Appendix "B"

(Syllabi & Courses of Reading)

M.Sc. Part-I

PAPER-I MATHEMATICAL METHODS OF PHYSICS

Vector Analysis:

Divergence theorem, Stokes's theorem, cylinderical, spherical and curvilinear coordinates.

Special Functions:

Legendere polynomials, Bessel functions, associated Legendre functions and spherical harmonics spherical spherical Bessel functions, Neumann functions.

Boundary Value Problem:

Boundary value problem in physics, the Sturm-Liouville problem.

Green's Function:

Definition, Green's functions for the Strum-Liouville operator Green's functions in electrodynamics.

Functions of Complex Variable:

Complex functions, analyticity, Cauchy-Riemann equations, multivalued functions, Cauchy's integral formula, Taylor and Laurent series, the residue theorem and its applications.

Fourier Series and Transforms:

Fourier series and its complex form, applications of Fourier series, representations of a function, properties of Fourier transforms, Fourier integral theorem, Fourier sine and cosine transforms, applications of Fourier transforms, Laplace transform.

Tensor Analysis:

Cartesian tensors, coordinate transformation, covariant and contravariant tensor, tensor algebra, metric tensor.

Books Recommended:

1. *Mathematical Methods for Physics and Engineering,* F. Riley, M. P. Hobson and S. J. Bence, Cambridge University Press, (1997).
2. *Mathematical Physics* by E. Butkov, Addison-Wesley Publishing Company, (1968).
3. *Mathematical Methods for Physicists* by G. Arfken and H. J. Weber, Academic Press, (1995).
4. *Applied Mathematics for Engineers and Physicists* by L.A. Pipes and L.R. Harvill, McGraw-Hill Book Company, (1970).
5. *Mathematics of Classical and Quantum Physics* Volume II, By F.W. Byron Jr. and R.W Fuller Addison-Wesley Publishing Company, (1970).
6. *Complex Variable* by M. R. Spiegel, Schaum Publishing Company, (1970).

PAPER-II **CLASSICAL MECHANICS** (2)

Lagrangian Formalism:

Brief survey of Newtonian mechanics of a single and system of particles, constraints, D. Alembert's principle, Lagrange's equation and its application, calculus of variation and Hamilton's principle, derivation of Lagrange's equation from Hamilton's principle, contact transformations.

Central Force Problem:

Two-body central force problem and its reduction to the equivalent one body problem, the equation of motion and solution for one body problem laboratory and centre of mass co-ordinate systems and their mutual transformation, Rutherford scattering formula,

Hamiltonian Formalism:

Legendre transformation and Hamilton equation of motion, cyclic co-ordinates, conservation theorems and physical significance of the Hamiltonian for simple cases.

Canonical Transformations:

The canonical transformations and their examples, the Lagrange's and the Poisson's brackets, integrals of motion, Poisson's theorems.

Hamilton-Jacobi theory:

Hamilton-Jacobi theory, connections with canonical transformation, action-angle variables.

Books Recommended:

1. *Classical Mechanics*, by H. Goldstein, Addison-Wesley, Reading, (1950).
2. *Mechanics*, by L. D. Landau, E. M. Lifshitz, Pergamon, Oxford (1960).
3. *Classical Mechanics*, by J. W. Leech, Methuen and Co. Ltd.,(1958)
4. *Classical Mechanics*, by V. D. Barger and M. G. Olsson, McGraw-Hill, (1995)
5. *Analytical Mechanics*, by L. N. Hand and J. D. Finch Cambridge University Press, (1998)

PAPER-III QUANTUM MECHANICS

Breakdown of Classical Concepts and Old Quantum Theory:

Particle aspects of radiation and Planck's hypothesis, wave aspects of matter and de Broglie's hypothesis, discrete levels and Bohr's hypothesis.

Farmulation of Quantum Mechanics:

Mathematical preliminaries, quantum mechanical wavefunction, Hilbert space, observables and operators, operator equations, the eigenvalue equation, commutation relations, expectation value, postulates of quantum mechanics, correspondence principle, complimentarity principle, Schrodinger equation and discrete energy levels, state functions and overlap integral, uncertainty principle.

One Dimensional Systems:

The potential step, reflection and transmission coefficients, potential well and bound states, potential barrier, tunneling, tunneling through thin films, alpha decay, one-dimensional models of molecules and delta function potential, Kronig-Penny model, harmonic oscillator, raising and lowering operators.

Angular Momentum:

Angular momentum operator, z-component, total angular momentum; eigenvalves, eigenfunctions and vector diagram, parity.

Central Potential:

Motion in a central potential, the hydrogen atom, energy spectrum, quantum numbers and degeneracies.

Spin and Statistics:

The Zeeman effect, matrix operators, spin statistics and exclusion principle, Pauli's two components formalism, identical particles, fermions and bosons, symmetry and antisymmetry of wavefunctions.

Approximation Methods in Quantum Mechanics:

Time independent perturbation theory, simple applications, damped linear harmonic oscillator, hydrogen like atoms in magnetic field, time dependent perturbation theory, transition probability, emission and absorption of radiation, WKB approximation and its applications, variational method and its applications.

Formal Theory of Quantum Systems:

Hilbert space, operators and state vectors, bras and kets, orthonormality, Dirac delta-function, completeness, expectation value, degeneracy, compatible and incompatible observables, discrete and continuous spectra generalized uncertainty relation, harmaonic oscillator, ladder operators. Schrodinger's equation of motion, Heisenberg's equations of motion, constants of motion, parity, conservation laws and invariance.

SOLID STATE PHYSICS-I

(2)

Crystal Structure:

Periodic arrays of atoms, fundamental types of lattices, index system for crystal planes, simple crystal structures, direct imaging of atomic structure, non-ideal crystal structures.

Reciprocal Lattice:

Diffraction of waves by crystals, scattered wave amplitude, Brillouin zones, Fourier analysis of the basis, quasi crystals.

Crystal Binding and Elastic Constants:

Crystals of inert gases, ionic crystals, covalent crystals, metals, hydrogen bonds, analysis of elastic strains, elastic compliance and stiffness constants, elastic waves in cubic crystals.

Crystal Vibrations: Phonons I:

Vibrations of crystals with monatomic basis, two atoms per primitive basis, quantization of elastic waves, phonon momentum, inelastic scattering by phonons.

Thermal Properties: Phonons II:

Phonon heat capacity, anharmonic crystal interactions, thermal conductivity, electronic heat capacity.

