BHARATHIAR UNIVERSITYU : COIMBATORE-46
DEPARTMENT OF PHYSICS

PART – I M.Phil. / Ph.D. – PHYSICS

(Syllabus Effective from the academic year 2008 – 2009 onwards)

PART- 1 SYLLABUS

PAPER – 1 - **Teaching Techniques/ Pedagogical methods in Physics**

PAPER - 2 - **Research Methodology and Trends in Physics**

PAPER - 3 - **1. Solid state Electronics**

2. Solar Energy and its Utilization

3. Molecular Physics

4. Plasma Physics

5. Thin Film Technology

6. Solid States Ionics

7. Molecular Quantum Mechanics

8. Nuclear Physics

9. Principles and Methods of Crystal Growth

10. Physics of Nonomaterials and devices

11. Nonlinear Dynamics

PAPER – I - Teaching Techniques/ Pedagogical Methods in PHYSICS

Unit – I

Maxwell's equations: – Magnetic field of a spherically symmetric current – A travelling field – The speed of light – Solving Maxwell's equations; the potentials and wave equation – Maxwell's equations for waves in free space, plane waves – Three dimensional waves – Spherical waves - Maxwell's equations for light and electromagnetic waves – Spherical waves from a point source – The fields of an oscillating dipole – The potentials of a moving charge – The potentials for a moving charge with constant velocity

Unit – II

Quantum behavior: Atomic mechanics – An experiment with bullets, waves and electrons – The interference of electron waves – Probability wave amplitudes – The laws of combining amplitudes – Scattering from crystal – The scattering electrons with parallel and anti-parallel spin - Schrödinger's equation in a magnetic field – The equation of continuity for probabilities – Two types of momentum – The meaning of the wave function – Superconductivity – The Meissner effect – Flux quantization – The dynamics of superconductivity

Unit – III

Ordinay differential equations: Runge Kutta IV order method for first order differential equation – RK4 method for simultaneous first order differential equations – RK4 method for second order differential equation – Milne's Predictor – Corrector method
Partial differential equations(PDE): Difference quotients – Graphical representation of Partial quotients – Classification of PDE of the second order – Elliptic equations – Standard five point formula – Diagonal five-point formula – Solution of Laplace's equation by Liebmann's iteration

Unit – IV

Numerical Integration: Trapezoidal and Simpson's $1/3^{rd}$ rule for single integrals – Error estimates – Trapezoidal and Simpson's rule for double integrals
Interpolation: Two points Gaussian quadrature – Three points Gaussian quadrature – Cubic spline interpolation
Eigen values: Power method – Jacobi method (Only 2 x 2 and 3 x 3 matrices)

Unit – V

Programming in C: Constants – Variables – Data types – Operators and Expressions – Input/Output Statements – Control statements – Functions – Arrays – One, two, multidimensional array declarations and initializations

Simple applications using C – Program: Program to integrate tabulated function using Trapezoidal rule – Program to integrate tabulated function using Simpson's 1/3 rule – Program to compute the solution of first order differential equation of the type y' = f(x,y) using RK4 mehtod - Program to compute first order differential equation y' = f (x,y) using Milne's method – Program to compute the interpolation value at a specified value from a set of table points using natural cubic spline interpolatin.

Books for study:

1. The Feynman Lectures on Physics (Volume 2 and 3) – Richard P. Feynman, Robert B. Leighton, Matthew Sands; Narosa publishing House, New Delhi.
2. Numerical methods – P. Kandasamy, K. Thilagavathy and K. Gunavathi, S. Chand and Company Ltd., (2007)
3. Numerical methods – E. Balagurusamy, Tata Mcgraw Hill Publishing Company Ltd,. New Delhi, (2006)
4. Ansi C – E. Balagurusamy, Tata Mcgraw Hill Publishing Company Ltd,. New Delhi, (2004)

BHARATHIAR UNIVERSITY, COIMBATORE – 641 046

PART – I M.Phil. / Ph.D. – PHYSICS

(Syllabus Effective from the academic year 2008 –2009 onwards)

PAPER – II Research Methodology and Trends in PHYSICS

Unit–I: Crystal Physics and Physical Properties of Crystals

Representation of physical quantities by scalars, vectors and tensors – Tensors of second rank- Transformations of components of a second-rank tensor – Representation quadric – Simplification of equations referred to principal axes – Effect of crystal symmetry on crystal properties: Neumann's principle – Magnitude of a property in a given direction – Geometrical properties of the representation quadric – Equilibrium properties represented by second-rank tensor: Electric Polarization: relations between D, E and P in a parallel plate condenser – Stress tensor: homogeneous and inhomogeneous stresses – Strain tensor: homogeneous three-dimensional strain.

