KRISHNA UNIVERSITY
MACHILIPATNAM

M.Sc PHYSICS SEMESTER-II
(Regulation-2014)
PAPER – I QUANTUM MECHANICS – II PHY 2.1

UNIT – I

Total angular momentum:

Total angular momentum J. Commutation relations of total angular momentum with components. Eigen values of J^2 and J_Z, Eigen values of J_+ and J_- .Explicit matrices for J^2, J_x, J_y & J_z. Addition of angular momenta.Clebsch-Gordon coefficients for $J_1 = ½$, $J_2 = ½$ and $j_1 = 1$, $j_2 = ½$. Wigner – Eckart theorem.

UNIT-II

Spin angular momentum:

The Pauli's exclusion principle and connection with statistical mechanics, spin angular momentum, Stern-Gerlach experiment and limitations, Pauli spin matrices, commutation relations, operators, Eigen values and Eigen functions. Electron spin functions.

UNIT – III

Quantum Dynamics and Identical Particles:

Equation of motion in Schrodinger's picture and Heisenberg's picture, correspondence between the two. Correspondence with classical mechanics. Application of Heisenberg's picture to Harmonic oscillator. The indistinguishability of identical particles – The state vector space for a system of identical particles – Creation and annihilation operators. Dynamical variables – the Quantum dynamics of identical particle systems.

UNIT – IV

Scattering Theory:

Introduction of scattering – notion of cross section – scattering of a wave packet – scattering in continuous stream model – Green's function in scattering theory – Born's approximation – first order approximation – criteria for the validity of Born's approximation. Form factor – scattering from a square well potential – partial wave analysis – Expansion of plane wave – optical theorem – calculation of phase shifts – low energy limit – energy dependence of βe – Scattering from a square well potential.

UNIT – V

Molecular Quantum Mechanics:

The Born – Openheimer Approximation – The hydrogen molecule ion, The Hydrogen molecule – The valance bond method – The molecule orbital method – Comparison of the methods – Heitler – London method. (Ref: Atkins, Chapter – 9, 279 – 294).

TEXT BOOKS:

Merzbecher, Quantum Mechanics
L I Schiff, Quantum Mechanics (Mc Graw-Hill).
J.J.Sakurai, Modern Quantum Mechanics.
N.Zettili, Quantum mechanics.
Mathews and Venkatesan Quantum Mechanics.
Quantum Mechanics "by R.D.Ratna Raju.
Quantum Mechanics by Kakani and Chandalia.

NOTE: Question paper contains 5 questions of equal marks with internal choice have to be set from each unit

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M.Sc. PHYSICS (SEMESTER-II)

PAPER – II STATISTICAL MECHANICS PHY 2.2

CLASSICAL STATISTICAL MECHANICS

UNIT – I

Foundations of statistical mechanics; specification of states of a system. Contact between statistics and thermodynamics, Postulate of classical statistical mechanics phase space, trajectories – Ensembles – micro canonical, canonical and grand canonical.

UNIT – II

Density of states – Liouville's theorem – equi-partition theorem – Classical ideal gas; entropy of ideal gas in micro canonical ensemble – Gibb's paradox.

UNIT – III

Canonical ensemble – ensemble density – partition function – Energy fluctuations in canonical ensemble – Grand canonical ensemble – Density fluctuations in the Grand canonical ensemble – Equivalence between the canonical ensemble and Grand canonical ensemble.

QUANTUM STATISTICAL MECHANICS

UNIT – IV

Postulates of quantum statistical mechanics – Density matrix – Ensembles in quantum statistics – statistics of indistinguishable particles, Maxwell – Boltzmann, Bose- Einstein and Fermi – Dirac statistics, Thermodynamic properties of ideal gases on the basis of micro canonical and grand canonical ensemble. The partition function: Derivation of canonical ensemble using Darwin and Fowler method.

UNIT – V

Ideal Fermi Gas : Equation of state of an ideal Fermi gas, theory of White dwarf stars, Landau diamagnetism.

Ideal Bose Gas : Photons – Phonons – Bose Einstein condensation – Random walk – Brownian motion.

TEXT AND REFERENCE BOOKS:

1. Statistical and Thermal Physics by S.Lokanadham and R.S. Gambhir (PHI)
2. Statistical Mechanics by K. Huang (Wiley Eastern)
3. Statistical Mechanics: Theory and application by S.K. Sinha
4. Fundamentals of statistical and Thermal Physics by F.Reif.
5. Statistical Mechanics by Gupta and Kumar , Pragathi Prakashan Pub. Meerut.

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KRISHNA UNIVERSITY
MACHILIPATNAM

M.Sc, PHYSICS SEMESTER- II PHY 2.3
PAPER III ELECTROMAGNETIC THEORY, LASERS & MODERN OPTICS

UNIT-I : Electromagnetic Theory

Maxwell's equations –General wave equation-Propagation of light in isotropic dielectric medium – dispersion –Propagation of light in conducting medium –Skin depth –Reflection and refraction at the boundary of a dielectric interface-Fresnel's equations-Propagation of light in crystals – double refraction. Electromagnetic Radiation –Retarded Potentials –Radiation from an Oscillating dipole –Linear Antenna – Lienard-Wiechert Potentials.