Noncrystalline Solids:

Diffraction pattern, glasses, amorphous ferromagnets and semiconductors, low energy excitations in amorphous solids, fiber optics.

Point Defects:

Lattice vacancies, diffusion, color centers.

Dislocations:

Shear strength of single crystals, dislocations, strength of alloys, dislocations and crystal growth, hardness of materials.

Books Recommended:

1. *Introduction to Solid State Physics* by C. Kittle, 7th Edition, John Wiley & Sons, Inc. (1996)
2. *Solid State Physics* by Neil W. Ashcroft, N. David Mermin, CBS Publishing Asia Ltd. (1987).
3. *Solid State Physics* by J. S. Blakemore, Cambridge University Press, (1991).

PAPER-V ELECTRONICS

(2)

The Semiconductor Diode:

The junction diode, the diode voltage-current equation, Zener diode, light-emitting diodes, capacitance effects in the pn diode.

The Diode as Rectifier and Switch:

The ideal diode model, the half-wave rectifier circuit, the full-wave rectifier circuit, the bridge rectifier circuit, measurement of the ripple in the rectifier circuit, the capacitor filter, the π filter; π-r filter, regulated power supply.

Models for Circuit:

The black box concept; active one-port models: the voltage-source circuit; active one-port models, the current-source circuit: the two-port network, the h-parameter equivalent circuit, power in decibels.

Junction Transistor as Amplifier:

The junction transistor, the volt-ampere curves of a transistor, the current amplification factors, relations between the amplification factors, the load line and Q point, the basic transistor amplifiers, simplification of the equivalent C-E circuit, the transconductance, g, the common-emitter amplifier, conversion of the h parameters, the common-collector amplifier, performance of the C-C amplifier, comparison of amplifier performance.

DC Bias for the Transistor:

Choice of the quiescent point, variation of the Q point: fixed transistor bias, the four-resistor bias circuit, design of a fixed-bias circuit, design of the bias-stabilized C-E amplifier, voltage feedback bias, design of voltage-feedback bias circuit, bias for the emitter follower, design of the emitter follower circuit.

The Field Effect Transistor:

The junction field-effect transistor; the MOS field-effect transistor, the load line for the FET, obtaining bias for the FET, the FET as an amplifier.

Frequency Response of RC Amplifiers:

Cascaded amplifier, the amplifier passband, the frequency plot, low-frequency response, the low-frequency limit, the unbypassed emitter resistor, high-frequency equivalent circuits and the Miller effect, high-frequency response, the frequency limit of the transistor, the common-base connection at high frequencies, bandwidth of cascaded amplifiers.

Negative Feedback in Amplifiers:

The black box with feedback, stabilization of gain by negative feedback, bandwidth improvement with negative feedback, reduction of nonlinear distortion, control of amplifier output and input resistances, a current series-feedback circuit, voltage shut-feedback circuit, voltage feedback with the FET.

2

Integrated Amplifiers.

The integrated amplifier, the differential amplifier, the Darlington compound transistor, introduction to operation amplifier.

Power Amplifiers:

Classification of power amplifier, power relations in the class a amplifier, voltage limitations, determination of output distortion, the push-pull circuit and glass B operation, performance of a class B push-pull amplifier, output circuits without transformers, phase inverters for push-pull input.

Oscillators:

Oscillator feedback principles, the Hartley and Colpitts oscillators, practical transistor oscillators, crystal control of frequency, resistance-capacitance feedback oscillator.

Waves Shaping and Switching Circuits:

Diode clipper, diode clamper, differentiator, integrator. Multivibrators, the bistabl multivibrator, the one-shot or monostable multivibrator and astable multivibrator.

Digital Circuits:

Binary numbers, Binary codes, Logic switches and gates, Logic Circuits.

Books Recommended:

1. *Electronic Circuits and Systems* by J.D. Ryder/Charles M. Thomson, (1976).
2. *Electronics devices and Circuits* by Millman and Halkies (1978).
3. *Electronics Devices* by Thomos L. Floyd, Prentice-Hall Inc., Englewood Clif (1996).
4. *Electronic Principles* by Albert P. Malvino, Glencoe McGraw-Hill Book Co. (1993
5. *Digital Fundamentals* by Thomas L. Floyd, Prentice-Hall International I Englewood Cliffs, (1994).
6. *Electronic Devices and Circuit Theory* by Boylestad and Nashhelsky, 7th Edition Published by Prentice-Hall, (1997).

M.Sc. PHYSICS SESSION 2001-2003
Appendix "A"
(Outlines of Tests)

M.Sc. Part-II

		Marks
Paper I	Solid State Physics II	50
Paper II	Statistical Physics	50
Paper III	Relativity and Cosmology	50
Paper IV	Computational Physics	50
Paper V	Classical Electrodynamics	100
Paper VI	Nuclear Physics	100
Optional Papers		
Paper VII	Solid State Theory	100
Paper VIII	Advanced Solid State Physics / Solid State Physics Lab	100
OR		
Paper IX	Particle Physics I	100
Paper X	Particle Physics II	100
OR		
Paper XI	Advanced Electronics	100
Paper XII	Advanced Electronics Lab	100
OR		
Paper XIII	Advanced Nuclear Physics	100
Paper XIV	Advanced Nuclear Physics Lab	100
OR		
Thesis		200
		600 Marks

Appendix "B"
(Syllabi & Courses of Reading)
M.Sc. Part-II

PAPER-I **SOLID STATE PHYSICS II**

Free Electron Fermi Gas:

Energy levels in one dimension, effect of temperature on the Fermi-Dirac distribution, free electron gas in three dimensions, heat capacity of the electron gas, experimental electrical resistivity of metals, umklapp scattering, motion in magnetic fields, Hall effect, thermal conductivity of metals, ratio of thermal to electrical conductivity, nanostructures.

Energy Bands:

Nearly free electron model, origin of the energy gap, magnitude of the energy gap, Bloch functions, Kronig-Penney model, wave equation of an 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 a zone boundary, number of orbital in a band, metals and insulators.

Homogeneous Semiconductors:

Band gap, equation of motion, effective mass, physical interpretation of the effective mass, effective masses in semiconductors, silicon and germanium, intrinsic carrier concentration, intrinsic mobility, impurity conductivity, donor states, acceptor states, thermal ionization of donors and acceptors, thermoelectric effects, semimetals, superlattices.

Inhomogeneous Semiconductors:

The semiclassical treatment of inhomogeneous solids, fields and carrier densities in the equilibrium p-n junction, elementary picture of rectification by a p-n junction, drift and diffusion currents, collision and recombination times fields, carrier densities and currents in the nonequilibrium p-n junction.