Unit–II: Crystal Optics and Non-Linear and Electro-Optical Effects in Crystals

Double refraction: Optical indicatrix – Effect of crystal symmetry on optical indicatrix – Wave surface: Uniaxial and Biaxial crystals – Non-Linear Optics: Harmonic generation – Second Harmonic Generation – Phase matching – Third Harmonic Generation – Optical Mixing: Sum and difference frequencies – Parametric generation of light – Self-focusing of intense light beams – Electro-Optic Effect: Phase retardation – Longitudinal electro-optic modulators: Amplitude modulation – Phase modulation of light – Transverse electro-optic modulators – Electro-optic beam deflection.

Unit– III: Nanomaterials and their applications

Properties of metallic and semiconducting Nanoparticles – various physical and chemical methods of preparation –self assembly and catalysis assisted growth methods - synthesis of carbon nanostructures and their applications –nanostructured ferromagnetism–size and dimensionality effects in nanostructures – biological application of nanomaterials.

Unit – IV: Surface analysis techniques

Atomic Collision and Backscattering Spectrometry: – Energy loss of Light Ions and Backscattering Depth Profiles – Sputter Depth Profile and Secondary Ion Mass Spectroscopy – Channeling: Basics and its application in Thin Film analysis - X-ray Photoelectron Spectroscopy – Electron Microprobe analysis of surface – Nonradiative Transitions and Auger Electron Spectroscopy.

Unit – V: Spectroscopic methods

Spectrophotometer – UV –VIS Near IR, - Basic concepts of FTIR and Raman and its applications to various materials - NMR and ESR and its applications – Thermal analysis (TG/DTA, DSC) of different Materials.

X-ray Method

The Bragg Law – X- ray Spectroscopy – Diffraction Directions – Diffraction Methods – Powder Method – Particle size Calculation – X ray scattering by electrons, atomic and unit cells.

Books for Study for

1. 'Physical Properties of Crystals: Their Representation by Tensors and Matrices' by J.F. Nye, 1985, Oxford University Press, New York.
2. 'Lasers and Non-Linear Optics' by B.B. Laud, Chapter-13, Wiley Eastern Ltd., 1985,
3. 'Quantum Electronics' by Amnon Yariv, Chapter-14, John Wiley & Sons, Inc., 1975, New York.
4. Introduction to Nanotechnology by C.P Pool Jr. and F.J Owens, John Wiley & Sons
5. Nanostructures & Nanomaterials Synthesis, Properties and Applications by Guozhong Cao (World Scientific Publishing)
6. Fundamentals of surface and thin film analysis – Leonard C. Feldman and James W. Mayer
7. Basic Principles of Spectroscopy – Raymond Chang, McGraw Hill International book company
8. Elements of x-Ray Diffraction (Second Edition) BD Cullity
9. Fundamentals of Molecular Spectroscopy by Banwell

BHARATHIAR UNIVERSITY, COIMBATORE – 641 046

PART – I M.Phil. / Ph.D. – PHYSICS

(Syllabus Effective from the academic year 2006 –2007 onwards)

PAPER – III 1. Solid State Electronics

UNIT- I: High Field Phenomena and Hot electron effect

High field drift velocity of carrier – The electron transfer effect – Impact ionization and carrier multiplication Phenomena – Analysis of Junction break down – Hot electron effect in MOSFET – Analysis of velocity saturation by transport equations - electron transfer and velocity field characteristics in two valley semiconductors .

UNIT-II: Micro controllers

8051 Micro controller hardware – input / Output pins, ports and circuits – external memory – counter and timers - serial date Input and Output - Interrupts – A Generic Computer - The mechanics of Programming - The PAL practice CPU - Programming tools and techniques - Programming the 8051.

UNIT-III

Moving data - addressing modes - External data moves - code memory Read only data moves - push and pop codes - Data exchanges - The jump and call program range - Jumps - calls and sub routines Interrupts and returns - 8051 Micro controller design - Testing the design - Timing sub routines - serial data transmissions.

UNIT- IV: Combinational Circuits

Multiplexers (Data selectors) - Application of multiplexer - De multiplexers - Decoders - Liquid crystal display - Encoders - priority encoder - parity generators – code conterters - magnitude comparator - application of comparators.

UNIT-V: Opto - Electronics

Optical communication system ; Modulation scheme – Analog modulation – Digital modulation – Free space communications- Fiber Optical communication systems -
Operating wave length Emitter design - Detector design - fiber choice - system design considerations - Local area networks - Integrated optics - optical fiber sensoss.

BOOKS OF STUDY AND REFERENCE

1. Fundamentals of semiconductor theory and device Physics - chapter 10 - Shyhwang Prentice – Hall International Editions - 1989 - Page 462-509 .

2. The 8051 Micro controller architecture, Programming and application - Kenneth j . Ayalar – Penram International - 1996 . Unit 1 ; Chapters – 3,4 Unit 2 chapters – 5,8,9.

