PHYSICS

Quantum Mechanics & Applications

THIRD YEAR SCIENCE – FIFTH SEMESTER
PHYSICS (HONOURS)
PAPER - XI (THEORY) [C-XI THEORY]

Full Marks - 60

Time – 3 Hours

(All units carry equal marks)

Unit-I

Schrodinger equation & the operators: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for physical Acceptability of wave functions. Normalization, Linearity and Superposition principles. Hermitian operator, Eigen values and Eigen functions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle, Ehrenfest Theorem.

Unit-II

Time independent Schrodinger equation- Hamiltonian, stationary states and energy Eigen values; expansion of an arbitrary wave function as a linear combination of energy Eigen functions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to Spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Ehrenfest theorem (operator method), Quantum virial theorem.

Unit-III

Fourier transforms and momentum space wave function; Position-momentum uncertainty principle.General discussion of bound states in an arbitrary potential: continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions ground state, zero point energy & uncertainty principle.

Unit-IV

One dimensional infinitely rigid box- energy eigen values and eigen functions, normalization; Quantum dot as example; Quantum mechanical scattering and tunneling in one dimension-across a step potential and rectangular potential barrier.

Unit-V

Atoms in Electric and Magnetic Fields: Electron angular momentum. Space quantization. Electron spin and spin angular momentum. Larmor's Theorem. Spin magnetic moment. Stern-Gerlach Experiment. Zeeman Effect: Electron magnetic Moment and Magnetic Energy, Gyromagnetic ratio and Bohr Magneton.Atoms in External Magnetic Fields: Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion Only).

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour

[TOTAL THEORY CREDIT - 4]

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Reference Books :

- A Text book of Quantum Mechanics: P.M. Mathews and K. Venkatesan, 2nd Edn., 2010, McGraw Hill.
- Quantum Mechanics, Robert Eisberg and Robert Resnik, 2nd Edn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3rd Edn., 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldhas, 2nd Edn., 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer.
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press.
- Quantum Physics ---- S. Gasiorowicz (Wiley India), 2013.
- Quantum Mechanics – J.L. Powell and B. Craseman (Narosa) , 1988.
- Introduction to Quantum Mechanics – M. Das, P.K. Jena (SriKrishna Prakashan).
- Basic Quantum Mechanics – A. Ghatak (McMillan India), 2012.
- Introduction to Quantum Mechanics – R. Dicke and J. Wittke.
- Quantum Mechanics – Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, D.J. Griffith, 2nd Edn., 2005, Pearson Education.
- Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer.
- Quantum Mechanics – F. Mandl (CBS) 2013.
- Cohen-Tannoudji, B. Diu and F. Laloe, Quantum Mechanics, (2 vols) Wiley-VCH, 1977.

THIRD YEAR SCIENCE – FIFTH SEMESTER
PHYSICS (HONOURS)
PAPER - XI (PRACTICAL) [C-XI LAB]

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:
   Here, m is the reduced mass of the electron. Obtain the energy eigen values and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is ≈-13.6 eV. Take e = 3.795 (eVÅ)1/2, hc = 1973 (eVÅ) and m = 0.511x106 eV/c2.
2. Solve the s-wave radial Schrodinger equation for an atom:
   Where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential.
   Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digit. Also, plot the corresponding wave function. Take e = 3.795 (eVÅ)1/2, m = 0.511x106 eV/c2, and a = 3 Å, 5 Å, 7 Å. In these units hc = 1973 (eVÅ). The ground state energy is expected to be above -12eV in all three cases.
3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

For the anharmonic oscillator potential
for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c2, k = 100 MeV fm-2, b = 0, 10, 30 MeV fm-3. In these units, ch = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule: Where μ is the reduced mass of the two-atom system for the Morse potential
Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.
Take: m = 940x106 eV/C2, D = 0.755501 eV, α = 1.44, ro = 0.131349 Å.

