Total number of printed pages – 8 B. Tech

BSCP 2101/BS 1102

First Semester Examination – 2008

PHYSICS – I

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right hand margin indicate marks for the questions.

Mass of electron = 9.11×10^{-31}kg, Mass of proton = 1.67×10^{-27}kg, Plank's constant = 6.62×10^{-34}Js, Boltzmann constant = 1.38×10^{-23} J/K.

1. Answer the following questions : 2×10

   (a) Find the speed of longitudinal wave propagating in a medium of density 6×10^3 kg/m^3 and bulk modulus 1.2×10^8 N/m^2.

(b) Why very narrow slits are taken in Young's double slit interference experiment ?

(c) In a Newton's ring arrangement, the diameter of a bright ring is 0.5 cm. What will be the diameter of the ring if the lens placed on the plane glass plate is replaced by another one having double the radius of curvature ?

(d) A light beam is allowed to pass through a Nicol prism. As the prism is rotated about an axis parallel to the incident beam, the intensity of the emergent beam undergoes variation and becomes zero at one position. What is the state of polarization of the incident beam ?

(e) A narrow slit, illuminated by monochromatic light produces Fraunhofer diffraction. Graphically show the intensity distribution of the diffraction pattern.

(f) Write down the all Maxwell's electro-magnetic wave equations.

(g) In free space electric field intensity is given as $E = \hat{y}\, 20 \cos(\omega t - 50x)$ V/m. Calculate displacement current density.

(h) Why quantization of energy is not observed in every day life ?

(i) The wave function y of a system is a linear combination of eigen functions

φ_1, φ_2, φ_3, φ_4 and φ_5,

$$\psi = \frac{1}{\sqrt{3}}\varphi_1 + \frac{1}{\sqrt{3}}\varphi_2 + \frac{1}{\sqrt{6}}\varphi_3 + \frac{1}{24}\varphi_4 + \frac{1}{\sqrt{8}}\varphi_5$$

What is the probability of the system being in the state given by φ_3 ?

(j) Write the time independent Schrodinger's equation for a free particle of mass 'm' moving in xy-plane.

2. (a) Derive an expression for the magnetic induction at an internal point of a long cylindrical current carrying straight conductor by using Ampere's circuital law of electromagnetism. 5

(b) The time period of simple harmonic oscillator is 4s. It is subjected to a damping force proportional to its speed with damping coefficient 0.1/sec. Find the time period and logarithmic decrement when simple harmonic oscillator was subjected to the damping force. 5

3. (a) A plano-convex lens of radius of curvature 2.5 m is placed on an optically plane glass plate in air medium and a parallel beam of monochromatic light is incident normally on the setup to observe the Newton's rings. The diameter of the 5 th bright ring as seen

by the refracted light is 0.75 cm. Calculate the wavelength of the light used. 4

(b) What is plasma frequency ? What role does it play in propagation of electromagnetic waves in ionized medium ? 6

4. (a) Describe the formation of diffraction pattern due to plane diffraction grating. Explain the meaning of missing spectra in the diffraction pattern. 6

(b) 1.2 million electrons with energy 1.0 eV are incident on a potential barrier of 8.0 eV high and 0.50 nm width. Calculate how many electrons will tunnel through the barrier ? 4

5. (a) What is half wave plate ? Derive an expression for its minimum thickness for a given wavelength in terms of its refractive indices for O-ray and E-ray. 5

(b) A beam of electrons with certain energy is incident on a quantum mechanical potential step of infinity height. Prove that no electrons can penetrate this barrier. 5

6. (a) What is optical rotation ? Explain how a sacharimeter is used for the determination of specific rotation of sugar solution. 5

(b) Electromagnetic waves are transverse waves; that means electric vector magnetic vector and propagation vector are perpendicular to each other. Prove this statement mathematically. 5

7. (a) Light from two monochromatic sources of wavelengths 5000 Å and 5200 Å is incident on a grating having 15000 lines/inch. The spectrum is focused by a lens of focal length 2 m on a curved screen of

radius of curvature 2 m. Find the linear distance between the maxima of two sources for first order and second order spectrum. 6

(b) An oscillator is subjected to an external sinusoidal periodic force and a damping force proportional to its velocity. Set up a differential equation for the oscillator. Mention the conditions under which velocity resonance occurs. 4

8. (a) The probability that a system can be in the states represented by eigenfunctions ψ_1, ψ_2, ψ_3 are $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{4}$ respectively. Write the wave functions for the system. If the energy eigenvalues for the above states are 2 eV, 3 eV and 4 eV respectively, find the energy expectation value. 4

(b) Derive the electromagnetic wave equation in terms of magnetic vector potential and scalar potential when the wave is propagating in vacuum. 6