MAHENDRA ARTS & SCIENCE COLLEGE
(AUTONOMOUS)

(Accredited by NAAC & Recognized under u/s 2(f) and 12(B))

DEPARTMENT OF PHYSICS

COURSE STRUCTURE AND SYLLABUS for PG

(CBCS)

(2016-2017) ONWARDS

MAHENDRA ARTS & SCIENCE COLLEGE

(Autonomous)

Accredited 'A' by NAAC with "A" grade & Recognized by u/s 2(f) and 12(B) of the UGC Act 1956

Affiliated to Periyar University

DEPARTMENT OF PHYSICS

PG – Syllabus (M.Sc)

1. OBJECTIVES OF THE COURSE

The recent developments in Physical sciences had been included in the enriched M.Sc., (Physics) Syllabus to meet out the present day needs of Academic and Research Institutions and Industries.

2. DURATION OF THE PROGRAMME

The two - year post - graduate programme in M.Sc., Physics consists of four semesters.

3. ELIGIBILITY

A candidate who has passed the B.Sc., Degree Examination in Branch III Physics Main or B.Sc., in Applied Physics or B.Sc., Physics - (Vocational) of this University or an examination of some other universities accepted by the Syndicate as equivalent there to shall be permitted to appear and qualify for the M.Sc., Physics degree Examination of this University after a course of two academic years.

4.COURSE OF STUDY

The course of study for the degree shall be in Physics under semester system with internal according to a syllabus prescribed from time to time.

For each paper -100 Marks

Project -200 Marks

5. EXAMINATION

The theory examination shall be three hours duration to each paper at the end of each year. The candidates failing in each subject(s) will be permitted to appear for each failed subject(s) in the subsequent examination. The practical examination for P.G. Course should be conducted at the end of each semester.

6. QUESTION PAPER PATTERN

Question paper pattern for Examinations

Time - 3 Hours Maximum - 75 Marks

Passing Minimum - 38 Marks

Part – A (5x5=25 Marks) Part – B (5x10=50 Marks)

Answer all questions (Either or Type)

7. PASSING MINIMUM

In order to pass a paper 50 % Minimum is compulsory

8. CLASSIFICATION OF SUCCESSFUL CANDIDATES

Candidates who obtain not less than 75 percent of the marks in the aggregate shall be deemed to have passed the examination in First class with Distinction provided they pass all the examinations prescribed for the course at the first appearance. Candidate who secures not less than 60 percent of the aggregate marks in the whole examination shall be declared to have passed the examination in the First class provided they pass all the examinations prescribed for the course within the period of two academic years from the year of completion of the course.

Candidates who secure not less than 50 percent of the aggregate marks in the whole examination but below 60 percent shall be declared to have passed the examination in the second class provided they pass all the examinations prescribed

for the course within a period of two academic years from the year completion of course. Candidates who pass all the examinations prescribed for the course in the first appearance only are eligible for ranking.

9. COMMENCEMENTS OF THIS REGULATION

These regulation and syllabus shall take effect from the academic year 2016 – 2017, that is, for students who are admitted to the first year of the course during the academic year 2015-2016 and thereafter.

10. TRANSITORY PROVISION

Candidates who are admitted to the P.G. Course of study before 2016 – 2017 shall be permitted to appear for the examinations under those regulations for a period for three years i.e. up to and inclusive of the examination of April / May 2012. Thereafter they will be permitted to appear only under regulations then in force.

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DEPARTMENT OF PHYSICS (2016 Regulations)

PG – Syllabus (M.Sc)

COURSE STRUCTURE

SEM	SUBJECT CODE	COURSE	SUBJECT TITLE	Hrs/ Week	CREDIT	INT. MARK	EXT. MARK	MARKS
I	M16PPH01	Core I	Classical mechanics	7	4	25	75	100
	M16PPH02	Core II	Mathematical physics	7	4	25	75	100
	M16PPH03	Core III	Quantum mechanics-I	6	4	25	75	100
	M16PPHE01	Elective I	Energy Physics	6	4	25	75	100
	M16PPHP01	Core practical I	General experiments	4	-	25	75	100
II	M16PPH04	Core IV	Statistical mechanics	6	4	25	75	100
	M16PPH05	Core V	Advanced Electronics	6	4	25	75	100
	M16PPH06	Core VI	Electromagnetic theory	5	4	25	75	100
	M16PPHE02	Elective II	Nano Science & Nano Technology	5	4	25	75	100
	M16PCSED2	EDC I	Fundamentals of Computers & Applications	2	4	25	75	100
	M16PPHP01	Core practical I	General experiments	4	6	25	75	100
	M16PPHP02	Core practical II	Electronics experiments	4	6	25	75	100
	M16PHR01		Human Rights	2	2	25	75	100

III	M16PPH07	Core VII	Condensed Matter Physics	6	4	25	75	100
	M16PPH08	Core VIII	Quantum Mechanics - II	6	4	25	75	100
	M16PPH09	Core IX	Microprocessor and Microcontroller	6	4	25	75	100
	M16PPHE03	Elective III	Electronic communication	6	4	25	75	100
	M16PVE01	VALUE EDU-I	Repairing electronic appliances	2	2	25	75	100
	M16PPHP03	Core practical III	Microprocessor and Microcontroller	4	-	25	75	100
IV	M16PPH10	Core X	Nuclear and particle physics	6	4	25	75	100
	M16PPH11	Core XI	Molecular spectroscopy	6	4	25	75	100
	M16PPH12	Core XII	Computational methods and Programming	5	4	25	75	100
	M16PPHE04	Elective IV	Material synthesis and characterization	5	4	25	75	100
	M16PPHP03	Core practical III	Microprocessor and Microcontroller	4	6	25	75	100
		MAJOR	Project viva voce	4	8		200	200
Grand Total				120	98	525	1775	2300

CLASSICAL MECHANICS

Unit –I Lagrangian Formulation

Limitation of Newton's method –Centre of Mass- Mechanics of system of Particles- Constraints- Generalized co-ordinates- D'Alembert's principle and Lagrangian equation of motion for the monogenic system with holonomic constrains –and with non-holonomic constraints – variational principles and Lagrangian equation for holonomic and non-holonomic systems-Simple application-Double pendulum –Atwood's machine- Bead sliding on rotating wire in a force.

Unit –II Hamiltonian Formulation

Legendre transformations and the Hamilton's equations of motion -Cyclic co-ordinates and Conservation theorems- Deduction of Hamilton's Principle from the D' Alembert's Principle- Deduction of Hamilton's equations from the modified Hamilton's principle-Principle of least action-Canonical transformations.