Laboratory based experiments:

5. Study of Electron spin resonance-determine magnetic field as a function of the resonance frequency.
6. Study of Zeeman effect with external magnetic field, Hyperfine splitting.
7. To show the tunneling effect in tunnel diode using I-V characteristics.
8. Quantum efficiency of CCDs.
9. To determine the diameter of narrow wire.
10. Verification of Brewster's law.
11. Callibration of meter bridge.
12. Determination of η of the given viscous liquid by Searle's viscometer.

Reference Books :

- Schaum's outline of Programming with C++, J. Hubbard, 2000. McGraw Hill Publication.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn., 2007, Cambridge University Press.
- An Introduction to Computational Physics: T. Pang, 2nd Edn., 2006, Cambridge University Press.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C.V. Fernandez, 2014, Spinger.
- Scilab (A free software to Matlab): H. Ramchandran, A.S. Nair, 2011, S. Chand & Co.
- Scilab Image Processing: L.M. Surhone, 2010,Betascript Publishing, ISBN:978-6133459274.
- Advance Practical Physics by Prof. B.B. Swin.

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THIRD YEAR SCIENCE – FIFTH SEMESTER
PHYSICS (HONOURS)
PAPER - XII (THEORY) [C-XII THEORY]

Time – 3 Hours Solid State Physics Full Marks - 60

(All units carry equal marks)

UNIT-I

Crystal structure: Solids: Amorphous and Crystalline Materials. Lattice translation Vectors. Lattice with a Basis – Central and Non-central Elements. Unit Cell, Weigner-Scitz Cell, SC, FCC, BCC and HCP Miller Indices. Types of Lattices, Reciprocal Lattice. Diffraction of X-Rays by Crystals. Bragg's Law. Brillouin Zones, Laue Condition, Bragg's law from Laue condition, Atomic form factor and Geometrical structure Factor.

UNIT II

Elementary Lattice Dynamics: Lattice Vibrations and phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye Theories of specific heat of Solids. T^3 law.

UNIT-III

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of Dia- and Paramagnetic Domains. Curie's law, Weiss theory of ferromagnetism and ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

UNIT-IV

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability.

Lasers: Einstein's A and B Coefficients. Metastable States. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Properties of Laser beam, Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser.

UNIT-V

Elementary band theory: Kronig Penny Model. Band Gap. Conductor, semiconductor (P and N type) and insulator. Conductivity of semiconductor, mobility, Hall effect. Measurement of conductivity (04 probe methord) and Hall coefficient.

Superconductivity: Experimental results. Critical temperature. Critical magnetic field. Meissner effect. Type I and type II superconductors, London's equation and penetration depth. Isotope effect. Idea of BCS theory(no derivation).

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour

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[TOTAL THEORY CREDIT - 4]

Reference Books :

- Introduction to Solid State Physics, Charles Kittel, 8th Edn., 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, Prentice Hall of India.
- Introduction to solids: Leonid V. Azaroff, 2004, Tata McGraw Hill.
- Solid State Physics: S.O. Pillai, New Age Publication.
- Solid State Physics: R.K. Puri and V.K. Babber, S. Chand Publication.
- Lasers and Non Linear Optics: B.B. Laud, Wiley Eastern.
- LASERS: Fundamentals and Applications, Thyagarajan and Ghatak, McMillan India.

THIRD YEAR SCIENCE – FIFTH SEMESTER
PHYSICS (HONOURS)
PAPER - XII (PRACTICAL) [C-XII LAB]

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method).
2. To measure the magnetic susceptibility of solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To determine the dielectric constant of a dielectric material with frequency.
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon Resonance (SPR).
6. To determine the refractive index of a dielectric layer using SPR.
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of Fe using solenoid and determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature by Four-probe method (room temperature to 150^0 C) and determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.
11. To determine H-component of earth's magnetic field and magnetic moment of a Bar magnet.

Reference Books :

- Advanced Practical Physics for Students: B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M Ogborn, 4th Edn., Reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Edn., 2006, Prentice Hall of India.
- Advance Practical Physics by Prof. B.B. Swin.

