PERIYAR UNIVERSITY
SALEM-636 011

M.Sc. DEGREE
Branch-III (B)-PHYSICS
(Choice Based Credit System (CBCS))

REGULATIONS AND SYLLABUS

(Effective from the academic year 2008-2009 and thereafter)

PERIYAR UNIVERSITY, SALEM -636 011

M.Sc. BRANCH III (B) - PHYSICS -CHOICE BASED CREDIT SYSTEM

REGULATIONS AND SYLLABUS

(For the candidates admitted from 2008-2009 onwards)

1. DURATION OF THE PROGRAMME

The two-year postgraduate program in M.Sc. Physics consists of four semesters under Choice Based Credit System.

2. CONDITION FOR ADMISSION

A candidate who has passed B.Sc. Degree Examination in Branch III Physics of this University or an examination of some other university accepted by the syndicate as equivalent thereto shall be permitted to appear and qualify for M.Sc Physics (CBCS) Degree Examination of this university after a course of two academic year in the Department of Physics of Periyar University.

3. DISTRIBUTION OF CREDIT POINTS

The minimum credit requirement for a two- year Master's programme shall be 90 Credits. The break-up of credits for the programme is as follow:

- Core Courses : Minimum 64 credits
- Elective Courses : Minimum 20 credits
- Supportive Courses : Minimum 6 credits
- Self Study courses : 8 credits

  (Optional, not mandatory)

*** ''Human rights"** will be a compulsory non-credit course offered in the semester

4. COURSE OF STUDY

The course of study for the degree shall be in Branch III. (B)-Physics (Choice Based Credit System) with internal assessment according to the syllabus prescribed from time to time

Total Mark : 2000

For Each Paper: 100 Marks (Int.25+Ext.75)

Project : 200 Marks

5. STRUCTURE OF THE COURSE

M.Sc. Branch III. (B) Physics -Choice Based Credit System (CBCS)

SCHEME OF EXAMINATION

Subject Code	Title of the Course	Credits L T P C	Internal Assessment Marks	End Semester Exam Marks	Total Marks
	CORE COURSES				
PHY C01	Mathematical Physics	4 0 0 4	25	75	100
PHY C02	Classical and Statistical Mechanics	4 0 0 4	25	75	100
PHY C03	Semiconductor Electronics		25	75	100
PHY C04	Quantum Mechanics-I		25	75	100
PHY C05	Electromagnetic Theory		25	75	100
PHY C06	Advanced Practical –I (General& Electronics)	0 0 4 4	25	75	100
PHY C07	Quantum Mechanics-II	4 0 0 4	25	75	100
PHY C08	Condensed Matter Physics	4 0 0 4	25	75	100
PHY C09	Spectroscopy	4 0 0 4	25	75	100
PHY C10	Nuclear and Particle Physics	4 0 0 4	25	75	100
PHY C11	Microprocessor and Microcontroller	4 0 0 4	25	75	100
PHY C12	Advanced Practical –II	0 0 4 4	25	75	100
PHY C13	Project	0 0 16			200
	ELECTIVE COURSES				
PHY E01	X- ray Crystallography	5 0 0 5	25	75	100
PHY E02	Crystal growth and Characterization	5 0 0 5	25	75	
PHY E03	Non- linear Dynamics	5 0 0 5	25	75	100
PHY E04	Bio materials Science	5 0 0 5	25	75	100
PHY E05	Nano Science	5 0 0 5	25	75	100
PHY E06	Molecular Biophysics	5 0 0 5	25	75	100
PHY E07	Fibre Optics	5 0 0 5	25	75	100
PHY E08	Instrumental Methods of Analysis	5 0 0 5	25	75	
	SUPPORTIVE COURSES				
PHY S01	Laser and its Application	2 0 0 2	25	75	100
PHY S02	Energy Physics	2 0 0 2	25	75	100
PHY S03	Geo Physics	2 0 0 2	25	75	100
PHY S04	Electronics in Daily Life	2 0 0 2	25	75	100

Note: C- Core Course; E- Elective Course: S-Supportive Course

One elective per semester have to be chosen from among the eight electives.

Two supportive courses have to be chosen from among the four supportive courses, by the other Departments.

6. EXAMINATILION

For the purpose of uniformity, particularly for interdepartmental transfer of credits, there will be a uniform procedure of examination to be adopted by all teachers offering courses. There will be three test and seminars and one End semester examination during each semester.

The distribution of marks between Sessional Evaluation and End Semester examination will be 25%and 75% respectively. The sessional evaluation is distributed to test, seminar and attendance as 15% & 5% and 5% respectively.

a. Sessional Test I will be held during Seventh Week for the Syllabi covered till then.
b. Sessional Test II will be held during Eleventh Week for the Syllabi covered between Eighth and Eleventh Week.
c. Sessional Test III will be held during 16th Week for the syllabi covered between 12^{th} Week and 16^{th} Week. The highest two marks scored of the three sessional Tests will be taken for sessional assessment.

PHY C01 MATHEMATICAL PHYSICS

UNIT - I Vectors Space and Tensors

Vector Space – Definitions - Linear independence of vector – Bilinear and quadratic forms – change of basis - Schmidt's orthogonalisation processes - Schwartz inequality – Application of vector to hydrodynamics the equation of flow in solids.

Tensors – N-dimensional space – superscripts – subscripts – coordinate transformations Kronecker delta symbol - properties of kronecker Generalized kronecker delta Tensors of higher Ranks- Algebric operations of Tensors- symmetric and asymmetric Tensors – Applications of Tensors – Dynamics of a particle – Elasticity – Rigid bodies.

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

Fourier transform - Properties of Fourier's transform - Fourier transform of a derivative – Fourier's sine and cosine transforms of a derivative – Finite Fourier transforms - simple Applications of Fourier transforms – Laplace transforms - Properties of Laplace transforms – Laplace transforms of the derivative of a function – Laplace transforms of integral – Inverse Laplace transform – Properties of inverse Laplace transform – convolution theorem- Application of Laplace transform.

UNIT- III Complex variable

Functions of complex variables- limit – continuity- Differentiability- Analytic function – Cauchy – Riemann condition – differential equation – Cauchy Integral theorem- Cauchy integral formula- Moreva's theorem – Liouville's theorem - Taylors Series-Laurent's series- singularities of an analytical function- Residues- Cauchy Residue theorem- Evaluation of definite integrals- contour integration

UNIT- IV Special function and differential equations

Gamma and Beta functions - Louville problem- solutions for Bessel- Legendre –Lagure and Hermite differential equation – properties- Generating functions- Rodrigue's formula- orthogonal properties- recurrence relation

UNIT- V Dirac delta function and green's function

Direct -Delta function - Three dimensional delta function – Green's function- for one Dimensional case – symmetry properties of green function –Green's function for poison equation – Quantum mechanical scattering problem.

Books for study and reference

(1) L.A. Pipes and Henvil, Applied Mathematical for Engineers and Physics, International Students Edition, Mc Graw Hill Ltd, Singapore (1970).

