BHARATHIAR UNIVERSITY, COIMBATORE – 46
M.Sc. PHYSICS (UNIVERSITY DEPARTMENT)
(For the students admitted during the academic year 2014-15 onwards)

SCHEME OF EXAMINATION (CBCS PATTERN)

Sem	Course Title		Exam Dur.	Exam			Credits
				CIA	Univ. Exam	Total	
I	Paper – 1	Classical Mechanics	3	25	75	100	4
	Paper – 2	Mathematical Physics – I	3	25	75	100	4
	Paper – 3	Quantum Mechanics-I	3	25	75	100	4
	Elective -1	Advanced Electronics	3	25	75	100	4
	Practical-1	Electronics Experiments	6	25	75	100	4
	Supportive 1	Offered from other Departments	-	-	-	50	2
II	Paper – 4	Mathematical Physics – II	3	25	75	100	4
	Paper – 5	Quantum Mechanics – II	3	25	75	100	4
	Paper -6	Condensed Matter Physics	3	25	75	100	4
	Elective - 2	Thermodynamics and Statistical Mechanics	3	25	75	100	4
	Practical-2	Advanced Physics Laboratory	6	25	75	100	4
	Supportive 2	Offered from other Departments	-	-	-	50	2
III	Paper – 7	Advanced Condensed Matter Physics	3	25	75	100	4
	Paper – 8	Computational Methods and Programming	3	25	75	100	4
	Elective -3	Semiconductor Devices	3	25	75	100	4
	Paper – 9	Electro Magnetic Theory	3	25	75	100	4
	Practical-3	Computational Programming Lab	3	25	75	100	4
	Supportive 3	Offered from other Departments	-	-	-	50	2
IV	Paper – 10	Modern Optics	3	25	75	100	4
	Paper – 11	Nuclear and Particle Physics	3	25	75	100	4
	Paper – 12	Atomic Physics and Molecular Spectroscopy	3	25	75	100	4
	Practical-4	Optics and Laser Laboratory	6	25	75	100	4
		Project & Viva-voce				200	8
Total						**2250**	**90**

Supportive Courses for Other Department Students:

1. Basic Electronics; 2. Energy Resources

SEMESTER – I
CORE PAPER – 1
CLASSICAL MECHANICS

Unit – I Mechanics of Single and Systems of Particles

Newton's laws of motion - Mechanics of a particle - Equation of motion of a particle - Motion of a particle under constant force and alternating force - Mechanics of systems of particles - Angular momentum of the system - Potential and kinetic energies of the system - Motion in a central force field - Motion of two particles equivalent to single particle - Equation of motion of centre of mass with respect to centre of force - Motion in an inverse-square law force field - Classification of orbits

Unit – II Collisions of Particles and Motion of Rigid Body

Elastic and inelastic scattering - Laboratory and centre of mass systems - Relations between different quantities in the laboratory and centre of mass systems –Kinematics of elastic scattering in the laboratory system- Inelastic scattering in the laboratory frame - Motion of a rigid body -Euler's theorem - Angular momentum and kinetic energy - Inertia tensor - Euler's equation of motion – Torque Free Motion – Euler's angles.

Unit – III Lagrangian and Hamiltonian Formulations

Hamilton's variational principle - Lagrange's equations of motion –Conservation theorems and symmetry properties – Cyclic coordinates - Application of Lagrange's equation; Linear harmonic oscillator, particle moving under a central force, Atwood's machine - Hamilton's equations of motion - Application of Hamiltonian's equations of motion; Particle moving in an electromagnetic field - Phase space - Principle of least action

Unit - IV Canonical Transformations and Poisson Brackets

Canonical transformations – Generating function – Properties of canonical transformations – Poisson brackets – Properties of Poisson brackets – Constant of motion using Poisson brackets – Poisson brackets of canonical variables – Poisson's Theorem – Invariance of Poisson bracket under canonical transformation – Motion as successive canonical transformation (Infinitesimal generators) – Liouville's theorem - The Hamilton–Jacobi equation – Action and angle variables

Unit – V Small Oscillations

Small oscillations - Stable and unstable equilibrium - Lagrange's equation of motion for small oscillations - Normal coordinates and normal frequencies - Small oscillations of particles on string - Free vibrations of linear triatomic molecule – Two carts connected with three springs – Triple pendulum - Double pendulum

Books for Study and Reference

1. Introduction to Classical Mechanics - R. G. Takwale and P. S. Puranik – Tata McGraw-Hill (2006), New Delhi
2. Classical Mechanics by Herbert Goldstein, Charles Poole and John Safko - Pearson Education and Dorling Kindersley (2007), New Delhi
3. Classical Mechanics by Gupta, Kumar and Sharma – Pragati Prakashan (2001), New Delhi
4. Classical Mechanics by John R. Taylor - University Science books (2005), India
5. Classical Mechanics by R. Douglas Gregory –Cambridge University press, (2008) India
6. Classical Mechanics J.C. Upadhyaya- Himalaya Publishing House (2005) india

Tutorial (This portion is not intended for examination)

1. A particle is projected vertically upwards with speed u and moves in a vertical straight line under uniform gravity with no air resistance, find the maximum height achieved by the particle and time taken for it to return to its starting position.
2. A body of mass m is suspended from a fixed point by a light spring and moving under uniform gravity. The spring is found to be extended by a distance b. Find a period of oscillations of the body about this equilibrium position (assume there is a small strain).
3. Find the moment of inertia of a uniform circular disk of mass M and radius a about its axis of symmetry.
4. Find the kinetic energy of rotation of a rigid body with respect to the principle axes in terms of Eulerian angles.
5. Find the equation of motion of harmonic oscillator using Hamilton–Jacobi method.
6. Simple pendulum with rigid support, and with variable length

CORE PAPER – 2
MATHEMATICAL PHYSICS - I

Unit-I Matrices and Determinants

Properties of matrix addition and multiplication – different type of matrices and their properties – Rank of a Matrix and some of its theorems – Solution to linear homogeneous and non homogeneous equations – Cramers rule – eigenvalues and eigenvectors of matrices – differentiation and integration of matrix.

Unit-II Solving of differential equations

Homogeneous linear equations of second order with constant coefficients and their solutions – ordinary second order differential with variable coefficients and their solution by power series and Frobenius methods – extended power series method for indicial equations.

Unit-III Special differential equations and their solutions

Legendre's differential equation: Legendre polynomials – Generating functions – Recurrence Formulae–Rodrigue's formula–orthogonality of Legendre's polynomial;Bessel's differential equation: Bessel's polynomial –generating functions–Recurrence Formulae–orthogonal properties of Bessel's polynomials– Hermite differential equation– Hermite polynomials – generating functions – recurrence relation.

Unit-IV Laplace Transforms

Laplace transforms: Linearity property, first and second translation property of LT – Derivatives of Laplace transforms – Laplace transform of integrals – Initial and Final value theorems; Methods for finding LT:direct and series expansion method, Method of differential equation; Inverse Laplace transforms: Linearity property, first and second translation property, Convolution property – Application of LT to differential equations and boundary value problems.

