Faculty of Science

Master of Science

Syllabus for

M.Sc. Physics (CBCS Programme)

Semester-1 & 2

Effective from June 2023

M.Sc. Semester - 1

MSC1C109 Quantum Physics and Mathematical Physics

Unit-1

Solution of Schrodinger equation in three-dimension separable variable method. Applications to (I) Square well (II) Attractive coulomb potential (III) Hydrogen Atom

Unit-2

Time independent perturbation theory: Stationary perturbation, Degenerate and no degenerate case, Application such as stark effect. Time dependent perturbation, General formulation and the first order theory, Periodic perturbation and Fermi Golden Rule, Interaction of electromagnetic field with atom.

Unit-3

Group theory: Group, subgroups and classes, Invariant subgroups, factor groups, Homomorphism and Isomorphism, Group representation, Reducible and irreducible representation, Schur's Lemmas, orthogonality theorem, Character of a representation, Character tables, Decomposing a reducible representation into irreducible ones, Construction of representation, Representations of groups and quantum mechanics.

Unit-4

Tensor: Introduction, n - dimensional space, superscripts and subscripts, Coordinate transformations, Indicial summation conventions, Dummy and Real indices, Kronecker sdelta symbol, Scalars, Contravariant vectors and covariant vectors, Tensors of higher ranks, Algebraic operations, Symmetric and Antisymmetric tensors, Invariant tensors, Conjugate and reciprocal tensors, Relative and absolute tensors, Line element and matrix tensor, Fundamental tensors.

Reference Books:

1. P.M. Mathews and K Venkatesan, A textbook of Quantum Mechanic, Tata MC Graw - Hill publishing company Limited.
2. L. I. Schiff, Quantum mechanics, Tata McGraw - Hill publishing company Limited.
3. G. Aruldhas, Quantum mechanics, Prentice - Hall of India
4. A. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and applications, Macmillan India Limited.
5. M.L. Boas, Mathematical methods in the physical sciences, JW, 1966
6. P.K. Chattopadhyaya, Mathematical Physics, Wiley Eastern Ltd.
7. G. Arfken, Mathematical methods for Physicists, Academic Press, 1970
8. Quantum Mechanics – Schiff (McGraw Hill)
9. A text book of Quantum Mechanics – Mathews and Venkatesan
10. Quantum Mechanics – Amit Goswami
11. Fundamental of Quantum Mechanics – Vaghmare
12. M.L. Boas, Mathematical methods in the physical sciences, JW, 1966
13. P.K. Chattopadhyaya, Mathematical Physics, Wiley Eastern Ltd.
14. G. Arfken, Mathematical methods for Physicists, Academic Press, 1970

M.Sc. Semester - 1

MSC1C110 Solid State Electronics

Unit-1

Introduction, Nearly Free Electron Model, Origin of energy gap, Magnitude of the energy gap. Bloch Functions, Kronig-Penney Model, Wave Equation of Electron in a Periodic Potential, Restatement of the Bloch theorem, crystal momentum of an electron, solution of the central equation, empty lattice approximation, Approximate solution Near Zone Boundary, Number of orbitals in a band, Metals, and Insulators.

Unit-2

Scattering of radiation by a free charge, Scattering of radiation by a bound charge, Radiation damping, Dispersion in dilute gases, Dispersion in liquids and solids. Frequency dependence ε, μ, σ. Dispersion in non-conductors, Free electrons in conductors and Plasma.

Unit-3

Junction Field Effect Transistors, Comparison with BJT, basic Construction, polarity conventions, Characteristics, JFET parameters, JFET-biasing methods, Common source amplifier, Source-follower, MOSFETS, DE-MOSFETS: Construction and Characteristics, E-MOSFETS: Construction and Characteristics, Complementary MOS.

Unit-4

Zener diode, voltage regulation, Silicon Controlled Rectifier, TRIAC, DIAC, Uni-Junction transistor, UJT-relaxation oscillator, Programmable UJT (PUT), Thermistors, Solar-cells, Semiconductor Laser, population inversion at junction, optical gain and threshold current for lasing

Reference Books:

1. C. Kittle, Introduction to Solid State Physics, 7th Ed., Wiley Eastern Limited, New Delhi
2. J.P.Srivastava: Elements of solid state physics, PHI, India.
3. Electronic Circuits: Discrete and Integrated, Donald Schilling & Charles Belove,MaGraw Hill International
4. Electronic devices and circuit theory, Robert Boylestad& Louis Nahselsky, PHI
5. Solid State Devices and integrated circuits, W.D. Cooper Weisbecker, RestonPub (USA)
6. Solid state Devices & applications, Frederick Driscoll & Robert Coughlin, Prantice hall.

