3. Intermediate Solid State Physics: AE Animalu (Prentice Hall of India Pvt. Ltd.)
4. Principle of Condensed matter Physics: Chaikin and Lubensky
5. Elementary Solid State Physics: Ali Omar

M. Sc. IV Semester

PHY – 402 [Nuclear and Particle Physics -II]

Unit-I

Radioactivity: Alpha decay, calculation of alpha decay rates. The Gamma-decay, transition probability of gamma decay, many particle configuration transition, internal conversion.

Unit-II

Beta Decay: experimental observations, shape of beta spectrum, neutrino hypothesis. The Kurie plot, Fermi's theory of beta decay, allowed transitions, parity non-conservation in beta decay and its experimental confirmation.

Unit-III

Nuclear reactions: Elastic scattering reaction cross section, the collision amplitude, elastic scattering of S-wave neutrons. Scattering of charged particle, cross section in terms of the scattering matrix in the general case. Reaction mechanism, compound nuclear reactions. Statistical model nuclear reaction.

Nuclear Fission: Neutron emission in fission, Fissile and fertile materials, theory of fission. Nuclear fission and thermonuclear reactions.

Unit-IV

Fundamental particles (Descriptive): The particles and force between them. Enumeration of various quantum numbers, properties of the muons, pions, kaons, hyperons, quarks. Partons and the J_ψ contemporary situation regarding elementary particles.

Text and References Books:

1. Introductory nuclear physics by Y.R. Waghmare (oxford and IBH)
2. Concepts of nuclear physics by B.L. Cohen (TMH)
3. Experimental Nuclear Physics by R.M. Singru (Wiley- Eastern)

M. Sc. IV Semester

PHY – 403 [Advanced Quantum Mechanics -II]

Unit-I

Scattering Theory: Differential scattering cross section, Total scattering cross section, Relationship between the scattering cross section to the wave function, the scattering amplitude, Method of partial waves, Expansion of plane wave in terms of partial waves, Scattering by a central potential, the scattering length, Scattering by a square well potential, Resonance scattering.

Unit-II

The Born approximation, Criterion for the validity of the Born approximation, Scattering of electrons to atoms.

Unit-III

Elements of Field Quantization: Quantization of the field, Non-relativistic fields, System of Bosons, System of Fermions, Commutators and anti-commutators, unequal times.

Unit-IV

Relativistic field, The Klein-Gorden field, Invariant delta functions, The Dirac field, Spins and statistics, covariant anti-commutation relations, Feynman diagrams.

Text and Reference Books:

1. V. K. Thankappan: Quantum Mechanics
2. Katiyar: Relativistic Quantum Mechanics and Field
3. A. J. Ghatak and S. Loknathan: Quantum Mechanics; Theory and Applications (Macmillan India Ltd.)

M. Sc. IV Semester
PHY – 404(A) [Microprocessor]

Unit-I
Microprocessor-I
(a) Introduction to microprocessors
(b) Programming and languages: Relationship between electronics and programming. Flowcharts, Programming languages, Assembly languages.
(c) System overview: Computer architecture, Microprocessor architecture, specific microprocessor -8085 only.

Unit-II
(a) Data transfer instructions: CPU control instructions, Data transfer instructions, Microprocessor 8085 family only.
(b) Addressing modes I: Concept of addressing mode, Paging concept, Basic addressing modes. Microprocessor-8085 family only
(c) Arithmetic and flags: Microprocessors and numbers, Arithmetic instructions, Flag instructions, Microprocessor 8085 family only.
(d) Logic instructions: The AND instruction, The OR instruction, X-OR, X-NOR and NOT instructions.

Unit-III
SAP
(a) Bistable multivibrators: Stable state of a binary, Fixed bias transistor binary, Self biased transistor binary.
(b) Simple-as-possible computer (SAP-1): Architecture, Instruction set, Programming, Fetch cycle, Execution cycle, Microprogramming, Schematic diagram, Micro Programming.

Unit-IV
(a) Simple-as-possible computer-II (SAP-2): Bidirectional resistors, Architectures, Memory reference instructions, Registers instruction, Jump and call instructions, Logic instructions.
(b) Simple-as-possible computers (SAP-3): Programming model, Arithmetic instructions, Increments, decrements and multiples Logic instructions.

Text and Reference Books:

1. Microprocessor Architecture Programming and Applications: R. S. Gaonkar.
2. Digital Computer Electronics: A. P. Malvino and Brown (Tata McGraw-Hill Educati[on] (P) Ltd.)

M. Sc. IV Semester
PHY – 404(B) [Laser & applications]

Unit-I

Interaction of radiation with matter: Stimulated and spontaneous emission, Einstein's A & B coefficients, line broadening mechanisms, gain and absorption coefficients, principles of laser, population inversion, population inversion in three and four level lasers, laser amplification, conductions for laser output.

Unit-II

Laser beam output modifications: Q-factor of laser oscillations, laser linewidth, resonators, stable and unstable resonators, a laser cavity, active and passive Q-switching, mode looking, detection of pulsed laser output.