Unit-V Fourier series and integrals

Fourier series definition and expansion of a function x – Drichlet's conditions - Assumptions for the validity of Fourier's series expansion and its theorems – Complex representation of Fourier series – problems related to periodic functions – graphical representation of FS – Fourier integrals – convergence of FS – some applications of Fourier transforms.

Books for Study and Reference

1. Mathematical Physics - B.D.Gupta (Vikas Publishing House PVT.LTD) 3rd Edition 2006
2. Topics in Mathematical Physics - Parthasarathy H Ane Books Pvt. Ltd 2007
3. Mathematical methods for physics - G. Arfken Elsevier 6th edition 2010
4. Mathematical Physics - Rajput (Pragati Prakasam) 17th Edition 2004
5. Advanced Engineering mathematics - Erwin Kreyszig (Wiley Eastern Limited Publications) 7th Edition 1993
6. Special Function - W.W.Bell 1968

CORE PAPER – 3

QUANTUM MECHANICS – I

Unit I General formalism of quantum mechanics

Linear Vector Space- Linear Operator- Eigen Functions and Eigen Values- Hermitian Operator- Postulates of Quantum Mechanics- Simultaneous Measurability of Observables- General Uncertainty Relation- Dirac's Notation- Equations of Motion; Schrodinger, Heisenberg and Dirac representation- momentum representation.

Unit II Energy Eigen value problems

Particle in a box – Linear Harmonic oscillator- Tunnelling through a barrier- particle moving in a spherically symmetric potential- System of two interacting particles-Rigid rotator- Hydrogen atom

Unit III Angular Momentum

Orbital Angular Momentum-Spin Angular Momentum-Total Angular Momentum Operators-Commutation Relations of Total Angular Momentum with Components-Ladder operators-Commutation Relation of J_z with J_+ and J_- - Eigen values of J^2, J_z- Matrix representation of J^2, J_z, J_+ and J_- - Addition of angular momenta- Clebsch Gordon Coefficients – Properties.

Unit IV Approximate Methods:

Time Independent Perturbation Theory in Non-Degenerate Case -- Degenerate Case-Stark Effect in Hydrogen atom – Spin-orbit interaction - Variation Method – Born-Oppenheimer approximation -- WKB Approximation.

Unit V Many Electron Atoms

Indistinguishable particles – Pauli principle- Inclusion of spin – spin functions for two-electrons- The Helium Atom – Central Field Approximation - Thomas-Fermi model of the Atom - Hartree Equation- Hartree -Fock equation.

Books for Study & Reference:

1) A Text Book of Quantum Mechanics-P.M. Mathews & K. Venkatesan - Tata McGraw Hill 2010.
2) Quantum Mechanics – G. Aruldhas - Prentice Hall of India 2006
3) Introduction to Quantum Mechanics – David J.Griffiths Pearson Prentice Hall 2005
4) Quantum Mechanics – L.I Schiff - McGraw Hill 1968
5) Quantum Mechanics-A. Devanathan-Narosa Publishing-New Delhi
6) Principles of Quantum Mechanics-R.Shankar, Springer 2005

Tutorial: (This portion is not intended for examination purpose)

1) Plotting of harmonic oscillator wavefunctions
2) problems involving matrix representations of an operator
3) Alpha emission
4) Kronig-Penney Square-well periodic Potential

ELECTIVE PAPER - 1

ADVANCED ELECTRONICS

Unit-I: Analog and Digital Instruments

Introduction-Basic Emitter Follower Voltmeter; FET Input Voltmeter; Voltage Follower Voltmeter; Amplifier Type OP AMP Voltmeter; Voltage to Current Converter; Current Measurement with Analog Electronic Instrument; Time Base; Basic Digital Frequency Meter System; Reciprocal Counting Technique; Digital Voltmeter System; Digital LCR Measurements.

Unit-II: UJTs and Thyristors

Operational Principle of UJT: UJT Relaxation Oscillator circuit; PNPN Diode: Characteristics- As a Relaxation Oscillator-Rate Effect; SCR: V-I Characteristics – Gate-Triggering Characteristics; DIAC and TRIAC; Thyristors: Basic Parameters- As Current Controllable Devices- Thyristors in Series and in Parallel; Applications of Thyristors-As a Pulse Generator, Bistable Multivibrator, Half and Full Wave Controlled Rectifier, TRIAC based AC power control, SCR based Crowbar Protection; Gate Turn-Off Thyristors; Programmable UJT.

Unit-III: Digital Integrated Circuits

7400 TTL; TTL Parameters; TTL-MOSFET's; CMOS FET's;Three State TTL Devices; External drive for TTL Loads; TTL Driving External Loads; 74C00 CMOS; CMOS Characteristics; TTL to CMOS Interface; CMOS to TTL interface; Current Tracers.

Unit-IV: Integrated Circuits as Analog System Building Blocks

Electronic Analog Computation; Active Filters: Butterworth Filter-Practical Realization-High Pass Filter-Band Pass Filter-Band Reject Filter; Delay Equalizer; Switched Capacitor Filters; Comparators; Sample and Hold Circuits; Waveform Generators: Square Wave Generator-Pulse Generator-Triangle wave Generator-Sawtooth Generator; Regenerative Comparator: Schmitt Trigger.

Unit-V: Integrated Circuits as Digital System Building Blocks

Binary Adders: Half Adder-Parallel Operation-Full Adder-MSI Adder-Serial Operation; Decoder/Demultiplexer: BCD to Decimal Decoder-4-to-16 line Demultiplexer; Data Selector/Multiplexer:16-to-1 Multiplexer; Encoder; ROM:Code Converters-Programming the ROM-Applications; RAM:Linear Selection-Coincident Selection-Basic RAM Elements-Bipolar RAM-Static and Dynamic MOS RAM; Digital to Analog Converters: Ladder Type D/A Converter-Multiplying D/A Converter; Analog to Digital Converters: Successive Approximation A/D Converter.

Books for Study and Reference:

1. Text Book of Electronics by S. Chattopadhyay, New Central Book Agency P.Ltd., Kolkata, 2006.
2. Digital Principles and Applications by A.P. Malvino and D.P. Leach, Tata McGraw-Hill, Publishing Co., New Delhi.
3. Electronics Principles and Applications by A.B. Bhattacharya, New Central Book Agency P.Ltd., Kolkata, 2007.
4. Integrated Electronics Analog and Digital Circuits and Systems by Jacob Millman, Christos C Halkins and Chetan Parikh, 2nd Edition, Tata McGraw Hill Educatio Private Limited, New Delhi, 2010.
5. Electronic Devices and Circuits by Anil K. Maini and VarshaAgarwal, Wiley India Pvt. Ltd. New Delhi, 2009.