(2) E.Kreyszig, Advanced Engineers Mathematics, 8th Edition, Wiley, NY (1999)

(3) P.K Chattopadhyay Mathematical Physics, Wiley Eastern Ltd, N. Delhi f(1990).

(4) B.D.Gupta, Mathematical Physics Vikar Publishing House Pvt. Ltd. (1995).

(5) Satyaprakash, Mathematical Physics, Sultan Chand & Sons, New Delhi (2004).

(6) A.K.Ghatak, I.G.Goyal and A.J.Chua, Mathematical Physics, Mc-Millan, New Delhi (1995).

(7) M.D.Greenbey, Advanced Engineering Mathematics, 2nd Edition, Printice-Hall International, NJ (1998).

(8) Charlie Harper, Introduction to Mathematical Physics, Prince-Hall, India Pvt. Ltd. (1993).

(9) S.S.Rajput, Mathematical Physics, Pragati Pragasam, Meerut, 11th Edition (1996).

(10) Murray R.Spiegel, Theory and Problems of Laplace Transforms – Schaum's outline series, McGraw-Hill International Edition (1986).

PHY C02 CLASSICAL AND STATISTICAL MECHANICS

A. CLASSICAL MECHANICS

UNIT- I

Elementary principles: D'Alembert's principle –Lagrange's equation- Hamilton's equation – Lagrangian and Hamiltonian.

Two body central force problem: Equations of motion and fist integrals- kepler's – laws – scattering by central potential – transformation from centre of mass to laboratory frame.

Special relativity in classical mechanics: Relativistic Lagrangian and Hamiltonian for a particle – space - time and energy - momentum four vectors - center of mass system for relativistic particles - invariance of Maxwell's equations.

UNIT- II

Kinematics of rotation: Orthogonal transformations – Euler poles – rotating frames of reference and Coriolis force.

Mechancis of rigid bodies: Angular momentum and kinetic energy – moment of inertia tensor – Euler's equations of motion.

Torque free motion – motion of a symmetrical trop under gravity.

UNIT – III

Canonical transformations: Canonoical transformations and their generators – simple examples – Poisson brackets.

Hamilton Jacobi theory: Hamilton – Jacobi equations – Action angle variables – Application to the Kepler problem.

Small oscillations: Formation of the problem – Transformation to normal co-ordinate – Linear triatomic molecule.

Books for study and reference:

1. H.Golstein, Classical Mechanics, Narosa Publishing House, New Delhi (1985).
2. V.C.Rana and P.S.Joag, Classical Mechanics, Tata McGraw-Hill, New Delhi (1991).
3. Gupta, Kumar and Sharma, Classical Mechanics, Pragati Prakasham, Meerut.
4. Donald T.Greenwood, Classical Mechanics, Printice-Hall of India Private Ltd.,New Delhi (1979).
5.B.D.Gupta and Sathya Prakash, Kedar-nath and Ram-nath, Meerut (1990).

B. STATISTICAL MECHANICS

UNIT –IV

Foundations of statistical Mechanics Phase space — Density of states – Livouville's theorem – Statistical equilibrium – Relation between

statistical and thermo dynamical quantities – Classical ideal gas – Entropy of mixing – Gibb's paradox.
Micro Canonical, Canonical and grand canonical ensembles – Partition function – Relation between partition function and thermo dynamical quantities.

Statistics of systems of independent particles Quantum picture – MB, BE, FD statistics – Limit of applicability of the three distribution laws – Density matrix – Liouville's equation.

MB ideal gas – Maxwell law of distribution of velocities – Equipartition law of energy – Classical real gas – Cluster expansion – Virial equation of state.

UNIT – V

BE and FD Statistics Ideal BE gas – Gas degeneracy – BE condensation - λ transition in He^4 – Theory of super fluidity (London, Tisza and Landau) – Photon gas – Planck's law of radiation – Phonon gas – Einstein and Debye's model for specific heat of solids. Ideal FD gas – Gas degeneracy – Electron gas – Thermionic emission – Pauli's theory of paramagnetism.

Books for study and reference

1. B.K Agarwal and Malvin Einster, Statistical Mechanics, New Age International Publisher's, New Delhi, 2002.
2. B.B.Laud, Fundamendals of Statistical Mechanics , New Age International Publisher's, New Delhi, 2002.
3. Sathya Prakash & Agarwal.J.P, Statistical Mechanics, Kedarnath company, Meerut Seventh Edn.
4. David J.Griffiths, Introduction to Electrodynamics, Printice Hall of India (P)Limited, New Delhi.
5. Kerson Huang Statistical Mechanics, Wiley Eastern Limited, New Delhi, 1986.
6. E.S.R.Gopal, Statistical Mechanics & Properties of matter, The Macmillan Co. of India Ltd.,

PHY C03 SEMICONDUCTOR ELECTRONICS

Unit - I

Junction-Diode characteristics-The open-circuited P-N Junction – The p-n junction as rectifier – The current components in a P-N Diode – The Volt-Ampere characteristic – The temperature dependence of the V/I characteristic- Diode resistance – Space-charge or transition, capacitance $C_{T.}$ Diode circuits – The diode as a circuit element – The load-line concept – The Piecewise linear diode model – Clipping (limiting) circuits – Clipping at two independent levels – Comparators – Sampling gates – Rectifiers.

Unit – II

Transistor Characteristics – The junction Transistor – Transistor current components -The transistor as an amplifier – Transistor construction – The Common-Base configuration – The Common-Emitter configuration – The CE cutoff region – The CE saturation region – Typical transistor-Junction voltage values – CE current gain – Common-Collector configuration – Expressions for characteristics – Maximum voltage – Phototransistor.

Unit - III

The transistor at low frequencies – Graphical analysis of CE configuration – Two port devices – Hybrid Model – h parameters – conversion – Amplifier circuit using h parameters – Thevenin's and Norton's Theorems – The Emitter follower – Comparisons of configurations – Linear analysis – Miller and its Dual theorems – Cascading Amplifiers. Transistor Biasing – The operating point – Bias stability – Self bias, or Emitter bias.

Unit-IV

Multistage Amplifiers – Classification – distortions – Frequency response – Bode Plots Step response – Band Pass – RC coupled – Effect of an Emitter By pass capacitor on low frequency response. Feedback amplifiers – Classification – feedback concept – Transfer gain with feedback – Negative feedback - Characteristics of Amplifier – Method of Analysis – Voltage series.

Unit-V

Linear Analog Systems: Basic Operational Amplifier applications – Differential DC amplifier – Stable AC amplifier – Analog Integration and differentiation. Nonlinear Analog Systems – Comparators – Sample and hold circuits – AD/DA converters – Logarithmic amplifier – Wave form generators - Schmitt Trigger, Digital circuits – Binary operation – The OR, AND, NOT gates – Transistor switching times – INHIBIT operation – X-OR-De Morgan's Laws. Sequential Digital systems – 1-Bit memory-Flip-Flops-Shift registers-Counters and its applications.

