Kumaun University, Nainital

Semester System (2019 onwards)

M.Sc. (PHYSICS)

TWO-YEAR FULL-TIME PROGRAMME (Four-Semester Course)

Faculty of Science
(Department of Physics)

COURSE CONTENTS

Kumaun University, Nainital

Kumaun University, Nainital

M. Sc. Syllabi in Physics
(Session July 2019 Onwards)

Semester System Course Structure

Total Four Semesters, 100 marks (75 marks external+ 25 marks internal) in each Paper followed by one practical carrying 100 marks in each Semester and Grade system in dissertation/project.

Semester–wise Distribution of Papers

I. First Semester:

Paper 1:	**Mathematical Methods**	**(PHY-4911)**
Paper 2:	**Classical Mechanics**	**(PHY-4912)**
Paper 3:	**Quantum Mechanics**	**(PHY-4913)**
Paper 4:	**General Theory of Relativity and Cosmology**	**(PHY-4914)**
Paper 5:	**Communication Electronics**	**(PHY-4915)**
Practical:		**(PHY-5181)**
Total Marks:	**600**	

II. Second Semester:

Paper 6:	**Statistical Mechanics**	**(PHY-4921)**
Paper 7:	**Atomic and Molecular Spectra**	**(PHY-4922)**
Paper 8:	**Electrodynamics**	**(PHY-4923)**
Paper 9:	**Digital Electronics and Computer Architecture**	**(PHY-4924)**
Practical:		**(PHY-5281)**
Total Marks:	**500**	

III. Third Semester:

Paper 10:	**Advanced Quantum Mechanics**	**(PHY-4931)**
Paper 11:	**Nuclear Physics**	**(PHY-4932)**
Paper 12:	**Elementary Particle Physics**	**(PHY-4933)**
Paper 13:	**Condensed Matter Physics**	**(PHY-4934)**
Paper 14:	**Plasma Physics**	**(PHY-4935)**
Practical:		**(PHY-5381)**
Total Marks:	**600**	

IV. Fourth Semester:

Paper 15: Special Paper (Part-I)

(a) Advanced Electronics-I	**(PHY-4941)**
(b) High Energy Physics-I	**(PHY-4942)**
(c) Spectroscopy-I	**(PHY-4943)**
(d) Astrophysics-I	**(PHY-4944)**
(e) Advanced Condensed Matter Physics-I	**(PHY-4945)**

Paper 16: Special Paper (Part-II)

(a) Advanced Electronics-II	**(PHY-4951)**
(b) High Energy Physics-II	**(PHY-4952)**
(c) Spectroscopy-II	**(PHY-4953)**
(d) Astrophysics-II	**(PHY-4954)**
(e) Advanced Condensed Matter Physics-II	**(PHY-4955)**

Paper 17: Dissertation/Project work with Grade System (Out of Maximum 100 Marks)

Marks	Grade
91 or above	**A+**
81 to 90	**A**
71 to 80	**B+**
61 to 70	**B**
51 to 60	**C+**
41 to 50	**C**
40 or Less	**FAIL**

Practical: **(PHY-5481)**

Total Marks: **300**

Note:

1. **Only those special papers will be allowed where at least three experiments are available.**
2. **Educational tour for scientific laboratories and Physics research institutes has been included as per university norms in the syllabus of M. Sc. (Physics). A Tour report will be submitted to the HOD (Physics) after visit.**

Detailed Syllabus

M.Sc. Physics (Semester System 2019 Onwards), Kumaun University, Nainital

Semester-I

Paper 1:	**Mathematical Methods**	**(PHY-4911)**
Paper 2:	**Classical Mechanics**	**(PHY-4912)**
Paper 3:	**Quantum Mechanics**	**(PHY-4913)**
Paper 4:	**General Theory of Relativity and Cosmology**	**(PHY-4914)**
Paper 5:	**Communication Electronics**	**(PHY-4915)**
Practical:		**(PHY-5181)**

Semester-I

Paper 1: Mathematical Methods **MM-75**

Unit I: Special Functions

Series solution of differential equations, Legendre, Bessel, Hermite, and Laguerre differential equations and related polynomials, Physical integral form of polynomials and their orthogonality relations, Generating Function and recurrence relation.

Unit II: **Curvilinear Coordinates and Tensors**

Curvilinear Coordinates and various operators in circular, Cylindrical and Spherical co-ordinate systems, classification of Tensors, Rank of a Tensor, Covariant and Contra-variant tensors, Symmetric and anti-symmetric Tensors, Kronecker delta symbol. Contraction of Tensor, metric Tensor and Tensor densities, Covariant differentiation and Geodesic equation (Variational Method).

Unit III: **Complex Variables**

Function of complex variable, Cauchy's Riemann differential equation, Cauchy's integral theorem, residues and Cauchy's residues theorem, singularities, evolution of residues and definite integral.

Unit IV: Integral Transform

Fourier Integral and Fourier Transform, Fourier integral theorem, Finite and infinite integral, Laplace transform of elementary function (Dirac delta & Green's function), Solution of simple differential equations.

Book recommended:

Rajput B.S.	:	Mathematical Physics
Pipes L.I.	:	Mathematical Physics
Chattopadhyay P.K.	:	Mathematical Physics
Afriken G.	:	Mathematical methods for Physics
Charlie Harper	:	Introduction to Mathematical Physics
Mathews and Walker	:	Mathematical Methods of Physics
Morse and Feshbach	:	Methods of Theoretical Physics

Semester-I

Paper 2: Classical Mechanics **MM-75**

Unit I: Mechanics of a system of particles

Constraints and generalized coordinates, D Alembert's principle, Lagrange equations for holonomic and non holonomic systems and their applications, Conservation laws of linear momentum, Energy and angular momentum.

Unit II: Hamiltonian formulation and Hamilton Jacobi theory

Hamiltonian equations of motion and their physical significance, Hamilton's principle, principle of least action, Canonical transformations Hamilton-Jacobi theory, Poisson brackets, Properties of Poisson bracket, Poisson's Theorem, Lagrange bracket.

Unit III: Dynamics of a Rigid Body

Motion of a rigid body, body and space Reference system, angular momentum and Inertia tensor, Principle axes- Principle moments of Inertia, spinning tops, Euler angles, Infinitesimal rotations.

Unit IV: Central Force Problem

Action and angle variables phase integral, Small oscillations, Kepler's laws of Planetary motion and their deduction, Scattering in a Central field, Rutherford scattering cross section.

Book recommended:

Mathematical Physics	:	B S Rajput
Classical Mechanics	:	H. Goldstein
Classical Mechanics	:	N.C. Rana & P. S. Jog
Mechanics	:	Landau and Lifshitz, Pergamon
Mechanics	:	Sommerfeld Academic Press
Analytical Dynamics of Particles and Rigid Bodies	:	Whittaker
Classical Mechanics	:	Raychaudhuri Oxford
Classical Mechanics	:	Bhatia Narosa.