3. Digital circuits and design – S. Arivazhagan - Vikas Publishing house - 1999 chapter – 6.

4. Opto Electronics and Introduction – j . Wilson J . F.E. Hawkes – Prentice Hall – 2001 , chapters 9,10 .

BHARATHIAR UNIVERSITY, COIMBATORE – 641 046

PART – I M.Phil. / Ph.D. – PHYSICS

(Syllabus Effective from the academic year 2006 – 2007 onwards)

PAPER-III 2. Solar Energy and its Utilization

UNIT - 1: Radiation Geomentry

Basis earth sun angles - Determination of Solar time - Derived Solar angles - Day length - Solar Radiation measurements - selective surfaces - Heat balance energy lost by radiation , convection and conduction - Physical characteristics of selectives surface - Anti reflection coatings - Solar reflector materials - production methods of coatings.

UNIT - II: Fundamentals of Heat Transfer

Transfer of Heat by Conduction: Study heat flow in a slab-steady heat flow in a cylindrical shell- Heat transfer through fins – Transient heat conduction.

Thermal Radiation: Basic laws of radiation – Radiant heat transfer between two black bodies- Radiant heat transfer between grey bodies.

Convention heat loss Evaluation of convective heat transfer co-efficient –Free convection from vertical planes and cylinders – Forced convection – Heat transfer for fully established flow in tubes.

UNIT-III: Solar Thermal systems

General description of plate collector – thermal losses and efficiency of FPC –Energy balance equation – Evaluation of overall loss coefficient – Thermal analysis of flat plate collector and useful heat gained by the fluid performance of solar air heaters – Heating and drying of agricultural products Types of drier in use.

Solar concentrators and Receiver geometries – General characteristics of focusing collector systems Evaluation of optical losses – Thermal performance of focusing collectors.

UNIT-IV: Photovoltaics

Description of the photovoltaic effect – Electrical characteristics calibration and efficienc measurement – silicon solar energy converters – Thermal generation of recombination centers silicon.

Role of thin films in solar cells Properties of thin films for solar ells CdSe, Cete, In P, Ga As, Cd C_{u2}, Cu In SnO_2, Cd_2SnO_4 ZnO)- Transport properties of metal films – poly crystalline film silicon solar cells (Photovoltaic characteristics, junction analysis loss mechanisms) Amorpho silicon solar cells (Structural compositional optical and electrical properties)

Unit- V: Energy storage and solar applications

Types of energy storage Thermal storage Latent heat storage – Electrical storage Principle of operation of solar ponds-Non convective solar ponds – Theortical analysis of solar pond – so distillation – solar cooking –solar pumping.

Books of Study and Reference:

1. Solar energy utilization GD. Raj. 1996
2. Treatise on solar energy volume I fundamentals of Solar Energy –H.P. Garg.1982
3. Thermal performances testing of FPC and CPC –GD Raj
4. Solar cells – Charles E. Backus IEEE Press (1976)
5. Thin film solar cells Kasturi Lal chopra and suhit Ranjan Das, (1983)
6. Solar energy Utilization G.D Raj (1996)

BHARATHIAR UNIVERSITY, COIMBATORE – 641 046

PART – I M.Phil. / Ph.D. – PHYSICS

(Syllabus Effective from the academic year 2006 – 2007 onwards)

Paper – III Molecular Physics

UNIT - I: Molecular Symmetry

Symmetry operation – symmetry elements – Different type of symmetry operations – symmetry point groups – Linear and non linear molecules – Representations of groups - Irreducible Representations and character – and character tables .

UNIT - II: Symmetry Aspects of molecular Orbital theory

General principles – the LACO approximation – the Huckel approximation – Bonding character of orbitals - symmetry factoring of secular equations – Transformation properties of Atomic orbitals – Hybridization schemes of and orbitals Hybrid orbitals as linear combinations of Atomic orbitals – Molecular orbital theory for AbBn – types molecules .

UNIT - III: Central field approximation

Hartree Fock equation – The method of self consistent filed – Hydrogen ion – Hydrogen molecule – covalent bond – Heitler – London theory – Approximate self – consistent molecular orbital theory I, II, III, and IV, Calculation of Equilibrium bond lengths by the CNDO Method .

UNIT - IV: Molecular vibrations

The symmetry of Normal vibrations – Determining the symmetry types of the Normal mode – Internal coordinates – symmetry coordinates - Normal coordinates – potential and kinetic energies interms of symmetry coordinates – removal of redundant coordinates – application of group theory of Raman and I .R .activity .

UNIT - V: Potential Functions

The General Quadratic potential function – The approximation of central forces, valence forces - Modification of the simple force functions - Isotopic effect – An harmonic terms in the potential energy – Quantum mechanical Resonance – characteristic values and characteristic vectors – symmertrization of the secular determinant – solution of the simulatanous equations – Matrix Iteration methods – Perturbation methods .