Book for study:

1.Millman and Halkias, Integrated Electronics, TMH, New Delhi (1995).
2.Malvino, Electronic principles, TMH, New Delhi (1991)
3.Malvino Leach, Digital Principles and Applications-III Edition, TMH, New Delhi

PHY C04 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 eigenfunctions – 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 order-anharmonic 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 matrix operators – 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 ½ , spin-1, total wave function- addition of angular momenta-Clebsch-Gordan coefficients-spin wave functions for a system of two spin-½ 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; Plenum US 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 Laloë – John Wiley Interscience Publications.
9. Quantum Mechanics – Pauling & Wilson

PHY C05 ELECTROMAGNETIC THEORY

Unit I - Electro Statics

Coulomb's law- Electric field-Gauss' law- Differential form of Gauss' law- surface distributions of charges and dipoles- Poisson and Laplace equations- Green's theorem- Solution of boundary value problem with green's function- Electrostatic potential energy and capacitance.

Unit II - Boundary value problems in Electro Statics

Method of Images- point charge in the presence of a – grounded conducting sphere-charged, insulated, conducting sphere- point charge near a conducting sphere at fixed potential- conducting sphere in a uniform electric field by method of Images- Laplace equations in spherical co-ordinates- multipole expansion- boundary value problems with dielectrics- molecular polarizability and electric susceptibility- electrostatic energy in dielectric media.

Unit III - Magneto Statics

Biot and Savart law- Differential equations of magneto statics and Ampere's law- vector potential- magnetic fields of localized current distribution and magnetic moment- force, torque and energy of a localized current distribution- macroscopic equations and boundary conditions of B and H- methods of solving boundary value problems in magneto statics- uniformly magnetized sphere

Unit IV - Electromagnetics

Faraday's law of induction-Maxwell's equations- vector and scalar potentials- gauge transformation- Lorentz gauge- Coulomb gauge- Poynting's theorem and conservation of energy and momentum- electromagnetic waves- plane electromagnetic waves in a non-conducting medium- linear and circular polarization- reflection and refraction of EM waves- plane interface between dielectrics- cylindrical cavities and wave guides

Books for study and Reference:

1. J.D. Jackson , Classical Electrodynamics, Third Edition, John Wiley (1999)
2. David J. Griffiths, Introduction to Electrodynamics, Prentice-Hall of India, New Delhi (2000)
3. E.C. Jordan and K.G. Balmin, Electromagnetic waves and radiating system, Second edition, Prentice Hall of India (1995)
4. John R. Reits, Fredrick, J. Milford and Robert W. Christy, Foundation of Electromagnetic Theory

PHY C06 ADVANCED PRACTICAL – I

(Any fifteen experiments)

1. Young's Modulus – Elliptical fringes
2. Young's Modulus – Hyperbolic fringes
3. Stefen's Constant
4. B-H loop using Anchor ring
5. Displacement measurements using LVDT
6. Thermistor – Determination of energy gap.
7. Resistance measurement – Hall apparatus
8. Computer Programming – Matrix Multiplication and Division
9. Computer programming – Simpson rule and Trapesoidal rule
10. Regulated and Dual power supply
11. Astable Multivibrator using Operational Amplifier
12. Schmidt's Trigger
13. UJT- Characteristics
14. UJT – Relaxation Oscillator
15. FET – Characteristics
16. Operational Amplifier - Adder, Subtractor, Integrator, Differentiator and Scale changer
17. Universality of NAND gates
18. Half Adder and Full Adder and Half Subractor and Full Subtractor
19. Flip–Flops - RS, JK and D flip-flops.
20. Shift Register

PHY C07 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 – non-resonant scattering-scattering length and effective range– Ramsauer-Townsend 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

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

Books for Reference

1. Quantum Mechanics (5th Edition) – Theory and Applications by A. K. Ghatak and
   Lokanathan ; Macmillan India Ltd Publication
2. Quantum Mechanics – Leonard I. Schiff ; McGraw-Hill International Publication.
3. Quantum Mechanics (3nd Edition)- E. Merzbacher; John Wiley Interscience Publications.
4. Fundamental principles of Quantum mechanics with elementary applications – Edwin C. Kemble
5. Quantum Mechanics –Vol.II – Claude Cohen-Tannoudji, Bernard Diu, Franck Laloë – John wiley Publications.
6. Principle of Quantum Mechanics (2nd Edition) - R. Shankar; Plenum US Publication

PHY C08 CONDENSED MATTER PHYSICS

Unit I Crystal Structure

Crystal classes and Symmetry – 2d, 3d, lattices – Bravais lattices – Symmetry point groups – Plane groups – Space groups – Reciprocal lattice – Ewald's sphere construction – Bragg's law – Systematic absences – Atomic scattering factor – Diffraction – Structure factor – Experimental techniques – Laue, Powder and Rotation methods – Phase problem – Electron density distribution (elementary ideas only). Bonding of common crystal structure – NaCl – CsCl & ZnS, Diamond – hcp, ccp, random stacking and polytypism.

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 – Clausius-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. C. Kittel, *Introduction to Solid State Physics,* 5th Edition Wiley Eastern, New Delhi (1977)
2. N. W. Asherof and N. D. Mermin, *Solid State Physics,* Holt, Rinehart and Winston, International Edition, Philadelphia.
3. J. S. Blakemore, *Solid State Physics*, Second edition Cambridge University press, Cambridge, London (1974)
4. A. J. Dekker, *Solid State Physics*, Mac Millen, Madras (1971)
5. M. M. Woolfson, *An Introduction to X-ray Crystallography,* Vikas publishing Ltd. (1978)
6. Thomas P. Sheahen, *Introduction to High-Temperature Superconductors*, Plenum Press, New York (1994)
7. S. O. Pillai, Solid State Physics, New Age International (p) Ltd, New Delhi (1995)

PHY C09 SPECTROSCOPY

UNIT-I Infrared Spectroscopy

Vibrational study of diatomic molecules – IR rotation – Vibration spectra of gaseous diatomic molecules – simple gaseous polyatomic molecules – vibrational frequencies and qualitative analysis – Quantitative IR analysis – determination of bond length and bond moment – determination of interstellar atoms and molecules – IR spectrometer – elementary ideas of FT-IR.

UNIT-II Raman Spectroscopy

Raman effect – Raman shift – definition – observation of Raman spectra – Raman spectrometer – Quantum theory of Raman effect – probability of energy transition in Raman effect – Vibrational Raman spectra – structure determination from Raman and IR spectroscopy – General features of electronic spectra of diatomic molecules – Franck-Condon principles – electronic states – configuration of some typical molecules.