Diamagnetism and Paramagnetism:

Langevin diamagnetism equation, quantum theory of diamagnetism of mononuclear systems, rare earth ions, Hund rules, iron group ions, crystal field splitting, quenching of the orbital angular momentum, spectroscopic splitting factor, Van Vleck temperature-independent-paramagnetism, paramagnetism, quantum theory of paramagnetism, paramagnetic susceptibility of conduction electrons.

Books Recommended

1. *Introduction to Solid State Physics* by C. Kittel, 7th Edition, Johan Wiley & Sons, inc. (1996).
2. *Elementary Solid State Physics* by M. A. Omar, Addison-Wesley Publishing Co. Inc. (1975).
3. *Solid State Physics* by Neil W. Ashcroft & M. David Mermin, Holt-Sanders Int. Edition.

PAPER-II STATISTICAL PHYSICS

Classical Statistical Mechanics:

Phase space description of physical systems, macrosystems and macrosystems, ensembles, entropy in statistical mechanics, microcanonical ensemble, canonical ensemble, grand canonical ensemble, diatomic molecules, heat capacities of diatomic gasses and crystals.

Quantum Statistics:

Basic concept of quantum statistics, Pauli exclusion principle, Bose-Einstein and Fermi-Dirac distributions, frequency spectrum of a black body and Planck's radiation law, Liouville's theorem, equality of probability for the perfect gas, energy distribution of conduction electrons in metals, degree of gas degenerations, completely degenerate Fermi-Dirac gas.

Special Topics:

Concept of fluctuations, Bose-Einstein condensation, introduction to density matrix approach.

Books Recommended:

1. *Elementary Statistical Physics* by C. Kittle.
2. *Fundamentals of Statistical and Thermal Physics* by R. Reif.
3. *Modern Physics An Introducing to its Mathematical Language* by William A. Blanped.
4. *Statistical Physics* by Pouition Longman.

PAPER-III RELATIVITY AND COSMOLOGY

Special Relativity:

Galilean relativity, concept of ether, Michelson-Morley experiment, Eistein's postulates of special relativity, Lorentz transformations, structure of spacetime, Minkowski spacetime tensors the light-cone, line element, four-vectors, relativity of simultaneity, time dilation, proper time, length contraction, twin paradox, velocity transformation and velocity addition.

Relativistic Mechanics:

Force equation in relativity, rest mass, kinetic and total energy, conservation of energy and momentum.

Elements of Tesnsor Calculus:

Manifolds and coordinates, curves and surfaces, tensor fields, Lie derivative, geodesics, Riemann tensor, metric tensor.

General Relativity:

Principles of general relativity, equation of geodesics deviation, Einstein's field equations.

Cosmology:

Newtonian cosmology, cosmological redshift, Hubble's law, microwave background, the Big Bang, expansion rate, matter and radiation domination, history of the universe.

Books Recommended:

1. *Dynamics and Relativity*, by W. D. McComb, Oxford University Press, (1999).
2. *Introduction to Cosmology*, J. V. Narlikar, Cambridge University Press, (1989).
3. *Introducing Einstein's Relativity*, R. D'Inverno, Oxford University Press, (1992).

PAPER-IV COMPUTATIONAL PHYSICS

Numerical Methods:

Euler-Newton method for solving differential equations, the trapezoidal rule for numerical quadrature and simple applications of random number, solution of integral equations, linear algebra, solution of linear algebraic equations, sorting and curve fitting.

Scientific Computing Languages:

Introduction to FORTRAN and C^{++} and programming techniques in practical applications to basic Physics problems.

Computer Graphics:

Use of computation and computer graphics to simulate the behavior of complex Physical systems, computational techniques in investigating and visualizing fundamental physics.

Scientific Packages:

Introduction to MATHIMATICA and MATLAB and their use in physics.

Books Recommended:

1. *Numerical recipes: The Art of Scientific Computing,* by W. H. Press, Brian P. Flannery, Saul A. Teukolsky and William T. Vetterling, Cambridge University Press (1988).

PAPER-V CLASSICAL ELECTRODYNAMICS

Electronics:

Electric dipole, potential energy of a dipole in an electric field, mutual energy of two dipoles, force and couple on the dipole placed in an external electric field, multipole expansion of electric fields external field of a dielectric displacement vector, electric susceptibility and dielectric constant, boundary conditions on the field vectors, potential energy of a group of point charges, electrostatic energy of a charge distribution, energy of an electrostatic field, energy of a system of charged conductors, stress in the electrostatic field and dielectric media, coefficients of potential, capacitance and inductance.

Equation of Poisson and Laplace, applications of Laplace's equation to problems (conductors and dielectrics) having spherical cylindrical and cartesian symmentry, electrical images (conductors and dielectrics).

Electric Current:

Nature of the current, current density and equation of continuity, Ohm's law, steady current in media without sources of e.m.f., approach to electrostatic equilibrium.

Magnetic induction, force on current carrying conductors, Biot-Sawart law, Ampere's circuital law, the magnetic vector and scaler potentials, the magnetic field of a distant circuit.

Magnetic Properties of Matter:

Magnetisation, vectors M and H produced by magnetized materials field equation, boundary conditions on the field vectors.

Maxwell's Equations and their Applications:

Maxwell's equations and the generalization of the Ampere's law, electromagnetic energy, vector and scalar potentials, gauge transformations (Lorentz gauge, coulombs guage). pressure of radiations, Green's function for time dependent wave equation, retarded scaler and vector potentials, radiation from an oscillating dipole, plane electromagnetic wave, plane waves in a conducting and non-conducting media, linear and cirucular polarization, and superposition of waves in one dimension, boundary conditions, reflection and refraction of electromagnetic waves at a plane interface between dielectrics, waves polarization by reflection and total internal reflection, reflection from a conducting medium, covariant formulation of electrodynamics, transformation laws of electro magnetic fields, the field of a uniformly moving and accelerated electron.

Plasma Physics:

Introduction, electrical neutrality in a plasma, particle orbits and drift motion in a plasma, magnetic mirrors, the hydromagnetic equations, pinch effect, plasma oscillations and wave motion.

Lasers:

Black body radiation, Induced emission and the gain coefficient, oscillations, output coupling, power and efficiency, optical resonators, fluctuation in lasers, solid state lasers, optical coupling, laser resonators, giant pulse techniques oscillators-amplifier lasers, power and energy supplies, high repetition rate laser, ruby laser, gas laser, semi-conductor diode laser, theory of p.n. junction laser, efficiency and thresh-hold current of diode lasers, applications of lasers.