Semester-I

Paper 3: Quantum Mechanics MM-75

Unit I: Operator formulation of Quantum Mechanics

State vectors and operators in Hilbert Space, Eigen values and Eigen vectors of an operator, Hermitian, Unitary and Projection operators, Commuting operators, BRA and KET Notations, Postulates of Quantum Mechanics, co-ordinate Momentum and Energy representations, Dynamical behavior, Heisenberg, Schrödinger and interaction Pictures.

Unit II: Schrödinger equation and Theory of Angular momentum

Probability and current densities associated with Schrödinger's equation, Ehrenfest's theorem, Three dimensional Schrödinger's equation in Cartesian and Curvilinear Coordinate systems, Centrally symmetric square well and harmonic potentials, harmonic oscillator and its wave functions, Hydrogen atom. Orbital Angular momentum operator, its eigen value and eigen functions, Pauli's theory of spin, Addition of angular momentum, Clebsch-Gordan coefficients.

Unit III: Approximation Methods and Time independent Perturbation theory

Stationary Perturbation, first and second order corrections, WKB approximation methods, connection formula and boundary conditions, Bohr Sommerfeld quantization rule, Penetration of potential barrier, Time independent perturbation theory and anomalous Zeeman Effect, variation method and its application to the ground state of helium atom, and harmonic oscillator

Unit IV: Time Dependent Perturbation Theory

Time dependent perturbation theory, Constant perturbation, Fermi Golden rule, Coulomb excitation, Sudden and adiabatic approximation, Harmonic perturbation, Radiative Transition in atoms. Einstein's A and B coefficients and Spontaneous emission of radiation .

Books recommended:

B. S. Rajput	:	Quantum Mechanics
L. I. Schiff	:	Quantum Mechanics
V. K. Thankppan	:	Quantum Mechanics
Loknathan and Ghata	:	Quantum Mechanics
Zatiely	:	Quantum Mechanics

Semester-I

Paper 4: General Theory of Relativity and Cosmology MM-75

Unit I: Foundations of General Relativity

Elements of Special relativity, Tensors as geometrical objects, Mach's Principle, Non-inertial frames of reference, Gravity and space-time, Principle of equivalence and principle of general covariance, Metric tensor and gravity, Geodesics and Affine parameters (Christoffel symbols), Covariant derivative and its geometrical interpretation, Parallel transport, Space- time curvature and curvature tensor, Riemann curvature tensor, Bianchi identity, Ricci tensor, Classification of space-time curvature (in different dimensions).

Unit II: Einstein's Field Equations and Gravitational Dynamics

Christoffels connection as Einstein's connection, Gravitational action, field equations and their general properties, Newtonian limit of Einstein's field equations, Metric in spherically symmetric space-time (Schwarzchild metric), Orbits in the Schwarzschild metric, gravitational collapse of a dust sphere, Schwarzschild black holes.

Unit III: Gravitational Radiation

Introduction of Gravitational radiation, Wave equation in linearized theory and plane waves, Propagating modes of gravity, Gravitational waves in a flat space-time background, Propagation of gravitational waves in the curved space-time, Energy and momentum of the gravitational waves, Detection of gravitational waves.

Unit IV: Cosmology

Basic Concepts and elementary idea of big-bang and steady state cosmologies, Seagull static models, Cosmological principle, Friedmann space-time, Robertson-Walker line element, Weyl's postulate, expansion of the universe, Hubble's law, dynamical equation of cosmology and their consequences, The primordial fire and the remnant radiation, Big-bang and steady state models of the universe.

Book Recommended:

R.R. Patharia	:	Theory of Relativity
S.K. Bose	:	An Introduction to General Relativity
J.V. Narlikar	:	An Introduction to Cosmology
C. Moller	:	The theory of Relativity
T. Padmanabhan	:	Gravitation
Raychaudhuri	:	Theoretical Cosmology
M. Carmeli	:	Classical fields: General Relativity and Gauge Theory

Semester-I

Paper 5: Communication Electronics MM-75

Unit I: Modulation AM and FM (Transmission and reception)

Modulation, AM generation, Power consideration, Balanced modulator, SSB transmission, AM detection, AGC, Radio receiver characteristics, Signal to noise ratio, FM analysis, Noise considerations, Generation, Direct method and reactance tube method, FM transmitter, AFC, FM Propagation, Phase discriminator.

Unit II: Propagation of Radio Waves

Ground wave, Sky wave and Space wave propagation, Ionosphere (Ecclr- larmer theory, magneto ionic theory.

Unit III: Antenna and TV

Antenna, HF antenna, Yagi antenna, loop antenna, Satellite communication, parabolic reflector, dish antenna, Fundamentals of image transmission, vestigial transmission, TV camera tubes, image orthicon, vidicon, TV transmitter, TV receiver and picture tubes.

Unit IV: Transmission Lines

Voltage and current relations on transmission line, Propagation constant, Characteristic impedance, impedance matching, Quarter wave T/L as impedance transformer, Attenuation along coaxial cable, cables of low attenuation, Propagation of radio waves between two parallel lines, Wave guide modes, TE10 mode and cut off wavelength, Cavity resonator, light propagation in cylindrical wave guide, Step index and Graded index fibers, Attenuation and Dispersion in fibers.

Books Recommended:

Kennedy and Davis	:	Electronics Communication Systems
Millar and Beasley	:	Modern Electronics Communication
R.R Gulani	:	Monochrome and colour television (Wiley Eastern Limited)
Taub and Schilling	:	Principle of Communication Systems (TMH)
Simon Gaykuti	:	Communication Systems (John Wiley & Sons Inc. 1994)

Semester-I

Practicals: Any eight (08) of the following experiments

1. Study of RC circuit with an AC source using phase diagrams.
2. Absorption Spectrum of KMnO4 using Hilger-Nutting Photometer.
3. Young's modulus by Interference method.
4. NPN and PNP Transistor Characteristics with (a) Common base (b) Common emitter configurations/ h – parameter.
5. Study of RC- coupled/ Transformer Coupled Amplifier.
6. Study of B-H curve.
7. Study of Amplitude Modulation /Demodulation.
8. Verification of the Hartmann's Formula.
9. Frank-Hertz experiment.
10. Determination of susceptibility.
11. Study of CRO.
12. Velocity of Ultrasonic waves.
13. Linear Air track.
14. Leacher Wire

Semester-II

Paper 6:	**Statistical Mechanics**	**(PHY-4921)**
Paper 7:	**Atomic and Molecular Spectra**	**(PHY-4922)**
Paper 8:	**Electrodynamics**	**(PHY-4923)**
Paper 9:	**Digital Electronics and Computer Architecture**	**(PHY-4924)**
Practical:		**(PHY-5281)**

Semester-II

Paper 6: Statistical Mechanics **MM-75**

Unit I: Foundation of Statistical Mechanics

Microscopic and macroscopic states, Density of states, Micro-canonical, Canonical and grand canonical ensembles, Canonical ensemble and Gibb's distribution, Boltzmann–Planck method, Partition function and statistical definition of thermodynamic quantities, Computation of partition functions of some standard systems.