UNIT – III NMR Spectroscopy

Basic principles of interaction of spin and applied magnetic field (Quantum mechanical description – Concepts of NMR Spectroscopy – concepts of spin-spin and spin lattice. relaxation process – High resolution continuous wave NMR spectrometer – Advantage of FT-NMR – Chemical shift – Spin-spin coupling between two and more nuclei – simple application to structural determinations

UNIT – IV ESR Spectroscopy

Origin of electron spin resonance and resonance condition – quantum mechanical theory of ESR – design of ESR spectrometer – Hyperfine structure study – ESR study of anisotropic systems – Triplet states study of ESR – application of ESR to solid state physics (Crystal defects and Biological studies)

UNIT –V NQR and Mossbauer Spectroscopy

General principles of NQR – energy levels of quadruple transitions for half-integral spins – design of NQR Spectrometer – Application of NQR (Molecular Structure).

Principle of Mossbauer effect – Schematic arrangement of Mossbauer spectrometer – Isomer shift – Quadruple interaction – magnetic hyperfine interactions – applications of Mossbauer spectroscopy (Biological applications)

Books for Study and Reference:

1.C.N.Banwell, Fundamentals of Molecular Spectroscopy, Tata Mc Graw Hill (1972)

2. B.P.Straughan and Walkar.S, Spectroscopy Vol.2, Chapman & Hall (1976)

3 Atta-Ur-Rahman, Nuclear Magnetic Resonance, Springer Verlag (1986)

4 E.Wertz and R.Bolton, Electron Spin Resonance, Chapman and Hall Co.,NY(2000)
5 B.P.Straughan and Walkar.Spectroscopy Vol.1, Chapman & Hall (1976)
6 N.N.Green wood & T.C.Gibb., Mossbauer Spectroscopy, Chapman & Hall (1971)
7. T.P.Das and E.L.Hehn., NMR spectroscopy, Academic press (1958)
8.EPR Elementary theory and Practical applications – J.E.Wertz and J.R.Boulton.Mc Graw Hill – 1972.
9.W.T.Dixon, Theory and Interpretation of Magnetic resonance spectra, Plenum press (1972)
10.Norman B.Colthup, Lawrence H.Daly & Stephen E. Wiberly, Introduction to IR andRaman Spectroscopy, Academic press.
11.D.A.Long, Raman Spectroscopy, Mc Graw Hill – International Book Company

PHY C10 NUCLEAR AND PARTICLE PHYSICS

Unit 1 Nuclear Structure

Nuclear radius, charge distribution, spin and magnetic moment – Determination of nuclear mass – Binding energy – Semiempirical mass formula – Nuclear stability – Mass parabolas – Nuclear shell model – Liquid drop model – Optical model – Collective model

Nuclear Forces

Exchange forces – Yukawa's meson theory – Yukuwa potential – Ground state of deuteron – Magnetic moment – Tensor forces – Scattering length, Phase shift, scattering amplitude – Low energy n-p scattering – Effective range – Spin dependence and charge independence of nuclear forces

Unit II Radioactive Decays

Alpha decay – Garmow's theory – Geiger Nuttal law – Neutrino hypothesis – Fermi's theory of beta decay – Selection rules – Non conservation of parity in beta decay – Gamma decay - Selection rules – Internal conversion – Nuclear isomerism.

Detection of Nuclear Radiation

Interaction of charged particles and X-rays with matter – Basic principles of particle detectors – Proportional counters and Geiger-Muller counters – BF3 counters – Solid state and semiconductor detectors – Scintillation counters.

Unit III Nuclear Fission

Characteristics of fission – Mass and energy distribution of nuclear fragments – Nuclear chain reactions – Four factor formula – Bohr Wheeler's theory of nuclear fission – Fission reactors – Power and breeder type reactors.

Nuclear Fussion Basic fusion processes – Solar fusion – Cold fusion – Controlled thermonuclear reactions – Pinch effects – Laser fusion techniques.

Unit IV Nuclear Reactions

Energetics of reactions – Q-equation – Level widths in nuclear reaction – Nuclear reaction cross sections – Partial wave analysis – Compound nucleus model – Resonance scattering – Breit Wigner one level formula – Direct reactions – Stripping and pick up reactions.

Scattering Process

The scattering cross section – scattering amplitude – Expression in terms of Green's function – Born approximation and its validity – Screened Coulomb potential – Alpha particle scattering – Rutherford's formula.

Unit V Elementary Particles

Four types of interactions and classifications of elementary particles – Isospin – Isospin quantum numbers – Strangeness and hyper charge – Hadrons – Baryons – Leptons – Invariance principles and symmetries – Invariance under chage-parity(CP), time(T) and CPT – CP violation in neutral K-meson decay – Quark model – SU(3) symmetry – Gell-Mann-

Nishijma formula – Gauge theory of weak and strong interactions – Charm, bottom and top quarks.

Books for study and Reference:

1.R.R.Roy and B.P.Nigam, Nuclear Physics, Wiley Eastern Ltd., New Delhi (1986)
2.B.L.Cohen, Concepts of Nuclear Physics, Tata McGraw Hill, New Delhi (1983)
3.H.A.Enge, Introduction to Nuclear Physics, Addision Wesley, New York (1971)
4.H.Semat, Introduction to Atomic and Nuclear Physics, Chapman and Hall, New Delhi,
(1983)
5.D.Griffiths, Introduction to Elementary particles, Wiley International Edition, New
York (1987)
6.W.S.C.Williams, Nuclear and Particle Physics, Clarendon Press, London (1981)
7.K.S.Krane, Introductory Nuclear Physics, John Wiley, New York (1987)
8.K.S.Krane, Modern Physics, John Wiley and Sons, Inc, New York (1988)

PHY C11 MICROPROCESSORS AND MICROCONTROLLER

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 set 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 8086

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 loop 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 Mc Graw Hill Company, II edition.
2. Ramesh S.Gaonkar, Microprocessor Architecture, Programming and Application with 8085,Wiley Eastern.
3. Douglas V.Hall, Microprocessors and Interfaces, Tata Mc Graw Hill Company.

4. Aditya P.Mathur , Introduction to Microprocessors, Tata Mc Graw 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.

PHY C12 ADVANCED PRACTICAL II

(Any 10 experiments)

Microprocessor based Experiments:

1. 16-bit Addition, Subtraction, Multiplication and Division using - 8085
2. (i) BCD to Binary (ii) Binary to BCD (iii) ASCII to HEX (iv) HEX to ASCII
3. Arranging numbers in Ascending and Descending order
4. Determination of *n* factorial and biggest and smallest of *n*
5. Temperature conversion
6. Wave form generator
7. Digital clock
8. Traffic light controller
9. Temperature controller
10. A/D converter
11. Stepper motor control
12. Display flash and delay of message

Microcontroller based Experiments

13. Code-conversion using 8051 Microcontroller
14. Microcontroller array operations
15. Microcontroller arithmetic operation

PHY C13 PROJECT WORK

(Topics to be decided by Student/Supervisor)

PHY E01 X-RAY CRYSTALLOGRAPHY

Unit –I X-ray Sources

Origin of X-rays – conventional generators-construction and geometry-sealed tube-rotating anode generator-choice of radiation-Synchrotron radiation – X-ray optics: filters - monochromators -collimators-mirrors-safety.