Books Recommended:

1. *Classical Electrodynamics* by Jackson, Wiley, (1975).
2. *Electricity and Magnetism* by W. J. Duffin , McGraw-Hill, (1990).
3. *Electromagnetism* by I.S. Grant and W. R. Phillips Wiley (1990).
4. *Introduction to Electrodynamics* by D. Griffiths Prentice Hall, (1989).

PAPER-VI NUCLEAR PHYSICS

Basic Properties of Nucleus:

Size and mass of the nucleus, nuclear spin, magnetic dipole moment, electric quadrupole moment, parity and statistics.

Detectors:

Passage of charged particles through matter, ionisation chamber, proportional counter, scintillation counter, semi-conductor detector, emulsion technique, bubble chamber.

Particle Accelerators:

Linear accelerator, Van de Graff, betatron, synchrocyclotorn, proton synchrotoron.

Radio-Active Decay:

Theory of alpha decay, and explanation of observed phenoma-measurement of β-ray energy, the magnetic lense spectrometer, Fermi theory of β-decay, neutrino hypothesis, theory of gamma decay, multipolarity of gamma-rays, nuclear isomerism.

Nuclear Forces:

Yukawa theory, proton-proton and neutron-proton scattering, charge independence of nuclear force, isotopic spin.

Elementary Particles:

Strong, electromagnetic and weak interactions, conservation laws, violation of parity conservation in weak interactions, neutrino and anti-neutrino, direct evidence of anti-neutrino, muons, the mean life of muons, spin and magnetic moment of muons, the pions, spin and mean life of charged and neutral poins, the strange particles, K-mesons, hyperons and hyperfragments.

Nuclear Models:

Liquid drop model, shell model, collective model.

Nuclear Reactions:

Conservation laws of nuclear reactions, Q-value of nuclear reaction, threshold energy, transmutation by photons, protons, deutrons and alpha particles, excited states of nucleus, energy levels, level width, Cross section from nuclear reactions, compound nucleus theory of nuclear reactions, limitations of compound nucleus theory, resonances, Breit-Wigner formula, direct reactions.

Neutron Physics:

Neutron sources, radioactive sources, photo neutoron sources, charged particle sources, reactor as a neutron source, slow neutron detectors, fast neutron detectors, measurement of neutron cross-sections as a function of energy, slowing down of neutron, nuclear fission, description of fission reaction, mass distribution of fission energy, average number of neutrons released, theory of fission and spontaneous fission, nuclear chain reaction and applications.

Thermonuclear Reactions:

Fusion and thermonuclear process, energy released in nuclear fusion, formation of heavy elements, semi-carbon nitrogen cycle controlled nuclear fusion.

Books Recommended:

1. *Nuclei and particles* by E. Serge. W. A. Banjamin Inc (1965).
2. *A Text Book of Nuclear Physics* by C.M.H. Smith, Pergamon Press Oxford (1966).
3. *Nuclear Physics* by A.E.S. Green, McGraw Hill Book Co. (1966).
4. *Nuclear Physics* by I. Kaplan, Addison-Wesley (1963).
5. *The Atomic Nucleus* by Evens, McGraw Hill, (1965).

OUTLINES OF COURSES

OPTION-I SOLID STATE PHYSICS

Paper-VII **Solid State Physics-I** **Marks 100**

Introduction: The solid state problem, the Born-Oppenheimer approximation.

The One-Electron Approximation: Free electron gas model (FEG), applications of FEG , failure of FEG.

Effect of Non-Uniform Crystal Potential: The Bloch wave, the reciprocal lattice, the nearly free electron model (NFE) in one-dimension, the concept of energy band structure, the Fermi surface, Fermi velocity in NFE. The Bloch electron, the concept of effective mass.

Methods of Calculating Energy Band Structures: The LCAO method. the APW method, the OPW method, the concept of pseudopotentials,

Electron interactions: The self-consistent calculations, the Hartree-Fock equation, plane-wave solution of the HF equation. problems.

Optical Processes and Excitons: Optical reflectance, Kramer-Kronig relations, example, conductivity of collisionless electron gas, electron interband transitions, excitations, Frenkel excitons Alkali halides, molecular crystals, weakly bound (Mott-Wannier) excitons, exciton condensation into electron-hole drops (EHD), Raman effect in crystals, electron spectroscopy with X-rays, energy loss of fast particles in a solid, summary.
Superconductivity:
Experimental survey, occurrence of superconductivity, destruction of superconductivity by magnetic fields, Meissner effect, heat capacity, energy gap, microwave and infrared properties isotope effect, theoretical survey, thermodynamics of the superconducting transition, London equation coherence length, BCS theory of superconductivity, BCS ground state, flux quantization in a superconducting ring, duration of persistent currents, type II superconductors, Vortex stat, estimation of H_{c1} and H_{c2}, Single particle tunneling, Dc Josephson effect, Ac Josephson effect, Macroscopic quantum interference, high-temperature superconductors, critical fields and critical currents, Hall number, fullerenes, summary,

Dielectrics and Ferroelectrics: Maxwell equations, polarization, macroscopic electric field, depolarization field, E_1, local electric field at an atom, Lorentz field, E_2, field of dipoles inside cavity, E_3, dielectric constant and polarizability, electronic polarizability, structural phase transitions, ferroelectric crystals, classification of ferroelectric crystals, displacive transitions, soft optical phonons, Landau theory of the phase transition, second-order transition, first-order transition, antiferroelectricity, ferroelectric domains, piezoelectricity, ferroelasticity, optical ceramics, summary.

Books Recommended:

1. *Solid State Physics* by Ashcroft & Mermin, (1976).
2. *Introduction to Solid State Physics*, 7th Eddition, by C. Kittle, (1996).
3. *Elementary Solid State Physics* by M. A. Omar, (1975).
4. *Quantum Theory of the Solid State* by j Callaway, (1991).
5. *Principles of the Theory of Solids* by J. M. Ziman, (1969).

Paper-VIII **Solid State Physics-II** **Marks 100**

Phonons: Classical, Einstein and Debye models for specific heat, Hamiltonian of the electron-phonon interaction, renormalization of the effective electron mass, screening of the electron-phonon interaction, ionic crystals, the polaron.

Optical Properties: Macroscopic description and microscopic model, mirco-scopic theory of frequency-dependent dielectric constants, optical properties of semi-conductors, quantization of electromagnetic field, interaction of conduction electrons.