Unit II: Statistical Properties

System of linear harmonic oscillators in the canonical ensemble; Grand canonical ensemble and its partition function; Chemical potential; Partition function and distribution for perfect gas; Gibb's paradox; Free energy, entropy, Equation of state and specific heat determination of perfect gas.

Unit III: Statistical models

Theory of phase transitions, First order phase transition, Second order phase transitions and higher order phase transitions (elementary discussion), Ising model, One dimensional (with exact solution), Two dimensional (with exact solution) & three dimensional model (elementary idea), Landau theory of phase transition, Weiss theory of Ferro-magnetism, Heisenberg model. Virial equation of states.

Unit IV: Quantum Statistics

Bose-Einstein and Fermi- Dirac distributions, Degeneracy, Gas degeneration, Degenerate Bose gas, Bose Einstein condensation, Highly degenerate B-E and F-D gases; examples of Molecular Hydrogen, liquid helium and electron gas in metals.

Books Recommended:

Quantum Mechanics	:	A.S. Davidov
Quantum Mechanics	:	B.S. Rajput
Quantum Mechanics	:	Paul Roman
Theoretical Chemistry	:	Glastohn
Statistical Mechanics	:	Landau and Lifshitz
Statistical Mechanics	:	Pathira
Statistical Mechanics	:	Huang

Semester-II

Paper 7: Atomic and Molecular Spectra MM-75

Unit I:

Fine structure of hydrogen spectrum, L- S and J- J coupling, Spectroscopic terms, Hund's rule and time reversal, Pauli's exclusion principle.

Unit II:

Alkali spectra, Spin-orbit interaction and fine structure in alkali Spectra, Equivalent and nonequivalent electrons, Normal and anomalous Zeeman effect, Paschen Back effect, Stark effect, Hyperfine structure (qualitative).

Unit III:

Molecular spectra of diatomic molecules, Born Oppenheimer approximation, elementary idea of quantization of rotational and vibrational energy, rotational spectra for rigid and non rigid

rotations, vibrational spectra (harmonic and an-harmonic), intensity and selection rules and molecular constants.

Unit IV:

Atomic Polarizability, Raman spectra, Quantum theory of Raman spectra, Determination of molecular structure, Electronic spectra, band system, Progression and sequences, band head formation, Condon parabola, Franck Condon Principle, dissociation energy and its determination.

Books Recommended:

C. B. Banwell	:	Fundamentals of Molecular Spectroscopy
Walker and Stranghen	:	Spectroscopy Vol. I, II, & III
G.M. Barrow	:	Introduction to Molecular Spectroscopy
Herzberg	:	Spectra of diatomic molecules
Jeanne L Mchale	:	Molecular Spectroscopy
J. M. Brown	:	Molecular Spectroscopy
P. F. Bemath	:	Spectra of atoms and molecules
J. M. Holias	:	Modern Spectroscopy
Thyagrajan and Ghatak	:	Lasers: Theory and applications
A Yariv	:	Quatum Electronics
M. D. Levenson	:	Intoduction to non-linear laser spectroscopy
B. B. Laud	:	Laser and non-linear optics

Semester-II

Paper 8: Electrodynamics MM-75

Unit I: Electromagnetism

Basic equations; Electrostatics; Magnetostatics; Different Systems of Units, Preliminary notations, Four- vectors, Lorentz transformations, Time, Space and light like separations, Lorentz invariants, Energy and Momentum.

Unit II: Maxwell's equations

Maxwell's equation, Displacement current, Electromagnetic waves in conducting and nonconducting medium, Poynting theorem, Boundary condition at the interface of conducting and non conducting media, Propagation between parallel conducting plates. Electromagnetic wave equations.

Unit III: Four-Vector formalism of Maxwell's Equations

Four vector potential, electromagnetic field tensor, Lorentz invariance, Lorentz force, Covariant form of Maxwell's equations, Four vector current, Continuity equation, Gauge invariance of Maxwell equation, electromagnetic energy- momentum tensor, Motion of charge particle in electromagnetic field, Lorentz force.

Unit IV: Electromagnetic Radiation

Lienard-Witchert potential, Conventional potential, Quantization of electromagnetic energy (virtual photon), Radiation from an Accelerated Charge, Fields of an accelerated charge; angular and frequency distributions of the emitted radiation, Special cases of acceleration-parallel and perpendicular (circular orbit) to velocity; Larmor's formula and its relativistic Generalization; Bremstrahlung, Cerenkov radiation.

Book recommended:

Jackson	:	Classical Electrodynamics
Landau and Lifshitz	:	Classical Theory of Fields
Thide	:	Electromagnetic field Theory
Panofsky and Phillips	:	Classical Electricity and Magnetism
Landau & Lifshitz	:	Electrodynamics of Continuous Media

Semester-II

Paper 9: Digital Electronics and Computer Architecture MM-75

Unit I: Digital Circuit and Microprocessor

Elementary idea of combinational and sequential circuits, Overview of Microcomputer organization and operation, Microprocessor evolution and types, Fundamental knowledge of Microprocessor (8085/8086), Architecture and its operation, Basic idea of logic devices for interfacing 8085/8086.

Unit II: Computer Organization and Architecture

Central Processing Unit, Computer organization, Instruction formats (e.g. Three address, Two address etc), Addressing modes, Timing diagram, Interconnection of different units, I/0 to processor and processor to memory communication, Interrupt structures, Multiprogramming, Processor features RISC, CISC, Cache memory, Real and virtual memory.

Unit III: Data Communication

Computer and Communications, Need for communication networks, Internet and World Wide Web, communication protocols, Local Area Networks, Interconnecting networks, Future of Network Technology.