Unit –III Poisson's Brackets & Hamilton-Jacobi Theory

Poisson's Bracket-Liouville's theorem-Hamilton-Jacobi Theory –Action and Angle variables –Kepler's –problem-Simple applications of Hamiltonian dynamics: compound pendulum –two dimensional harmonic oscillator.

Unit –IV Small Oscillations and Rigid-body Dynamics

General theory of small oscillation - Lagrange's equation of motion for small oscillation-solution of eigenvalue equation-normal co-ordinates and normal frequencies of vibration-Examples:Two coupled pendulum –Vibration of a linear triatomic molecule.

Euler's angle - Equation of motion of Rigid body -Euler's equations- the motion of a symmetric top under action of gravity.

Unit –V Special Relativity

Lorentz transformation-consequences of Lorentz transformation:- Length contraction: simultaneous, time dilation-Force in relativistic mechanics-Minkowski space and Lorentz

transformation-orthogonal transformation-Thomas Precession- four vectors-covariant Lagrangian formulation for a freely moving particle.

Books for Study

1. Classical Mechanics – H.Goldstein, NarosaPublishing (2008)
2. Classical Mechanics – V.B. Bhatia Narosa Publishing (1997)
3. Classical Mechanics – J.C. Updhaya, Himalaya Publishing House (2003)

Books for Reference

1. Classical Mechanics – N.C.Rana and P.S. Joag, Tata McGraw-Hill (1991).
2. Classical Mechanics –Gupta & Kumar.

MATHEMATICAL PHYSICS

UNIT - I : Vector Analysis

The scalar and vector fields- Gradient, Divergence, curl and Laplacian - Orthogonal and curvilinear co-ordinates - Rectangular, cylindrical and spherical co-ordinates. Vector integration - Line integrals, surface integrals and volume integrals - Gauss Divergence theorem - Stokes theorem and Green's theorem.

UNIT - II : Fourier's and Laplace's integral transforms

Fourier transform- properties of transform-Fourier transform of a derivative- Fourier's sine and cosine transform of a derivative- Finite Fourier transforms-Simple application of Fourier transforms of integral - Inverse Laplace transform-Properties of inverse Laplace transforms- Properties of inverse Laplace transform -convolution theorem-Applications of Laplace Transform.

UNIT - III : Complex variable

Function of complex variables-limit-continuity -Differentiability- Analytic Function - Cauchy-Rieman condition -Differential equation -Cauchy Integral theorem-Cauchy Integral formula—Moreva's theorem -Liouville's theorem-Taylor's series-Laurent's series-singularities of an analytical fuction-Residues-Cauchy Residue theorem-Evaluation of definite integralscontour integration.

UNIT - IV : Special Functions

Legendre, Bessel, Hermite and Laguerre differential equations- power series solutionsGenerating functions- Recursion relations- Rodrigue's formula - Orthogonality relations.

UNIT - V : Beta, Gamma, Delta Functions

Definition of gamma function - Fundamental property of gamma function and values of gamma function - Definition of beta function - Different forms of beta function - Relationship between beta and gamma functions - Reduction of different integrals to gamma function - Dirac delta function - Derivatives of delta function.

BOOKS FOR STUDY AND REFERENCE

1. M. R. Spiegel, Vector Analysis, Schaum'a outline series, McGraw Hill, New York, 1974.
2. L. A. Pipes and L.R. Harvill, Applied Mathematics for Engineers and Physicists, McGraw Hill, London, 1970.
3. P. K. Chattopadhyay, Mathematical Physics, Wiley Eastern, New Delhi, 1992.
4. B. D. Gupta, Mathematical Physics, Vikas Publishing House Pvt. Ltd, New Delhi, 2004.
5. D. G. Zill and M. R. Cullen, Advanced Engineering Mathematics, 3rd Ed. Narosa, New Delhi, 2006.
6. E. Kveyszig, Advanced Engineering Mathematics, Wiley Eastern, New Delhi, 1983.
7. H. K. Dass, Mathematical Physics, S. Chand & Co, New Delhi, 2003.
8. S. S. Rajput, Mathematical Physicsc, Pragati Pragasan, Meerut, 11th Edition, 1996.

QUANTUM MECHANICS-I

UNIT - I : Foundations of wave mechanics

Equation of motion of matter waves- Schroedinger equation for the free particle - Physical interpretation of wave function-normalized and orthogonal wave functions-expansion theorem-admissibility conditions - solution of Schroedinger wave equation - stationary state solutions operator associated with different observables - expectation values - probability current density- Ehrenferts theorem.

Postulates of wave mechanics-representation of states-dynamical variables-commutation relations-expectation values-linear operators adjoint and self-adjoint operators-degeneracy-eigen value, eigen functions-observables: completeness and normalization of eigen functions-Physical interpretation of eigen values and eigen functions and expansion coefficients- momentum eigen functions-Uncertainty principle-states with minimum value-commuting observables: removal of

degeneracy-evolution of system with time: constant of motion. Interacting and Non-interacting systems- System of identical Particles: symmetric and antisymmetric wave functions - Exclusion principle.

UNIT - II : Stationary state and eigen spectrum

Stationary states: time independent Schrodinger equation - Particle in a square well potential - Bound states -eigen values, eigen functions - nonlocalized states -potential barrier - quantum mechanical tunneling - reflection at barriers and wells-multiple potential well - Splitting energy levels-energy bands-Kronig - Penny model.

Exactly soluble Eigenvalue Problems

The simple harmonic oscillator: Energy Eigenvalues and energy eigen functions - properties of stationary states- abstract operator- eigen value spectrum-eigen functions- Angular momentum: operators- Separation of variables-eigen values and eigen functions- spherical harmonics - physical interpretation -Angular momentum in stationary states of systems with spherical symmetry: rigid rotator - diatomic particles- energy level spacing - particle in a potential - radial wave function - Hydrogen atom: solution of the radial equation - stationary state wave functions - bound states.

UNIT - III : Approximation methods for Time - independent Problems

Perturbation theory for discrete levels: Equations in various orders of perturbation theory - Non-degenerate case-first and second orderanharmonic oscillator-Degenerate case- removal of degeneracy - Effect of electric field (stark effect) on ground state of Hydrogen atom - two electron atom.

Variation method: Variation Principle - for excited states- ground state of Helium atom - hydrogen atom ion - WKB approximation - one dimensional Schrodinger equation-Asymptotic solution-validity of WKB approximation-solution near a turning point - connection formula for penetration barrier - Bohr-Sommer field quantization condition- tunneling through a potential barrier.