M.Sc. Semester - 1

MSC1C111 Classical Mechanics

Unit-1

Integral transform, Laplace transform, some simple properties of Laplace transforms (a)linearity property (b) shifting properties, first & second shifting (c) change of scale property, Laplace Transform of Derivatives & Integral, Inverse Laplace Transform by Partial Functions.

Unit-2

Fourier Series and Applications. Fourier Transform, Fourier Sine & Cosine Transform, Simple Application of Fourier Transform.

Unit-3

Equation of Canonical Transformation, Example of Harmonic Oscillator, Poisson Brackets Properties of Poisson Brackets, Angular Momentum Poisson Bracket Relation. Virial Theorem.

Unit-4

Hamilton – Jacobi Theory, Hamilton – Jacobi Equation for Hamilton's Principal Function, Harmonic Oscillator Example, Hamilton's Characteristic and Principal Functions. Moving Coordinate System, Coordinate System with Relative Translational Motions, Rotating Coordinate Systems, Coriolis Force, Motion on the Earth.

Reference Books:

1. Classical Mechanics – H. Goldstein
2. Classical Mechanics – N.C. Rana and P.S. Joag
3. Introduction to Classical Mechanics – R.G. Takwale&Puranik
4. Classical Mechanics of Particles and Rigid Bodies – Kiran C. Gupta
5. Classical Mechanics – Y.R. Waghmare
6. Classical Mechanics – Bhatia
7. Classical Mechanics – Leech
8. A. B.Bhatia, Classical Mechanics, Narosa Pub. House, New Delhi
9. J.C. Upadhyay, Classical Mechanics

M.Sc. Semester - 1

MSC1C112 Electrodynamics and Plasma Physics

Unit-1

Vector algebra, Introduction to electrodynamics, Electrodynamics before Maxwell, Ampere's law, Maxwell equations in matter and boundary conditions

Unit-2

The wave equation for E and B, propagation in linear media, reflection and transmission at normal and oblique incidence, electromagnetic waves in conductors, scalar and vector potentials, Gauge transformations, Retarded potentials, Lie nard - Weichert potentials, the field of a moving point charge.

Unit-3

The moment equations, Derivation of the moment equations, Magnetohydrodynamic OR MHD, One fluid model, Two fluid model, Illustrative Examples. Collisions, Liouville equation, The system of B.B.G.K.Y. Equations, The B-V equation with self-consistent field, Illustrative Examples.

Unit-4

Controlled thermonuclear reaction, Lawson criterion, The Coulomb barrier, Heating and confinement of the plasma, Radiation loss of energy, Instability problem, Magnetohydrodynamic conversion of energy, Plasma propulsion, other plasma devices, Illustrative Examples.

Reference Books:

1. J. Griffiths, Introduction to electrodynamics, Prentice Hall India Ltd. (2nd ed.)
2. B.B. Laud, Electromagnetics, Wiley Eastern, (2nd ed.)
3. E. C. Jordan and K. G. Balmain, Electromagnetic waves and radiating systems, Prentice Hall of India, New Delhi, 1976
4. Introduction to Plasma Physics & controlled fusion (IInd edition): Vol. 1: Plasma Physics By F.F. Chen
5. Plasma Physics by Bettencourt
6. Plasma Physics by Chakraborty

M.Sc. Semester - 1

MSC1P109 Physics Experiment - I

List of Experiments:

1. Normal Mode
2. Fourier Analysis
3. e/m Helical Method
4. Hall Effect
5. Ultrasonic Interferometer
6. Transducers-I
7. Michelson's Interferometer

MSC1P110 Physics Experiment - II

List of Experiments:

1. Measurement of Electrical Conductivity of Graphite.
2. Measurement of Energy Band Gap of a Semiconductor
3. SCR Characteristic
4. RF Oscillator
5. Numerical Solution of a Polynomial
6. Resistivity of a semiconductor by four probe method
7. Gas filled Photocell.

M.Sc. Semester - 2

MSC1C209 Quantum and Statistical Mechanics

Unit-1

Approximation Methods for Stationary States: Perturbation theory for discrete levels, Equations in various orders of perturbation theory, non-degenerate case, Degenerate case - removal of degeneracy, Effect of an electric field on the energy levels of an atom (Starkeffect), Two – electron atoms. Illustrative examples.