Tutorials:

1. A voltage follower voltmeter uses an IC OP AMP with an internal voltage gain of 2,00,000. The maximum voltage applied directly to the non-inverting inputs is E_B=1 volt. Find the percentage error in the measured voltage due to OP AMP.
2. To a digital frequency meter a 3.5 kHz sine wave is applied. The time base is derived from a 1 MHz clock generator frequency divided by decade counters. Find the meter indication when time base uses (i) six decade counters (ii) four decade counters.
3. A unijunction transistor has 10 V between the bases. If the intrinsic stand-off ratio is 0.85, find the value of stand-off voltage. What will be the peak-point voltage if the forward voltage drop in the P-N junction is 0.7 volt?
4. A half-wave rectifier circuit employing an SCR is adjusted so that the gate current becomes 1 mA. The forward breakdown voltage of the SCR is 100 V for I_G=1 mA. Assume that the load resistance is 250 Ω and the holding current to be zero. Calculate the firing angle, conduction angle and the average current when the sinusoidal voltage of 200 volts peak is applied.
5. Design a wide band pass filter with f_L=150 Hz, f_H=1 kHz and a pass band gain of 4. Calculate the value of Q for this filter.
6. A 6-bit DAC has a maximum precision supply voltage of 20 V. What voltage change does each LSB represent and what voltage does 100110 represent?

Practical – 1

ELECTRONICS EXPERIMENTS

1. Study the forward and reverse characteristics of a Zener diode.

2. Construction of adder, subtracter, differentiator and integrator circuits using the given OP – Amp.

3. Study the static and drain characteristics of a JFET.

4. Construction of an Astable multivibrator circuit using transistors.

5. Study the characteristics of UJT.

6. Construction of a single FET amplifier with Common Source configuration.

7. Construction of a relaxation oscillator circuit using the given UJT and study its performance.

8. Construction a single stage RC coupled amplifier using transistor and study its frequency responses.

9. Construction of a two stage RC coupled amplifier using transistor and study its frequency responses.

10. Construction of an A/D converter circuit and study its performance.

11. Construction of an D/A converter circuit and study its performance.

12. Construction of a half-adder and a full-adder circuit using NAND gates and study their performance.

13. Construction of a half- subtracter and full- subtracter circuit using NAND gates.

14. Construction of a bistable multivibrator circuit using transistors and study its performance.

15. Construction of a phase shift oscillator circuit using the given transistor and study its performance.

16. Construction of a Wein's bridge oscillator circuit using transistor and study its performance.

17. Construction of a low-pass filter circuit and study its output performance.

18. Construction of a high-pass filter circuit and study its output performance.

19. Construction of a band-pass filter circuit and study its output performance.

20. Construction of a voltage regulated power supply using Zener diode.

SEMESTER - II

CORE PAPER – 4
MATHEMATICAL PHYSICS - II

Unit –I Probability

Probability-Addition rule of Probability - Multiplication Law of Probability- Probability distribution-Binomial distribution - mean Binomial distribution - Standard deviation of binomial distribution -Poisson distribution - Normal distribution - characteristics of normal distribution - Applications of normal distribution.

Unit – II Complex variables

Complex Algebra- Cauchy-Riemann Conditions-Cauchy's Integral Theorem- Cauchy's Integral formula-Laurent expansion-singularities-Mapping- Conformal mapping- Calculus of residues.

Unit – III Group Theory

Definition of Group - Subgroup, invariant group, abelian group, orthogonal and unitary groups -Homomorphism, isomorphism - Reducible and irreducible representations - Generators of Continuous groups.

Unit – IV Linear vector spaces

Definition and Examples-Real Linear vector space-Uniqueness of Null and Reversed vectors-Scalar Products of Vectors- : Definition of Scalar Product of two vectors, Scalar product for real linear vector spaces, Cauchy-Schwartz inequality-Metric Spaces-Linear Independence of vectors and basis for a vector space-Dimension of a vector space-Orthonormal basis-Vector Subspaces-Direct sum decomposition.

Unit – V Tensor Analysis

Definition of Tensors – Contravariant, covariant and mixed tensors – addition and subtraction of Tensors – Summation convention- Symmetry and Anisymmmetry Tensor – Contraction and direct product – Quotient rule- Pseudotensors, Levi-Civita Symbol - Dual tensors, irreducible tensors-Metric Tensors-Christoffel symbols – Geodesics.

Books for Study and Reference

1. Mathematical Methods for Physicists - Arfken & Weber Elsevier 6th edition 2010.
2. Topics in Mathematical Physics - Parthasarathy H Ane Books Pvt. Ltd 2007
3. Mathematical Physics -S.D. Joglekar (Universities Press Pvt.Ltd.) 1st Edition 2005
4. Mathematical Physics - H.K. Dass and R. Verma (S. Chand & Company) 2nd Ed. 2001
5. Advanced Engineering mathematics - Erwin Kreyszig (Wiley Eastern) 7th Edition 1993
6. Mathematical Physics - B.D. Gupta (Vikas Publishing House Pvt.Ltd) 3rd Edition 2006

CORE PAPER - 5

QUANTUM MECHANICS - II

Unit I Time Dependent Perturbation Theory

Time Dependent Perturbation Theory-First and Second Order Transitions-Transition to Continuum of States-Fermi Golden Rule-Constant and Harmonic Perturbation- Collision-Adiabatic and Sudden Approximation- A Charged Particle in an Electromagnetic Field.

Unit II Scattering Theory

Scattering Amplitude - Expression in terms of Green's Function - Born Approximation and Its validity- Partial wave analysis - Phase Shifts – Asymptotic behaviour of Partial Waves-The Scattering Amplitude in Terms of Phase Shift- Scattering by Coulomb Potential and Yukawa Potential.

Unit III Theory of Radiation (Semi Classical Treatment)

Einstein's Coefficients-Spontaneous and Induced Emission of Radiation from Semi Classical Theory-Radiation Field as an Assembly of Oscillators-Interaction with Atoms-Emission and Absorption Rates-Density Matrix and its Applications.

Unit IV Relativistic Wave Equation

Klein Gordon Equation-Plane Wave Equation-Charge and Current Density-Application to the Study of Hydrogen Like Atom-Dirac Relativistic Equation for a Free Particle-Dirac Matrices -Dirac Equation in Electromagnetic Field - Negative Energy States.

Unit V Quantum Field Theory

Quantization of Wave Fields- Classical Lagrangian Equation-Classical Hamiltonian Equation - Field Quantization of the Non-Relativistic Schrodinger Equation-Creation, Destruction and Number Operators-Anti Commutation Relations-Quantization of Electromagnetic Field Energy and Momentum.

Books for Study & Reference:

1. Text Book of Quantum Mechanics -P.M. Mathews & K. Venkatesan-Tata McGraw Hill 2010
2. Quantum Mechanics – G Aruldhas - Prentice Hall of India 2006
3. Introduction to Quantum Mechanics – David J.Griffiths Pearson Prentice Hall, 2005
4. Quantum Mechanics – A Devanathan - Narosa Publishing-New Delhi
5. Quantum Mechanics – L.I Schiff - McGraw Hill 1968
6. Quantum Mechanics - A.K. Ghatak and S. Loganathan-McMillan India
7. Principles of Quantum Mechanics - R.Shankar, Springer 2005
8. Quantum Mechanics – Satya Prakash- Kathar Nath Ramnath – Meerut

Tutorial: (This portion is not intended for examination purpose)

1) Difference in collision process between Classical and Quantum identical particles.
2) Absorption and Emission of Radiation and its Selection Rules
3) Phase shift: Optical Theorem - Relation to the Potential- Potentials of finite Range
4) Partial Wave Analysis of Scattering from standard simple potential;
5) Application of TD perturbation theory to semi classical theory of Radiation

CORE PAPER – 6
CONDENSED MATTER PHYSICS

Unit – I: Fundamentals of Crystallography and Diffraction

Crystalline state – Basic definitions – Bravais lattices and crystal systems – Elements of symmetry – Crystal directions – Miller indices - Simple Crystal structures (NaCl, CsCl, Hexagonal close packed structure, Diamand structure, Cubic ZnS structure).