UNIT - IV : Matrix formulation of quantum theory and equation of motion

Quantum state vectors and functions- Hilbert space-Dirac' s -Bra-Ket notation-basis in Hilbert space - dynamical variables and linear operators - abstract operators - self adjoint - eigen value, eigen vectors - unitrary operators - representations of state vector-dynamical variables as matrixoperators - commutation relation - diagonalization Harmonic oscillator - Schrodinger, Heisenberg and Interaction representation - coordinates and momentum representations - symmetries and conservation laws

UNIT -V : Angular momentum

Angular momentum operators-commutation rules-eigen value spectrum matrix representation of J in the |jm> basis - spin angular momentum - spin 1/2 , spin-1, total wave function- addition of angular momenta- Clebsch-Gordan coefficients-spin wave functions for a system of two spin-1/2

particles.

Identical Particles and spin

Identical Particles - symmetry and Antisymmetric wave function - exchange degeneracy - Spin and statistics: Pauli's exclusion Principle- Slater determinant- collision of identical particles-spin and Pauli's matrices- density operator and density matrix.

BOOKS FOR STUDY AND REFERENCE

1. A Text book of Quantum Mechanics - P. M. Mathews and K.Venkatesan; Tata McGraw -Hill Publications

2. Quantum Mechanics - Satya Prakash; Kedar Nath Ram Nath and Co. Publications

3. Quantum Mechanics (5th Edition) - Theory and Applications by A.K.Ghatak and Lokanathan ; Macmillan India Ltd Publication.

4. Principle of Quantum Mechanics (2nd Edition) - R.Shankar; PlenumUS Publication.

5. Quantum Mechanics - Leonard I. Schiff ; McGraw-Hill International Publication.

6. Quantum Mechanics (2nd Edition)- V. K. Thankappan, New Age International (P) Ltd. Publication.

7. Quantum Mechanics (3nd Edition)- E. Merzbacher; John Wiley Interscience Publications.

8. Quantum Mechanics -Vol.I - Claude Cohen-Tannoudji, Bernard Diu, Franck Laloe - John Wiley Interscience Publications.

9. Quantum Mechanics - Pauling & Wilson

STATISTICAL MECHANICS

Unit – I Classical Statistical Mechanics

Phase space and ensembles – Types of ensembles - Liouville's theorem – Statistical Equilibrium –Thermal Equilibrium- Elementary ideas of Partition Functions-Connection between Statistical and Thermodynamical quantities - Micro and macro states - Maxwell - Boltzmann distribution law - Distribution of energy and velocity - Principle of equipartition of energy - Boltzmann's entropy relation.

Unit – II Kinetic Theory

Binary collisions - Boltzmann transport equation and its validity - Boltzmann's H-theorem and its analysis – Poincare's theorem - Transport phenomena: Mean free path - Zero order approximation - Viscosity of a gas - Navier - Stokes equation - Application to Incompressible fluids.

Unit – III Entropy and Thermodynamics

Entropy - Principle of entropy increase – Entropy and Disorder– Change in Enrtopy for reversible and irreversible processes - Gibbs paradox – Resolution of the paradox – Sackur – Tetrode equation –Thermodynamic Potentials and Reciprocity relations-– Nernst Heat Theorem.

Unit – IV Quantum Statistics

Ideal Bose Systems – Photon gas – Radiation pressure and density - Bose - Einstein condensation – Debye's model of solids: Phonon gas - Ideal Fermi Systems – Fermi energy – Mean energy of Fermions – Electron gas in metals - Thermionic emission - Pauli Para magnetism.

Unit – V Advanced Topics in Statistical Mechanics

Phase transition- Order of phase transitions-First and second order- Interaction of spin in Ferromagnetism- Weiss molecular field approximation—General formulism of Ising model - One dimensional Ising model - Fluctuations- Mean Square deviation- Brownian motion- Expression for Brownian motion- Fourier Analysis of random function: Weiner- Khinchine theorem.

Books for Study and Reference:

1. Elementary Statistical Mechanics – Gupta and Kumar, Pragati Prakashan, Meerut, 8th Edition.
2. Statistical Mechanics – B.K. Agarwal and M. Eisnor, New Age International Publishers, 2nd Edition.
3. Fundamentals of Statistical Mechanics – B.B.Laud, New Age International Publishers, New Delhi, 2007.
4. Statistical Mechanics – Kerson Huang, Wiley eastern Ltd., New Delhi, 1983.
5. Statistical and Thermal physics – F. Reif, , McGraw Hill, International Edition, Singapore (1979)

ADVANCED ELECTRONICS

UNIT - I : SEMI CONDUCTOR DIODES

The continuity equation - Application of the continuity equation for an abrupt PN junction under forward and reverse bias - Einstein equation - Varactor diode - Schottky diode - Tunnel Diode - Gunn diode - Optoelectronic diodes - LASER diode, LED and photo diode.

UNIT - II : SPECIAL SEMICONDUCTOR DEVICES

JFET- Structure and working - I -V Characteristics under different conditions - biasing circuits - CS amplifier design - ac analysis - MOSFET: Depletion and Enhancement type MOSFFT - UJT characteristics - relaxation oscillator - SCR characteristics - application in power control DIAC,TRIAC.

UNIT - III : OPERATIONAL AMPLIFIER

Operational amplifier characteristics - inverting and non-inverting amplifier - instrumentation amplifier - voltage follower - Integrating and differential circuits - log & antilog amplifiers - op amp as comparator - Voltage to current and current to voltage conversions - active filters : low pass, .high pass, band pass & band rejection filters - Solving simultaneous and differential equations.

UNIT - IV : OP-AMP APPLICATIONS (OSCILLATORS AND CONVERTORS)

Wien bridge, phase shift oscillators - triangular, saw-tooth and square wave generators - Schmitt's trigger - sample and hold circuits - Voltage control oscillator - phase locked loops. Basic D to A conversion: weighted resister DAC - Binary R-2R ladder DAC - Basic A to D conversion: counter type ADC - successive approximation converter - dual slope ADC.

UNIT - V : IC FABRICATION AND IC TIMER

Basic monolithic Ics - epitaxial growth - masking - etching impurity diffusion - fabricating monolithic resistors, diodes, transistors, inductors and capacitors - circuit layout - contacts andinter connections - charge coupled device - applications of CCDs.555 timer - description of the functional diagram - mono stable operation - applications of mono shots - as table operation pulse generation.