Unit-2

WKB Approximation: One - dimensional Schrodinger equation, Bohr -Sommerfeld quantum condition, WKB solution of the radial wave equation.Evolution with time: Exact formal solutions: Propagators, Schrodinger equation: general solution, Propagators, Alteration of Hamiltonian.

Unit-3

Liquid Helium, why helium does not solidify? Tisza's two – fluid model , Definition of the Ising model, Lattice gas, Binary alloys.

Unit-4

Kinematics of the scattering process, Differential and total cross – sections, Wave mechanical picture of scattering, The scattering amplitude, Green's functions, Formal expression for the scattering amplitude, Born approximation, The screened Coulomb potential, Validity of Born approximation, Born series, The eikon approximation.

Reference Books:

1.Statistical Mechanics – K. Huang (Wiley)
2. Quantum Mechanics – Mathews and Vankatesan
3. . P.M. Mathews and K Venkatesan, A textbook of Quantum Mechanic, Tata MC Graw - Hill publishing company Limited.
5. L. I. Schiff, Quantum mechanics, Tata McGraw - Hill publishing company Limited.
6. G. Aruldhas, Quantum mechanics, Prentice - Hall of India
7. A. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and applications, Macmillan India Limited.

M.Sc. Semester - 2

MSC1C210 Atomic and Molecular Physics

Unit-1

The shape of Atomic Orbital; Atomic Quantum Numbers – The Energies of Atomic Orbital; Hydrogen Atom Spectrum. Orbital Angular Momentum – Electron Spin Angular Momentum – Total Electronic, Angular Momentum – The Fine Structure of the Hydrogen Atom Spectrum.

Unit-2

Quantum Numbers Associated with the Vector Atom Model – Coupling Schemes: The LS Coupling, The j-j Coupling – Important Principles: Pauli‟s Exclusion Principle, The Selection Rules, The Intensity Rules, The Interval Rule, The Lande Splitting Factor "g" – Magnetic Moment Due to Orbital Motion; The Bohr Magneton – Magnetic Moment Due to Electron Spin – Zeeman Effect – Paschen-Back Effect – Stark Effect.

Unit-3

Classification of Molecules, Interaction of Radiation with Rotating Molecule, Rotational Spectra of Rigid Diatomic Molecules, Isotope Effect in Rotational Spectra, Intensity of Rotational Lines, Non-rigid Rotator, Linear Polyatomic Molecules.

Unit-4

Symmetric Top Molecules, Asymmetric Top Molecules, Stark Effect, Microwave Spectrometer, InfraredSpectroscopy: Vibrational Energy of a Diatomic Molecule; The Morse Curve and the Energy Levels of a Diatomic Molecule, Infrared Spectra (Preliminaries)

Reference Books:

1. Fundamentals of Molecular Spectroscopy by Colin N. Banwell (Tata MacGraw-Hill, New Delhi)
2. Atomic Physics by J. B. Rajam (S. Chand & Company, New Delhi)
3. Molecular Structure and Spectroscopy by G. Aruldhas (Prentice - Hall of India, New Delhi)
4. Elements of Spectroscopy by Gupta-Kumar-Sharma (Pragati Prakashan, Meerut)
5. Introduction to Atomic Spectra by H. E. White (Tata McGraw Hill, New Delhi)
6. Spectroscopy Vol. 1, 2 & 3 by Straughan B. P. and Walker M. A. (Chapman and Hall, London)
7. Spectra of Atoms and Molecules by Peter Bernath (Oxford Uni. Press, USA)
8. Atomic Spectroscopy by K. P. Rajappan Nair (MJP Publishers, Chennai)
9. Atom, Laser and Spectroscopy by S. N. Thakur – D. K. Rai (PHI Learning Private Ltd., Delhi)

M.Sc. Semester - 2

MSC1C211 Classical and Solid State Physics - II

Unit-1

Introduction, Singular Points of Trajectories, Nonlinear Oscillations, , Limit cycle, Chaos,Logistic Map, Poincare System, Strange attractors

Unit-2

Relativistic Mechanics, Proper time and proper velocity, Relativistic energy and momentum,Relativistic kinematics, Relativistic dynamics, Relativistic electro dynamics, How field transform. The field tensor, Electro dynamics in tensor notation, Relativistic potentials.The transition from a discrete to a continuous system., The Lagrangian formulation for continuous system, Sound vibrations in gases as an example of Lagrangian formulation.