UNIT-II : Principles of Lasers

Lasers: Introduction – directionality- brightness- monochromacity- coherence – relation between the coherence of the field and the size of the source – absorption and emission processes - the Einstein coefficients - amplification in a medium- laser pumping Boltzmann's principle and the population of energy levels – attainment of population inversion - two level – three level and four level pumping . Optical feedback: the optical resonator laser power and threshold condition confinement of beam within the resonator – stability condition.

UNIT-III: **Lasers and optical processes**

Laser output - Absorption and emission - shape and width of broadening lines – line broadening mechanisms – natural, collision and Doppler broadening.

Types of Lasers: Ruby laser, He-Ne Laser, Semiconductor GaAs laser, applications of lasers.

UNIT –IV: Non linear Optics and Holography

Basic Principles- Harmonic generation – Second harmonic generation- Phase matching –Third Harmonic generation-Optical mixing –Parametric generation of light –Parametric light oscillator-Frequency up conversion-Self focusing of light. Introduction to Holography-Basic theory of Holography-Recording and reconstruction of Hologram-Diffuse object illumination-Speckle pattern –Fourier transform Holography-Applications of Holography.

UNIT-V Fiber Optics

Fiber Optics : Introduction – total internal refraction –optical fiber modes and configurations- fiber types – rays and modes- Step index fiber structures – ray optics representation – wave representation – Mode theory for circular wave guides- wave guide equations – wave equations for step indexed fibers – modal equation – modes in step indexed fibers – power flow in step indexed fibers .

Graded indexed fiber structure: Structure – Numerical aperture and modes in graded index fibers-Signal degradation in optical fibres – losses in optical fibres.

Reference Books:

1. Electromagnetic theory and Electrodynamics by Satyaprakash
2. Introduction to Electro dynamics by Griffiths
3. Laser and Non-Linear Optics, B.B.Laud, Wiley Eastern Ltd., 1983.
4. Introduction to Electrodynamics, D. J. Griffiths
5. Electromagnetics, B. B. Laud Wiley-Eastern, New Delhi.
6. Modern Optics, Fowels
7. Laser and their applications M . J. Beesly, Taylor and Francis, 1976.
8. Laser and Nonlinear Optics. B. B. Laud, Wiley Eastern Ltd., 1983
9. Optical Fibre Communications, Gerel Keiser, Mc Graw Hill Book,2000.

NOTE: Question paper contains 5 questions of equal marks with internal choice have to be set from each unit

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M.Sc., PHYSICS (SEMESTER-II)

PAPER – IV: SOLID STATE PHYSICS (General) PHY 2.4

UNIT – I

CRYSTAL STRUCTURE:

Periodic array of atoms-Lattice translation vectors and lattices, symmetry operations, The Basis and the Crystal Structure, Primitive Lattice cell, Fundamental types of lattices-Two Dimensional lattice types, three Dimensional lattice types, Index system for crystal planes, simple crystal structures- sodium chloride, cesium chloride and diamond structures.

UNIT – II

CRYSTAL DIFFRACTION AND RECIPROCAL LATTICE:

Bragg's law, Experimental diffraction methods - Laue method and powder method, derivation of scattered wave amplitude, indexing pattern of cubic crystals and non-cubic crystals (analytical methods). Geometrical structure Factor, Determination of number of atoms in a cell position of atoms. Reciprocal lattice, Brillouin Zone, Reciprocal lattice to bcc and fcc Lattices.

UNIT – III

FREE ELECTRON FERMI GAS:

Energy levels and density of orbitals in one dimension, Free electron gas in 3 dimensions, Heat capacity of the electron gas, Experimental heat capacity of metals, Motion in Magnetic Fields – Hall effect, Ratio of thermal to electrical conductivity.

UNIT IV

FERMI SURFACES OF METALS:

Reduced zone scheme, periodic Zone schemes, Construction of Fermi surfaces, Electron orbits, hole orbits and open orbits, Experimental methods in Fermi surface studies – Quantization of orbits in a magnetic field, De-Hass-van Alphen Effect, external orbits, Fermi surface of Copper.

UNIT V

THE BAND THEORY OF SOLIDS:

Nearly free electron model, Origin of the energy gap, The Block theorem, Kronig-Penny Model, wave equation of electron in a periodic potential, Crystal momentum of an electron-Approximate solution near a zone boundary, Number of orbitals in a band – metals and isolators. The distinction between metals, insulators and semiconductors.

TEXT BOOKS:

1. Introduction to Solid State Physics, C.Kittel, 5^{th} edition,
2. Solid State Physics, A.J.DEKKER.
3. Introduction to Solid state physics, Arun Kumar
4. Solid state physics, B.Srivastava

NOTE: question paper contains 5 questions with internal choice have to be set from each unit.