BOOKS FOR STUDY AND REFERENCE

1. T.F.Schubert and E.M.Kim, "Active and Nonlinear Electronics", John Wiley Sons, New York (1996).
2. L.Floyd, Electronic Devices, "Pearson Education" New York (2004)
3. Dennis Le Crissitte, Transitors, Prentice Hall India Pvt. Ltd (1963)
4. J.Milman and C.C. Halkias, Integrated Electronics, McGraw Hill (1972)
5. A. Mottershed, Semiconductor Devices and Applications, New Age Int Pub
6. M. Goodge, Semiconductor Device Technology Mc Millan (1983)
7. S.M.Sze, Physices of Semiconductor Devices , Wiley-Eastern Ltd.,
8. Milman and Taub, Pulse, digital and switching Waveforms, McGrew Hiil (1965)
9. Ben.G.Streetman, Solid state electronic devices, Printice Hall, Englewood cliffs, NJ (1999)
10. R.A.Gayakwad, Op-Amps & Linear integrated circuits, Printice Hall India Pvt. Ltd.(1999)

ELECTROMAGNETIC THEORY

UNIT - I : Electrostatics

Coulomb's Law - Electric field intensity - Field due to point and continuous charges - Gauss' Law and its applications- Gauss's law and application - Electric potential - Electric field and equipotential plots. Electric field in free space, conductors, dielectric -Dielectric polarization - Dielectric strength - Electric field in multiple dielectrics- Molecular polarisability and electric susceptibility-Electrostatic energy in dielectric medium- Clausius- Mossotti equation Laplace and Poisson equations, boundary value problems.

UNIT - II : Magnetostatics

Lorentz Law of force, magnetic field intensity - Biot-savart Law - Ampere's Law - Magnetic field due to straight conductors, circular loop, infinite sheet of current - Magnetic flux density (B) - B in free space, conductor, magnetic materials - Magnetization - Magnetic field in multiple media - Boundary conditions - Scalar and vector potential - Magnetic force - Torque - Inductance - Energy density - Magnetic circuits.

UNIT - III : Electrodynamic fields

Faraday's laws, induced emf - Transformer and motional EMF - Forces and Energy in quasi-stationary Electromagnetic Fields - Maxwell's equations (differential and integral forms) - Displacement current - Relation between field theory and circuit theory. Vector and scalar potential- Gauge transformation- Lorentz gauge- Coulomb gaugeConservation laws for a system of changes- Poynting theorem.

UNIT - IV : Electromagnetic waves

Generation - Electro Magnetic Wave equations - Wave parameters; velocity, intrinsic impedance, propagation constant - Electromagnetic waves in free space, dielectrics, and conductors; Reflection and refraction, polarization, Fresnel's Law, interference, coherence, and diffraction; Dispersion relations in plasma skin depth, Poynting vector Wave guides-Propagation of waves in a rectangular wave guide-inhomogeneous wave equation and retarded potentialsfield and radiation due to an oscillating electric dipole.

UNIT - V : Plasma physics:

Defnition of plasma; Its occurrence in nature; Dilute and dense plasma; Uniform but time-dependent magnetic field: Magnetic pumping; Static non-uniform magnetic field: Magnetic bottle and loss cone; MHD equations, Magnetic Reynold's number; Pinched plasma; Bennett's relation; Qualitative discussion on sausage and kink instability.

BOOKS FOR STUDY AND REFERENCE:

1. Mathew N. O. Sadiku, 'Elements of Electromagnetics (Oxford University press Inc. First India edition, 2007)
2. Ashutosh Pramanik, Electromagnetism - Theory and Applications (Prentice-Hall of India Private Limited, New Delhi, 2006)
3. J.A. Bittencourt, Fundamentals of Plasma Physics, Third edition, (Springer Publication, 2004)
4. David J Griffiths -Introduction to Electromagnetics- III Edition - (Prantice Hall of India Pvt.Ltd.- New Delhi, 2000)
5. T.V.S Arun Murthy, Electromagnetic fields, (S. Chand, New Delhi,2008)
6. Joseph. A.Edminister, Theory and Problems of Electromagnetics, Second edition, Schaum Series (Tata McGraw Hill, 1993)
7. William .H.Hayt, 'Engineering Electromagnetics', (Tata McGraw Hill edition, 2001)
8. John R.Reitz-Foundations of Electromagnetic Theory-VI Edition (Narosa Publishing House, New Delhi, 2000)
9. K.L. Goswami, Introduction to Plasma Physics (Central Book House, Calcutta)

CONDENSED MATTER PHYSICS

UNIT - I : Crystallography and Bonding

Reciprocal lattices - Vector development of reciprocal lattice - Properties of the reciprocal lattice - Reciprocal lattice to bcc lattice and fcc lattice - Bragg's condition in terms of reciprocal lattice – Crystal diffraction-Neutron and electron diffraction - Brillouin zones. Binding energy of ionic crystals - Madelung constant - Cohesive energy - Compressibility and bulk modulus - Born Haber cycle. Crystals of inert gases - Vanderwaal's interaction - London interaction - Cohesive energy.

UNIT - II : Lattice Vibrations and Thermal properties

Vibration of monoatomic lattices- Lattices with two atoms per primitive cell- Quantization of lattice vibrations- Phonon momentum - Inelastic scattering of neutrons by phonons. Lattice heat capacity - Einstein model - Density of mode in one-dimension and three-Dimension - Debye model of the lattice heat capacity -Thermal conductivity - Umklapp process.

UNIT - III : Free Electron theory, Energy Bands and Semiconductor Crystals

Energy levels and density of orbitals - Fermi-Dirac distribution - Free electron gas in three dimensions - Heat capacity of the electron gas -Electrical conductivity and Ohm's law - Motion in magnetic fields - Hall effect - Thermal conductivity of metals - Nearly free electron model -Electron in a periodic potential - Semiconductors - Band gap - Effective mass - Intrinsic carrier concentration.

UNIT - IV : Diamagnetism, Paramagnetism, Ferromagnetism and Antiferromagnetism

Langevin classical theory of Diamagnetism and Paramagnetism- Weiss theory- Quantum theory of Paramagnetism - Demagnetization of a paramagnetic salt - Paramagnetic susceptibility of conduction electrons - Hund's rules- Kondo effect. Ferroelectric order – Curie point and the exchange integral- Temperature dependence of saturation magnetization Magnons- Thermal excitation- Ferromagnetic order- Antiferromagnetic order - Antiferromagnetic Magnons - Ferromagnetic domains - Origin of domains - Coercive force and hysteresis.