Transport Phenomenon: Semiclassical model of for conduction of metals, Boltzmann equation, relaxation time, conductivity equation.

Solids in External Magnetic Fields: Free electron approximation in magnetic field, Landau diamagnetism in free electrons, spin Hamiltonian, the Hubbard model, Pauli paramegnetism of conduction electrons, De Haas van Alphan effect, the quantum Hall effect.

Ferromagnetism and Antiferromagnetism: Ferromagnetic order, curie point and the exchange integral, temperature dependence of the saturation magnetization, saturation magnetization at absolute zero, magnons, quantization of spin waves, thermal excitation of magnons, neutron magnetic scattering, ferromagnetic order, curie temperature and susceptibility of ferrimagnets, iron garnets, antiferromagnetic order, susceptibility below the Neel temperature, antiferromagnetic magnons. Ferromagnetic domains, anisotropy energy, transition region between domains, solitons, origin of domains, coercivity and hysteresis, single domain particles, geomagnetism and biomanetism, magnetic force microscopy, magnetic bubble domains, summary.

Magnetic Resonance: Nuclear magnetic resonance, equations of motion, line width, motional narrowing, hyperfine splitting, examples: paramagnetic point defects, knight shift, nuclear quadrupole resonance, ferromagnetic resonance, shape effects in FMR, spin wave resonance, antiferromagnetic resonance, electron paramagnetic resonance, exchange narrowing, zero-field splitting, priciple of master action, three-level maser, ruby laser, summary.

Books Recommended:

1. *Solid State Physics* by Ashcroft & Mermin, (1976).
2. *Introduction to Solid State Physics*, 7th Eddition, by C. Kittle, (1996).
3. *Elementary Solid State Physics* by M. A. Omar, (1975).
4. *Quantum Theory of the Solid State* by j. Callaway, (1991).
5. *Principles of the Theory of Solids* by J. M. Ziman, (1969).

OPTION-II PARTICLE PHYSCIS

Paper-IX Particle Physics-I

Marks 100

Particle Classification: Quantum numbers, leptons, hadrons, baryons, mesons, quarks.

The Fundamental Interactions: The electromagnetic coupling, the strong coupling, the weak coupling.

Symmetry Transformation and Conservation Laws: Translation in space, rotation in space, the group SU (2), systems of identical particles, parity, isospin charge conjugation, time reversal, G parity, CPT theorem.

The Electromagnetic Field: Gauge invariance and Maxwell's equations, polarization and photon spin, angular momentum, parity and C parity of the photon.

The Klein-Gordan Equation: Non relativistic quantum mechanics, Lorentz covariance and 4 vector notation, the Klein Gordon equation, the Feynman-Stuckelberg interpretation of $E < 0$ solutions, non relativistic perturbation theory (brief review), rules for scattering amplitudes in the Feynman-Stukelberg approach.

The Dirac Equation: Covariant form of the Dirac Equation, Dirac γ-matrices, conserved current and the adjoint equation, free particle spinors, anti particles, normalization of spinors and the completeness relations, bilinear covariants, zero mass fermion, the two-component neutrino.

Books Recommended:

1. *Nuclear and Particle Physics* by Burcham, E. E. and Jobes, M., Longman, (1995).
2. *Introduction to Nuclear and Particle Physics* by Das, A. and Ferbel, T., Johan Wiley and Sons, (1994).
3. *Concepts of Particle Physics* by Gottfried, K. and Weisskopt, F., Vol. 1, Oxford University Press, (1986).
4. *Introduction of elementary Particles* by Griffiths, D., John Wiley and Sons, (1987).
5. *Nuclear and Particle Physics* by Williams, W.S.C., Oxford University Press, (1995).
6. *A Modern Introduction to Particle Physics* by Fayyazudding and Riazuddin, World Scientific, (1992)
7. *Quarks and Leptons* by Halzen F and Martin A.D., Wiley, (1984).
8. *Relativistic Quantum Mechanics* by Bjorken, J. D. and Drell, S. D., McGraw-Hill, (1964) International Edition reprinted in (1995).
9. *Quantum Mechanics* by Riazuddin and Fayyazuddin, World Scientific, (1990).

Paper-X Particle Physics-II

Marks 100

Hadron Spectroscopy: Formation experiments, partial wave formalism and the optical theorem, the Breit-Wigner resonance formula, baryon resonances, phase space considerations, production experiments.

The Quark Model: The group SU (3), quarks, hadrons (baryons, mesons in quark model, heave meson spectroscopy, the quarkonium model.

The Standard Model (qualitative treatment only): Unification of weak and electromagnetic interactions Glashow-Salam-Weinberg Model.

Electrodynamics of spinless particles: An "electron" in an electromagnetic field A^{μ} ,"spinless" electron – muon scattering, the cross section in terms of the invariant amplitude M, the decay rate in terms of M, "spinless" electron – electron scattering, electron – positron scattering: and application of crossing, invariant variables, the origin of the propagator.

Electrodynamics of Spin ½ Particles: An electron interacting with an electromagnetic field A^{μ} , Moller scattering $e^- e^- \to e^- e^-$, the process $e^- \mu^- \to e^- \mu^-$, trace theorems and properties of γ matrices, $e^- \mu^-$ scattering and the process $e^+ e^- \mu^+ \mu^-$, helicity conservation at high energies, survey of $e^- e^- \to e^+ e^-, \mu^+ \mu^-, e^- \mu^- \to e^- \mu^-$ in the laboratory frame; kinematics relevant to the parton model, photons, polarization vectors, more on propagators, the electron propagator, the photon propagator, massive vector particles, real and virtual photons, Compton scattering $\gamma e^- \to \gamma e^-$, pair annihilation $e^+ e^- \to \gamma\gamma$, the + is prescription for propagators, Eeynman rules QED.

Books Recommended:

1. *Relativistic Quantum Mechanics* by Bjorken, J. D. and Drell, S. D., McGraw-Hill, (1964) International Edition reprinted in (1995).
2. *Nuclear and Particle Physics* by Burcham, E. E. and Jobes, M., Longman, (1995).
3. *Introduction to Nuclear and Particle Physics* by Das, A. and Ferbel, T., Johan Wiley and Sons, (1994).
4. *Concepts of Particle Physics* by Gottfried, K. and Weisskopt, F., Vol. 1, Oxford University Press, (1986).
5. *Introduction of elementary Particles* by Griffiths, D., John Wiley and Sons, (1987).
6. *Nuclear and Particle Physics* by Williams, W.S.C., Oxford University Press, (1995).
7. *A Modern Introduction to Particle Physics* by Fayyazudding and Riazuddin, World Scientific, (1992)
8. *Quarks and Leptons* by Halzen F and Martin A.D., Wiley, (1984).
9. *Quantum Mechanics* by Riazuddin and Fayyazuddin, World Scientific, (1990).