Bragg's Law – Scattering from an atom - Scattering from a crystal – Reciprocal lattice and X-ray diffraction - Diffraction conditions and Bragg's law – The Rotating Crystal method – The Laue method – The Powder method – Neutron Diffraction

Unit – II: Bonding in solids

Forces between atoms – Ionic bonding – Bond dissociation energy of NaCl molecule – Cohesive energy of ionic crystals – Evaluation of Madelung constant for NaCl structure – The Born-Haber Cycle – Covalent bonding – Metallic bonding – Hydrogen bonding – Van Der Waals bonding.

Unit- III: Crystal Imperfections and Atomic Diffusion

Point imperfections – Concentrations of Vacancy, Frenkel and Schottky imperfections – Line Imperfections – Burgers Vector – Presence of dislocation – surface imperfections- Polorans – Excitons.

Ficks first and second law - solutions to Ficks second law – Applications of diffusion – Diffusion mechanism – Random walk treatment of diffusion – Kirkendall effect - diffusion in alkali halides - ionic conductivity in alkali halides.

Unit –IV: Free electron theory of metals and Phonons

The Drude model for electrical conductivity and thermal conductivity of metals - Lorentz modification of the Drude model, Fermi-Dirac distribution function - the electron heat capacity - The sommerfield theory of electrical conduction in metals – Matthiessen's Rule – Thermoelectric effect.

Vibrations of crystals with monoatomic basis – Quantization of elastic waves – Phonon momentum – Phonon heat capacity – Density of states in 1D and 3D – Debye model for density of states – Debye T^3 law – Einstein model of the density of states.

Unit –V: Band theory and Fermi surfaces

Bloch theorem - The Kronig Penney Model - construction of one, two and three dimensional Brillouin zones - Extended, Reduced and Periodic zone schemes - Effective mass of an electron - The nearly free electron model - Tight binding model – The Pseudopotential method

Harrison's method of constructing Fermi surfaces – Fermi surface in metals - effect of electric and magnetic fields on Fermi surfaces – quantization of electron orbit – Anomalous skin effect – the cyclotron resonance – de Haas Van Alphen effect.

Books for Study and Reference

1. Elementary Solid State Physics: Principles and Applications, 4th Ed., M.A.Omar, Pearson Education Pvt. Ltd., Delhi, India, 2004.

2. Solid State Physics: Structure and Properties of Materials, 2nd Ed. A.M.Wahab, Narosa Publishing house, New Delhi, India, 2007.
3. Introduction to Solid State Physics, 7th Ed, C. Kittel, John –Wiley & Sons (Asia) Pvt Ltd., New Delhi, 1996.
4. Elements of Solid State Physics 2nd Ed, J.P.Srivastava, Printice Hall of India, New Delhi, 2001.
5. Solid State Physics, 4th Ed. S.O.Pillai, New Age International Publishers, New Delhi, 2001.
6. Solid State Physics, 1st Ed, Ashcroft and Mermin, Eastern Press Pvt Ltd, Bangalore, 2003.
7. Introductory to Solid State Physics 2nd Ed, H.P.Myers, Taylors and Francis Ltd, London, 1998.

Tutorials:

1. Calculate the number of atoms per unit cell for rock salt crystal. Given a = 5.63A^o, Mol. wt of NaCl = 58.5 and the density is 2180kg/m^3
2. Calculate the glancing angle on the plane (110) of a cube rock salt (a=2.81 A^o) corresponding to second order diffraction maximum for the X-rays of wavelength 0.71 A^o.
3. If the ionic radius of Na decreases by 0.88 and that of Cl increases by 0.89, calculate the binding energy of NaCl. Madelung constant for NaCl is 1.75 and n=9 for ionic crystals. Express your result in kJ/mol [r_{Cl} = 0.0905nm and r_{Na} = 0.186nm].
4. Calculate the spacing between dislocations in a tilt boundary in fcc copper crystal, when the angle of tilt is 10^o (Burgers vector = 2.6 A^o)
5. Use the Free electron theory to calculate the Fermi energy of Na and Al metals. Their lattice constants are 4.3 A^o and 4.0 A^o respectively.
6. The Fermi energy of Al is 12 eV and its electrical conductivity is 3 x 10^{-8} Ωm. Calculate the mean free path of the conduction electrons and their mean drift velocity in a field of 1000 Vm^{-1}. (For Al, the atomic weight = 27 and density = 2700 kg/m^3
7. The Fermi energy of copper is 7 eV. Calculate (a) The Fermi momentum of electron in copper, (b) the de Broglie wavelength of the electron and (c) the Fermi velocity.

ELECIVE PAPER – 2

THERMODYNAMICS AND STATISTICAL MECHANICS

Unit – I Thermodynamics, Microstates and Macrostates

Basic postulates of thermodynamics – Fundamental relations and definition of intensive variables – Intensive variables in the entropic formulation – Equations of state – Euler relation, densities - Gibbs-Duhem relation for entropy - Thermodynamic potentials – Maxwell relations – Thermodynamic relations – Microstates and macrostates – Ideal gas – Microstate and macrostate in classical systems – Microstate and macrostate in quantum systems – Density of states – Volume occupied by a quantum state

Unit – II Microcanonical, Canonical and Grandcanonical Ensembles

Microcanonical distribution function – Two level system in microcanonical ensemble – Gibbs paradox and correct formula for entropy – The canonical distribution function – Contact with thermodynamics - Partition function and free energy of an ideal gas – Distribution of molecular velocities – Equipartition and Virial theorems – The grand partition function – Relation between grandcanonical and canonical partition functions – One-orbital partition function

Unit – III Bose-Einstein, Fermi-Dirac and Maxwell-Boltzmann Distributions

Bose-Einstein and Fermi-Dirac distributions – Thermodynamic quantities – Fluctuations in different ensembles – Bose and Fermi distributions in microcanonical ensemble - Maxwell-Boltzmann distribution law for microstates in a classical gas - Physical interpretation of the classical limit – Derivation of Boltzmann equation for change of states without and with collisions – Boltzmann equation for quantum statistics – Equilibrium distribution in Boltzmann equation

Unit – IV Bose Gas and Fermi Gas

Non-interacting Bose gas and thermodynamic relations – Chemical potential of bosons – pressure and energy density of bosons – Black body radiations and Planck's distribution law – Number density of photons and Bose condensation - Thermodynamic relations for non-interacting Fermi gas – Fermi gas at zero temperature – Fermi energy and Fermi momentum – Pressure and energy density – Fermi gas at low temperature – Massless Fermi gas at any temperature, Particles and antiparticles