Diffraction of X-rays

Lattice-Lattice planes-Miller indices - X-ray diffraction reciprocal lattice – relation between direct and reciprocal space - Bragg's law in reciprocal lattice – sphere of reflection – limiting sphere.

Symmetry of crystals

Crystal systems and symmetry – unit cell – space lattices- nonprimitive lattices – point groups–space groups –screw axes-glide planes-equivalent positions-matrix representation of symmetry-intensity weighted reciprocal lattice – analysis of space group symbols.

Crystals and their properties

Crystallization – growing crystals – choosing a crystals –mosaic structure-absorption- crystal mounting- alignment – measurement of crystal properties.

Unit-II Data collection techniques for single crystals

Laue method- single crystal diffraction cameras: rotation and Oscillation method – Ewald construction – Weissenberg method – Precession method. Single crystal diffractometers: Instrument geometry-crystal in a diffracting position – Data collection strategy: determination of unit cell –orientation matrix - Intensity Data collection - Unique data –equivalent reflections – selection of data - Intensity measurement methods: Film methods - counter methods : Point detector - Area detectors –CCD's – Image plates - Low temperature single crystal diffractometry.

Unit-III Data Reduction

Integration of intensity-Lorenz and Polarization corrections – absorption – deterioration or radiation damage-scaling – Interpretation of Intensity data.

Structure factors and Fourier syntheses

Structure factor – Friedel's Law – exponential and vector form – generalized structure factor – Fourier synthesis –Fast Fourier transform – Anomalous scattering and its effects.Calculation of structure factors and Fourier syntheses.

Unit-IV Phase Problem

Methods of solving Phase Problem: Direct methods – Patterson methods – Heavy atom methods – molecular replacement-search methods – completing the structure -

Unit-V Refinement of crystal structures

Weighting – Refinement by Fourier syntheses – Locating Hydrogen atoms-identification of atom types – least squares – goodness –of-fit –least square

and matrices-correlation coefficients- Relationship between Fourier and Least squares – Practical consideration in least squares methods.

Random and systematic errors

Random errors: Probability plots – Esd from Fourier and least squares refinement- standard deviation and the model- Systematic errors: absorption-extinction – diffuse scattering- errors in scattering factors – rotary oscillation

Derived results

Molecular geometry –Bond lengths – bond angles - their standard deviations – least squares planes – absolute configuration – thermal motion.

Books for study

1. X-ray Structure Determination (2nd Edition) - Stout and Jensen – John Wiley Publications.
2. Fundamentals of Crystallography –(2nd Edition)- C. Giacovazzo- Oxford Press.
3. Structure Determination by X-ray Crystallography (2nd Edition)- Ladd and Palmer

Books for Reference

1. Woolfson – X-ray Crystallography – Cambridge University Press
2. Elements of X-ray crystallography – Leonid V.Azaroff- McGraw-Hill Publications
3. Crystal Structure analysis for Chemist and Biologist – Glusker, Lewis and Rossi- VCH Publishers Inc.
4. Crystal, X-ray and Proteins - Sherwood, Longman group Ltd, London, 1976.
5. An Introduction to crystallography – Phillips.

PHY E02 CRYSTAL GROWTH AND CHARACTERIZATION

Unit I Crystal Growth Theory

Phase equilibria -Single component system - component system - Simple eutectic - Peritectic - Binary compounds with congruent melting - Solid solutions - Solid-liquid and liquid - vapour equilibria. Nucleation concept - Kinds of nucleation - Homogeneous nucleation - Equilibrium stability and metastable state - Classical theory of nucleation - Gibbs-Thomson equation –Kinetic theory of nucleation - Energy of formation of a nucleus - Statistical theory of nucleation - Free energy of formation of nucleus considering translation, vibration and rotation energies.

Unit II Solution Growth

Growth of crystals from solutions - solvents and solutions - solubility - preparation of a solution - saturation and supersaturation - Measurement of supersaturation - Expression for supersaturation - Low temperature solution growth - Slow cooling method - Mason-jar method - Evaporation method -Temperature gradient method - Electro crystallization. Crystal growth in gels - Growth of biological crystals - Crystal growth by hydrothermal method.

Unit III Melt Growth

Growth of crystal from melt - Bridgman method - Kyropolous method - Czochralski method-Verneuil method - Zone melting method - LEC growth of III - V materials -

Growth of oxide materials. Growth of crystal from flux - Slow cooling method - Temperature difference method - High pressure method - Solvent evaporation method - Top seeded solution growth - Growth of superconducting single crystal.

Unit IV Vapor Growth and Epitaxy

Methods of vapour phase growth – Physical Vapor Transport (PVT) – Physical Vapor Deposition (PVD) – Chemical Vapor Deposition (CVD) – Chemical Vapour Transport (CVT) – reaction types - thermodynamics, kinetics - transport processes - Thermodynamics of Chemical vapor deposition process – physical, thermo – chemical factors affecting growth process.

Epitaxy - Vapour phase epitaxy (VPE)- Liquid phase epitaxy (LPE) - Molecular Beam Epitaxy (MBE) - Atomic layer Epitaxy (ALE) - Electroepitaxy - Metalorganic Vapour Phase Epitaxy (MOVPE)- Chemical Beam Epitaxy (CBE).

Unit V Characterization methods

Characterization of grown crystals - X-ray Laue, powder diffraction and oscillation photographs - ESCA - SEM and EPMA studies - TGA and DTA to analyses thermal properties - Infrared spectroscopy - Spectrophotometers - Fourier Transforms Interferometer - Sample

handling. Raman spectroscopy - Theory - Resonance Raman Spectroscopy - Comparison of Raman with Infrared Spectroscopy.

Books for Study and Reference

1. K.Sangwal, Elementary Crystal Growth - Saaan Publiser, UK, 1994.
2. M.M. Faktor, I.Garret, Growth of Crystals from Vapor, Chapmann and Hall, 1988
3. P. Santhana Ragavan, P.Ramasamy, Crystal Growth And Processes, KRU Publications, Kumbakonam, 2000
4. P.Ramasamy, ISTE Summer school Lecture Notes, Crystal Growth Centre, Anna University, Chennai, 1991.
5. J.C.Brice, Crystal Growth Process, John Wiley publications,New York,1996
6. A.A.Chernov, Modern crystallography:III,- Crystal Growthin solid state, Springer Series New York, 1984.
7. B.R. Pamplin, Progress in Crystal Growth Characterization, Pergamon Press Ltd.(UK)
8. X.F. Zong, Y.Y. Wang, J. Chen, Material and Process Characterization for VLSI, World scientific, New Jersey, 1988

PHY E03 NONLINEAR DYNAMICS

Unit I Introduction to Nonlinear Dynamical Systems The notion of nonlinearity- superposition principle and its validity- linear and nonlinear oscillators- autonomous and nonautonomous systems- equilibrium points- phase space- classification of equilibrium points.