OPTION-III ELECTRONIC COMMUNICATION

Paper-XI Electronic Communications-I (Theory) Marks 100

Amplitude modulation principles: Modulation, AM, FM, pulse modulation, power relationships, assignable frequency spectrum, band selection.

AM transmitters: cCircuits, high level modulation, double modulation, AM with pulse width modulation, low level modulation.

AM radio receivers and transmitters: Superheterodyne receiver, double conversion receivers, receiver circuits: IF Amplifiers AM detectors, automatic gain control, audio amplifiers, squelch, receiver schematics, loudspeakers, AM stereo.

Frequency Modulation Principles: Modulated wave, FM radio frequency band, direct and indirect frequency modulation (Phase Modulation), carrier phase in the frequency-modulated wave. FM detectors, stereo FM, FM receiver.

Television: Scanning principles, deflection systems, video camera tubes, video picture, signal, TV receiver Front end, color TV receivers.

Satellite Communication: Basic concept, earth station to earth station via satellite, service requirements, orbits, modulation and multiplexing, packetiser and depacketises, special problems in satellite communication.

Optical communication: Introduction of Optical Fibers, Optical sources and detection optical modulation techniques

Digital Communication: Spectral analysis and filtering theory, communication channels, entropy and source coding, data compression techniques, digital radio, spectrum communication systems, mobile wireless communication system.

Communication principles in earth observation: Remote sensing, sensors for optical remote sensing, remote sensing from space, environment and agricultural applications.

Books Recommended:

1. *Electronic Communication* by Kennedy George, McGraw Hill, 1992.
2. *Electronic Fundamentals* by Thomas L. Floyd, 2nd. Ed., Maxwell-Macmillan, New York, 1991.
3. *Essential of Communication Electronics* by M. Slurzberg and W. Osterfield, National Book Foundation, Islamabad, 1991.
4. *Introduction to Linear Electrical Circuits and Electronics* by M. C. Kelly and B. Nichols, John Wiley, New York, 1988.
5. *Electronic Circuits Handbook* by Michael Tooley, BPB Publications, New Delhi, 1994.
6. *Introduction to Electronic Design* by F. H. Mitchell Jr. and Mitchell Sr., Prentice Hall, London, 1988.
7. Digital Principles and Applications by A. P. Malvino and D. P. Leach, 4th Ed., McGraw Hill, New York, 1986
8. Perspectives in communication by U.R. Rao, Pub. World Scientific, 1987.
9. Digital Electronics By C. E. Strangio, Prentice Hall, London, Latest Edition
10. Digital Computer Electronics By Malvino A. P. and Brown J A., McGraw Hill School Publishing Company, 1993.
11. Electronics for Today by Tom Duncan, Oxford University Press.

Paper-XII Electronic Communications-I (Laboratory) Marks 100

Note: The students are required to do 8 experiments from the following experiments:

1. Design and study the application of operational amplifier (current to voltage converter, Instrumentation amplifier, buffer, voltage clamp, integrator, differentiator, low and high pass filter, half–wave rectifier etc.).
2. Design sinusoidal oscillators and function generators.
3. Design RF transistor oscillator. Convert it into a transmitter. detect the transmitted wave by a radio receiver (both for AM & FM).
4. Circuit study and fault finding of audio-oscillator/ commercial radio and T.V.
5. Design and construct an analog to digital and digital to analog converters using IC's.
6. Design and study of decoder, encoder, multiplexer and demultiplexer circuits and compare the input output waveforms.
7. To construct and understand an operation of arithmetic logic unit and study of different arithmetic logic operations.
8. Design and construct active filters and study their frequency response.
9. Design and constrict a infrared transmitter detected the transmitted wave.
10. Design and constrict a ultrasonic transmitter and receiver.
11. Using microprocessor based trainer's and study the microve and optical communication and control the information from host personal computer.

OPTION-IV ADVANCED ELECTRONICS

Paper-XIII Digital Electronics, Microprocessors and Microcomputer Systems-I (Theory) Marks 100

Operational amplifiers: Ideal operational amplifier, differential amplifier, emitter coupled differential amplifier, offset error and voltages/currents, operational amplifier parameters and applications, frequency response of operational amplifiers.

Combinational Digital Circuits and Systems: Overview of number system, digital codes and circuits. Arithmetic circuits, Decoders/Encoder and multiplexers.

Sequential Logic; Flip-flops, latches, JK, T and D flip-flops, Master-slave flip-flops.
Register and Counters; Shift registers, ripple and Synchronous binary counters. Analog to digital conversion and digital to analog conversion, conversion errors.

Memory and programmable logic: ROM and RAM, memory decoding, error detection and correction, PLD, PLA and PAL.

The Quark Model: The group SU (3), quarks, hadrons (baryons, mesons in quark model, heave meson spectroscopy, the quarkonium model.

The Standard Model (qualitative treatment only): Unification of weak and electromagnetic interactions Glashow-Salam-Weinberg Model.

Electrodynamics of spinless particles: An "electron" in an electromagnetic field A^μ ,"spinless" electron – muon scattering, the cross section in terms of the invariant amplitude M, the decay rate in terms of M, "spinless" electron – electron scattering, electron – positron scattering: and application of crossing, invariant variables, the origin of the propagator.

Electrodynamics of Spin ½ Particles: An electron interacting with an electromagnetic field A^μ , Moller scattering $e^- e^- \rightarrow e^- e^-$, the process $e^- \mu^- \rightarrow e^- \mu^-$, trace theorems and properties of γ matrices, $e^- \mu^-$ scattering and the process $e^+ e^- \mu^+ \mu^-$, helicity conservation at high energies, survey of $e^- e^- \rightarrow e^+ e^-$, $\mu^+ \mu^-$, $e^- \mu^- \rightarrow e^- \mu^-$ in the laboratory frame; kinematics relevant to the parton model, photons, polarization vectors, more on propagators, the electron propagator, the photon propagator, massive vector particles, real and virtual photons, Compton scattering $\gamma e^- \rightarrow \gamma e^-$, pair annihilation $e^+ e^- \rightarrow \gamma\gamma$, the + is prescription for propagators, Eeynman rules QED.