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THIRD YEAR SCIENCE – FIFTH SEMESTER
PHYSICS (HONOURS)
PAPER – DSE:1 (THEORY)

Time – 3 Hours Classical Dynamics. Full Marks - 60

(All units carry equal marks)

Unit-I
Mechanics of system of particles, Generalised co ordinates D'Alemberts principle and Lagrange equation and its simple application .

Unit-II
Classical Mechanics of Point Particles: Generalized coordinates and velocities. Hamilton's Principle. Derivation of Langrangian and Eular-Langrange equations. Applications to simple systems such as coupled oscillators.

Unit-III
Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for harmonic oscillator, particle in central force field. Motion of charged particles in external electric and magnetic fields.

Unit-IV
Special Theory of Relativity: Postulates of Special Theory of relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space time diagrams. Time –dilation, length contraction and twin paradox.

Unit-V
Four vectors: space- like ,time-like and light like. Four velocity and acceleration. Metric and alternating tensor .Four momentum and energy- momentum relation. Doppler effect from a four vector perspective. Concepts of Four force .Conservation of Four momentum. Relativistics kinematics . Application to two body decay of an unstable particle.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour
[TOTAL THEORY CREDIT - 4]

Reference Books :

- Classical Mechanics: H. Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002, Pearson Education.
- Mechanics: L.D Landau and E.M. Lifshitz, 1976, Pergamon.
- Classical Mechanics: An Introduction, Dieter Strauch, 2009, Springer.
- Solved problems in Classical Mechanics: O.L. Delange and J. Pierrus, 2010, Oxford Press.
- Classical Mechanics: J.C. Upadhyay (Himalaya Publication), 2014.
- Classical Dynamics of Particles and Systems: S.T. Thornton (Cengage Learning), 2012.
- Introduction to Classical Mechanics: R.K. Takwale, S. Puranik (Tata McGraw Hill).
- Classical Mechanics: M. Das, P.K. Jena, M. Bhuyan, R.N. Mishra (Srikrishna Prakashan)

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THIRD YEAR SCIENCE – FIFTH SEMESTER
PHYSICS (HONOURS)
PAPER – DSE:1 (PRACTICAL)

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. To determine the Rigidity Modulus by Static method.
2. To determine the Rigidity Modulus by Dynamic method.
3. To determine the Young's modulus by double cantilever.
4. Verification of Stoke's law.
5. Study and draw static characteristics of P-N junction / Zener diode.
6. To determine the velocity of sound at 0^0 C.

Reference Books :

- Advanced Practical Physics for Students: B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M Ogborn, 4th Edn., Reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal.
- Advance Practical Physics by Prof. B.B. Swin.

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THIRD YEAR SCIENCE – FIFTH SEMESTER
PHYSICS (HONOURS)
PAPER – DSE:II (THEORY)

Time – 3 Hours Nuclear and Particle Physics. Full Marks - 60

(All units carry equal marks)

Unit-I

General Properties of nuclei: Constituents of nucleus and their intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.

Unit-II

Nuclear models: Liquid drop model approach semi empirical mass formula and significance of its various terms , condition for its nuclear stability, two nucleon separation energies , evidence for nuclear shell structure nuclear magic numbers , basics assumption of shell model

Unit-III

Radioactive decay (a) Alpha decay basics of α decay process , theory of α emission Gamow factor , Gieger Nuttal law (b) β-decay ,positron emission , electron capture , neutrino hypothesis (c) Elementary of gamma decay

Nuclear reaction: Types of reaction ,conservation laws ,kinematics of reaction, Q-value

Unit-IV

Detector for nuclear Radiation: Gas detectors ,estimation of electric field ,mobility of particles ,for ionization chamber and GM counter .Basics principles of scintillation Detectors and construction of photo multiplier tube (PMT) Semiconductor (Ge and Si) detectors for charge particles and photon detection ,neutron detector.

Unit-V

Particle accelerator :Van de Graff generator(Tandem accelerator), Linear accelerator, Cyclotron ,synchrotrons.