Unit II Chaos Simple bifurcations- the logistic map- period doubling phenomenon- onset of chaos- bifurcation scenario in Duffing oscillator- chaos in conservative systems: Poincare surface of section- Henon-Heiles systems- Lyapunov exponents

Unit III Solitons Nonlinear dispersive systems – Cnoidal and solitary waves- the Scott Russel phenomenon and K-dV equation- Fermi-Pasta-Ulam numerical experiment- Numerical experiment of Zabusky and Kruskal- birth of soliton

Unit IV Integrability and methods to solve soliton equations The notion of Integrability – Painleve′ analysis- Lax pair- Inverse Scattering Transform method-Bilinearization procedure- examples- Korteweg- de –Vries- Nonlinear Schrödinger equations

Unit V Applications – Chaos and secure communications- soliton in condensed matter system- non linear optics and biological systems.

Books for Study and Reference

1. M. Lakshmanan and S. Rajasekar, Nonlinear Dynamics: Integrability Chaos and Patterns , Springer-Verlag, Berlin, 2003.
2. P. G. Drazin, Nonlinear Systems, Cambridge University Press, Cambridge, 1992.
3. P.G. Drazin and R.S. Johnson, Solitons: An introduction Cambridge University Press, Cambridge, 1989.
4. M.J. Ablowitz and P.A. Clarkson, Solitons, Nonlinear Evolution Equations and Inverse Scattering, Cambridge University Press, Cambridge, 1991.

PHY E04 BIOMATERIALS SCIENCE

Unit I

Crystal Growth from solution - Driving force for crystallization - solubility in biological fluids - Growth kinetics - Nucleation - Diffusion effects - Dissolution - Morphology in vivo & Invitro studies -Crystals responsible for the crystal deposition diseases – Mono sodium urate monohyrate - Calcium pyrophosphate dihydrate - Cholesterol - Steroids - Discalcium phosphate dihydrate - Hydroxy apatite - Calcium oxalate - Calcium hydrogen phosphate dihydrate - Lithium heparin crystals.

Unit II

Crystals and joint diseases: Crystal depositon diseases - Deposition of crystals in joints - Crystals induced damage to joints - Crystals and its environment - Mechanism of crystals formation - Induced joint diseases - Actute inflammatory response - Protein binding - Causes for the initiation and termination for the acture inflammation - Chronic inflammation and fibrosis - Destruction of articular cartilage and bone – Gout - Introduction - History - Metabolism of uric acid - hyperuricaemia - Crystallization of urate - Gout crystal - monosdium urate monohydrate - Pathology of gout - Unanswered question regarding gout - Other purine disorders associated with crystals.

Unit III

Calcium pyrophosphate dihydrate deposition - Introduction - Pyrophosphate deposition - Metabolism of inorganic pyrophosphate - Crystallization of calcium pyrophosphate dihydrate - Conditions associated with the deposition of calcium pyrophosphate dihydrate crystals - Chronic destructive arthritis - Unanswered questions - Diseases of calcium phosphate deposition:

Unit IV

Introduction - Crystallization of hydroxy appatite - Hydroxy apatite deposition and joints - Relationship between the apatite deposition and osteoarthritis - Other calcium phosphate Miscellaneous crystals and particles - Crystals deposited in synovial joints - Extrinsic crystals and particles found in synovial joints.

Unit V

Steroids - The chemistry of sterols - Analysis of steroids and related steroids - steroids in biological membrances cholesterol and atherosclerosis - sterol storatge diseases - cholesterol gallstones: Plasma cholesterol in liver disease - solubilization of cholesterol - conditions required for the formation of stones - Bile supersaturated with cholesterol - Origin of biliary lipids - The pathogenesis of supersaturated bile - Secretion rates of biliary lipids - Effect of removing the gallibladder - Medical treatment of gallstones - Dissolution of cholesterol stones by chenodeoxycholic acid - Experimental gallstones in animals - Plasma

lipids - lipoproteins - the cause of hypercholesterolaemia - Lipid composition of blood cells - Xanthomas in biliary obstruction - parenchymatous liver disease.

Books for Study and Reference

1. N.B.Myant The biology of cholesterol and related steroids, William Heinemann
   Medical Books Ltd, London, 1981.
2. Paul Dieppe & Paul Calvert, Crystals & Joint disease, Chapman and Hall Ltd, London, 1983.
3. Sujata V. Bhat, Biomaterials, Narosa Publising House, New Delhi,2002
4. Albert L.Lehninger, Principles of Biochemistry, CBS, Publishers, India, 1984.
5. Brain R. Pamlin, Inorganic Biological Crystal Growth, Pergamon Press Ltd., UK, 1988
6. A. Ducruix and R.Giege, Crystallization of Nucleic Acids and Proteins A Practical Approach, Oxford University Press, England, 1992

PHY E05 NANOSCIENCE

Unit I

Introduction to the Nanoworld: Introduction – Historical perspective on Nanomaterial - Classification of Nanomaterials – nanorods- nanotubes- nanoparticles - Nanobiotechnology.

Unit II

Metals, Semiconductors and Ceramics Nanocrystals Reduction of size – Synthesis of metal nanoparticles and structures – Routes to arrangements – Background on Quantum Dot semiconductors - background on reverse Micellar solution – Synthesis of Semiconductors – Cadmium Telluride Nanocrystals – Cadmium sulfide Nanocrystals – Alloy Semiconductors – 2D and 3D Superlattices of Silver Sulfide Nanocrystals – Synthesis of Ceramics – Bondings and defects - Chemical, Physical and Mechanical properties of Ceramics.

Unit III

Nanoparticles and Magnetism Magnetism in particles of reduced size and dimensions – variations of magnetic moment with size – magnetism in clusters of non magnetic solids – magnetic behavior of small particles – diluted magnetic semiconductors (DMS) – Fe – DMS and IV-VI Mn DMS and their applications – intermetallic compounds – binary and ternaries and their magnetic properties. Importance of nanoscale magnetism.

Unit IV

Chemical and Catalytic Aspects of Nanocrystals Nanomaterials in Catalysis – Nanostructured Adsorbents – Nanoparticles as new Chemical reagents – Nanocrystal Superlattices.

Specific Heats and Melting Points of Nanocrystalline Materials: Specific Heat of Nanocrystalline materials – melting points of Nanoparticle materials.

Unit V

Application of Nanotechnology: Structural and Mechanical materials – Colorants and Pigments – Carbon Nano tubes - Applications – Electronics and magnetic applications- Nano-lithography. Nanobiotechnology – DNA – Chips, DNA array devices, Drug delivery systems**.**

Books for study and reference

1. Kenneth J.Klabunde, Nanoscale materials in Chemistry, A John Wiley & Sons, Inc.,Publication, 2001.
2. J.de Jongh, Physics and Chemistry of Metal Cluster Compounds, Kluwer Academic Publishers, Dordrecht, 1994.
3. V. Henrich, P.A.Cox, Metal Oxides, Cambridge University Press, New York, 1994.