Unit-3

Diamagnetism, Paramagnetism, Electron Spin Resonance, Nuclear Magnetic Resonance, Spin Relaxation, Weiss theory of Ferro magnetism, the exchange interaction, The Heisenberg model,Ferromagnetic domains, The Bloch wall, Origin of domains, Neel model of Antiferromagnetism, Neel model of Ferrimagnetism, Spin waves, Magnons in Ferromagnets, The Bloch T3/2 law,Magnons in Antiferromagnets.

Unit-4

Introduction, Meissner effect, Heat Capacity, Energy gap, Isotop effect, Thermodynamics of the superconducting transition, London equation, Coherence Length, BCS theory of superconductivity, BCS ground state, Flux quantization in a superconducting ring, Type - I and Type –II superconductors, Vortex state, Single particle tunneling, Josephson superconductor tunnelin, DC Josephson effect, AC Josephson effect, Macroscopic quantum interference, Introduction to High Tc Superconductors.

Reference Books:

1. Classical Mechanics, A. B. Bhatia, Narosa Publishing house.
2. Classical Mechanics (2nd Ed), Herbert Goldstein, Addison - Wesley Publishing Co.
3. Classical Mechanics, G. Aruldhas PHI Pvt. Ltd.
4. Classical Mechanics, J. C. Upadhyaya Himalaya Publishing House.
5. Classical Mechanics, S. N. Biswas Books and allied (P.) Ltd.
6. Classical Mechanics (3rd ed.), Goldstern, Poole and Safko, Pearson Education.
7. C. Kittle, Introduction to Solid State Physics, 7th Ed., Wiley Eastern Limited, New Delhi
8. J.P.Srivastava: Elements of solid state physics, PHI, India.

M.Sc. Semester - 2

MSC1C212 Space Physics and Semiconductor Physics

Unit-1

Atmospheric nomenclature, Hydrostatic equation scale height, Geopotential height, Exosphere and gaseous escape, Chemical concepts of atmosphere, Thermodynamic considerations, elementary chemical kinetics composition and chemistry of middle atmosphere and thermosphere. Thermal balance in the atmosphere, models of neutral atmosphere (CIRA, US Standard atmosphere).

Unit-2

Solar radiation at the top of the atmosphere, Attenuation of solar radiation in the Atmosphere, radiative transfer, thermal effect of radiation, photochemical effects of radiation, Airglow. Introduction to ionosphere, photochemical processes, Chapman's theory of photo ionization, production of ionospheric layers, loss mechanisms and chemistry of ionosphere regions, morphology of the ionosphere.

Unit-3

Energy Bands; Energy levels of isolated atoms, Energy momentum Diagram, Direct and Indirect band gap semiconductors; band diagrams of metals, semiconductors and insulators, Intrinsic carrier concentration, Concept of Fermi factor, Extrinsic semiconductors : Donors and Acceptors, Nondegenerate and Degenerate semiconductors, Carrier Drift : Mobility and its relation with resistivity and conductivity, The Hall effect.

Unit-4

Band Diagram of p-n junction in thermal equilibrium; Equilibrium Fermi levels; Space Charge; Depletion region, Abrupt junction; Widths of the depletion region in abrupt junction; Depletion capacitance; Capacitance-voltage characteristics; Current voltage characteristics; Ideal diode equation.

Reference Books:

1. Physics of the Space Environment T.I. Gombosi, (CUP)
2. The Solar-Terrestrial Environment: JK. Hargreaves (CUP)
3. Semiconductor Devices : Physics and Technology (2nd Ed) by S.M. Sze, Wiely (India)
4 . Physics of Semiconductor Devices (4th Ed), S. M. Sze and Kwok. K. Ng., John Wiely& Co.
5. Semiconductor Physics and Devices: Basic Principle (3rd Edition), Donald Neauman, Tata McGraw Hill.

M.Sc. Semester - 2

MSC1P209 Physics Experiment - I

List of Experiments:

1.R-C coupled amplifier.
2.Logic Gates
3.Distance to the moon by Parallax
4.Analysis of aerosols using aerosol spectrometer
5.Studies using Solar Spectrometer
6.Determination of Stefan's constant
7.Vibrational spectrum of AIO molecule
8.Phonon dispersion relation using Lattice dynamics kit.
9.Measurement of 'h' by Solar Cell

MSC1P210 Physics Experiment - II

List of Experiments:

1.Efficiency of a G.M. Counter
2.Performance of a vacuum pump and verification of Gaede's equation
3.OPAMP parameters
4.OPAMP as an inverting / non-inverting amplifier
5.Study of Electron Spin Resonance
6.Numerical Analysis
7.Measurement of Susceptibility of Liquid by Quinck's Methods
8.Lattice Dynamics
9.X-Ray Diffraction