Books Recommended:

1. *Relativistic Quantum Mechanics* by Bjorken, J. D. and Drell, S. D., McGraw-Hill, (1964) International Edition reprinted in (1995).
2. *Nuclear and Particle Physics* by Burcham, E. E. and Jobes, M., Longman, (1995).
3. *Introduction to Nuclear and Particle Physics* by Das, A. and Ferbel, T., Johan Wiley and Sons, (1994).
4. *Concepts of Particle Physics* by Gottfried, K. and Weisskopt, F., Vol. 1, Oxford University Press, (1986).
5. *Introduction of elementary Particles* by Griffiths, D., John Wiley and Sons, (1987).
6. *Nuclear and Particle Physics* by Williams, W.S.C., Oxford University Press, (1995).
7. *A Modern Introduction to Particle Physics* by Fayyazudding and Riazuddin, World Scientific, (1992)
8. *Quarks and Leptons* by Halzen F and Martin A.D., Wiley, (1984).
9. *Quantum Mechanics* by Riazuddin and Fayyazuddin, World Scientific, (1990).

OPTION-III ELECTRONIC COMMUNICATION

Paper-XI Electronic Communications-I (Theory) Marks 100

Amplitude modulation principles: Modulation, AM, FM, pulse modulation, power relationships, assignable frequency spectrum, band selection.

AM transmitters: cCircuits, high level modulation, double modulation, AM with pulse width modulation, low level modulation.

AM radio receivers and transmitters: Superheterodyne receiver, double conversion receivers, receiver circuits: IF Amplifiers AM detectors, automatic gain control, audio amplifiers, squelch, receiver schematics, loudspeakers, AM stereo.

Frequency Modulation Principles: Modulated wave, FM radio frequency band, direct and indirect frequency modulation (Phase Modulation), carrier phase in the frequency-modulated wave. FM detectors, stereo FM, FM receiver.

Television: Scanning principles, deflection systems, video camera tubes, video picture, signal, TV receiver Front end, color TV receivers.

Satellite Communication: Basic concept, earth station to earth station via satellite, service requirements, orbits, modulation and multiplexing, packetiser and depacketises, special problems in satellite communication.

Optical communication: Introduction of Optical Fibers, Optical sources and detection optical modulation techniques

Digital Communication: Spectral analysis and filtering theory, communication channels, entropy and source coding, data compression techniques, digital radio, spectrum communication systems, mobile wireless communication system.

Communication principles in earth observation: Remote sensing, sensors for optical remote sensing, remote sensing from space, environment and agricultural applications.

Books Recommended:

1. *Electronic Communication* by Kennedy George, McGraw Hill, 1992.
2. *Electronic Fundamentals* by Thomas L. Floyd, 2nd. Ed., Maxwell-Macmillan, New York, 1991.
3. *Essential of Communication Electronics* by M. Slurzberg and W. Osterfield, National Book Foundation, Islamabad, 1991.
4. *Introduction to Linear Electrical Circuits and Electronics* by M. C. Kelly and B. Nichols, John Wiley, New York, 1988.
5. *Electronic Circuits Handbook* by Michael Tooley, BPB Publications, New Delhi, 1994.
6. *Introduction to Electronic Design* by F. H. Mitchell Jr. and Mitchell Sr., Prentice Hall, London, 1988.
7. Digital Principles and Applications by A. P. Malvino and D. P. Leach, 4th Ed., McGraw Hill, New York, 1986
8. Perspectives in communication by U.R. Rao, Pub. World Scientific, 1987.
9. Digital Electronics By C. E. Strangio, Prentice Hall, London, Latest Edition
10. Digital Computer Electronics By Malvino A. P. and Brown J A., McGraw Hill School Publishing Company, 1993.
11. Electronics for Today by Tom Duncan, Oxford University Press.

Paper-XII Electronic Communications-I (Laboratory) Marks 100

Note: The students are required to do 8 experiments from the following experiments:

1. Design and study the application of operational amplifier (current to voltage converter, Instrumentation amplifier, buffer, voltage clamp, integrator, differentiator, low and high pass filter, half –wave rectifier etc.).
2. Design sinusoidal oscillators and function generators.
3. Design RF transistor oscillator. Convert it into a transmitter. detect the transmitted wave by a radio receiver (both for AM & FM).
4. Circuit study and fault finding of audio-oscillator/ commercial radio and T.V.
5. Design and construct an analog to digital and digital to analog converters using IC's.
6. Design and study of decoder, encoder, multiplexer and demultiplexer circuits and compare the input output waveforms.
7. To construct and understand an operation of arithmetic logic unit and study of different arithmetic logic operations.
8. Design and construct active filters and study their frequency response.
9. Design and constrict a infrared transmitter detected the transmitted wave.
10. Design and constrict a ultrasonic transmitter and receiver.
11. Using microprocessor based trainer's and study the microve and optical communication and control the information from host personal computer.

OPTION-IV ADVANCED ELECTRONICS

Paper-XIII Digital Electronics, Microprocessors and Microcomputer Systems-I (Theory) Marks 100

Operational amplifiers: Ideal operational amplifier, differential amplifier, emitter coupled differential amplifier, offset error and voltages/currents, operational amplifier parameters and applications, frequency response of operational amplifiers.

Combinational Digital Circuits and Systems: Overview of number system, digital codes and circuits. Arithmetic circuits, Decoders/Encoder and multiplexers.

Sequential Logic; Flip-flops, latches, JK, T and D flip-flops, Master-slave flip-flops.
Register and Counters; Shift registers, ripple and Synchronous binary counters. Analog to digital conversion and digital to analog conversion, conversion errors.

Memory and programmable logic: ROM and RAM, memory decoding, error detection and correction, PLD, PLA and PAL.

Control Logic Design: Microoperations, shifter unit, micriprogrammed control. ALU and control of microprocessor unit.

CPU addressing modes: Address field and modes, stack organization, data transfer instructions, data manipulation instructions, program interrupt. Input-output interface, design of a CPU, pipeline processing.

Electronic Devices (operation and characteristics): Tunnel and IMPATT diodes, Quantum-effect devices, MESFET and MODFET and Hot-Electron devices. LED, Gunn, and Laser diodes, photodetector, UJT and the basic sweep circuit, circuit to generate triggered sweep.

Radio communication: Production and propagation of radio waves, direct waves, ground reflected, surface wave and space waves, formation of Ionospheric layer and their variations, skip distance.