Unit IV: Computer Network

Characteristics of communication channels, Allocation of Channels, Physical Communication media, Public Switched Telephone Network, Cellular Communication Path, ATM networks,

Books Recommended:

Computer system Architecture	:	Morris Mano
Fundamentals of computers	:	V. Rajaraman (Prentice Hall of India)
Computer fundamental architecture and organization	:	B. Ram (New Age International Publishers)
Computer Network	:	Tenan Bomm

Microprocessor, Architecture,
programming and application with the 8085 : Ramesh Gaonkar
Microprocessor programming and
Interfacing Intel 8085 and 8086 : Hafizer Rehaman

Semester-II

Practicals: Any eight (08) of the following experiments

1. Study of the Phase measurement by superposition of voltages with LCR Circuits.
2. Study of different oscillators (Hartely, colpit, Weinbridge oscillators etc.).
3. Study of an electronically regulated power supply.
4. Study of negative Feed- back Amplifier.
5. Determination of wavelength (λ) and wavelength difference ($\Delta\lambda$) by Michelson Interferometer.
6. Study of different type of Resistances and Diodes.
7. Study of Photo Voltaic Cell.
8. e/m by Zeeman effect.
9. Stefan's Constant
10. FET characteristics.
11. Fresnel's Law.
12. Cauchy Formula.
13. Lattice Dynamic Kit.
14. Study of Logic gates.
15. Detection Efficiency of Diode.
16. Fabry – Perot Interferometer.
17. Four Probe method

Semester-III

Paper 10:	**Advanced Quantum Mechanics**	**(PHY-4931)**
Paper 11:	**Nuclear Physics**	**(PHY-4932)**
Paper 12:	**Elementary Particle Physics**	**(PHY-4933)**
Paper 13:	**Condensed Matter Physics**	**(PHY-4934)**
Paper 14:	**Plasma Physics**	**(PHY-4935)**

Practical

Semester-III

Paper 10 Advanced Quantum Mechanics MM-75

Unit I: Non-Relativistic Theory of Quantum Scattering

Scattering Theory, Scattering cross section, method of partial wave analysis, phase shift, Optical theorem, scattering length, effective range; low energy scattering, Resonance, scattering from a square potential well and a rigid sphere, Born approximation, Validity of Born approximation, Born approximation through time dependent perturbation, its application to square well potential, Elementary idea of S and T Matrix .

Unit II: Free particle Dirac equation

Discrepancies faced by Schrödinger equations, Klein-Gordon equation and its drawbacks, Dirac's equation for a free particle, Dirac matrices, covariant form of Dirac equation, Probability and current densities, Free particle solutions of Dirac equation, Non conservation of Orbital Angular momentum and idea of spin, Interpretation of negative energy and hole theory.

Unit III: Dirac particle in Electromagnetic Fields

Dirac equation in electromagnetic fields, Magnetic moment of charged particle, Gauge invariance of Dirac equation in electromagnetic fields, Non- relativistic correspondence of Dirac

equation; Pauli equation, Adjoint spinors, Discrete Symmetries of Dirac Equation: Parity, Time reversal and Charge Conjugation, Difference between Dirac-Pauli and Majorana spinors; Lorentz covariance of Dirac Equation, , Bilinear covariants

Unit IV: Identical Particles and Second Quantization of Schrödinger's field

Identical particles, Exchange degeneracy, Symmetric and Anti-symmetric functions, Pauli Exclusion Principle; Schwinger's action principle and rules of quantization,, Lagrangian and Hamiltonian densities, Field equation, quantum structure of free fields and the particle concept, Quantization relations, Quantization of non relativistic Schrödinger matter field, System of identical bosons and fermions, Commutation and anti-commutation relations, Occupation number representation, creation and annihilation operators.

Books Recommended:

Davydov : Quantum Theory
Messiah : Quantum Mechanics Vols. I & II
Rajput, B. S. : Advanced Quantum Mechanics
Roman : Advanced Quantum Mechanics
Trigg : Quantum Mechanics
Thankappan : Quantum Mechanics
Sakurai : Quantum Mechanics

Semester-III

Paper 11 Nuclear Physics MM-75

Unit I: Nuclear Properties and Nuclear Models

Concepts of Atomic Nuclear-Size, Shape, charge distribution, Spin & parity, Magnetic moment; Electric quadrupole moment; Binding energy; Semi-empirical mass formula, Mirror nuclei,

Liquid drop model, Experimental evidence for shell effects, Shell model, Magic numbers, Spin orbit coupling, Single particle shell model-its validity and limitations; collective model.

Unit-II: Nuclear Forces and Nuclear Interactions

Theory of Deuteron and nuclear level properties, nucleon - nucleon interactions, low & high energy nucleon-nucleon scattering, Yukawa's Meson theory of nuclear forces, Spin dependence and charge independence of nuclear forces.

Unit-III: Nuclear Reactions

Kinds of nuclear reactions; Conservation laws; Nuclear reaction Kinematics; Charge particle reaction spectroscopy; Neutron spectroscopy; Nuclear cross-section; Compound nucleus; Nuclear transmutations, continuum theory of nuclear reaction, Nuclear fission, Chain reactions, Nuclear fusion, Thermonuclear reactions.

Unit-IV: Nuclear Decays

Basic understanding and Formulations for α, β and γ-decays, Gamow theory of α-decay, Fermi theory of β-decay, selection rules in β-decay, Neutrino hypothesis, Parity violation in β-decay, K-capture and internal conversion.

Book Recommended:

Nuclear Physics	:	W. E. Bercham
Nuclear Physics	:	Ervin Kapallan
Nuclear Physics	:	Roy Nigam
Atomic and Nuclear Physics	:	S. N. Ghoshal
Nuclear Physics	:	H.A.Enge
Nuclear Physics	:	Evans
Problem based Nuclear Physics	:	H. M. Agrawal

Semester-III

Paper 12 Elementary Particle Physics MM-75

Unit I: Elementary Particles

History of elementary particles, Classification of elementary particles, Fundamental interactions, Resonances, Lepton and Baryon number; Isospin, Strangeness, Hypercharge, Gell-Mann Nishijima relations, Symmetries and conservation laws, Parity, Time reversal and charge conjugation, Parity violation, CP violation in mesons, CPT invariance.

Unit II: Unitary Symmetries

Basics of Unitary groups, Fundamental representation, generators and Weight diagrams of SU(2) and SU(3) groups, Young tableaux and unitary symmetries, standard arrangements of Young tableaux, Dimensionality of the representation of SU(N), Simple product representation using Young tableaux techniques.

Unit III: Quark Model

Fermi Yang model, Sakata model, Eight fold way and its shortcomings, Necessity of Quark model, Gell - Mann Zweig model, Quark lepton symmetry, and structure of Hadrons, Elementary idea of SU(6) Quark model, charm, bottom, and top quarks, Exotic Quarks, Experimental status of Quarks.

Unit IV: Nuclear and Particle Detectors

Basic principle of particle detectors, Ionization chamber, Proportional detector, Geiger-Muller detector, Scintillation detector and gamma-ray spectrometer, Semiconductor detector, Nuclear emulsion technique, Cloud chamber, Bubble chamber.

Book Recommended:

D. H. Perkins : Introduction to High Energy Physics

S. N. Ghoshal : Atomic and Nuclear Physics

D. Griffiths : Introduction of Elementary Particles

DB Lichtenberg	:	Unitary Symmetry and Elementary Particles
Hughes	:	Elementary Particles
Blatt and Weiskopff	:	Theoretical Nuclear Physics
FE Close	:	Quarks and Patrons
Cheng and Li	:	Gauge Field Theory
W. E. Burcham	:	Nuclear Physics
R. M. Singru	:	Introduction to experimental nuclear physics

Semester-III

Paper 13 Condensed Matter Physics MM-75

Unit I: Crystal structure

Interaction of radiation with matter (for elastic and en elastic scatterings of x- ray). Concept of reciprocal lattice point, calculation of reciprocal lattice point of SC, BCC. and FCC lattices, Application of reciprocal lattice point in diffraction techniques.