Unit – V Heat capacities, Ising model and Phase Transitions

Heat capacities of heteronuclear diatomic gas – Heat capacities of homonuclear diatomic gas – Heat capacities of solids; Dulong and petit law, Einstein temperature and Debye theory – Heat capcities of metals – Heat capacitiy of Bose gas – One-dimensional Ising model and its solution by variational method – Exact solution for one-dimensional Ising model - Phase transitions and criterion for phase transitions – Classification of phase transitions by order and by symmetry – Phase diagrams for pure systems

Books for study and Reference

1. An Introductory Course of Statistical Mechanics - Palash B. Pal, Narosa Publishing House (2008), New Delhi
2. Elements of Statistical Mechanics - Kamal Singh & S.P. Singh - S. Chand & Company, New Delhi.
3. Statistical Mechanics An Elementary Outline – Avijit Lahiri – University Press - 2002- Hyderabad

Tutorial: (This portion is not intended for examination)

1. Show explicitly that Gibbs paradox disappears when the correction is included.
2. Obtain free energy of linear harmonic oscillator through thermodynamic quantities
3. Derive Helmholtz free energy in terms of T, H and N.
4. Derive entropy, energy and heat capacity of a two level system when the temperature is zero and infinity.
5. Estimate the critical temperature for Bose condensation for ^{4}He atoms. Take g=1 and n=3X10^{22} cm^{-3}.
6. Calculate energy density and number density of massless Fermi gas at any temperature when chemical potential is equal to zero and chemical potential is equal to some arbitrary value

Practical – 2

ADVANCED PHYSICS EXPERIMENTS

1. Young's modulus – Corn`s Method
2. Cauchy's Constant and dispersive power of a prism
3. Polarizability of Liquids
4. Frank Hertz Experiment
5. Electron Spin Resonance Spectrometer Experiment
6. Four Probe Method –Determination of resistivity of semiconductor at different temperatures
7. Hysteresis Loop Tracer Experiment
8. Ultrasonic Interferometer Experiment
9. Michelson Interferometer Experiment – I
10. Michelson Interferometer Experiment – II
11. GM Counter Experiment – I
12. GM Counter Experiment - II
13. Compact microwave training system Experiment
14. Determination of optical absorption coefficient and determination of refractive index of the liquids using He-Ne - Laser
15. Refractive index of liquids – Using – He-Ne Laser/Diode Laser
16. Determination of Ultrasonic velocity in an given liquid for a fixed frequency
17. Photosensitive devices
18. Hall effect in semiconductor
19. Young's modules – elliptical fringe method
20. Young's modules – Hyperbolic fringe method

SEMESTER – III

CORE PAPER – 7
ADVANCED CONDENSED MATTER PHYSICS

Unit – I: Theory of Semiconductors

Intrinsic and extrinsic semiconductors - Free carrier concentration in semiconductors – Fermi level and carrier concentration in semiconductors – Mobility of charge carriers – Effect of temperature on mobility – electrical conductivity of semiconductors – Hall Effect in semiconductors – Junction properties.

Unit – II: Theory of Dielectrics, Piezoelectrics and Ferroelectrics

Dipole moment – Polarization – the electric field of a dipole – local electric field at an atom – Clausius –Mosotti equation - Dielectric constants and its measurements - Polarizability – The Classical theory of electronic polarizability – dipolar polarizability – Ferro electricity – Dipole theory of ferroelectricity – Piezoelectricity.

Unit – III: Magnetic Properties of Materials

Terms and definitions used in magnetism – Classification of magnetic materials – theory of diamagnetism – Langevin theory of paramagnetism - Weiss theory – Paramagnetic susceptibility of a solid – Quantum theory of paramagnetism – Determination of susceptibility of para and dia magnetism using Gouy method - Ferromagnetism – Spontaneous magnetization in ferromagnetic materials – Quantum theory of ferromagnetism – Weiss Molecular field – Curie-Weiss law – Ferromagnetic domains – The Domain Model – Domain theory – Antiferromagnetism – Ferrimagnetism – Structure of Ferrite.

Unit – IV: Superconductivity

Sources of superconductivity – The Meissner effect – Thermodynamics of superconducting transitions – Origin of energy gap – London equations –London Penteration depth – Type I and Type II Sueprconductors - Coherence length – BCS theory – Flux quantization – Theory of DC and AC Josephesen effect – Potential applications of superconductivity.

Unit – V: Optical Processes and Excitons

Optical reflectance: Kramers-Kronig relations – Electronic interband transitions, Excitons: Frenkel excitons – Weakly bound excitons – Exciton condensation into electron hole drops, Raman effect in crystals – Electron spectroscopy with X-rays – Energy loss of fast particles in solids

Absorption processes- Photoconductivity – Photoelectric effect – Photovoltaic effect – Basics of Photoluminescene – Colour centres – Types of colour centres – Generation of colour centres.

Books for Study and Reference:

1. Solid State Physics: Structure and Properties of Materials, 2nd Ed. A.M.Wahab, Narosa Publishing house, New Delhi, India, 2007.
2. Elementary Solid State Physics: Principles and Applications, 4th Ed., M.A.Omar, Pearson Education Pvt. Ltd., Delhi, India, 2004.
3. Introduction to Solid State Physics, 7th Ed, C. Kittel, John –Wiley & Sons (Asia) Pvt Ltd., New Delhi, 1996.

4. Elements of Solid State Physics 2nd Ed, J.P.Srivastava, Printice Hall of India, New Delhi, 2001.
5. Solid State Physics, 4th Ed. S.O.Pillai, New Age International Publishers, New Delhi, 2001.
6. Solid State Physics, 1st Ed, Ashcroft and Mermin, Eastern Press Pvt Ltd, Bangalore, 2003.
7. Introductory to Solid State Physics 2nd Ed, H.P.Myers, Taylors and Francis Ltd, London, 1998.

Tutorials:

1. In an intrinsic semiconductor, the effective mass of an electron is 0.07 m_o and that of hole is 0.4 m_o, where m_o is the rest mass of the electron. Calculate the intrinsic concentration of charge carriers at 300 K. (Given the energy gap = 0.7 eV)
2. If a sample of silicon is doped with 3 x 10^{23} arsenic atoms and 5 x 10^{23} atoms of boron. Determine the electron and hole concentrations if the intrinsic charge carriers of silicon are 2 x 10^{16}/ m^3
3. The polarizability of NH_3 molecule in the gaseous state, from the measurement of dielectric constant is found to be 2.42 x 10^{-39} Fm^2 at 309 K and 2 x 10^{-39} Fm^2 at 448 K, respectively. Calculate for each temperature the polarizability due to permanent dipole moment and due to deformation of molecules.
4. The magnetic field intensity in a piece of ferric oxide is 10^6 ampere/metre. If the susceptibility of the material at room temperature is 1.5 x 10^{-3}, calculate the flux density and magnetization of the materials.
5. The critical temperature for mercury with isotopic mass 199.5 is 4.185K. Calculate its critical temperature when its isotopic mass changes top 203.4
6. The penetration depths for lead are 396 A^o and 1730 A^o at 3 K and 7.1K, respectively. Calculate the critical temperature for lead.
7. Diamond (atomic weight of carbon = 12) has Youngs modulus of 10^{12} Nm^{-2} and a density of 3500 kg/m^3. Compute the Debye temperature for diamond.
8. A photon of wavelength 1400 A^o is absorbed by cold mercury vapour and two other phonons are emitted. If the wavelength of one of them is 1850 A^o, what is the wavelength of the other photon?