Books for study and References

1. Chemical applications of group theory – Wiley Inter science F .A . Cotton .
2. infra red Raman spectroscopy – Herzberg.
3. Quantum chemistry A .K .Chandra
4. Molecular vibrations – E .B .Wilson , Decies and cross
5. Group theory application to molecular vibrations – PG Puranik
6. Approximate self – consistent molecular orbital theory II calculations with complete neglect of Differential over lap J . A . people and G .A .Segai J . Che . Phy . vol. 43 . (1965) .
7. Approximate self – consistent molecular orbital theory II Calculations with complete Neglect of Differential over lap J .A . people and G .A . segal J . che. Phy . Vol. 43 No .10
8. Approximate self – consistent molecular orbital theory III CNDD Results for AB,2 and AB,3 Systems .
9. Approximate self – consistent molecular orbital theory 4 Calculations on Molecules including the Elements sodium through chlorine D .P . Santry and G . A . segal J . chem. . phys . vol. 47 – 158 – 174 (1967) .
10. Calculation of Equilibrium bond lengths by the CNDO method G . A . Segal J . chem. . Phys . vol. 47 . 1876 – 1877 (1967) .

BHARATHIAR UNIVERSITY, COIMBATORE – 641 046

PART – I M.Phil. / Ph.D. – PHYSICS

(Syllabus Effective from the academic year 2006 – 2007 onwards)

PAPER III - Plasma Physics

UNIT - I

Plasma state – charaterisation : Occurance of Plasma in nature – Definition of Plasma – concept of temperature – Debye Shielding – The Plasma parameters – Criteria for Plasma – Applications of Plasma physics (basis ideas) single – Particle motions ; uniforms E and B fields – Gravitational field – Non uniform B fields – Gravitational field – Non – uniform B field – Curve B - magnetic mirrors non Uniform E filed Time – varying B field – Adiabatic Invariants .

UNIT - II

Plasma as fluids ; the equation of motion – Fluid drifts perpendicular to B fluid drifts parallel to B – The plasma approximation , Equilibrium and stability : Hydromagnetic Equilibrium – The concept of diffusion of Magnetic filed into a plasma classification of instabilities – Two stream Instability – The gravitational instability - Resistive Drift waves – The weibel instability .

UNIT - III

Waves in plasma : Representation of waves – Group velocity – plasma Oscillations – Electron Plasma waves – sound waves – Ton waves – Validity of plasma approximation – comparision of ion and Electron waves – Electromagnetic waves with Bo = O – Experimental applications – Electro magnetic waves perpendicular to Bo Experimental consequences – Hydromagnetic waves – Magnetosonic waves Summary of Elementary plasma waves – The CMA Diagram .

UNIT - IV: Kinetic Theory

The meaning of f (v) Equations by Kinetic theory – Derivations of the fluid equation – plasma Oscillations and Landau damping – The meaning of landay Damping – Aphysica derivation of Landu Damping – BGK and van Kampen modes – Experimental verification – Kinetic effects in a Magnetic field .

UNIT - V: Plasma Diagnostics

Electrical methods : Langmuir profits spectroscopic methods – Line spectrum of a plasma – low density plasma – high density plasma ionization state of a plasma – particle methods : Beam of charged particle to measure electric field in a plasma – measurement of the density of natural particles and charged particles .

Books for study

1 . Frencies F chen : introduction to plasma and controlled Fusion vol . plasma physics (plenum press)
2 . I M podgomyl : Topics in plasma diagnostics (plenum press)

Books for Reference

1 . Nocholas A Krail and Alvin W Trivelpiece – Principles of plasma physics (McGraw Hillkogkusha Ltd .
.
2 . Richard H Huddlestone and stanely Leonard – plasma Diagnostic Techniques (Academic Press) .

BHARATHIAR UNIVERSITY, COIMBATORE – 641 046

PART – I M.Phil. / Ph.D. – PHYSICS

(Syllabus Effective from the academic year 2006 –2007 onwards)

PAPER III : Thin Film Technology

UNIT - I: Preparation of Thin Films

Spray pyrolytic process – characteristic feature of the spray pyrolytic process – ion plating – Vacuum evaporation – Evaporation theory – The construction and use of vapour sources – sputtering Methods of sputtering – Reactive sputtering – RF sputtering - DC planar m magnetron sputtering .

UNIT - II: (Thickness measurement and Nucleation and Growth in Thin Film)

Thickness measurement : electrical methods – optical interference methods – multiple beam interferometry – Fizeau – FECO methods – Quartz crystal thickness monitor .

Theories of thin film nucleation – Four stages of film growth incorporation of defects during growth .

