M.Sc Question Bank

Semester-III

Paper-Advanced Quantum Mechanics

1. How does the idea of relativity can be introduced?
2. Define D'Alembertian Operator.
3. What do you understand by equation of continuity?
4. Prove that Dirac matrices $\vec{\alpha}$ and $\vec{\beta}$ must be even dimensional.
5. How probability density expression in K.G. equation reduces to non-relativistic expression?
6. Give a simple derivation of Klein-Gordan equation. What type of particles obeys this equation? Discuss the difficulties historically associated with the interpretation of this equation and how they have been overcome?
7. Obtain expression for current and charge densities.
8. Derive the K.G. relativistic wave equation of the free particle. Determine the current density and probability density. What are its shortcomings and how they are removed by Dirac's equation?
9. Discuss Schrodinger's relativistic equation for a free particle. What are the difficulties present in its interpretation? Show how this equation in the presence of electromagnetic potentials reduces to the correct non-relativistic formula?
10. Obtain Dirac equation for a free particle and obtain its solution. Discuss various implications of negative energy states. Derive the Dirac's linear Hamiltonian for free particle and find out the Dirac matrices $\vec{\alpha}$ and $\vec{\beta}$.

11. Show that the Dirac's equation automatically endows the hypothetical spinning motion of electron.
12. Use Dirac's equation to show that electron is endowed with a spin ½.
13. Show that
    a) $\propto_x = \frac{1}{2}[\propto_x \propto_y, \propto_y]$
    b) $\propto_x \propto_y \propto_z = [\propto_x \propto_y \propto_z \beta, \beta]$
    c) Trace $(\overrightarrow{\propto.B})(\overrightarrow{\propto.C}) = 4B.C$ where B and C are three dimensional vectors.

Paper-Statistical and Solid State Physics

1. How do you define fermi energy level at finite temperature?
2. State Bloch theorem.
3. How does Bose-Einstein condensation differ from normal condensation?
4. Keeping energy constant, the volume of a perfect gas of N atoms is doubled. What is the change in entropy?
5. Define effective mass of an electron. Write formula for the effective mass of electron.
6. Derive an expression that shows temperature dependence of fermi energy for a metal.
7. Consider a 3D gad of N free electron at 0K. Starting from formulation of Schrodinger equation for a such a system, find out the expression for
    a) Fermi Energy
    b) Density of states
8. How Grand Canonical ensemble is different from the Micro Canonical ensemble. Write the partition function in grand canonical ensemble and use it to calculate thermodynamical quantities:
    a) Entropy
    b) Internal Energy
    c) Chemical Potential
9. Explain the Croning-Penney Model and discuss its results.
10. Explain Bose-Einstein Condensation and derive expression for number of particles in ground state in Bose-Einstein Condensation.

Paper-Nuclear Physics I

1. Write the ground state properties of Deuteron?
2. Write the characteristics properties of Nuclear forces?
3. Discuss four types of interaction between two nucleons.
4. What is the working principle of linear particle accelerator?
5. Draw a schematic diagram to show the path of a charged particle in the medium and the wave front that illustrates the concept of Cherenkov detector.
6. Explain the size of deuteron and an absence of excited state of Deuteron.
7. Write the ground state properties of the deuteron? How do these properties suggest that the nucleon interaction has a tensor component?
8. What is the role of tensor forces in the interaction of deuteron magnetic moment? Show that 4% of D-state admixture can satisfactorily account for the magnetic field and quadrupole moment of deuteron.
9. What are non-central forces? Write their properties.
10. Explain the magnetic moment and quadrupole moment of deuteron on the basis of central forces.
11. Give reasons for the following:
    a) There is no excited state of Deuteron
    b) Di-proton and Di-neutron does not exist in nature
    c) The algebraic sum of magnetic moments of neutron and proton is not equal to the magnetic moment of deuteron

12. Discuss the general characteristic of nuclear detector. Draw appropriate schematic diagram to explain it.
13. Explain semiconductor detector and its advantages over gas filled detector.
14. Write short notes on:
    a) Diffused Junction Detector
    b) Surface barrier detector

Paper- Condensed Matter Physics-II

1. What is the difference between four probe method and Vander Paw method?
2. What do you understand by surface topography and surface morphology?
3. Explain difference between first order and second order phase transition for amorphous crystal?
4. What are the factors that affect glass transition temperature?
5. Define Counting States.
6. Explain nucleation and growth process in metallic glass and obtain expression for Gibbs free energy and critical radius for nucleation.
7. Explain different phenomenon of interaction of electron with matter.
8. For three dimensional box, discuss density of states in terms of δ- function.

Paper-Electronics and Communication-I

1. Explain the wave guides.
2. What is characteristic impedance?
3. What do you understand by cavity resonator?
4. Define the excitation of cavities.
5. What do you understand by 'Q' of a cavity resonator?
6. Discuss the properties of S-Matrix.
7. Discuss TE and TM Mode.
8. Define cut-off wavelength and guided wavelength.
9. What are the applications of Magic-Tee.
10. Define the coupling factor of directional coupler.
11. What do you understand by the attenuation in waveguide? Discuss various types of attenuations explaining the attenuation due to dielectric losses.
12. A rectangular wave guide with the dimensions 5 cm ×2 cm is used to propagate TM_{11} at 9 GHz. Calculate the wave impedance and cut-off wavelength.
13. Describe the operation of E-Plane, H-Plane and Magic T hybrid junction. Why E-H Plane Tee is referred as magic Tee. Derive the scattering matrix for magic Tee.
14. Explain the functioning of reflex klystron oscillators with the help of apple gate diagram and give the performance characteristics.
15. A reflex klystron operates at the peak mode *i.e.* n=2 with beam voltage is 300V, beam current is 30 mA and signal voltage is 40V. Calculate
    (i) Input and output power
    (ii) Efficiency

Paper-Energy Studies-I

1. What are the traditional sources of energy?
2. What are disadvantages of traditional sources of energy?
3. What are the advantages of solar photovoltaics?
4. Define solar cell?
5. Discuss solar spectrum.
6. Explain the effects of the earth's atmosphere on solar spectrum.
7. What is photovoltaic energy conversion and explain the basic four steps headed for it.
8. Explain I-V characteristic curve for a solar cell explaining efficiency and fill factor parameter.