UNIT - V : Dielectrics, Ferroelectrics and Superconductivity

Macroscopic electric field- Local electrical field at an atom- Dielectric constant and Polarizability - Classius-Mossotti equation - Ferroelectric crystals - Polarization Catastrophe - Ferroelectric domains. Occurrence of Superconductivity - Meissner effect - Thermodynamics of Superconducting transition- London equation- Coherence length- BCS theory - Flux Quantization - Type-I and Type-II Superconductors -Josephson tunneling effect- DC and AC Josephson effect- SQUID - Recent developments in high Temperature Superconductivity- Application of superconductors.

BOOKS FOR STUDY AND REFERENCE

1. Solid State Physics - S.L.Gupta & Dr.V.Kumar.

2. Fundamentals of Solid State Physics - Saxena Gupta and Saxena.

3.C. Kittel, Introduction to Solid State Physics, 5th Edition Wiley Eastern, New Delhi (1977)

4. N. W. Asherof and N. D. Mermin, Solid State Physics, Holt, Rinehart and Winston, International Edition, Philadelphia.

5. J. S. Blakemore, Solid State Physics, Second edition Cambridge University press, Cambridge, London (1974)

6. A. J. Dekker, Solid State Physics, Mac Millen, Madras (1971)

7. M. M. Woolfson, An Introduction to X-ray Crystallography, Vikas publishing Ltd. (1978)

8. Thomas P. Sheahen, Introduction to High-Temperature Superconductors, Plenum Press, New York (1994)

9. S. O. Pillai, Solid State Physics, New Age International (p) Ltd, New Delhi (1995).

QUANTUM MECHANICS – II

UNIT - I : Approximation methods for Time dependent perturbation theory

Time dependent Perturbation theory - first order transitions - constant perturbation-transition probability: Fermi Golden Rule -Periodic perturbation -harmonic perturbation - adiabatic and sudden approximation. Semi-classical theory of radiation: Application of the time dependent perturbation theory to semi-classical theory of radiation - Einstein's coefficients - absorption - induced emission- spontaneous emission -Einstein's transition probabilities- dipole transition - selection rules- forbidden transitions.

UNIT -II : Scattering theory

Kinematics of scattering process - wave mechanical picture- Green's functions - Born approximation and its validity -Born series - screend coulombic potential scattering from Born approximation. Partial wave analysis: asymptotic behavior - phase shift - scattering amplitude in terms of phase shifts - differential and total cross sections - optical theorem - low energy scattering- resonant scattering - nonresonant scattering-scattering length and effective range- RamsauerTownsend effect - scattering by square well potential.

UNIT - III : Relativistic quantum Mechanics

Schrodinger relativistic equation- Klein-Gordan equation-charge and current densities - interaction with electro magnetic field- Hydrogen like atom - nonrelativistic limit- Dirac relativistic equation: Dirac relativistic Hamiltonian - probability density- Dirac matrices-plane wave solution - eigen spectrum - spin of Dirac particle - significance of negative eigen states - electron in a magnetic field - spin magnetic moment - spin orbit energy. Quantisation of the field Electro magnetic wave as harmonic oscillators -quantisation: classical E.M.wave -quantisation of fields oscillators- Photons- number operator - creation and annihilation operators of photons.

UNIT - IV : Quantum theory of Atomic and Molecular structure

Central field approximation: residual electrostatic interaction-spin-orbit interaction-Determination of central field: Thomas Fermi statistical method-Hartree and Hartree-Fock approximations (self consistent fields) -Atomic structure and Hund' s rule - effect of magnetic field in Hydrogen atom- weak and strong field-quadratic Zeeman effect. Molecules: Born -Oppenheimer approximation - An application : the hydrogen molecule Ion (H_2^+) - Molicular orbital theory: LCAO-Hydrogen molecule - Heitler- London method - energy level of the two atoms molecule- Van der waals force.

UNIT - V : Methods of electronic structure calculation

Hartree-Fock SCF method -formulation-Hartree-Fock approach- restricted and unrestricted HF calculations - Roothaans equations - selection of basis sets- electron correlation - Moller - Plesset many body perturbation theory - DFT - Semi-emphirical methods.

BOOKS FOR STUDY AND REFERENCE

1. A Text book of Quantum Mechanics - P. M. Mathews and K.Venkatesan; Tata McGraw -Hill Publications

2. Quantum Mechanics (2nd Edition)- V. K. Thankappan; New Age International (P) Ltd. Publication

3. Quantum mechanics - Franz Schwabl; Narosa Publications.

4. Molecular Quantum mechanics (3rd Edition) - P.W.Atkins and R.S.Friedman;Oxford

University Press publication.

5. Quantum Mechanics - Satya Prakash; Kedar Nath Ram Nath and Co. Publications.

6. Quantum Mechanics (5th Edition) - Theory and Applications by A.K. Ghatak and Lokanathan ; Macmillan India Ltd Publication

7. Quantum Mechanics - Leonard I. Schiff ; McGraw-Hill International Publication.

8. Quantum Mechanics (3nd Edition)- E. Merzbacher; John Wiley Interscience Publications.

9. Quantum Mechanics -Vol.II - Claude Cohen-Tannoudji, Bernard Diu, Franck Laloe - John wiley Publications.

MICROPROCESSORS AND MICROCONTROLLERS

UNIT - I Architecture and Programming of 8085

Architecture of 8085 - Organization of 8085: Control, data and address buses - registers in 8085 - Addressing modes of 8085 - Instruction sets of 8085: Instruction types (based on number of bytes, based on operation), data transfer, arithmetic, logical, branching, stack and I/O instructions. Timing and sequencing : Instruction cycle, machine cycle, halt state, walt state - Timing diagram for opcode fetch, memory read and write cycles. Assembly language programming, Simple programs using arithmetic and logical operations - Interrupts: Maskable and non-maskable, hardware and multilevel interrupts.

UNIT - II Architecture of 8O86

Memory organization, Register organization: General purpose, index, pointer, segment registers and flags - Bus structure: data bus, address bus, effective & physical address and pipeling. Addressing modes of 8086: Register, immediate, direct and indirect addressing.

UNIT - III Applications of Microprocessors

Microprocessor based process control - closed loop control - open 1oop control. Example for closed loop control - crystal growth control. Microprocessor based temperature monitoring systems - limit setting - operator panel - block diagram. Analog to digital conversion using ADC 0809 interfacing through PPI 8255 - Block diagram.