UNIT - III: Electrical properties of metallic thin films

Sources of resistivity in metallic conductors – sheet resistance - Temperature coefficient of resistance (TCR) – influence of thickness on resistivity – Hall effect and magneto resistance – Annealing – Agglometation and oxidation .

UNIT - IV: Transport properties of semiconducting and insulating Films

Semiconducting films ; Theoretical considerations - Experimental results – Photoconduction – Field effect thin films – transistors, Insulation films Dielectric properties – dielectric losses – Ohmic contracts – Metal – Insulator and Metal – metal contacts – DC and AC conduction mechanism .

UNIT - V: Optical properties of thin films and thin films solar cells

Thin films optics –Theory – Optical constants of thin films – Experimental techniques – Multilayer optical system – interference filers – Antireflection coating ,Thin films solar cells : Role, Progress , and production of thin solar cells – Photovoltaic parameter, Thin film silicon (Poly crystalline) solar cells : current status of bulk silicon solar cells – Fabrication technology – Photo voltaic performance : Emerging solar cells : GaAs and CulnSe .

Books for study

1 . Hand book of Thin films Technology : L I Maissel and R Clang .
2 . Thin film Phenomena : K L Chopra .
3 . physics of thin films, vol. 12 , Ed George Hass and others .
4 . Thin films solar cells – K L Chopra and S R Das .
5 . Thin films processes – J L vilsan

Books of Reference

1 . vacuum deposition of thin films – L Holland .
2 . The use of thin films in physical investigation – J C Anderson .
3 . Thin films technology – Berry, Koil and Harris

BHARATHIAR UNIVERSITY, COIMBATORE – 641 046

PART – I M.Phil. / Ph.D. – PHYSICS

(Syllabus Effective from the academic year 2006 – 2007 onwards)

PARER - III Solid state Ionics

UNIT - I

Crystalline solids – space lattice – the basis and crystal structure ; crystal translational vectors, symmetry operation primitive lattice cell and unit cell symmetry elements, Fundamental type of lattice, atomic packing, atomic radius, lattice constants and density, crystal structure other cubic structure- type of bonding – Ionic bonding – Energy of formation of NACL Molecules, medelung constants – potential energy of diagram of ionic molecules – calculation of repulsive exponent – Born Haber cycle characteristics of ionic bond .

UNIT - II: Transport Properties of Ionic Conductors

Ionic conductivity – Normal and super ionic conductors – distinguision – Mass transport in crystals – Diffusion – Atomic diffusion theory – Experimental determination of the diffusion constant – Ionic conduction – Experimental results – for ionic conduction – The Einstein relation – Dielectric loss in ionic crystals – Electronic conduction in ionic crystals – Excess conductors – Deficit conductors – Amphoetric semiconductor .

UNIT - III

Phenomenological Models – Huberman's Theory – Ries Strassler Toom's Theory – Weleh and Diene Theory – Lattice Gas theory – Free ion model – Domain Model – Rica and Roth Theory – The Path Probability Method – The static variables – the Path variables – The path Probability – Stationary state condition – Classification of Superionic solids – Crystalline and – Amorphous – Glasses – Dispersed solid Electrolytes - polymers – Ion exchange resins – biological basis resins - Classification over conducting ion species – mode and mechanism of conduction in each case and their corresponding criteria to be superionic conductors .

UNIT - IV: Experimental Techniques and Methods

Structural characterization – XRD surface Analysis, EXAFS, IPS, and Quasi neutron scattering – Thermodynamical characterization – Differential scanning calorimetry, Differential Thermal Analysis, Thermo Gravimetric Analysis and Thermo electric power – Ion transport properties – Electrical conductivity – Two probe method – four probe method - Immitance spectroscopy – Dynamical conductivity – state conductivity – polarisation characteristic – determination of small electronic transport numbers – The permeation

Technique (Static) – The polarization cell (Static) – the polarized cell technique (Dynamic) – The permeation technique (Dynamic) .

UNIT - V

Application of superionic solid – Battery and Non – Battery application – conventional cells – fuel cells – sensors and partial pressure – gauges – Oxygen and non Oxygen sensors – coulometers – timers – Diffusion coefficient measurement in solids and liquids – Electro chemic displays .

Books of Reference :

1 . Superionic solid – Principles and applications (Ed . S. Chandra) North Holland 1981 .
2 . solid state ionics . (Eds. T Kudo and Fueki) VCH Publishers, Kodansha 1990 .
3 . Lectures on solid state physics (Eds. G Bush and H Schade), international series on Natural Phiolosphy Vol. 79 Pergamon, press 1976 .
4 . " Solid Electrolyted" (Eds. S Geller) Springer Verlag New york 1977 .
5 . 'Importance Spectroscopy' (Eds. Joscher) Springer Verlag .
6 . 'Physics of Electrolytes – Transport Processes solid Electrolytes and in Electrodes (Eds. J Hladik) Academic press, New york 1972 .