Modulation and Detection: AM and FM modulation, bandwidth of FM signal, Angle Modulation, Vestigial Sideband and Single Sideband Modulation, Phase-locked Loop, Digital Communication, transmitter and superhetrodyne receiver.

Microwaves: Microwave spectrum and radar bands, properties of microwaves, production of microwave (klystron, magnetron, traveling wave oscillator), gunn oscillator, measurement of microwave power, radar system.

Books Recommended:

1. *Introduction to Digital Computer Technology* by Mashelsky (Wiley),
2. *Pulse Digital and Switching Wave forms* by Millman and Taub (McGraw-Hill)
3. *Microwave Principles*, by Reich-Skalmik-Ordung-Kranss.
4. *Microwave Measurements* by Gingston.
5. *Electronic and Radio Engineering* by F.E. Terman McGraw-Hill.
6. *Integrated Electronics* by Millman and Halkias.
7. *Microprocessors (principles and application)* 2nd Eddition by *Gilmore, (1996).*
8. *Computer Engineering, Hardware design* by M. Morris Mano, Prentice Hall (1988)

Paper-XIV Digital Electronics, Microelectronics and Microcomputer System-II (Laboratory)

Marks 100

Note: The students are required to do 8 experiments from the following experiments:

1. Design of a UJT relaxation oscillator of a variable frequency, measure frequency and amplitude of the output.
2. Design RF transistor oscillator, Convert it into a transmitter. detect the transmitted wave by a radio receiver (both for AM & FM).
3. Design an inverting and non-investing D.C. amplifier, measurement of parameters of a given IC operational amplifier.
4. Design and study the application of operational amplifier (current to voltage converter, Instrumentation amplifier, buffer, voltage clamp, integrator, differentiator, low and high pass filter, half–wave rectifier etc.).
5. Design a fixed and self bias transistor binary and triggering of binary, using IC's construct and study RS, JK (Master slave), T and D flip-flops.
6. Design and study of a half and full adder with different Boolean expression using IC's.
7. Synchronous and asynchronous BCD counters, Memory shift register with IC's.
8. Frequency counter and optional digital clock.
9. Circuit study and fault finding of stabilized power supply, Audio-oscillator/ CRO, multimeter/commercial radio and T.V.
10. Design and construct an analog to digital and digital to analog converters using IC's.
11. Design and study of decoder, encoder, multiplexer and demultiplexer circuits and compare the input output waveforms.
12. To construct and understand an operation of arithmetic logic unit and study of different arithmetic logic operations.
13. To construct and study of data storage and retrieval using semiconductor memory and understand the process of fetching an instruction and its operand with ALU.
14. Using microprocessor trainer's and study of microprocessor application working from host personal computer.

14. To study the thermal changes occurring in the given clays on heating with differential thermal analysis. (for refractory spalling index).
15. To determine the % age loss of moisture of the given clay.
16. To calculate moisture contents in the given sample of ceramics material.
17. To determine the %age water absorption in the given sample of refractory material.
18. To determine the loss in ignition in the given sample of clay.
19. To determine the porosity and density of a given refractory material.
20. To find out the corrosion rate of given specimen by loss in weight method.
21. To protect metals from corrosion – electroplating & colouring
22. To fabricate fiber-glass reinforced composite material by using hand-lay-up technique.
23. To determine and compare the specific heats of metallic and non-metallic materials.
24. To determine the plasticity of the given of clay.
25. To determine the effect on plasticity of the given sample of clay by adding (non plastic) impurity SiO_2
26. To measure the green strength of the given ceramic substance.
27. To determine the viscosity of a given sample of glass by penetrating method.
28. To study the process of enameling.
29. To study the process of glazing.
30. To measure the thermal conductivity of the given sample of refractory material.
31. To determine the thermal expansion coefficient of the given sample.
32. To determine the crushing strength of the given material.
33. Determine the %age linear shrinkage in the given sample of clay.
34. Determine the green compression strength of sample of clay.
35. Determine the green compression strength of sample of clay with the addition of impurity.
36. To apply the raw glaze and frit glaze on a ceramics body.

OPTION-VII MEDICAL PHYSICS / RADIATION PHYSICS

Paper-XIX Medical Physics / Radiation Physics-I (Theory) Marks 100

Interactions of Ionising Radiation with Matter: Introduction; Beta-rays, range-energy relationship, mechanism of energy loos, Ionization and excitation, Bremsstrahlung, Alpha-rays, Rang-energy relation – ship, Energy transfer, Gamma-rays, exponential absorption, interaction mechanisms, Pair production. Compton scattering, photoelectric absorption, photodisintegration, Combined effect, Neutrons, Production classification, interaction, Scattering. Absorption.

Radiotherapy: Introduction, The development of radiotherapy, Radiotherapeutic aims, External beam therapy, Brachytherapy, Unsealed source therapy. Requirements for accuracy and precision, Quality assurance, The role of medical physics.

Medical Imaging: Diagnostic X-rays, Production of X-rays, Absorption of x-ray to other planes, Partial volume effect, Artifacts, Contrast agents in conventional radiography and CT, Diagnostic Ultrasound, Doppler effect, Radionuclide imaging, positron emission tomography (PET), Magnetic resonance imaging (MRI), Contrast agents for MRI.

Radiation Dosimetry: History of Absorbed Dose, Stochastic and Non-stochastic quantities, Units for Absorbed Dose, Absorbed Dose Calorimeters, Exposure and its measurements. The free-air chamber, Exposure measurement with calibrated cavity chamber. The concept of Kerma, absorbed Dose in air, Absorbed dose in other Materials, Factors converting Exposure to Absorbed Dose to wake, High energy calibrations, The Bragg-Gray Cavity theory.

Methods of Dosimetry: Calorimeters, Ionisation Chambers, chemical Dosimetry, Thermoluminescence Dosimetry (TLD), Photographic Dosimeter, Scintillation Detectors, Other Dosimetric Systems.

Health Physics : Cardinal principles of radiation protection, Minimize time, Maximize distance, Maximize shielding, Time, Distance and shielding, Maximum permissible dose, whole-body occupational exposure, whole-body non-occupational exposure, partial bodyoccupational exposure, X-ray and pregnancy , Basic radiation safety criteria, effective dose-equivalent, allowable limit on intake (ALI) , inhaled radioactivity, derived air concentration, Gastrointestinal tract, Basis of radiation safety regulations.

Books Recommended:

1. *Introduction to Health Physics* by Herman Cember. 3rd Ed. McGraw Hill, New York, 1996.