4. Ed. George C. Hadjipanyis and Gary A.Prinz, NATO ASI Series, Science and Technology of Nanostructured Magnetic Materials, Plenum Press, New York, 1991.
5. D. Jiles, Introduction to Magnetism and Magnetic Materials, Chapman and Hall, London, 1991.
6. Christof M. Niemeyer, Chad A. Mirkin, Nanobiotechnology: Concepts, Applications and Perspectives, 2004.

PHY E06 MOLECULAR BIOPHYSICS

Unit-I Cell: Its organelles and molecules

Basic structure of prokaryotic and eukaryotic cells–mitochondiria and the generation of ATP–Chemical composition of living systems – molecular components of cell – chemical structure of carbohydrate–Lipids-proteins–Nucleic acids–hetromacromolecules.

Molecular interactions

Molecular forces–forces hold macrmolecules together–intermolecular weak forces-van der waals-inductive force-dispersion force-Lenard-Jones potential-hydrogen bond – hydrophobic forces-acid, bases and pH, pK, pl and buffering.

Unit-II Macromolecular Structure

Nucleic acid structure–conformation of monomers and polymers–double helical structure of DNA–polymorphism of DNA–DNA super coiling – structure of transfer RNA.

Protein structure–amino acids–primary structure–peptide bond–secondary structure – α-helix and β-sheet-tertiary and quaternary structure – Virus structure.

Unit-III X-ray Protein Crystallography

Crystals and symmetries–crystal system–Pont groups–space groups–Preparing Protein samples – protein crystal growth–X-ray sources–diffraction–data collection and data reduction–computational techniques–Phase problem–Patterson function–Fourier technique–Isomorpous replacement –molecular replacement–Anomalous scattering – refinement–fitting maps.

Unit-IV Physics of Bio-membranes and Enzymes

Cell membrane –structure of cell membrane – membrane asymmetry – transport through membrane – active transport–Passive transport–transport of charged particles.

Enzymes: Chemical Kinetics and catalysis – Enzymatic reactions–Chemical aspect of enzymatic action–conformation of enzyme–Physics of enzyme-substrate interactions.

Unit-V

Molecular thermodynamics

Equilibrium thermodynamics – near equilibrium thermodynamics- Gibbs free energy – chemical potential – thermodynamic analysis of membrane transport – phase equilibrium – irreversible thermodynamics.

Molecular mechanism of genetic information transfer

Genetic code – transmission of genetic information – molecular mechanism of Protein synthesis-transcription – translation – recognition of Amino acids – Protein Biosynthesis-principle of molecular recognition – intercellular interaction.

Books for study

1. Molecular Biophysics –Structure in motion- M. Duane; Oxford University Press.
2. Introduction to Molecular Biophysics – J. A. Tuszynski and M. Kurzynski;
   CRC Press Publications
3. Principles of Physical Biochemistry- K.E. Van Holde, N.C. John and P.S. Ho
   Prentice Hall Publications
4. Biophysics – M. V. Volkenshtein ; Mir Publications , Moscow.
5. Biophysical Chemistry
   Part I. The conformation of Biological macromolecules.
   Part II.Techniques for the study of biological structure and function.
   Part III.The behavior of biological macromolecules; C. R. Cantor and P.R. Schimmel; Publications W. H. Freeman
6. Practical Protein Crystallography- Duncan E. McRee- Academic Press
   Publications.

Books for Reference

1. Biophysics An Introduction – Rodney M. J. Cotterill; John Wiley Publication
2. Biophysics – Vasantha Pattabhi and N.Gautham; Narosa Publishing House
3. Biophysics – Roland Glacer; Pringer Publications
4. Elementary Biophysics An Introduction – P. K. Srivastava ; Narosa Publishing House.

PHY E07 FIBRE OPTICS

UNIT-I

Physics of light:- Geometrical Optics - Speed of light - law of reflection - law of refraction - dispersion. Wave/Physical optics - amplitude – Wavelength - frequency and velocity - phase and coherence - electromagnetic wave – interference – Diffraction –Polarization - Double refraction. Quantum Optics - probability density of states - atomic spectra - energy levels - lasers and holography (basic ideas only).

UNIT-II

Nature of Optical fibre:– manufacturing - advantages and disadvantages - light sources for optical fibres - light emitting diodes - semiconductor lasers - operational parameters - operational setups - fibre jargon - telephone communications - computer network - cable television - fibre optic system examples.

UNIT-III

Light propagation:- ray propagation - geometrical optics model - fibre modes - physical optics model - skew rays – alternative paths – characteristics of light. Types of optical fibres – losses – attenuation – dispersion.

UNIT-IV

Optical fibre measurement and testing:- Equipment used in field testing: optical power meter – cutback method – insertion loss – Optical Time Domain Reflectometers (OTDR) analysis. Lab measurement techniques: loss due to absorption and scattering – dispersion – core/cladding diameter – index of refractive profile – numerical aperture.

UNIT-V

Operation of devices:– general theory – characteristics – common detector designs – detector circuitry and devices – splices – connectors – cables – couplers and switches – wavelength division multiplexer – fundamentals of communications.

Books for study and Reference

1. Allen H. Cherin: An introduction to Optical fibers, New York: McGraw-Hill (1983)
2. Christian Hentshel: Fiber Optics Handbook, Hewlett – Packard (1984)
3. John M.Senior: Optical fibre communications – Principles and Practice. Prentice Hall International (1985)
4. Donald J.Sterling: Technician's Guide to fibre Optics, Albany, NY Delmar Publishers Inc. (1987)
5. Henry Zanger and Cynthia Zanger: Fibre Optics – communications and other applications, Merrill/Prentice hall (1991)
6. Allen shotwell: An Introduction to Fiber Optics, Prentice- Hall of India private limited, New Delhi (2004)

PHY E08 INSTRUMENTAL METHODS OF ANALYSES

Unit 1 Errors and Analysis of Experimental Data

Types of errors – Mean, variance and standard deviation, standard deviation of standard deviation – sampling techniques – Chi square test.

Experimental Stress Analysis: Stress analysis by strain gauging- high temperature strain gauge techniques – photoelasticity and holography.

Unit 2 Thermal Analysis

Introduction – thermo gravimetric analysis – instrumentation of weight loss and decomposition products – differential scanning calorimetric – instrumentation – specific heat capacity measurements – determination of thermo chemical parameters – differential thermal analysis – basic principles – melting point determination and analysis.

Unit 3 X-ray Analysis

Single Crystal and powder diffraction – Diffractometer – interpretation of diffraction patterns – indexing – unknown and phase identification – double and four crystal Diffractometer for epitaxial characterization – lattice mismatch – tetragonal distortion – thin film characterization – X-ray fluorescence spectroscopy – uses.