BHARATHIAR UNIVERSITY, COIMBATORE – 641 046

PART – I M.Phil. / Ph.D. – PHYSICS

(Syllabus Effective from the academic year 2008 – 2009 onwards)

PAPER – III MOLECULAR QUANTUM MECHANICS

Unit – I: Many-Electron Atoms

The Hartree-Fock self consistent field method - Electron correlation - The atomic Hamiltonian- The Condon-Slater rules - The Born-Oppenheimer approximation - Nuclear motion in diatomic molecules - The Hydrogen molecule ion - Approximate treatments of H_2^+ ground electronic state - Molecular orbitals for H_2^+ excited states - Molecular orbital configurations of homonuclear diatomic molecules - Electronic terms of diatomic molecules

Unit – II: Many electron molecules:

The hydrogen molecule – The valence bond treatment of H_2 – Comparison of the MO and VB theorems – MO and VB wave functions for homonuclear diatomic molecules – Electron probability density – The Hartree-Fock method for molecules – SCF wave functions for diatomic molecules – MO treatment of heteronuclear diatomic molecules – Variational principle for the ground state - The viral theorem – The Viral theorem and chemical bonding – The Hellmann-Feynman theorem – The electrostatic theorem

Unit – III: Ab initio method for polyatomic molecules:

Ab initio methods and semi-empirical methods – The SCF MO treatment of polyatomic molecules – Rayleigh-Schrödinger many body perturbation theory - Basis functions – Population analysis – Dipole moment – Molecular geometry – Calculation of Vibrational frequencies and thermodynamic properties – Molecular conformations and barrier to rotation and inversion – Thermochemical stabilities of molecules

Unit – IV: Density Functional Theory

Electron density - The original idea: The Thomas-Fermi model – The traditional Thomas-Fermi and Thomas-Fermi-Dirac models – Three theorems in Thomas Fermi theory - Thomas-Fermi-Dirac-Weizsacker model – The Hohenberg-Kohn theorems – Kohn-Sham equations – Derivation of Kohn-Sham equations – Kinetic energy functional – Local density approximation (LDA) – Density gradient and kinetic energy density corrections – Adiabatic connection methods

Unit – V: Density functional theory and Reactivity parameters

The chemical potential in the grand canonical ensemble at zero temperature – Physical meaning of the chemical potential – The chemical potential for a pure state and in the canonical ensemble – Change from one ground state to another – Electronegativity and electronegativity equalization – Hardness and softness – Reactivity index: Fukui function – Local softness, local hardness and softness and hardness kernels – Atoms in molecules – HSAB principle – Maximum hardness principle and its proof - Modeling the chemical bond: the bond-charge model

Books for study:

1. Quantum Chemistry – Ira. N. Levine, Vth Edition; Prentice-Hall of India, New Delhi, 2000

2. Ab initio molecular orbital theory – W. J. Hehre, L. Radom, P. V. R. Schleyer and J. A. Pople; John Wiley & Sons, New York, 1985.

3. Essential of Computational Chemistry - Theories and Models , IInd Edition, Christopher J. Cramer; John Wiley & Sons, England, 2004.

4. Modern quantum chemistry – Introduction to advanced electronic structure theory – Attila Szabo and Neil S. Ostlund, Dover publications INC, New York, 1996.

5. Density functional theory of atoms and molecules – R. G. Parr and W. Yang; Oxford University press, New York, 1989.

6. Chemical reactivity theory: A density functional view – P. K. Chattaraj; CRC press, 2008.

BHARATHIAR UNIVERSITY, COIMBATORE – 641 046

PART – I M.Phil. / Ph.D. – PHYSICS

(Syllabus Effective from the academic year 2008 – 2009 onwards)

PAPER – III - Nuclear Physics

Unit – I

Nuclear reactions : Types of Nuclear reactions – Conservation laws – General features of Nuclear reactions – Energy spectra – Angular distributions – Cross sections – Classical estimates – Quantum mechanical considerations .

Nuclear instability: Gamma emission – selection rules – Transition rate – Internal conversion – Beta decay – Beta-particle energy spectrum – Allowed and Forbidden transitions – Alpha decay – Semi classical theory of alpha decay – Alpha particle energies and selection rules.

Unit – II

Exotic decay: Quantum Mechanical Fragmentation theory - Cluster radioactivity – Unified fission model – Preformed cluster model.

Binding energy: Weizacker mass formula – Beta stability condition – Drip line condition from Weizacker mass formula - Temperature dependent mass formulae - Halo nuclei characteristics – Cluster core model.