Unit II: Bonding in Solids

Different types of bonding in solids, covalent, metallic, Vander Waal, hydrogen bonding & ionic bonding, Madelung constant of ionic crystals, cohesive energy.

Unit III: Lattice Vibrations and theory of metals

Concept of dispersion relation, quantization of lattice vibrations (Phonons), normal modes & normal coordinates, longitudinal and transverse modes of vibration, modes of vibration of monatomic and diatomic lattices. Density of states (Phonons) , Theory of specific heat of solids : classical theory , Einstein theory and Debye theory .Theory of metals : Classical theory , free electron theory and F-D distribution function , Hall effect.

Unit IV: Crystal Defects, Superconductivity & Magnetism

Point defects (Schottky and Frankel Defects) Imperfections, Line defects (Edge& Screw dislocations), Burger vector & Burger Circuit, Role of dislocation in plastic deformation and crystal growth. Elementary idea of super conductivity nearly zero resistivity, Meissner effect, Tc, Hc type I, & II, superconductors & BCS theory, ferri, ferro, and anti ferromagnetism.

Books Recommended:

A. J. Dekker	:	Solid State Physics
S.O. Pillai	:	Solid State Physics
C. Kittle	:	Introduction to Solid State Physics
Verma & Srivastava	:	Crystallography for Solid State Physics
L.V. Azaroff	:	Introduction to Solid State Physics
Ashcroft & Mermin	:	Solid State Physics
J.M. Ziman	:	Solid State Physics

Semester-III

Paper 14 Plasma Physics MM-75

Unit I: Introduction to Plasma

Elementary concept of Plasma, Debye Shielding, Plasma parameter, Single particle motions in presence of Uniform and non uniform electric and magnetic field, Drift of guiding center, Gradient drift, Curvature drift, Magnetic mirror, Adiabatic invariants in Plasma, Techniques of Plasma confinement.

Unit II: Magneto-Hydrodynamics and Fluid Plasma

Hydro-dynamical description of Plasma, Concept of convective derivative, Fluid equations of plasma, Diamagnetic drift of plasma, Electron-ion plasma waves, Upper and Lower hybrid frequency, Single fluid M. H. D. equations, Pinch effect and instabilities in plasma, Hydromagnetic waves, Magneto-sonic and Alfven waves.

Unit III: Magneto Plasma

Wave phenomena in Magneto plasma: Polarization, Phase velocity, group velocity, cutoff and resonance For electromagnetic wave in parallel and perpendicular to the magnetic field. Concept of ordinary and extraordinary waves in Plasma, Left and right handed circularly polarized waves in plasma, Whistler mode, Faraday rotation,

Unit-IV: Plasma Propagation

Propagation of waves through ionosphere and magnetosphere, Propagation at finite angle and CMA diagram, Helicon, Kinetic theory description of Plasma, Moments of Boltzmann equation, Continuity equation, Momentum balance equation, Two-fluid description of Plasma, Plasma resistivity.

Book recommended:

Jackson	:	Classical Electrodynamics
Bittencourt	:	Plasma Physics
Chen	:	Plasma Physics
Goldston and Rutherford	:	Introduction to Plasma Physics

Semester-III

Practicals: Any eight (08) of the following experiments

1. Verification of Richardson's law.
2. Study of ESR spectra of a given sample.
3. Hall Effect
4. RCS Spectrometer
5. gamma ray spectrometer
6. Radio Receiver
7. Determination of e by Millikan's oil drop method.
8. Temperature dependence of diode characteristics.
9. Elastic constants of a cubic crystal by ultrasonic waves.
10. Study of Multivibrators.
11. Study of transistor amplifier cum feedback amplifiers.
12. Study of absorption of $KMnO_4$ by Spectrophotometer
13. Study of different FETs and MOSFETs.
14. Study of Thermo luminance.
15. Study of VTVM.

Semester-IV

Paper 15 Special Paper-I (Any one of the followings)

(a)	**Advanced Electronics**	**(PHY-4941)**
(b)	**High Energy Physics**	**(PHY-4942)**
(c)	**Spectroscopy**	**(PHY-4943)**
(d)	**Astrophysics**	**(PHY-4944)**
(e)	**Advanced Condensed Matter Physics**	**(PHY-4945)**

Paper 16 Special Paper-II (Any one of the followings)

(a)	**Advanced Electronics**	**(PHY-4951)**
(b)	**High Energy Physics**	**(PHY-4952)**
(c)	**Spectroscopy**	**(PHY-4953)**
(d)	**Astrophysics**	**(PHY-4954)**
(e)	**Advanced Condensed Matter Physics**	**(PHY-4955)**

Practical

Semester-IV

Paper 15 (a) Advanced Electronics – I MM-75

Unit I: Operational Amplifier

Basic operational Amplifier, Inverting & Non inverting OP – AMP, Common Mode Rejection Ratio (CMRR), Summing Amplifier, Voltage follower, Current to voltage, Voltage to current converter, Integrator, Differentiator, Log – Antilog Amplifier, Circuit type of OP – AMP 741, Operational Amplifier parameters, Effects of offset, Frequency response and Stability,

Comparators, Discriminators, sample and hold circuits, Zero crossing detector, Precision rectifier, Waveform generators, OP -AMP as astable, Monostable and bistable Multivibrater, Regenerative comparator (Schmitt trigger), IC 555 timer.

Unit II: Power Supply Regulation

Servomechanism, Regulation using OA, Zener reference source, The 723 regulator, Current regulator, Short circuit and over load protection, Precision rectifier, IC regulated power supply. Three terminal voltage regulators, Dual Polarity regulated power supplies using 78 XX and 79 XX series regulators (Basic ideas only), Switched mode power supply(SMPS), Active filter, PLL.

Unit III: Microwave production and Microwave Communications

Limitation of conventional electronic devices at UHF, Microwave frequencies, Principle of velocity modulation. Reflex klystron. Theory and uses of cavity magnetron, PIN & GUNN diode, Detection of microwave, measurement of power, Advantages and disadvantages of Microwave transmission, loss in free space, propagation of microwaves, atmospheric effects on propagation, Fresnel zone problem, ground reflection, fading ,sowlles, detectors, components, antennas used in microwave communication system.

Unit IV: Digital and Optical Communication

Digital signal processing, Image processing (Basic ideas only), Pulse Modulation systems, Pulse Amplitude Modulation, Pulse Width Modulation, Pulse position modulation, Pulse code modulation, Delta modulation Frequency division multiplexing (FDM), Basic idea of digital telemetry.

Principle of optical communication, Different modes of propagation of E. M. Wave through optical fibre, Brief concept, classification of fibres and ray path, Advantages of multimode fibres and cladding , Optical Fibre connectors, Optical Fibre communication Receiver, Brief Introduction , Signal path through optical data link, Block diagram of optical Receiver, Advantages of optical communication, Light propagation in cylindrical wave guide.