Unit 4 Optical Methods and Electron Microscopy

Photoluminescence – light-matter interaction – fundamental transitions – excitons – instrumentation – electroluminescence – instrumentation – photo reflectance-electronic transitions – behavior of electronic transitions as a function of electric field. Principles of SEM, TEM, EDAX, AFM, EPMA – Instrumentation – sample preparation – analysis of materials – study of dislocations – ion implantation – uses – Nanolithogrphy.

Unit 5 Electrical Methods

Hall Effect – carrier density – resistivity – two probe and four probe methods – scattering mechanism – van der pauw method – CV characteristics – Schottky barrier capacitance – impurity concentration – electrochemical CV profiling – limitations

Books for study and Reference

1. Willard.M, Steve.D, Instrumental Methods of Analysis, CBS Publishers, New Delhi, 1986
2. Stradling, R.A, Electron Microscopy and Microanalysis of Crystalline materials, Applied Science Publishers, London, 1979
3. Belk.J.A, Electron microscopy and Microanalysis of Crystalline Materials, Applied Science Publishers, London, 1979.
4. Philips V.A, Modern Metallographic Techniques and their Applications, Wiley Interscience, 1971.

PHY S01 LASER PHYSICS AND ITS APPLICATIONS

Unit – I

Basic Physics on the Operation of Lasers

Einstein's theory – Interaction of radiation with matter – Theory of some simple processes.

Unit – II

Laser Characteristics

Gaussian beam and its properties

Stable two mirror optical resonators, Longitudinal and Transverse Modes of Laser cavity – Mode selection - gain in a Regenerative Laser cavity – Threshold for 3 and 4 level laser systems – Q Switching Mode locking pulse shortening _ Pico second & femto second operation – Spectral narrowing and stabilization.

Unit – III

Laser Systems

Laser systems involving low density gain media – Nitrogen Laser, Carbondioxide Laser and Eximer laser. Laser systems involving high density gain media – Ruby Laser, Nd-Yag Laser, Semiconductor Laser, Diode Pumped solid state Laser, Dye Laser High power semiconductor diode Laser systems.

Unit – IV

Laser Spectroscopic Techniques and other Applications

Laser fluorescence and Raman scattering and their use in Pollution studies, Non-linear interaction of light with matter, Laser induced multi photon processes and their applications, Ultra high resolution spectroscopy with laser and its applications, Propagation of light in a medium with variable refractive index, Optical Fibres. Light wave communication. Qualitative treatment of medical and Engineering applications of Lasers.

Unit-V

Meteorological Application:

Distance and range measurement – Lidar for range findings and tracking – pulsed laser sources – Configuvation of a pulsed range finder – Range finding equation – Energy and power relation – signal detectalsility – Switched lidars , Satellite and Lunar Range finders.

Books for study and Reference

1. Grazio Svelto, Principle of Lasers, Plemum Press, New York (1989).
2. William Silfvast, Laser Fundamentals, Cambridge University Press, London (1996).
3. B.B.Laud, Lasers and Non-linear Optics, Wiley Eastern Ltd., New Delhi (1991).
4. Lengyel, Lasers, Wiley Inter Science, New York1(1971).
5. Ghatak and Thyagarajan, Lasers.

PHY S02 **ENERGY PHYSICS**

Unit I

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

Solar radiation and its measurements: Solar constant – solar radiation at the Earth's surface – solar radiation Geometry – solar radiation measurements – solar radiation data – estimation of average solar radiation – solar radiation of tilted surfaces.

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 voltaics – 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 – schemes 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, Mc Graw Hill Pub.,
2. A.B.Meinel and A.P.Meinel, 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.

PHY SO3 GEOPHYTSICS SYLLABUS

UNIT – I ORIGIN OF EARTH :
Petrology – Evolution and composition of earth – Major subdivisions of earth's Sphere – Atmosphere – Hydrosphere – Lithosphere – Interior of earth – Composition of earth crust - Relative abundance of earth's crust,

UNIT – II GEOMAGNETISM:
Origin of earth's magnetism – elements of earth's magnetic field – inclination, declanation and dib- earth's magnetic field – Diurnal, annual and secular variations – magnetosphere.

UNIT – III EISMOLOGY:
Basic principles of elasticity and wave motion – primary wave (P-waves) and elasticity wave (S-wave) – density within the earth – pressure distribution – variation of 'g' and elastic constants - earth quakes – Elementary ideas about Ritter's scale.

UNIT – IV GEO – THERMAL EFFECT:
Fundamentals concept of Thermal conductivity – heat flow measurement of on ground level and ocean – heat flow gravity variation – temperature of the primitive earth – inner core – melting point – adiabatic temperature gradient.

UNIT – V GRAVIMETRY:
Fundamental concepts of gravitational filed – gravitational anomalies – use of gravitational anomalies in geophysical prospecting – petroleum and mineral survey – factors affecting gravitational field due to magnetic stroms and cosmic ray showers -
Mammond and Faller method of absolute gravity measurement – princible and working.

BOOKS FOR REFERENCES AND STUDY:

1. Pedology – Concept and applications – J.SEHGAL
   Kalyani publishers, 4863/2B, Bharat Ram Rode , 24, Daryaganj, New Delhi – 110 002
2. Introduction to, geophysics (mantle, core and crust)- George G. Garland, W.B.Saunder's company – Philadelphia – London and Toranto.
3. Physics and Geology – Jacobbs ,Russel and Wilson – International Students Edition, Tata McGraw Hill , New Delhi
4. Rock Magnetism – Nagata – McGraw Hill Publications, New Delhi
5. Geology – Debrin – McGraw Hill Publications , New Delhi.
6. Physics and Geology n- A.J.Aitken – tata McGraw Hill – Publications, New Delhi.
7. Bio – graphy of the earth (Its past , present and future) – George Gamove - Macmillon company Ltd , Canada

PHY SO4 **ELECTRONICS IN DAILY LIFE**

UNIT – I

Electrical and Electronic Symbols Resistors – Capacitors – Resistance wale – Capacitor wale – Electrical quantities – Electrical formulas – Magnetism – Meters – Fuse wire Transistors – Integrated chips

UNIT – II Electrical appliances

Switch board – Main box – Metal circuit breakers (MCB) – AC – DC currents – Two Phase – Three Phase electrical connections – generators – un intrepid power supply (UPS)- stabilizer – voltage regulators – Electrical devices – Iron box – Fan – Electrical Oven – water Heaters Air conditioners – Refrigerators – washing machines

UNIT – III Electronic home appliances

Radio – Audio taper veaulem, speaker- televisions – VCR – CD Players – DVD – calculators – Computers – scanner – Printer – Digital Camera – LCD Projectors – Display devices

UNIT – IV Communications Electronics

Principles of optical fiber Cables (OFC) – Telephone – Mobile phones – wire less phone - Antenna - Internet - Intranet

UNIT - V Safety Mechanisem

Handling Electrical appliances - Power saving methods - Hazards Prevention Methods - Protection of Hi –Fi- electronic devices

Book for Study:

(1) S.S. Kamble – Electronics and Mathematics
Data book – Allied publishers Ltd – 1997