Synthesis of superheavy elements – Cold, Tepid and Hot fusion reactions – Empirical Shell correction formula of Myers and Swiatecki .

Unit – III

Characteristics of Fission: Fission and fission products – Fission energy budget – Delayed neutrons – Neutron interactions – Breeder reactions.

Thermal fission reactor: Nuclear power plant – Neutron cycle in thermal reactor – Moderator – Optimizing the design – The finite reactor – Diffusion – Continuity equation – Diffusion length – Reactor equation – Solution using rectangular and spherical geometry .

Reactor Operation and Commercial reactors – Reactor power and fuel consumption – Reactor kinetics – Reactor poisoning – Gas cooled reactors – Pressurized water reactor – Boiling water reactor – Heavy water reactor – Breeder reactor – Accelerator driven system.

Unit – IV

Gas Detectors: Ionization Chamber – Proportional counter – Geiger Muller Counter Scintillation detectors – Semi conductor detectors .

Detector performance for gamma rays: Response to mono energetic photons – Energy resolution – Peak to Total ratio.

Neutron detectors; Slow neutron detection – Fast neutron detection.

Particle Identification – E-Delta E counter telescope – Time of flight – Magnetic analysis.

Accelerators: DC machines – Linear accelerator – Cyclotron – Betatron – Electron and Proton synchrotron - Applications

Unit – V

Interaction of Radiation with Matter: Charged particle – Electrons – Gamma rays - Neutrons
Industrial and Analytic applications: Tracing – Gauging – Material modification – Sterlization – Food preservation
Neutron activation analysis – Principle - Instrumentation – Sources – Applications.
Rutherford back scattering – Particle induced X- ray emission – Applications of PIXE - Accelerator mass spectrometry

Books Reference

1. Concepts of Nuclear Physics, Bernard L. Cohen, Tata McGraw Hill Edition, (2007)
2. Nuclear Physics: Principles and Applications, John Lilley, Wiley India, (2006).
3. Techniques for Nuclear and Particle Physics Experiments, A How to Approach, W.R. Leo, Narosa Publishing House, (1995)
4. Advanced Experimental Techniques in Modern Physics, K.M. Varier, A. Joseph and P.P. Pradyumnan, A Pragati Edition, (2006)
5. Heavy elements and related new phenomena – Vol. I and Vol. II, Editors – W. Greiner and R.K. Gupta, World Scientific, Singapore (1999)

BHARATHIAR UNIVERSITY, COIMBATORE – 641 046

PART – I M.Phil. / Ph.D. – PHYSICS

(Syllabus Effective from the academic year 2008 –2009 onwards)

PAPER – III - Principles and Methods of Crystal Growth

Unit – I: Fundamentals of Crystal Growth

Importance of crystal growth – Classification of crystal growth methods – Basic steps: Generation, transport and adsorption of growth reactants – Nucleation: Kinds of nucleation –Classical theory of nucleation: Gibbs Thomson equations for vapour and solution – Kinetic theory of nucleation – Becker and Doring concept on nucleation rate – Energy of formation of a spherical nucleus – Statistical theory on nucleation: Equilibrium concentration of critical nuclei, Free energy of formation.

Unit – II: Theories of Crystal Growth

An introductory note to Surface energy theory, Diffusion theory and Adsorption layer theory –Concepts of Volmer theory, Bravais theory, Kossel theory and Stranski's treatment – Two-dimensional nucleation theory: Free energy of formation, Possible shapes and Rate of nucleation – Mononuclear, Polynuclear and Birth and Spread models – Modified Birth and Spread model – Crystal growth by mass transfer processes: Burton, Cabrera and Frank (BCF) bulk diffusion model, Surface diffusion growth theory.

Unit – III: Experimental Crystal Growth-Part-I: Melt Growth Techniques.

Basics of melt growth – Heat and mass transfer – Conservative growth processes: Bridgman-Stockbarger method – Czochralski pulling method – Kyropolous method – Non-conservative processes: Zone-refining – Vertical and horizontal float zone methods – Skull melting method – Vernueil flame fusion method.

Unit – IV: Experimental Crystal Growth-Part-II: Solution Growth Techniques.

Growth from low temperature solutions: Selection of solvents and solubility – Meir's solubility diagram – Saturation and supersaturation – Metastable zone width – Growth by restricted evaporation of solvent, slow cooling of solution and temperature gradient methods– Crystal growth in Gel media: Chemical reaction and solubility reduction methods – Growth from high temperature solutions: Flux growth Principles of flux method – Choice of flux – Growth by slow evaporation and slow cooling methods – Hydrothermal growth method.

Unit –V Experimental Crystal Growth-Part-III: Vapour Growth Techniques.