Book Recommended:

Coughlin	:	Operational Amplifiers and linear Integrated Circuits
Rajaraman	:	Introduction to digital Computer Design
Schilling and Belov	:	Electronics circuits Discrete and Integrated
Sloan	:	Computer Hardware and Organisation
Vishwanathan Mehta	:	Electronics for Scientists and Engineers
Roychaudhary and Jain	:	Operational amplifier and Linear Integrated Circuits
Taub and Schiling	:	Principles of Communication systems
Simon Gaykuti	:	Communication Systems (John Wiley & Sons Inc. 1994)

Semester-IV

Paper 15 (b) High Energy Physics–I MM-75

Unit I: Quantization of Scalar Fields

Lagrangian Formulation, Hamiltonian and momentum densities, Neutral and Charged scalar fields and their quantization, Momentum representation and frequency splitting, Identification of various particle operators, Charge operator, Algebra of field operators, Invariant delta function and its representations, Covariant commutation relations and their properties.

Unit II: Quantization of Spinor Field

Lagrangian formulation for Spinor field, Hamiltonian and momentum densities, Quantization of Spinor Field, Momentum representation and frequency splitting, Identification of various particle operators, Charge operator for Spinor field, Algebra of Spinor field operators, Covariant form of anti-commutation relations.

Unit III: Quantization of Electromagnetic Field

Classical electromagnetic field theory and its gauge formulation, Covariant Lagrangian formulation for EM field, Quantization of EM field, Momentum representation and frequency

splitting, Identification of various particle operators, Concept of longitudinal, temporal and transverse photons, Covariant commutation relations for EM potential operators, Problems with temporal photons and Lorentz condition, Resolution through Gupta- Bleular formulation.

Unit IV: Propagators and Interacting Fields

Meson Propagator, Fermion Propagator, Photon Propagator, Operator products (Normal, Dyson and Chronological T-products), Wicks Theorem and Reduction of S-matrix for the case of QED, Representation and description of various first and second order processes in QED using Smatrix expansion, Feymann diagrams and Feynman Rules in QED, Compton scattering, Moller scattering, Bhabha scattering, Electron self energy, Photon self energy, vacuum configuration in QED, Renormalization.

Books recommended:

L. Ryder	:	Quantum Field Theory
B.K. Agarwal	:	Quantum Mechanics and Field Theory
F Mandel and Shaw	:	Quantum Field Theory
P.Roman	:	Quantum Field Theory
A. Das	:	Quantum Field theory
Peskin and Schroeder	:	An Introduction to Quantum Field Theory
B.S. Rajput	:	Advanced Quantum Mechanics

Semester-IV

Paper 15 (c) Spectroscopy–I MM-75

Unit I: Rotational Spectra

Rotational energy level populations, Linear, Symmetric, Spherical and asymmetric top molecules, Rotational selection rules for linear molecules, Stark effect in molecular rotation spectra, Molecular rotation – nuclear spin coupling, Positive and negative character of the wave

functions of linear molecules, Symmetric – antisymmetric character and statistical weight of homo-nuclear linear molecule.

Unit II: Vibrational Spectra

Vibration spectra of poly atomic molecule, Coupling of rotation and vibration, Perpendicular and parallel bands, Normal modes of vibration and their analysis in Cartesian coordinates, Normal coordinates and their internal coordinates, Calculation of vibrational frequencies and force field of H2O and CO2 molecules, Anharmonicity, Aegenerate and non degenerate vibrations, Inversion doubling, Quantized Vibrational motion of polyatomic molecules.

Unit III: Molecular symmetry and Group theory

Symmetry properties of molecules, Symmetry element, Symmetry operation and point group, Character table, Group theory: representation of a group, Reducible and irreducible representations, LCAO coefficient of a polyatomic molecule, Huckel approximation, Overlap and resonance integrals, Wheal's approximation.

Unit IV: Electronic Spectra

Spectroscopy of Diatomic and Polyatomic Molecules: Coupling of Electronic and Rotational motion in Diatomic Molecules and Rotational structure of 1π - 1Σ and 1Σ - 1Σ transitions. Vibronic interaction and Herzberg Teller theory for absorption spectrum of benzene vapour, Single vibronic level spectroscopy and lifetime of vibronic levels in benzene, Quantum yield, Kasha Rule and the concept of nonradiative transtions in molecules, Jablanski diagram and qualitative treatment of small molecule and large molecule limit for nonradiative transitions.

Books recommended:

Barrow G.M	:	Introduction to Molecular spectroscopy.
Herzberg G	:	Infrared and Raman Spectra of Polyatomic Molecules
Von Nostrand & Herzberg G	:	Spectra of Polyatomic Molecules.
J.R.Lackowicz	:	Principle of Fluorescence Spectroscopy.
King G	:	Molecular Spectroscopy.

King G.W : Spectroscopy and Molecular Structure.
Banwell : Fundamenals of Molecular Spectroscopy.

Semester-IV

Paper 15 (d) Astrohysics–I MM-75

Unit I: Equilibrium and stability of stars

Hydrostatic equilibrium, virial Theorem, Polytrophic indices, Lane- Emden equation LTE, Radiative equilibrium, stability condition for convective and radiative equilibrium.

Unit II: Interior properties of stars

Continuous spectrum of star, Stellar opacity, Limb darkening and blanketing theory of Fraunhofer lines, curve of growth and line broadening .

Unit III: Study of Sun

Sun as a typical star, Solar inner and outer atmosphere, Quiet and Active Sun, Sunspots and their formation, Solar flares, Solar filaments/prominences, Coronal mass ejections (CMEs), Solar wind, Different type of solar eruptions models, Coronal heating, Origin of solar cycle, solar geomagnetic storm.

Unit IV: Galaxies and Quasi-stellar objects

Classification of galaxies, Distributions of stars in the Milky way, Morphology, Kinematics, Interstellar medium, Galactic center, External galaxies, spiral structures, Dark matter and dark energy in spiral galaxies, Galactic rotation, Theory of AGNs, Syferts, Quasars and their energy generation and redshift anomaly, Different AGN models, radio lobes and jets, Gamma ray bursts, BL – Lac objects, concept of expanding universe.

Books Recommended:

Abhyankar K.D.	:	Astrophysics, Galaxies and Stars
Baidyanth Basu	:	An Introduction to Astrophysics
Motz	:	Astrophysics

Semester-IV

Paper 15 (e) Advanced Condensed Matter Physics–I MM-75

Unit I: Crystal Symmetry

Point group and space group, External symmetry elements of a crystal: axis of symmetry, Plane of symmetry (mirror plane), Point of symmetry (point of inversions), Internal symmetry elements of a crystal: screw axis, glide plane, Elementary idea of notation used to define symmetry elements of the crystal.