CORE PAPER – 8
COMPUTATIONAL METHODS AND PROGRAMMING

UNIT – I Roots of equation

Bisection method – False position method – Newton Raphson method – Basic Gauss elimination method – Gauss elimination with partial pivoting – Gauss Jacobi iteration method – Gauss Seidal iteration method – Inversion of a matrix using Gauss elimination method – LU decomposition.

UNIT – II Eigen values and Interpolation

Power method to find dominant eigen value - Inverse power method to find all eigen values – Jacobi method – (only 2x2 and 3x3 matrices) Forward and Backward differences – Gregory Newton forward and backward interpolation formula for equal intervals – Divided difference – properties of divided differences – Newton's divided differences formula – Lagrange's interpolation formula for unequal intervals.

UNIT – III Numerical integration and differences

Method of least squares – straight line, parabola , $y = ax^n$, $y = ae^{bx}$, $y = a+bx^n$ type curves – sum of squares of residuals for straight line and parabola fit – Newton's forward and backward differences formula to get the derivatives (First and Second order) - Divided differences table to calculate derivatives for unequal intervals Newton – cotes formula – (Trapezoidal rule, Simpson's rule, Simpson's 3/8 rule, Boole's rule) – Error estimates in trapezoidal and Simpson's rule.

UNIT – IV Differential Equation

Basic Euler method – Improved Euler method – Modified Euler method – Runge Kulta fourth order method – RK4 method for simultaneous first order differential equation RK4 Method for second order differential equation – partial differential equation – Difference – quotients – Graphical representations of partial quotients – Classification of partial differential equation of the second order – standard and diagonal five point formula for laplace equations – solution of laplace's equation (Liebmann's iterations process).

UNIT – V Fortran Programming

Fortran programming – Flowcharts – Fortran constants Fortran variables – subscripted variables – Input – Output statement – Control statement (Do, If, Goto structures) subprograms – Function subprogram – subroutine subprograms simple applications like, Ascending, descending order, matrix manipulation, character handling, trapezoidal & Simpson's rule.

****** For iteration methods problems not exceeding 10 iterations.

TEXT AND REFERNCE BOOKS

1. K. Venkataraman, "Numerical methods in science and engineering", National publishing company , Madras – 1996.
2. P. Kandasamy, K. Thilgavathy, K. Gunavathy, "Numerical methods", S. Chand & Company Ltd., New Delhi, 2007.
3. E. Balagurusamy, "Numerical methods", Tata McGraw Hill Publishing Company Ltd, New Delhi, 2006.
4. Rajaraman, Fortran Programming.
5. John H. Mathews, "Numerical methods for mathematics, science and Engineering, Prentice Hall of India Pvt. Ltd., New Delhi 2000.
6. T.Veerarajan and T. Ramachandran "Numerical methods" Tata McGraw Hill, New Delhi, 2008.

ELECTIVE PAPER – 3

SEMICONDUCTOR DEVICES

Unit-I Semiconductor Basics

Formation of Energy bands – Kronig-Penny model – *k*-Space diagram – Electron effective mass – Concept of holes – Density of states function – Fermi-Dirac probability function and distribution - Equilibrium distribution of electrons and holes in intrinsic semiconductors – the n_0 and p_o equations - intrinsic Fermi level position- dopant energy levels – Equilibrium distribution of electrons and holes in extrinsic semiconductors - Degenerated/Non-degenerated semiconductors.

Unit- II Transport Properties

Drift current density – Mobility Effect – Conductivity – Diffusion Current Density – Total Current Density – Graded Impurity Distribution and induced electric field– the Einstein relation - The Hall Effect – Carrier Generation and Recombination – Continuity Equations – time dependent diffusion equation - Basics of ambipolar effect and its transport equation – Haynes-Shockley Experiment.

Unit- III Metal-semiconductor contact theory & Devices

Metal-semiconductor contact: The Schottky barrier formation - its characteristics and junction properties - Non-ideal effects on the barrier height - Current voltage relationship - Ideal non-rectifying barriers - specific contact resistance - Basics Hetero-junction and 2DEG formation – MESFET device structure and principles of operation – MESFET current voltage characteristics – MODFET fundamentals and current voltage characteristics.

Unit- IV Metal-Oxide-Semiconductor contact theory & Devices

MOS structure and its energy band diagram - Depletion layer thickness - work function differences - Flat band voltage - charge distribution – capacitance-voltage characteristics and frequency effects – Fixed oxide and interface charge effects – MOSFET structure and principle of operation – MOSFET current-voltage characteristics relationship- substrate bias effects.

Unit-V Theory of Microwave and Optoelectronic Devices

Tunnel diodes - Impact diodes and its static and dynamic characteristics – Transferred Electron devices (TED): negative differential resistance – TED device operation; Quantum effect devices (QED): Resonance tunnel diode –unipolar resonant tunneling transistor - Visible and Infrared LEDs (Device structure and Working principle) – Semiconductor lasers (device structure, laser operation, optical confinement) – basics of quantum well lasers – photoconductor & photodiode (device structure&working principle) – PN junction solar cells.

Text Book

1. Semiconductor Physics and Devices (Third Editio) by Donald A. Neamen (the McGraw-Hill companies)
2. Semiconductor devices Physics and Technology (2nd Edition) by S. M. Sze (Wiley Student Edition).(For Vth unit)

Tutorial

1. Measurement of Metal/ Semiconductor barrier height
2. Application of Possion's equation in Semiconductor devices
3. Depletion width calculations
4. Construction of equivalent circuits for devices like MOSFET, MESFET, JFET and determination of noise figure.

CORE PAPER – 9

ELECTROMAGNETIC THEORY

Unit I: Electrostatics

Columb's law – surface, line and volume charge distributions - Gauss' Law and its applications; Electrostatic potential - Laplace and Poisson equations – Potential of a localised charged distributions – Laplace equation in one, two and three dimensions – Boundary conditions and Uniqueness theorems.

Unit II: Magnetostatics

Lorentz force law- Biot-Savart law – condition for steady electric current - Ampere's law – Application of Ampere's law – comparison of Magnetostatics and Electrostatics – Magnetic vector and Scalar potential – Magneto static boundary conditions

Unit III: Electrodynamics

Electromotive force – ohms law – Faradays law – Induced electric field – Energy in magnetic fields – Maxwell's equation in free space – Magnetic charge - Maxwells equation in matter – Boundary conditions - Conservation laws – Conservation of energy – Poynting's theorem - conservation of momentum .

Unit IV: Electromagnetic waves & interaction with matter

Electromagnetic waves in vacuum – Energy and momentum of EMW – EMW in matter – Propagation in linear media – Reflection and transmission at Normal incidence – Reflection and Transmission at Oblique incidence – Implications: Laws of incidence and reflectance, snell's law, Brewster law – Freshnel's equations.