UNIT - IV Architecture of Microcontroller 8051

Introduction - comparison between microcontroller and microprocessors - Architecture of 8051 - Key features of 8051 - memory organization - Data memory and program memory-internal RAM organization - Special function registers - control registers - I/O ports - counters and timers - interrupt structure.

UNIT - V Programming the Microcontroller 8051

Instruction set of 8051 - Arithmetic, Logical, Data move jump and call instructions, Addressing modes - Immediate, register, direct and indirect addressing modes - Assembly language programming - simple programs to illustrate arithmetic and logical operations (Sum of numbers, biggest and smallest in an array) - software time delay.

BOOKS FOR STUDY AND REFERENCE

1. Aditya P.Mathur, Introduction to Microprocessors, Tata McGraw Hill Company, II edition.

2. Ramesh S.Gaonkar, Microprocessor Architecture, Programming and Application with 8085,Wi1ey Eastern.

3. Douglas V.Hall, Microprocessors and Interfaces, Tata McGraw Hill Company.

4. Aditya P.Mathur, Introduction to Microprocessors, Tata McGraw Hill Company, III edition.

5. Kenneta J.Ayala, The 8051 Microcontroller, Penram International - India.

6. Lance A. Leventhal, Introduction to Microprocessors software, hardware, Programming, Prentice Hall of India.

7. Kenneth L. Short, Microprocessor and Programmed Logic, Prentice Hall of India.

8. Gilmore, Microprocessors, TMH Edition.

NUCLEAR AND PARTICLE PHYSICS

Unit - I : Nuclear Structure

Distribution of nuclear charge - spin and magnetic moment - determination of nuclear mass - Binding Energy - Nuclear stability - Mass parabolas - Nuclear Shell model - Liquid drop model - Optical Model - Collective Model.

Unit - II : Nuclear Interactions

Exchange forces - Yukawa's meson theory - Yukawa potential - Ground state of deuteron - Low energy n-p scattering - effective range - spin dependence and charge independence of nuclear forces.

Unit - III : Nuclear Reactions

Types of reactions and Energetics of nuclear reactions - conservation laws - Q Value - Scattering and reaction cross sections - Compound nucleus - Reciprocity theorem - Breit and Wigner Dispersion formula - stripping and pickup reactions.

Unit - IV : Radioactive Decays

Alpha decay - Geiger - Nuttal law - Gamow's Theory - Neutrino hypothesis - Fermi theory of beta decay - Selection rules - Gamma decay - Selection rules - Internal conversion

Unit - V : Elementary Particles

Types of interactions between elementary particles - Leptons - Hadrons - Mesons - Hyperons - Pions - Gell - Mann Okubo mass formula for octet and decaplet - SU(2) - SU(3) Multiplet - Quark model - Color and flavor - weak and strong interactions.

BOOKS FOR STUDY AND REFERENCE

1. R.P. Roy and B.P. Nigam, Nuclear Physics, Age International Ltd, New Delhi, 2005.
2. B.L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill, New Delhi, 1983.
3. H.Semat, Introduction to Atomic and Nuclear Physics, Chapman and Hall, New Delhi, 1983.
4. W.S.C Williams, Nuclear and particle Physics Claredon Press, London, 1981.
5. K.S. Krane, Introductory Nuclear Physics, John - wiley, New york, 1987.
6. S.B. Patel, Nuclear Physics: An introduction, Wiley - Eastern, New Delhi, 1991.
7. D.C. Tayal, Nuclear Physics, Himalaya Publishing house, New Delhi, 2004.

MOLECULAR SPECTROSCOPY

UNIT - I : IR - Spectroscopy

Principle and theory of Infrared spectroscopy - Far and Near IR absorption spectroscopy - Mid and Near IR reflectance spectroscopy- Photo acoustic IR spectroscopy - Dispersive IR spectrometer - IR Imaging - FT - IR spectroscopy - Vibrational frequencies and qualities analysis - sampling methods - Instrumentation- Applications.

UNIT - II : Raman Spectroscopy

FT Raman spectroscopy - degree of depolarization - structure determination using IR and Raman spectroscopy - Resonance Raman spectroscopy - Coherent anti - Stokes Raman spectroscopy - Inverse Raman and surface Enhanced Raman spectroscopy - principles, techniques and applications - non - linear Raman spectroscopy.

UNIT - III : Electronic Spectra : Florescence & Phosphorescence Spectroscopy

Electronic Excitation of Diatomic Species - Vibrational Analysis of Band Systems of Diatomic Molecules - Deslandre's Table - Intensity Distribution - Franck Condon Principle - Rotational Structure of Electronic Bands - Resonance and Normal Fluorescence - Intensities of Transitions - phosphorescence Population of Triplet State and Intensity - Experimental Methods - Applications of Florescence and Phosphorescence.

UNIT - IV : NMR & NQR Spectroscopy

NMR Spectroscopy : Quantum Mechanical and Classical Description - Bloch Equation - Relaxation Process - Experimental Technique - Principle and Working of High Resolution NMR Spectrometer - Chemical Shift

NQR Spectroscopy : Fundamental Requirements - General Principle - Experimental Detection of NQR Frequencies - Interpretation and Chemical Explanation of NQR Spectroscopy

UNIT - V : ESR & Mossabauer Spectroscopy

ESR Spectroscopy : Basic Principles - Experiments - ESR Spectrometer - Reflection Cavity and Microwave Bridge - ESR Spectrum - Hyperfine Structure

Mossabauer Spectroscopy : Mossabauer Effect - Recoilless Emission and Absorption - Mossabauer Spectrum - Experimental Methods - Hyperfine Interaction - Chemical Isomer Shift - Magnetic Hyperfine and electric Quadrupole Interaction

BOOKS FOR STUDY AND REFERENCE:

1. C.N. Banwell, Fundamentals of Molecular Spectroscopy. Tata MCGraw Hill (1972)
2. B.P. Straughan and Walkar, Spectroscopy Vol. 1, Chapman and Hall (1976)
3. B.P. Straughan and Walkar, Spectroscopy Vol. 2, Chapman and Hall (1976)
4. D.N. Sathyanarayana - Vibrational Spectroscopy and Application - New Age International Publications (2004)
5. G. Aruldas - Molecular Structure and Spectroscopy (2001) - Prentice Hall of India Pvt. Ltd. - New Delhi
6. Raymond Chang, Basic Principles of Spectroscopy, McGraw Hill Koyakusha Ltd., (1980)
7. D.A. Long, Raman Spectroscopy, Mc Graw Hill, International Book Company.

