B.E. End-semester (1st Semester CST, EE, ETC, IT) Examination, 2011

PHYSICS (PH - 1201)

Full Marks: 70 Time: 3 hrs.

Answer any five questions:

1.a) Write down the differential forms of Faraday's law and Ampere's law. What is the inconsistency in Ampere's law? What is the contribution of Maxwell to remove this inconsistency?

b) Obtain the following forms of wave equations corresponding to electric field and magnetic field in free space. $\nabla^2\vec{E} = \mu_0 \epsilon_0 \frac{\partial^2 E}{\partial t^2}$ and $\nabla^2\vec{H} = \mu_0 \epsilon_0 \frac{\partial^2 H}{\partial t^2}$

c) State Poynting's theorem and write down its mathematical form and explain the terms involved.

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

2.a) Obtain an expression for the intensity distribution of Fraunhofer single slit diffraction. Find the conditions for maxima and minima of the intensity distribution. What are the relative intensities of the first and second maxima with respect to the central maximum? Give a plot of the intensity distribution.

b) Find out the missing orders for a double slit Fraunhofer diffraction pattern if the slit widths are 0.16mm and they are 0.8 mm apart.

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

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

3.a) Discuss, with the help of a diagram, how optical signal is transmitted through a step-index optical fiber.

b) Obtain an expression for the acceptance angle of a fiber in terms of the refractive indices of the core, the cladding and the surrounding medium.

c) An optical fiber (in air) has a numerical aperture 0.5 and a cladding refractive index 1.60. Determine (i) the refractive index of the core, and (ii) the critical angle of propagation.

d) Show that the Einstein's coefficient for absorption is equal to that for stimulated emission.

e) What are the conditions for lasing action? Briefly discuss how these conditions can be fulfilled.

[3+2+2+3+4]

4.a) Derive an expression for total binding energy of lattice for an ionic crystal.

b) The potential energy of a diatomic molecule is given in terms of the interatomic distance r by the expression $U(r) = -a/r^2 + b/r^{10}$.
Calculate the equilibrium spacing of the two atoms and the dissociation energy
[$a = 1.44 \times 10^{-39}\ Jm^2$ and $b = 2.19 \times 10^{-115}\ Jm^{10}$]

c) Discuss conductor, insulator and semiconductor from the point of view of band theory of solids.

[5+4+5]

5.a) State and explain fundamental postulates of special theory of relativity and deduce from them the Lorentz transformation equations. Show how Lorentz transformations are superior than Galilean transformations.

b) Muons have an average life-time of 2 micro-second in their own frame of reference. In a beam of cosmic ray muons has a speed $0.98\ c$ relative to earth. Find the average life and the distance travelled by the beam during the life interval.

[(2+7+2)+3]

6.a) What is black body radiation? Write down Planck's radiation formula. Show the limits when this reduces to Rayleigh-Jeans and Wein's distribution law.

b) X-rays of wavelength 0.24 nm are Compton scattered and the scattered beam is observed at an angle 60° relative to the incident beam, find the wavelength of the scattered X-rays. Derive the necessary formula you use.

c) Find the minimum energy of a simple harmonic oscillator using Heisenberg's uncertainty principle.

d) Find the ground state energy and the normalized wave function of a particle inside a box given by potential $V = 0,\ 0 \le x \le L$ and $V = \infty,\ x < 0$ and $x > L$ in one dimension.

[3+4+3+4]