Unit V: Applications – Plasma Physics

Plasma – Plasma criteria – Debye shielding (DC current) – Plasma frequency (AC shielding) – Motion charge particles in uniform E and B field - non uniform B field – non uniform E field – time varying E field – time varying B field – guiding centre drifts – plasma confinement

Books for Study and Reference:

1. Introduction to Electrodynamics , David J. Griffiths
2. Feyman Lectures, Vol. 2, Richard Feyman
3. Classical Electrodynamics, J.D. Jackson
4. Classical Electrodynamics, Hans Ohanian (ISBN-13:9780977858279) (ISBN-10:0977858278)

Tutorials:

1. Calculation of electric field around a charged sphere and wire
2. Representation of Divergence, Curl and gradient into Spherical and cylindrical co-ordinates

PRACTICAL -3

COMPUTATIONAL PROGRAMMING LAB

1. Ascending and descending order of numbers and characters
2. Matrix addition, subtraction and multiplication
3. Transpose of a matrix
4. Evaluating a root of non-linear equation by Newton-Raphson method using external function
5. Program to solve system of linear equations using simple Gaussian elimination method
6. Program for straight line fit using the method of least squares for a table of data points
7. Program for polynomial curve fitting
8. Program to integrate any function or tabulated data using trapezoidal rule
9. Program to integrate any function or tabulated data using Simpson's rule
10. Program to compute the solution of a first order differential equation of type y'=f(x,y) using the fourth order Runge-Kutta method
11. Program to compute the interpolation value at a specified point, given a set of data points using Lagrangian interpolation representation
12. Program to compute the interpolation value at a specified point, given a set of data points using Newton's interpolation representation
13. Program to calculate and print the mean, variance and standard deviation of set of N numbers
14. Program to solve the quadratic equation
15. Program to read a set of numbers, count them and find and print the largest and smallest numbers in the list and their positions in the list

SEMESTER – IV

CORE PAPER – 10

MODERN OPTICS

Unit-I: Polarization and Double Refraction

Linearly and circularly polarized waves-Transverse character of light waves-Polarizer and Analyser; Production of polarized light: The wire grid polarizer and the polaroid-Polarization by Reflection-Polarization by Scattering; Malus' law; The phenomenon of double refraction: Normal and oblique incidence; Interference of polarized light: Quarter and half wave plates; Analysis ofpolarized light; Optical activity.

Unit-II: Lasers

Basic principles-Spontaneous and stimulated emissions, components of a laser, Optical amplification, Resonator and Lasing Action; Types of Lasers-Solid State Lasers-Ruby laser, Nd:YAG laser; Gas lasers-He-Ne laser, CO_2 laser; Semiconductor lasers-central features and laser action; Liquid laser, Dye laser and Chemical lasers.

Unit-III: Fiber Optics

Total Internal Reflection; The Optical Fiber; Glass fibers-the coherent bundle; The numerical aperture; Attenuation in Optical Fibers; The attenuation limit; Single mode and Multi-mode fibers; Pulse dispersion in multimode Optical Fibers; Ray dispersion in multimode step index Fibers; Parabolic-index Fibers; Material dispersion; Dispersion and Maximum bit rates; Fiber-Optic Sensors.

Unit-IV: Non-Linear Optics

Basic Principles; Harmonic Generation-Second Harmonic Generation; Phase Matching; Third Harmonic Generation; Optical Mixing; Parametric Amplification; Self-Focusing of Light.

Unit-V: Magneto-Optics and Electro-Optics

Magneto-Optical Effects; Zeeman Effect; Faraday Effect; Voigt Effect or Magnetic double refraction; Cotton-Mouton Effect; Kerr Magneto-Optic Effect. Electro-Optical Effects; Stark Effect; Electric double refraction; Kerr Electro-Optic Effect; Pockels Electro-Optic Effect.

Books for Study and Reference:

1. Optics by AjoyGhatak, 3rd Edition, Tata McGraw-Hill Publishing Co., New Delhi, 2005.
2. Lasers and Non-Linear Optics by B.B. Laud, Wiley Eastern Ltd., New Delhi, 1985.
3. Fundamentals of Optics by F.A. Jenkins and H.E. White, 4th Edition, McGraw-Hill International Edition, London, 1981.
4. Optics, Light and Lasers by Dieter Meschede, Wiley-VCH, Verley GmbH, 2004.
5. Optical Physics by S.G. Lipson, H. Lipson and D.S. Tannhauser, 3rd Edition, Cambridge University Press, 1996.

Tutorials:

1. A left circularly polarized beam (λ_0=5893 Å) is incident normally on a calcite crystal (with its optic axis cut parallel to the surface) of thickness 0.005141 mm. What will be the state of polarization of the emergent beam?

2. In a CO_2 laser ($\lambda_0 \approx 10.6$ μm) the laser transition occurs between the vibrational states of the CO_2molecule. At T ≈500 K, calculate the Doppler line width $\Delta\nu_D$ and $\Delta\lambda_D$ [$M_{CO2} \approx 44\ M_H$].

3. For a step-index multimode fiber, n_1=1.5 and Δ=0.015. Calculate n_2, NA and the maximum acceptance angle.

4. A 5 mW laser beam passes through a 26 km fiber of loss 0.2 dB/km. Calculate the power at the output end.

5. Consider a parabolic index multimode fiber with $n_1 = 1.46$, $\Delta = 0.01$ operating at 850 nm with an LED of spectral width 20 nm. Calculate the intermodal dispersion, material dispersion and maximum bit rate.

CORE PAPER – 11 NUCLEAR AND PARTICLE PHYSICS

Unit 1: Nuclear force ad Binding

Properties of Nuclear Force – Ground state properties of Deuteron – Square well solution of Deuteron – Low energy, neutron proton scattering - Limits of energy for the scattering of different partial waves - Binding energy - Weizacker's semi empirical mass formula – Application of semi empirical formula for alpha decay – mass parabola for stability of nuclei against beta decay - Evidence of shell effects – Single particle energy levels for infinite square well, harmonic oscillator with spin orbit potential – Application of shell model for spin and parity

Unit 2: Radioactive disintegration

Properties of radioactive rays – Law of radioactivity – Half life and mean life- Radioactive equilibrium - Radioactive series - Range of alpha particles – Alpha spectrum and Fine structure - Alpha-Particle Disintegration Energy- Gamow's theory of Alpha decay – Energetics of Beta decay - Beta-Ray Spectra- Pauli's neutrino hypothesis – Properties of neutrino - Gamma emission – Selection rules – internal conversion - Fission process on the basis of liquid drop model - Nuclear fission energetics - Stability limits against spontaneous fission – Potential for fission - Bohr-Wheeler model

Unit 3: Nuclear reactions

Types of nuclear reaction – Conservation laws in nuclear reactions – Balance of Mass and Energy in nuclear reactions – The Q equation and its solution – Proton, deuteron, neutron and alpha induced reactions – Cross section of nuclear reactions - Separation of center of mass motion in two body problem – Partial wave method for scattering and reaction cross section – Compound nucleus hypothesis – Breit Wigner one level formula