Basic principles – Physical Vapour Doposition (PVD): Vapour phase crystallization in a closed system – Gas flow crystallization – Chemical Vapour Deposition (CVD): Advantageous and disadvantageous – Growth by chemical vapour transport reaction: Transporting agents, Sealed capsule method, Open flow systems – Temperature variation method: Stationary temperature profile, Linearly time varying temperature profile and Oscillatory temperature profile.

Books for Study and Reference

1. 'Crystal Growth Processes' by J.C. Brice, 1986, John Wiley and Sons, New York.
2. 'Crystallization' by J.W. Mullin, 2004, Elsevier Butterworth-Heinemann, London.
3. 'Crystal Growth: Principles and Progress' by A.W. Vere, 1987, Plenum Press, New York.
4. 'Crystals: Growth, Morphology and Perfection' by Ichiro Sunagawa, 2005, Cambridge University Press, Cambridge.
5. 'Crystal Growth' by B.R. Pamplin, 1975, Pergamon Press, Oxford.

BHARATHIAR UNIVERSITY, COIMBATORE – 641 046

PART – I M.Phil. / Ph.D. – PHYSICS

(Syllabus Effective from the academic year 2008 – 2009 onwards)

PAPER – III Physics of Nonomaterials and device

Unit – I: Physics of quantum dots

Growth of quantum dots – SK quantum dots – basics of semiconductor quantum dots – Electron photon scattering - Exciton dynamics in quantum dots – carrier relaxation in quantum dots – optical spectroscopy of single and multiple quantum dots – basics of metal quantum dots and their applications.

Unit- II: Physics of quantum wells.

Introduction – infinite deep square wells – parabolic wells –triangular wells –subband formation in low dimensional system –occupation of subbands –quantum wells in heterostructures – basics of tunneling transport – current and conductance – current in one dimension – current in two and three dimensions – basis of coherent transport

Unit – III: Growth of heterostructures

Growth of heterostructures by MBE and MOCVD method – band gap engineering – modulation doping – 2DEG formation – Strained layers and its effect – wire and dot formation – optical confinement – effective mass approximation in heterstructures – photo and electron beam lithography methods –methods in the nanoscale device fabrication

Unit – IV: Photonic devices

Metal semiconductor contacts – space charge region – schottky effect – ohmic contact – Basic microwave technology – tunnel diode – impatt diodes – transferred electron devices – quantum effect devices – light emitting diodes – basics of Solar cells – lasers and quantum well lasers

Unit – V: Transistor related devices:

Metal insulator semiconductor contacts – space charge region – capacitance at hetero interface and high frequency effect – MOSFET fundamentals and current voltage characteristics – MOSFET scaling – CMOS and BiCOMOS – MOSFET on insulators – MOS memory structures – Basics of MODFET

Books

1. The Physics of Low dimensional semiconductors by JOHN H. Davies
2. Semiconductor devices: Physics and technology by S. M. Sze
3. Optics of quantum dots an wires by S. Soloman Glenn.
4. The Physics of Semiconductors by Marius Grundmann.

BHARATHIAR UNIVERSITY, COIMBATORE – 641 046

PART – I M.Phil. / Ph.D. – PHYSICS

(Syllabus Effective from the academic year 2006 – 2007 onwards)

PAPER – III Nonlinear Dynamics

UNIT – I

Linear and Nonlinear systems – Mathematical models examples – Mathematical Implications of Nonlinearity: superposition principle – Linear oscillators & Predictability – Nonlinear oscillators – Resonance and Hysteresis.

UNIT – II

Autonomous and Nonautonomous systems – Phase plane trajectories – stability, attractors & repellers, - equilibrium points and stability – limit cycle – Bifurication – Period doubling phenomenon –onset of chaos – Logistic map – Route to chaos – Lorentz systems – Sensitive dependence on initial condition – controlling of chaos.

UNIT – III

Integrability & separability – Painleve analysis – singular points – P-analysis of ordinary differential equations – symmetries – Integrals of motion – Painleve analysis of partial differential equations – Laxpair and integrable properties .

UNIT – IV

Linear wave propagation (nondispersive and dispersive) – Fourier transform and solution of intial value problem – wave packet and dispersion – Nonlinear Dispersive system – Scott Russel`s phenomenon –cnoidal waves and Korteweg-de Vries equation – Fermi Pasta Ulam phenomenon-Numerical experiments of Zabusky and Kruskal – birth of solitons.

UNIT – V

AKNS Linear eigen valve problems – standard soliton equation – Inverse scattering trnsform method – soliton solutions of KdV equation – Hirota's Direct method and 'N' soliton solutions.

Books for Study and References:

1. M. Lakshmanan and S. Rajasekar, Nonlinear Dynamics, Integrability, chaos and patterns, springer (2003)

2. M.J. Ablowitz and PA Clarkson, Solitons, Nonlinear Evolution Equations and Inverse Scattering (Cambridge University Press, Cambridge 1991)