B.E. (2nd Semester CE, ME, Met. & Min. and AE) End-semester Examination, 2012

PHYSICS (PH - 1201)

Full Marks: 70 Time: 3 hrs.

Answer any five questions:

1. a) Show that the vectors $\mathbf{P} = 2\mathbf{i} - \mathbf{j} + \mathbf{k}$, $\mathbf{Q} = \mathbf{i} + 2\mathbf{j} - 3\mathbf{k}$ and $\mathbf{R} = 3\mathbf{i} - 4\mathbf{j} + 5\mathbf{k}$ are coplanar.
   b) Show that the gradient of a scalar function f(x, y, z) at any point on the surface f(x, y, z) = constant, is normal to the surface at that point.
   c) Show that the vector field $\mathbf{E} = \mathbf{r}/|\mathbf{r}|^3$ is a conservative field. Also obtain the scalar potential corresponding to this field.
   d) State divergence theorem and verify it using the function $y^2\mathbf{i}+(2xy+z^2)\mathbf{j}+2yz\mathbf{k}$ for a unit cube having one corner coincident with the origin.

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

2. a) Obtain an expression for the intensity distribution of Fraunhoffer double slit diffraction. Explain the significance of each term. What happens to the intensity distribution if the two slits merge into one single slit?
   b) What do you understand by the missing order? Find the missing orders if the slit separation is double the slit width.
   c) Light of wavelength of 6000Å is incident on a slit of width 0.30 mm. The screen is placed 2 m away from the slit. Find out the position of the first dark fringe.
   d) What do you mean by linearly and circularly polarized light?

[(5+2)+2+2+3]

3. a) Distinguish between the spontaneous and stimulated emission of radiation. Calculate the temperature at which the rates of spontaneous and stimulated emissions are equal. Assume wavelength $\lambda = 5000$Å.
   b) Describe the population inversion technique and hence the working principle of a Helium- Neon Laser.
   c) Sketch the refractive index profiles of a step index and a graded index optical fibre.
   d) Find out the total acceptance angle of a step index optical fibre.

[(2+2)+5+2+3]

4. a) Using the law of conservation of electric charge obtain the equation of continuity.
   b) State Ampere's circuital law in integral form and obtain its differential form. How does one remove the contradiction of this law with the equation of continuity?
   c) Obtain the electromagnetic wave equations in vacuum from Maxwell's equations. Show that the electromagnetic wave is transverse in nature and moves in vacuum with speed $3X10^8$m/s.

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

5. a) A cubic lattice has lattice constant '*a*'. Calculate the spacing between (2, 1, 1) planes.
   b) The Bragg's angle corresponding to the first order reflection from (1, 1, 1) plane in a crystal is 30^0, when X-ray of wavelength 1.75 Å is used. Find the interatomic spacing.
   c) How energy bands are formed in solids? Classify solids according to the structure of energy bands. Draw the acceptor level in the band diagram of a doped semiconductor.
   d) Find out the Madelung constant of an infinite line of ions of alternating signs.

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

6. a) What was the aim of Michelson-Morley experiment? Derive the expression for fringe shift assuming the Sun to be at rest in the ether frame. Discuss the result and conclusion of the experiment.

b) Write down the Lorentz transformation relations. Show that $c^2(dt)^2 - (dx)^2-(dy)^2-(dz)^2$ does not change under this transformation.

c) What is proper time interval? Find this between the occurrences of two events separated by 10^9m and occur 5 sec apart in some inertial frame.

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

7. a) What is de Broglie's hypothesis? Find the phase velocity and group velocity of a particle moving with a velocity 10^4 m/s. Calculate de Broglie wavelength of an electron having energy 2 MeV.

b) Write down Planck's law of black-body radiation and obtain Wein's displacement law from it. Given that the wavelength corresponding to maximum emissive power for radiation from the surface of the Sun is 4900Å. Find the surface temperature of the Sun.

or

What is Compton effect? Find the change in wavelength of X-rays due to Compton process. Find the maximum possible shifts of wavelength for X-rays of wavelengths 50 and 100 nm.

or

Write down the time-dependent Schrödinger equation.
Find out the energy eigenvalues and normalized eigenfunctions for a particle in a box of width '*L*' and infinite depth. Find out the average position of the particle in the box.

(Given rest mass energy of electron = 0.511 MeV, $c = 3\times10^8$ m/s, $h = 6.62\times10^{-34}$ J-s, 1eV = 1.6×10^{-12} erg and Boltzmann constant = 1.38 ×10-23 JK^{-1})

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