Particle physics: Particle interaction; basic features ,types of particles and its families. Symmetric and conservation laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin strangeness and charm. Elementary ideas of quarks and gluons.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour
[TOTAL THEORY CREDIT - 4]

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Reference Books :

- Introductory Nuclear Physics by Kenneth (Wiley India Pvt. Ltd.), 2008.
- Concepts of Nuclear Physics by Bernard L. Cohen (Tata McGraw Hill), 1998.
- Introduction to High Energy Physics: D.H. Perkins, (Cambridge Univ. Press).
- Introduction to Elementary Particles: D. Griffith (John Wiley & Sons).
- Basic Ideas and Concepts in Nuclear Physics: An Introductory Approach by K. Heyde (IOP Institute of Physics Publishing), 2004.
- Theoretical Nuclear Physics: J.M. Blatt & V.F. Weisskopf (Dover Pub. Inc., 1991).
- Atomic and Nuclear Physics: A.B. Gupta, Dipak Ghosh (Books and Allied Publishers).
- Physics of Atoms and Molecules: Bransden (Pearson India), 2012.

THIRD YEAR SCIENCE – FIFTH SEMESTER
PHYSICS (HONOURS)
PAPER – DSE:II (PRACTICAL)

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. To determine the Refractive Index of solid and liquid.
2. To determine the Refractive Index of prism by I-D curve method.
3. To determine the magnetic field at the center of the coil and hence to show its variation with numbers of turns of the coil.
4. To determine the figure of merit.
5. To determine e/m by Thomson method.
6. Verification of magnetic field along the axis of a circular coil.

Reference Books :

- Advanced Practical Physics for Students: B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M Ogborn, 4th Edn., Reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal.
- Advance Practical Physics by Prof. B.B. Swin.

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THIRD YEAR SCIENCE – SIXTH SEMESTER
PHYSICS (HONOURS)
PAPER - XIII (THEORY) [C-XIII THEORY]

Time – 3 Hours Electromagnetic Theory **Full Marks - 60**

(All units carry equal marks)

UNIT-I

Maxwell Equations: Maxwell's equations. Displacement current. Vector and scalar potentials. Gauge transformations: Lorentz and coulomb gauge. Boundary conditions at interface between different media. Wave equations. Plane waves at dielectric media. Poynting theorem and poynting vector. Electromagnetic (EM) energy density. Physical concept of electromagnetic field energy density.

UNIT-II

EM wave propagation in unbounded media: Plane EM waves through vaccum and isotropic dielectric medium. Transverse nature of plane EM waves, refractive index and dielectric constant, wave impedence.Propagation through conducting media, relaxation time, skin depth. Electrical conductivity of ionized gases, plasma frequency, refractive idex, skin depth, application to propagation through ionosphere.

UNIT-III

EM wave in bounded media: Boundary conditions at a plane interference between two media. Reflection and refraction of plane waves at a plane interface between two dielectric media- Laws of reflection and refraction. Fesnel's formulae for perpendicular and parallel polarization cases, Brewster's law. Reflection and transmission coefficients. Total internal reflection , evanescent waves. Metallic reflection (normal incidence).

UNIT-IV

Polarization of electromagnetic waves: Description of linear, circular and elliptical polarization. Propagation of EM waves in anisotropic media. Symmetric nature of dielectric tensor. Fresnel's formula. Uniaxial and biaxial cryatals. Light propagation in uniaxial crystal. Double refraction . Polarization by double refraction. Nicol prism. Ordinary and extraordinary refractive indices. Production and detection of plane, circularly and elliptically polarized light.

UNIT-V

Phase retardation plates: Quarter-wave and half-wave plates. Babinet compensator and its uses. Analysis of polarized light.

Rotatory Polarization: Optical rotation, Biot's laws for rotatory polarization. Fresnel's theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade polarimeter.

Optical fibres: Numerical aperture. Step and graded indices(definitions only). Single and multiple mode fibres(concept and definition only).

