B.E. End-semester (1st Semester CST, EE, ETC, IT) Examination, 2012

PHYSICS (PH - 1201)

Full Marks: 70 Time: 3 hrs.

Answer any five questions:

1.a) How can you represent Gauss's law and Ampere's law in their integral form? Explain the inconsistency in Ampere's law. How did Maxwell remove this inconsistency?

b) Write down Maxwell's equations in free space. Obtain the following forms of wave equations corresponding to electric field and magnetic fields in free space

$$\nabla^2 \vec{E} = \mu_0 \epsilon_0 \frac{\partial^2 \vec{E}}{\partial t^2} \text{ and } \nabla^2 \vec{H} = \mu_0 \epsilon_0 \frac{\partial^2 \vec{H}}{\partial t^2}$$

[(2+2+3)+(4+3)]

2.a) What is meant by Fraunhofer diffraction? Derive an expression for the intensity distribution of Fraunhofer double slit diffraction. Give a plot of the intensity distribution.

b) What is a diffraction grating? Define the resolving power of a grating.

c) Calculate the possible order of spectra with a plane transmission grating having 18000 lines per inch when light of wavelength 4500A is used.

d) Write a short note on the polarization of light wave.

[6+3+2+3]

3.a) What is stimulated emission? Find the relation between Einstein's A and B coefficients and hence calculate the ratio of the rate of spontaneous emission and stimulated emission for a given pair of energy levels. What is meant by optical pumping?

b) Describe the working principle of Helium-Neon Laser.

c) Establish the relation between numerical aperture and acceptance angle in a step index optical fibre.

[(2+4)+(1+3)+4]

4.a) Distinguish between a crystalline and a non-crystalline material.
Write down the specification of a tetragonal and hexagonal unit cell.

b) i) The lattice parameters of a crystal are 1.2A, 1.8A and 2A along three axes where a plane intercepts at lengths 2.4A, 1.8A and 6A along their respective crystal axes. Find the Miller intercepts of the planes.

ii) Draw the planes of a cubic crystal where Miller indices are (110), (111).

iii) The distance between consecutive (111) planes in a cubic crystal is 2A. Determine the lattice parameters.

c) Find out the coordination number and packing fraction for a bcc structure.

d) Why X-rays are used to analyse the crystal structure? A beam of X rays of wavelength 0.637A is incident on a crystal at a glancing angle $8^0 35'$ when first order Bragg's reflection occurs. Find out the glancing angle for the third order reflection.

[(1+2)+(2+2+1)+(1+2)+3]

5.a) Write down the postulates of Einstein's special theory of relativity.

b) Derive the Lorentz transformation relations. State clearly the postulates used in obtaining the relation. Write down the inverse Lorentz transformation equations. Under what condition Lorentz transformation equation reduces to Galilean transformation equation?

c) Show that if the proper volume of a cube is L_0^3, then $L_0^3(1-\beta^2)^{\frac{1}{2}}$ is the apparent volume as viewed from a reference frame moving with uniform velocity v parallel to an edge of the cube. $\left(\beta = \frac{v}{c}\right)$.

d) What will be the period of the 'seconds' pendulum *(of time period = 2s)* measured by an observer moving at a speed of $0.8c$?

[2+(6+1+1) +2+2]

6.a) State de Broglie hypothesis. Show that the de Broglie wavelength of a particle of rest mass m_o and kinetic energy K is given by $\lambda = \frac{hc}{\sqrt{K(K+2m_oc^2)}}$, where h is Plank's constant and c is the speed of light in vacuum.

b) What is "ultraviolet catastrophe" in a black body radiation? Write down Plank radiation distribution formula and obtain its limiting form in the small and large frequency limit.

c) What is Compton effect? Obtain an expression for the Compton shift in wavelength. Does it depend on the incident wavelength?

[(2+2)+(1+4)+5]

<u>or</u>

a) Write down Schrodinger's time-dependent wave equation. Obtain stationary state Schrodinger equation stating the condition needed.

b) Find the energy eigenvalues and normalized wave functions of a particle inside a one dimensional infinite potential well of width L. Obtain the probability of finding the particle in between 0.5L and 0.6L.

[4+(7+3)]