COMPUTATIONAL METHODS AND PROGRAMMING

UNIT - I : C++ programming

Constants, variables and their declarations - Input, output and comparison operators-if, if. else, switch, while, do-while, for, break statements- main, void, exit, swap functions- Arrayspassing by value and passing by reference.

UNIT - II : Curve fitting and interpolation

Curve fitting: Method of least squares- Normal equations- Straight line fit- Exponential and power-law fits.

Newton interpolation polynomial: Linear Interpolation- Higher-older polynomials-First-order divided differences-Gregory-Newton interpolation polynomials-Lagrange interpolation - Truncation error.

UNIT - III : Solutions of Linear and Nonlinear Equations

Simultaneous linear equations: Gauss elimination method - Jordan's modification- Inverse of a matrix by Gauss- Jordon Method - Roots of nonlinear equations: Newton-Raphson method - Iterative rule - Termination criteria - Pitfalls - Order of convergence

UNIT - IV : Numerical integration and Differentiation

Newton-Cotes quadrate formula - Trapezoidal, Simpson's 1/3 and 3/8 rules - Errors in the formulas.

Differentiation: First -order derivative:-Two and four-point formulas second -order derivative: Three and five-point formulas.

UNIT - V : Numerical solution to ordinary Differential Equations

First-order equations: Euler and improved Euler methods-Formulas-Local and global truncation errors-Fourth-order Runge-Kutta method-Geometric description of the formula-Errors versus step size -Second order equation- Euler methods and Fourth order Runge-Kutta method.

BOOKS FOR STUDY AND REFERENCE

1. J. R. Hubbard, Programming with C++, McGraw-hill, New Delhi, 2006.
2. J. H. Mathews, Numerical Methods for Mathematics, Science and Engineering, Prentice-Hall of India, New Delhi, 1998.
3. M. K. Jain S.R.K Iyengar and R.K.Jain, Numerical Methods for Scientific and Engineering Computation, New Age International, New Delhi, 1993.
4. S. D. Conte and C.Boor, Elementary Numerical Analysis, 3rd Ed, McGraw Hill, Singapore, 1981.

ENERGY PHYSICS

UNIT - I :

Introduction to energy sources: Energy sources and their availability - prospects of renewable energy sources.

UNIT - II :

Solar Cells: Solar cells for direct conversion of solar energy to electric powers - Solar cell parameter - Solar cell electrical characteristics - Efficiency - Single crystal silicon solar cells - Polycrystalline silicon solar cells - cadmium sulphide solar cells.

UNIT - III :

Applications of solar energy: Solar water heating - space heating and space cooling - solar photo valtaics - agricultural and industrial process heat - solar distillation - solar pumping - solar furnace - solar cooking - solar green house.

UNIT - IV :

Wind Energy: Base principles of wind energy conversion wind data and energy estimation - Base components of wind energy conversion systems (WECS) types of wind machines - Generating systems - scheme for electric generation - generator control - load control - applications of wind energy.

UNIT - V :

Energy from Biomass: Biomass conversion Technologies - wet and Dry process - Photosynthesis.

Biogas Generation: Introduction - basic process and energetic - Advantages of anaerobic digestion - factors affecting bio digestion and generation of gas.

Classification of Biogas plants: Continuous and batch type - the done and drum types of Bio gas plants - biogas from wastes fuel - properties of biogas - utilization of biogas.

BOOKS FOR STUDY AND REFERENCE

1. Kreith and Kreider, Principles of Solar Engineering, McGrew Hill Pub.,
2. A.B.Meinel and A.P.Meinal, Applied Solar Energy.,
3. M.P.Agarwal, Solar Energy, S.Chand & Co.,
4. S.P.Sukhatme, Solar Energy, TMH.,
5. G.D.Rai, Non-conventional Energy sources, Khauna Publications, Delhi.

NANO SCIENCE AND TECHNOLOGY

UNIT - I : Basics of Nanotechnology

Background to Nanotechnology - scientific revolutions - types of nanotechnology and nano machines - atomic structure molecules & phases - molecular and atomic size - surfaces and dimensional space - top down and bottom Nanoscale formation

UNIT - II : Nanocrystals

Synthesis of metal Nan particles and structures - Background on quantum semiconductors - Background on reverse Miceller Solution - Synthesis of semiconductors - Cadmium telluroid nano crystals - Cadmium sulfide nano crystals - Silver sulfide nano crystals - Nano manipulator - Nano tweezes - Nanodots.

UNIT - III : Nano Tubes

Types of nanotubes - formation of nanotubes - methods and reactants - arcing in the presence of cobalt - laser methods - ball milling - chemical vapour deposition methods - properties of nano tubes - plasma arcing - electro deposition - pyrolytic synthesis - Zeolites and templated powders layered silicates.

UNIT - IV : Characterization of Nanomaterials

Scanning Electron Microscope : Theory - Instrumental setup and its application - Low KV SEM and its application - Low temperature SEM and its application - working of electron probe micro analysis and its application in elemental analysis - EDX spectra Important material systems - optical process in semiconductors - optical process in quantum wells - semi conducting optoelectronic devices - organic optoelectronic devices (qualitative).

Unit - V : Applications of Nanotechnology

Structural and Mechanical materials - Nan electronics - opto electronic devices - LED - Applications - Colorants and Pigments - Nano - Lithography - Nanobiotechnology - DNA - Chips, DNA array devices, drug delivery systems.

BOOKS FOR STUDY AND REFERENCE:

1. Nanotechnology: Basic science and emerging technologies - Mick Wilson, Kamali Kannagara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press (2005).
2. Amorphous and Nanocrystalline Materials: Preparation, Properties, and Applications, A.Inoue, K.Hashimoto(Eds.,) (2000).
3. Introduction to Nanotechnology, Charles P. Poole, Frank J. Owens, Wiley - Interscience (2003).
4. Fundamentals of Surface and Thin Film Analysis, Leonard C.Feldman and James W.Mayer.
5. Nanocomposite science and technology, Pulickel M. Ajayan, Linda S. Schadler, Paul V. Braun, Wiley - VCH Verag, Weiheim (2003).
6. Quantum Heterostructures : Microelectronics and Optoelectronics, Vladimir Mitin
7. Smart Electronic Materials (Fundamentals and applications), Jasprit Singh
8. Nanostructures and Nanomaterials (Synthesis, Properties and Applications), Guozhong Cao.
9. Nanoelectronics and Information technology Edited by Rainer Weser.