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour

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[TOTAL THEORY CREDIT - 4]

Reference Books :

- Introduction to Electrodynamics: D.J. Griffiths, Benjamin Cummings.
- Elements of Electromagnetics: M.N.O. Sadiku, 2001, Oxford University Press.
- Electricity and Magnetism: D.C. Tayal, Himalaya Publication.
- Introduction to Electrodynamics: A.Z. Capri and P.V. Panat (Alpha Science).
- Optics: E. Hecht (Pearson India).
- Electromagnetic Theory: A. Murthy, S. Chand Publication.
- Classical Electrodynamics: J.D. Jackson (Wiley India)

THIRD YEAR SCIENCE – SIXTH SEMESTER
PHYSICS (HONOURS)
PAPER - XIII (PRACTICAL) [C-XIII LAB]

Time – 6 Hours **Full Marks – 25**

(TOTAL PRACTICAL CREDIT – 2)

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized light by using Babinet's Compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study reflection and refraction of microwaves.
7. To study polarization and double slit interference in microwaves.
8. To determine the refractive index of liquid by total internal reflection using Wollaston's air-film.
9. To determine the refractive index of (1) Glass and (2) a liquid by total internal reflection using a Gaussian eye piece.
10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
11. To determine the Boltzmann constant using V-I characteristics of PN junction diode.
12. To determine η of a given liquid by oscillating disc method.

Reference Books :

- Advanced Practical Physics for Students: B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M Ogborn, 4th Edn., Reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Edn., 2006, Prentice Hall of India.
- Electromagnetic Field Theory for Engineers and Physicists: G. Lehner, 2010, Springer.
- Advance Practical Physics by Prof. B.B. Swin.

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THIRD YEAR SCIENCE – SIXTH SEMESTER
PHYSICS (HONOURS)
PAPER - XIV (THEORY) [C-XIV THEORY]

Time – 3 Hours Statistical Mechanics **Full Marks - 60**

(All units carry equal marks)

UNIT-I

Classical statistics: Macrostate and Microstate, elementary concept of ensemble, Microcanonical, canonical and grand canonical ensemble. Phase space, entropy and thermodynamic probability, Maxwell-boltzmann distribution law, partion function, Thermodynamic functions of an ideal gas, Classical entropy expression, Gibbs paradox, Sackur tetrode equation. Law of equipartition of energy (with proof) – applications to specific heat and its limitations, Thermodynamic functions of a two-energy levels system. Negative temperature.

UNIT-II

Radiation: Properties of thermal radiation. Black body radiation. Pure temperature dependence. Kirchhoff's law. Stefan-boltzmann law: Thermodynamic proof. Radiation pressure. Wien's displacement law. Wien's distribution law. Saha's ionization formula. Rayleigh-jean's law. Ultraviolet catastrophe.

UNIT-III

Planck's law of blackbody radiation: Derivation and experimental verification of Plank's law. Deduction of (1) wien's distribution law, (2) Rayleigh-jean's law, (3) Stefan-boltzmann law, (4) wien's displacement law from planck's law.

Differential equation of heat flow in one dimension, its solution, Ingen-Hausz experiment, Radial flow of heat in an isotropic medium.

UNIT-IV

Quantum statistics: Identical particles, macrostates and microstates. Fermions and Bosons, Bose Einstein distribution function and Fermi-dirac distribution function.

UNIT-V

Bose-Einstein condensation, Bose deviation from planck's law, Effect of temperature on F-D distribution function, degenerate fermigas, density of states, Fermi energy.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour
[TOTAL THEORY CREDIT - 4]

Reference Books :

- Statistical Mechanics: R.K. Pathria & Paul D. Beale (Academic Press).
- Statistical Physics, Berkeley Physics Course: F. Reif, 2008, Tata McGraw Hill.
- Statistical and Thermal Physics: S. Lokanathan and R.S. Gambhir, Prentice Hall.
- Statistical Physics: F. Mandl (CBS), 2012.
- Statistical Physics of Particles: M. Kardar (CUP), 2007.