Unit 4: Neutron Physics and detectors

Properties of neutron – Classification of neutrons according to energy – Sources of neutron – Neutron detectors – Neutron multiplication and fission chain reaction – Four factor formula – Reactor materials – Geiger Muller counter –Semi conductor detectors (Diffused junction detector, Surface barrier detector) – Uses of semiconductor detectors – Scintillation detector

Unit 5: Particle Physics

Meson Physics – Yukawa's hypothesis – Properties of Pi mesons - Classification of elementary particles — Particle Interaction types – Feynman diagram for electromagnetic interaction, np interaction, weak decays - Symmetry and Conservation laws – Energy and momentum – Angular momentum – Parity – Baryon number – Leptron number – Isospin – Strangeness and Charm – Quark model – Isospin versus strangeness chart (Super multiplet) of mesons and baryons, three quark triplet, quark anti quark couplings

Books for Study and Reference

1. Nuclear Physics – S.N. Ghosal, S. Chand Company Ltd (2010)
2. Nuclear Physics – D.C. Tayal, Himalaya Publishing House Ltd.,
3. Nuclear Physics an Introduction – S.B. Patel, New Age international Publishers, 2009
4. Introductory Nuclear Physics – K.S. Krane, Wiley India Ltd.,
5. Nuclear Physics – I. Kaplan, Narosa Publishing House 2002

Tutorial

1. Estimate Q values of alpha decay using Weizacker mass formula
2. Calculate the most stable Z value of an isobaric family
3. Study the magnetic and quadrupole moment using shell model
4. Estimate the half life of ^{235}U using WKB method
5. Prove that the Deuteron doesn't have excited sates.

CORE PAPER – 12
ATOMIC PHYSICS AND MOLECULAR SPECTROSCOPY

Unit-I Microwave and Raman Spectroscopy

Rotation of molecules and their spectra – diatomic molecules – intensity of line spectra – the effect of isotropic substitution – non-rigid rotator and their spectra – polyatomic molecules (linear and symmetric top molecules) – Classical theory of Raman effect - pure rotational Raman spectra (linear and symmetric top molecules).

Unit-II Infra-red and Raman Spectroscopy

The energy of diatomic molecules – Simple Harmonic Oscillator –the Anharmonic oscillator – the diatomic vibrating rotator – vibration-rotation spectrum of carbon monoxide – breakdown of Born-Oppenheimer approximation – the vibrations of polyatomic molecules – influence of rotation on the spectra of polyatomic molecules (linear and symmetric top molecules) – Raman activity of vibrations – vibrational Raman spectra – vibrations of Spherical top molecules.

Unit-III Electronic Spectroscopy of Atoms

Electronic wave function and atomic quantum numbers – hydrogen spectrum – orbital, spin and total angular momentum - fine structure of hydrogen atom – many electron spectrum: Lithium atom spectrum, angular momentum of many electrons – term symbols – the spectrum of helium and alkaline earths – equivalent and non equivalent electrons – basics of X-ray photoelectron spectroscopy.

Unit-IV Electronic Spectroscopy of Molecules

Diatomic molecular spectra: Born-Oppenheimer approximation – vibrational spectra and their progressions – Franck-Condon principle – dissociation energy and their products – rotational fine structure of electronic-vibration transition - molecular orbital theory – the spectrum of molecular hydrogen – change of shape on excitation – chemical analysis by electronic spectroscopy – reemission of energy – fundamentals of UV photoelectron spectroscopy.

Unit-V Spin Resonance Spectroscopy

Spin and magnetic field interaction – Larmor precession – relaxation time – spin-spin relaxation - spin–lattice relaxation - NMR chemical shift - coupling constants – coupling between nuclei – chemical analysis by NMR – NMR for nuclei other than hydrogen - ESR spectroscopy - fine structure in ESR.

Books for Study and Reference

1. Fundamentals of Molecular Spectroscopy by Colin N. Banwell and Elaine M. McCash (Tata McGraw-Hill Publishing Company limited)

2. Physical method for Chemists (Second Edition) by Russell S. Drago (Saunders College Publishing)

Practicals- 4

OPTICS AND LASER LABORATORY

1. Determination of numerical aperture of an optical fiber.
2. Determination of wavelength of a laser source using diffraction grating.
3. Determination of diameter of a thin wire.
4. Determination of diameter of a pin hole.
5. Determination of the width of the slit.
6. Determination of particle size.
7. Determination of least count of a meter scale.
8. Determination of the beam-spot size.
9. Determination of focal length of a given lens.
10. Measurement of the divergence of a laser beam.
11. Verification of Malus law.
12. Determination of wavelength of a laser by Michelson Interferometer method.
13. Determination of the thickness of sleeve on a fine wire.
14. Experiment on Magneto-optical effect using laser source.
15. Experiment on Faraday effect with He-Ne laser source.
16. Direct reading of Zeeman effect (e/m of an electron) with a laser source.
17. Fabry-Perot Interferometer.
18. Twyman-Green Interferometer.
19. Reyleigh Interferometer.
20. Experiment on Holography.

SUPPORTIVE

PAPER 1 BASIC ELECTRONICS

(for the students from other departments)

Unit I Electrical and Electronic Components

Electricity and power - Ohm`s law - Ammeter and Voltmeter - Multimeter -Resistors - Capacitors - Transformer – Inductor – Alternating current simple circuits - Diode – Transistors –UJT, SCR, Thyristor, FET, and MOSFET and their applications – Integrated circuits – operational amplifiers; Inverting, noninverting

Unit II Application of Electronics

Radio Communication – satellite communication – Radar communication - Cathode ray oscilloscope – Elements of Television system- Strain gauge

Books for Study and Reference

1. Electronics Fundamental and application – D Chattopadhyay and P C Rakshit New age International Pvt. Ltd. 2nd edition 2000

2. Basic Electronics and Linear Circuits- N N Bhargava D C Kulshrestha, S C Gupta Tata McGraw-Hill Publishing Company 33rd edition 2002

3. Electronic Principles – Albert Paul Malvino Tata McGraw-Hill Publishing Company 6th edition 1999

SUPPORTIVE

PAPER 2 ENERGY RESOURCES

(for the students from other departments)

UNIT - I

General: Energy Consumption as a measure of prosperity, world energy future.

Energy Sources and their availability (Conventional):

Coal, Oil, Organic wastes, Water power, Nuclear power, Thermal and breeder Reaction.

UNIT - II

Non – Conventional or Renewable Energy:

a) Solar Energy

Flat Plate Collector

Point Focusing Collector

Advantages and Disadvantages of Solar energy

Applications of Solar energy

b) Wind Energy

Wind Energy Conversion

Advantages and Disadvantages of Wind Energy Conversion

c) Utilization of H_2 gas

Safety Management

H_2 technology in India

d) Energy from Bio-mass and Bio-gas

e) Ocean Thermal Energy

f) Basic Principle of Tidal power, Advantages and limitations, Prospects of Tidal Energy in India

g) Geothermal Energy

h) Energy Storage

(i) Electrical Storage
(ii) Chemical Storage

i) Fuel cells