Unit II: Crystal Structure

Interpretation of powder photographs using graphical method and analytical method, Moving film method of x-ray crystallography, Crystal structure factor and intensity of diffraction maxima, Extinction due to lattice centering, Neutron scattering and their applications, Debye Waller factor, Mossbauer effect.

Unit III: Lattice dynamics & electronic properties

Anharmonicity, thermal expansion and thermal conductivity, Interaction of electrons & phonons with photons (direct & indirect transitions), Optical properties of metals. Electron in periodic lattice, band theory of solids (metal, semiconductor & insulator). Effective mass, Tight binding approximation, introductory idea: magneto resistance (GMR&CMR) & Q Hall effect (Integer & Fractional).

Unit IV: Superconductivity

Phenomenological, Semi phenomenological and microscopic theories of super conductors, Penetration depth, coherence length, Josephson effects (DC, AC and microscopic interference), Elementary idea of high temperature superconductors.

Books recommended:

C.S. Kittle	:	Introduction to solid state Physics
C.S. Kittle	:	Quantum theory of solids
Verma & Srivastava	:	Crystallography for solid state Physics
S. O. Pillai	:	Solid State Physics
Ashcroft & Mermin	:	Solid State Physics
Ziman	:	Solid State Physics

Semester-IV

Paper 16 (a) Advanced Electronics–II MM-75

Unit I: (a) Integrated Circuit Technology

Classification of IC's, Fabrication of IC's & components, Basic monolithic integrated circuit technology, processes used in monolithic technology, active & passive components, metal semiconductor contact, thick & thin film IC's, hybrid IC's, charge coupled devices (CCD), advantages & limitations of integrated circuits.

(b) Analog Computation

Solution of ordinary linear differential equations with constant coefficients, Operation modes of analog computers, repetitive operation of computers, Time scaling, amplitude scaling, Generation of functions, Simulation of time varying systems.

Unit II: Combinational Circuits

Boolean algebra, Canonical forms of Boolean functions, Simplification of Boolean functions (Kmap method, Tabulation method), Don't care conditions, Digital logic families; Adders &

Subtractors, Magnitude comparator, Code converters; Parallel adders, Encoders, Decoders, Multiplexers, Demultiplexers, Parity bit generator and checker; Read only memory (PROM, EPROM), P. L. A., Digital to Analog and Analog to Digital converters.

Unit III: Sequential Circuits

Sequential Logic- Memory element; RS, JK, JKMS, D type, T type and Edge triggered Flip flop; Registers; Shift register; Counters-Asynchronous and Synchronous; The memory unit; Semiconductor Random Access Memory. Inter-register transfer; Arithmetic; Logic and Shift Micro-operation; Fixed point and Floating point data.

Unit IV: Memory and Optoelectronic devices

Bulk and thin films, Photoconductive devices (LDR), Memory devices, Static and dynamic random access memories SRAM and DRAM, CMOS and NMOS, non-volatile-NMOS, Magnetic, Optical and ferromagnetic memories, Charge coupled devices (CCD), LCDS.

Books Recommended:

Digital Technology	:	Virendra Kumar
Digital Logic and Computer Design	: `	M. Morris Mano
Introduction to digital Computer Design	:	Rajaraman
Electronics circuits Discrete and Integrated	:	Schilling and Belov:
Computer Hardware and Organization	:	Sloan:
Electronics for Scientists and Engineers	:	Vishwanathan Mehta
Operational amplifier and Linear Integrated Circuits	:	Roychaudhary and Jain
Electronics for Scientists	:	Malmsradl, Enke and Toren
Electronics for Scientists (Khanna Publishers)	:	Bodhkar

Semester-IV

Paper 16 (b) High Energy Physics–II MM-75

Unit I: Gauge Field Theories

Concept of gauge fields and gauge connections, Principle of gauge invariance, Global and local Abelian gauge invariance , U (1) gauge invariance of QED, The Yang- Mills gauge field, Non-Abelian gauge field theory (SU(2) case), Concept of spontaneous symmetry breaking and Goldstone Bosons, Higgs Mechanism and mass generation of gauge fields.

Unit II: Lie Group and Unitary Symmetries

Symmetries, Groups and Conservation Laws, Lie groups, General concept of about Generators of Lie groups Lie group, Its application for finding put Lie algebra of different dimension and parameter group, SU (3) shift operators, Concept of I, U and V spins, Young Tableaux and its application for Unitary Symmetries.

Unit III: Weak and Electromagnetic interactions

Classification of weak interaction in terms of Leptonic, Semi-leptonic and Non- Leptonic weak Decays, Current-Current Interaction and VA theory, Intermediate Vector Boson (IVB), Vector Current (CVC) Hypothesis, Two Component Theory of Neutrino, Basics of electro weak unification and W-Z bosons.

Unit IV: Strong Interactions

Paradoxes of Naive Quark Model, Need of color quantum Number for Quarks, Color SU(3) and Gluons, Quantum Chromodynamics, Pion-Nucleon Scattering, Spin Classification of Hadrons and Regge Trajectories, Asymptotic freedom, Elementary idea of standard model and its limitations.

Books Recommended:

D.B. Lichtenberg : Unitary Symmetry and Elementary Particles

F.E. Close : Quarks and Patrons

I.J. Aitchison and A.J. Hey	:	Gauge theories in Particle Physics
F. Haltzin & A.D. Martin	:	Quarks and Leptons
D.H. Perkins	:	Introduction of High Energy Physics
T.P. Cheng and G.F. Li	:	Gauge Field Theory
ED Commins	:	Weak Interactions
D.C. Cheng and O Neil	:	Elementary Particle Physics
B.S. Rajput	:	Advanced Quantum mechanics
K. Moriyasu	:	An elementary Primer for gauge theory
D.C. Joshi	:	Introduction to Quantum Electrodynamics and Particle Physics
D.J. Griffith	:	Introduction to Elementary Particles

Semester-IV

Paper 16 (c) Spectroscopy–II MM-75

Unit I: Lasers

Einstein's quantum theory of radiation, Life time, Possibility of amplification, Theory of some simple optical processes, Kinetics of optical absorption, Line broadening mechanism, Stimulated emission, laser pumping, three and four level scheme, Threshold condition, laser pumping power, different types of lasers, gas lasers: He-Ne, N2 and CO2 , Dye lasers, Solid state lasers, Nd-YAG, Semiconductor lasers, Basic application of laser spectroscopy, Laser cooling and trapping of atoms etc.

Unit II: Dynamics of Laser Processes and Advances in Laser Physics

Production of giant pulse, Q-Switching by different types of shutters, Giant pulse dynamics, Laser amplifiers, mode locking, Mode pulling, ultra-short pulse, Hole burning, Holography, Laser applications e.g. isotope separation method, Laser produced plasma, Synthesis of nanoparticles, Laser cooling and trapping of atoms etc.