COMMUNICATION ELECTRONICS

UNIT - I : Antennas & Wave Propagation

Radiation field and Radiation resistance of a short dipole antenna -Grounded λ /4 Antenna-Ungrounded λ /2 Antenna- Antenna Arrays-Broadside and End Side Arrays-Antenna Gain-Directional High Frequency Antennas- Sky Wave Propagation-Ionosphere-Ecles & Larmor Theory-Magneto Ionic Theory-Ground Wave Propagation.

UNIT - II : Pulse Code and Digital Modulation Techniques

Sampling theorem - Low - Pass and Band - Pass signals, PAM, Channel BW for a PAM signal. Natural sampling. Flat-top sampling, Signal recovery through Holding, Quantization of signals, PCM transmission, quantization of noise, differential PCM Delta Modulation, Adaptive Delta modulation, CVSD. Signal to noise ratio in PCM and Delta Modulations - ASK, FSK, BPSK, DPSK, QPSK, QASK, MSK and QAM.

UNIT - III : Microwaves(Operation only)

Microwave Generation-Multicavity Klystron-Reflex Klystron-Magnetron-Travelling WaveTubes (TWT) and other Microwave Tubes-MASER-Gunn Diode.

Broad Band Communication Systems

Multiplexing - Frequency division - Time division. Short and medium Haul systems: Coaxial cables - fibre optic link - Microwave link - Tropospheric Scatter links. Long Haul system: Submarine cables.

UNIT - IV : Radar and Television

Elements of a Radar System-Radar Equation-Radar Performance Factors-Radar Transmitting Systems- Radar Antennas-Duplexers-Radar Receivers and Indicators-Pulsed Systems-Other Radar Systems. Colour TV Transmission and Reception - Colour mixing principle - Colour Picture Tubes -Delta Gun picture tube - PIL colour picture tube - Cable TV, CCTV and Theatre TV.

UNIT - V: Optical Fibres

Propagation of Light in an Optical Fibre-Acceptance Angle-Numerical Aperture-Step and Graded Index Fibres-Optical Fibre as a Cylindrical Wave Guide-Wave Guide Equations-Wave Equations in Step Index Fibres-Fibre Losses and Dispersion-Applications.

Satellite communication

Orbital Satellites, Geostationary Satellites, Orbital Patterns, satellite system link models, satellite system parameters, satellite system link equation, Link budget. INSAT communications satellites.

BOOKS FOR STUDY & REFERENCE:

1.Handbook of Electronics by Gupta & Kumar - 2008 Edition

2.Electronic Communication System-George Kennedy & Davis -Tata McGraw Hill 4th edition 19889

3. Taub and schilling, " Principles of Communication Systems" ,Second edition, Tata McGraw Hill (1991)

4. Electronic Communications - Dennis Roddy & Coolen , Prentice Hall of India, IV Edition, 1995

5. Wayne Tomasi, " Advanced electronics communication Systems" ,fourth Edition, Prentice Hall, Inc., (1998)

6. M. Kulakarni, " Microwave and Radar Engineering" , Umesh Publications, 1998.

7. Monochrome and Colour TV - R.R.Gulati.

MATERIALS SYNTHESIS AND CHARACTERIZATION

UNIT - I : Nucleation and Growth

The crystalline state - concept of crystal growth - historical review - Importance of crystal growth - crystal growth theory : classical theory - Gibbs - Thomson equation- kinetic theory of nucleation - Energy of formation of a nucleus - kinetics of thin film formation - Film growth - five stages - Ncleation theories - In corporation of defects and impurities in films - Deposition parameters and grain size - structure oof thin films.

UNIT - II : Growth Techniques

Solution growth technique : low temperature solution growth : solution -Solubility - constant temperature bath an crystallizer - seed preparation and mounting - slow cooling and solvent evaporation methods.

Gel growth technique : Principle - various types - structure of gel - Importance of gel - Experimental procedure - Advantage of gel method.

Melt technique : Bridgman technique - czochralski technique - Experimental arrangement - Growth process.

Vapous technique : physical vapour deposition - chemical vapour deposition (CVD) - chemical vapour transport.

Unit - III: Thin Film Deposition Techniques

Thin films - Introduction to vaccum technology -deposition techniques - physical methods - resistive heating , electron beam cun and laser gun evaporation - sputtering : Reactive sputtering , radio frequency sputtering - chemical methods - spray pyrolsis - preparation of transport conducting oxides.

Unit - IV : Characterization Technique

X-ray Diffraction (XRD) - power and single crystal - fourier transform infrared analysis - FT -Raman analysis - Elemential dispersive x-ray analysis (EDAX) - scanning electron microscopy (SEM) - UV -VIS Spectrometer Vickers micro hardness - Auger emission spectroscopy. Photolumine scene (PL) - UV -Vis -IR spectrometer- AFM- Hall effect - SIMS - X-ray - photoemission spectroscopy (XPS) - dynamic light scattering - ellipsmety method.

Unit - V : Applicaions

Micro electrochemical systems (MEMS) - optoelectronic devices : LED , LASER and solar cell - polymer films - Fabrication and characterization of thin film transistor, capacitor , resistor , inductor and FET - Sensor - quanum dot - Applications of ferromagnetic and super conducting films : Data storage , Giant magneto resistance (GMR).

BOOKS FOR STUDY AND REFERENCE

1.K.Sangawal , Elementary crystal growth - shan publisher , UK ,1994.

2.P.Santhana Ragavan , P.Ramasamy ,Crystal Growth and processes. KRU publications. Kumbakonam(2000).

3.J.C.Brice , Crystal Growth Process , John wiley publications , NewYork (1996).

4.L I Maissel and R clang , Hand book of thin films Technology , Mc Graw - Hill (1970).

5.J.L. Vossen and W.kern ,Thin films process , Academic press ,1978.

6.M.Ohring , The materials science of Thin Films, Academic press , 1992.

7.M.William and D.Steve , Instrumental Methods of analysis (CBS publishers) Newdelhi. (1986).

8.H.H. Williard , L.L. Merritt.Methods, J.Dean, and F.A. Settle , Instrumental methods of analysis - Sixth Edition. Cbs Publishers & distributors, Delhi (1986).

9.R.W.Berry , P.M.Hall and M.T.Harris, Thin Film Technology , Vn Nosrand (1968).

10.A.Goswami , Thin film Fundamentals , New Age International (P) Ltd. Publishers, New Delhi(1996).