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THIRD YEAR SCIENCE – SIXTH SEMESTER
PHYSICS (HONOURS)
PAPER - XIV (PRACTICAL) [C-XIV LAB]

Time – 6 Hours **Full Marks – 25**

(TOTAL PRACTICAL CREDIT – 2)

Use C/C++/Scilab for solving the problems based on Statistical Mechanics like

1. Plot Planck's law for Black Body radiation and compare it with Wein's Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature.
2. Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases.
3. Plot Maxwell-Boltzmann distribution function versus temperature.
4. Plot Fermi-Dirac distribution function versus temperature.
5. Plot Bose-Einstein distribution function versus temperature.

Laboratory based experiments:

6. Calibration of Sets' of weights taking 100 gm as standard.
7. To determine Y of wooden scale by vibrating Cantilever.
8. To determine λ of Laser by plane diffraction granting.
9. To determine resolving power of Telescope.
10. To study the Colpitt's oscillator.
11. To verify the Stefan's law of radiation and to determine Stefan's constant.

Reference Books :

- Elementary Numerical Analysis: K.E. Atkinson, 3rd Edn. 2007, Wiley India Edition.
- Statistical Mechanics: R.K. Pathria, Butterworth Heinemann, 2nd Edn. 1996, Oxford University Press.
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics: Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics: Carl S. Helrich, 2009, Springer.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C.V. Fernandez, 2014, Springer, ISBN: 978-3319067896.
- Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444.
- Scilab Image Processing: L.M. Surhone, 2010, Betascript Pub., ISBN: 978-6133459274.
- Advance Practical Physics by Prof. B.B. Swin.

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THIRD YEAR SCIENCE – SIXTH SEMESTER
PHYSICS (HONOURS)
PAPER – DSE:III (THEORY)

Time – 3 Hours Computational Physics Full Marks - 60

(All units carry equal marks)

Unit-I

Introduction: Importance of computers in physics, paradism for solving physics problems for solution.Usage for linux as an editor.

Algorithm and flow chart: Algorithm :definition, properties and development ,Flow chart: concept of flow chart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrix, sum and product of finite series, calculation of sin(x) as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.

Unit-II

Scientific Programming: Some Fundamental Linux Commands (Internal and External Commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of introduction and program. Operaters: Arithmetic, Relational, Logical and Assignment Operators.

Unit-III

Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Frotran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Frotran Program, Format of Writing program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.

Unit-IV

Control Statements: Types of Logic (Sequential, selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DOWHILE, Implide and Nested DO Loops).

Unit-V

Jumping statements (Unconditional,GOTO, Computed GOTO, Assigned GOTO), Subscripted Variables (Arrays: types of Arrays, DIMENSION Statement, Reading and Writing Arrays)Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine, RETURN, CALL, COMMON and EQUIVELENCE Statements), Structure, Disk I/O Statements, open a File, reading from a file. Examples from physics problems.

INTERNAL ASSESSMENT (MID-SEM) TEST – 15 Marks, 1 Hour

[TOTAL THEORY CREDIT - 4]

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THIRD YEAR SCIENCE – SIXTH SEMESTER
PHYSICS (HONOURS)
PAPER – DSE:III (PRACTICAL)

Time – 6 Hours **Full Marks - 25**

(TOTAL PRACTICAL CREDIT - 2)

1. Exercises on syntax on usage of FROTRAN.
2. To write the program and print out all natural even/odd numbers between given limits.
3. To write the program and find maximum, minimum and range of a given set of numbers.
4. To write the program and find a set of prime numbers and Fibonacci series.

Reference Books :

- Introduction to Numerical Analysis: S.S. Sastry, 5th Edn. 2012, PHI Learning Pvt. Ltd..
- Computer Programming in Fortran 77", V. Rajaraman (Publisher: PHI).
- Schaum's Outline of Theory and Problems of Programming with Fortran, S. Lipsdutz and A. Poe, 1986, McGraw Hill Book Co.
- Computational Physics: An Introduction, R.C. Verma, et al. New Age International.
- A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. 2007, Wiley India Edition.

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