Unit III: Non-Linear Optics

Harmonic generation, Phase matching, Second harmonic generation, Third harmonic generation, Optical mixing, Parametric generation of light, Self focusing of light.

Unit IV: Multi-Photon Processes

Multi quantum photoelectric effect, Two photon processes, Frequency up-conversion, Stimulated Raman effect, Coherent stokes & anti-stokes Raman scattering, Photo acoustic spectroscopy.

Books recommended:

Laud B.B.	:	Laser and non linear optics, wiley eastern
Thyagrajan & Ghatak	:	Laser and applications.
Hollas J.M.	:	Laser and non-linear optics.
Svelto	:	Lasers.
Demtroder	:	Laser Spectroscopy

Semester-IV

Paper 16 (d) Astrophysics–II MM-75

Unit I: Observing the Universe

Celestial sphere, Brief idea of constellations and Solar system, Study of planets, asteroids, meteors, comets and their origin. Right Ascension, Declination, Greenwich Sideral time, Local Sideral time, Hour angle, Different types of detectors: photographic plate, Photomultiplier tube, CCD, Astronomical telescopes.

Unit II: Basic Parameters of Stars and Hertzsprung-Russel Diagram

Basic parameters of the star: Mass, radius, Distance, Luminosity and temperature, Magnitude systems and colour indices, Hertzsprung-Russel diagram (H-R Diagram), classification of stellar spectra, classification of Luminosity class.

Unit III: Star Clusters and their properties

Star Clusters - open, globular and stellar associations, stellar population, population I and population II type objects, inter-stellar extinction, Reddening determination from colour–colour diagram, age and distance determinations of star clusters, Luminosity function, Mass function, Mass segregation, dynamical evolution in clusters, Mass-Luminosity relation.

Unit IV: Stellar Evolution

Birth of stars, protostar, nebula, Hyashi tracks, Zero age main sequence, (ZAMS) main sequence life time, energy generation in stars – gravitational contraction, pp chain, CN cycle and triple alpha process, stellar life cycles-Premain sequence, main sequence, giants, white dwarf etc., Chandrashekhar mass limit, Low, medium mass stars and high mass stars, Death of high mass stars, supernova remnants, Pulsars and idea of black holes using relativistic astrophysics.

Books Recommended:

Abhyankar K.D. : Astrophysics, Galaxies and Stars

Baidyanth Basu : An Introduction to Astrophysics

Motz : Astrophysics

Semester-IV

Paper 16 (e) Advanced Condensed Matter Physics–II MM-75

Unit I: Advance methods of crystallography and surface topography

Accurate determination of lattice parameter, least square method, application of powder methods (including in designing advanced method of crystallography), observations of imperfection in crystal using radiation (X-ray), Electron microscopy (scanning & tunneling): elementary idea of transmission electron microscopy, scanning electron microscopy, Atomic force microscopy.

Unit II: Disordered systems

Point defects: Shallow impurity states in semi-conductors, Vacancies, Interstitials and colour centers of an ionic crystal, Disorder in the condensed matter systems: substitutional disorder, Positional disorder and topological disorders, short range & long range order.

Unit III: Exotic Solids Structure and symmetries of liquids

Amorphous solids, glass, liquid crystals, Fibonacy sequence, elementary idea of an a periodic solids and quasi crystals, definition and properties of nano structured materials, quantum size effect, special carbon solids: fullerenes and nano tubules.

Unit IV: Thin film and surface states

Definition & properties of thin film, Difference in behavior of thin film form bulk, electrical conductivity of thin film, Boltzmann transport equation for a thin film for only diffused scattering case, Elementary idea regarding surface states, metallic, surface & surface reconstruction.

Books recommended

C.S. Kittle	:	Introduction to solid state Physics
C.S. Kittle	:	Quantum theory of solids
Verma and Srivastava	:	Crystallography for solid state Physics
Poole	:	Nanotechnology
Steinhardt & Ostulond	:	The Physics of Quasi crystal
Singh Shri	:	Introduction to Liquid crystals
S. O. Pillai	:	Solid State Physics
Ashcroft & Mermin	:	Solid State Physics
Ziman	:	Solid State Physics
K L Chopra	:	Thin Film
Madelung	:	Solid State Physics

Semester-IV

Practicals: Minimum three experiments from each of the lists given below.

List of Experiments: (a) Advanced Electronics

1. Study of regulated power supply (723).
2. Study of operational amplifier (741).
3. Study of Timer (555).
4. A to D and D to A converter
5. 1 of 16 Decoder/Encoder.
6. Study of Multiplexer/Demultiplexer.
7. Study of Logic gates (Different types).
8. Study of Comparator and Decoder.
9. Study of amplitude and frequency modulations and demodulations.
10. Study of different flip- flop circuits (RS, JK, Dk type, T-type, Master slave).
11. Study of Digital combinational and sequential circuits.
12. Study of Microprocessor (8085).
13. Study of SCR, DIAC, TRIAC.
14. Study of IC- Based Power supply.
15. Microwave experiment.
16. Shift Registers.
17. Fiber Optics communication

List of Experiments: (b) High energy Physics

1. Characteristic curve of a GM Detector and verification of inverse square law.
2. Characteristic curve of a GM Detector and Absorption coefficient of a using aluminum GM Detector.
3. Energy spectrum of gamma rays using gamma ray spectrometer.

4. Absorption coefficient of aluminum using gamma-ray spectrometer.
5. Characteristics of Scintillation Detector.
6. Study of gamma-gamma unperturbed angular correlations.
7. Study of particle tracks using a Nuclear Emulsion Detector.
8. Classification of tracks in interaction with Nuclear Emulsion and determination of excitation energy.

List of Experiments: (c) Astrophysics

1. Study of Hubble's law (from given data).
2. Study of constant density neutron star.
3. Study of the static parameters of a Neutron Star model with inverse square density distribution.
4. Study of star cluster from a given data.
5. Study of Extinction coefficients.
6. Study of variability of stars.
7. Verification of Limb darking using the solar data.
8. Verification of Solar cyclic using the given data

List of Experiments: (d) Spectroscopy

1. Study of the vibrational levels of Iodine.
2. Measurement of the fluorescence spectra of Uranyl Nitrate Hexahydrate.
3. Determination of the intrinsic life time for a dye molecule.
4. Determination of change in dipole moment in excited state using Solvatochromic shift method.
5. Measurement of non radiative decay rate for a known sample.
6. Determination of the quantum yield of known samples using steady state spectroscopy.

List of Experiments: (e) Advanced Condensed Matter Physics

1. Determination of elastic constant of crystals by optical methods.
2. Study of color centers.
3. Determination of lattice parameters using powder method.
4. Study of ratio of energies of the X-ray in different orders of diffraction.
5. Determine the interplaner crystal spacing of the NaCl crystal.
6. Investigation of Bragg reflection at a NaCl monocrystal and confirm Bragg's law of reflection.
7. Simultaneous first and higher order diffraction on a crystal.