Unit-III

Specific Laser and Pumping Mechanisms: Solid state rare earth ion lasers and optical pumping, Dye lasers and optical pumping, Electron impact excitation, Excitation Transfer, He-Ne lasers, Rate equation model of population inversion in He-Ne lasers, Radial gain variation in He-Ne laser tubes, CO_2 electric discharge lasers, Gas-Dynamic lasers, Free-Electron lasers, Semiconductor lasers.

Unit-IV

Elementary concepts of nonlinear optics: operating principles and characteristics, introduction second order optical susceptibility, parametric up and down conversion, second harmonic generation, third order optical susceptibility, nonlinear refraction and absorption, optical phase conjugation.

Unit-V

Applications of lasers: Distance and Velocity Measurements, The Laser Gyroscope, Holography: The Essential Principle, Holography: Practical Aspects, Optical Communications, Lasers in Medicine: Ophthalmology.

Text and Reference Books:

1. Introduction to laser physics- K. Shimoda
2. An introduction to laser and their applications: D.C. O'shea
3. Quantum electronics- A. Yariv
4. Optical electronics- A.K. Ghatak and K. Thyagarajan
5. Lasers and applications: K. Thyagarajan and A.K. Ghatak
6. Lasers: Peter W. Milonni and Joseph H. Eberly.
7. Nonlinear Optics- R W Boyd.

M. Sc. IV Semester

PHY – 404(C) [Fiber optics & integrated optics]

Unit-I

Introduction : The optical fiber, comparison of optical fiber with other inter connectors, concept of an optical waveguide, rays and modes, principal of light guidance in optical waveguide: basic wave guides, fiber types. Electromagnetic analysis of simplest optical waveguide. TE wave guide equation, propagating modes of symmetric step index planar waveguide, the relative magnitude of longitudinal modes of symmetric step index planer waveguide, the relative magnitude of longitudinal component of electric and magnetic field, power associated with a mode, radiation modes, leaky modes.

Unit-II

Optical fiber waveguides: Scalar wave equation and modes of fiber, modal analysis for step index fiber, fractional power in the cone, modal analysis of parabolic index medium. Attenuation in optical fiber, pulse dispersion in optical fiber, losses at fiber splices, measurement of refractive index profile and spot size of an optical fiber.

Unit-III

Optical fiber fabrication and cabling: Material consideration, loss and band width limiting mechanisms, mechanical and thermal characteristics, perform fabrication of multicomponent glass fibers, mechanical consideration for optical fiber cabling, fiber cable design, example of cable design. Applications: fiber optic components and devices, fiber optic sensors.

Unit-V

EM wave propagation in anisotropic crystals: Index ellipsoid, index ellipsoid in presence of external electric field. Electrooptic (EO) effect in KDP crystals; EO devices, Acoustooptic (AO) effects. Raman-Nath and Bragg AO effect. AO devices.

Text and Reference Books:

1. An introduction to optical fibers- A. H. Cherin
2. Optical electronics- A. Ghatak & K. Thyagarajan
3. Optical fiber communication – G. Kasser
4. Theory of dielectrics optical waveguides – D. Marcuse
5. Fiber optics technology & applications- S.D. Personick
6. Fiber optics- N. S. Kapany
7. Integrated optics- D. Marcuse
8. Integrated optics- T. Tamir
9. Electromagnetic principle of integrated optics- D. Lee
10. Fiber Optic Communication System- G P Agrawal

M. Sc. IV Semester

PHY – 404(D) [Physics of Nano materials]

Unit-I

Systematic Development of Materials: Solid materials and their strength, Perspective of length, Nanoscience and nanotechnology, Nanostructures in nature, Quantum structures, Quantum confinement, Surface effects of nanomaterials, Prime materials, Carbon nanostructures, Metal Oxides, Bright future of nanotechnology.

Unit-II

Methods of Generation of Nanomaterials: Nanomaterials synthesis, Physical approaches; Arc discharge method, Laser ablation, Aerosol synthesis, Inert gas condensation, High energy ball milling, Chemical vapor deposition, Plasma synthesis method, Electro-deposition. Chemical approaches; Solvothermal synthesis, Hydrothermal Synthesis, Reverse micellar/ Micro-emulsion method, Sol gel synthesis, Microwave method, Sonochemical process, Co-precipitation.

Unit-III

Properties of Nanomaterials: Mechanical behavior, Optical Properties, Electrical Properties, Dielectric materials and properties, Magnetic properties, Electrochemical properties, Chemical sensing properties.

Unit-IV

Applications of Nanomaterials: Nanomaterials in medicine, energy sector, next generation computer technology, catalysis, water purification, communication sector, food, fabric industry, for the environment, automobiles, ceramics industry, veterinary applications.

Text and Reference Books:

Principles of Nanoscience and Nanotechnology; M.A. Shah & Tokeer Ahmad (Narosa) 2010.

Physics of Nanostructures; K.P. Jain (Narosa) 1987.

Physics of Low dimensional semiconductors; John H. Davies (Cambridge University Press).

M.Sc. IV Semester

PHY-405 Research Project Work (Internal)

A working model should be developed and its model and write-up should be submitted. A presentation based on it would be arranged.

M.Sc. IV Semester

PHY-406 Laboratory Course - IV (Electronics)

At least 10 experiments based on digital electronics and microprocessor.