SPRING END SEMESTER EXAMINATION-2016

2nd Semester B.Tech & B.Tech Dual Degree

PHYSICS

PH-1003

(Regular-2015 Admitted Batch)

Time: 3 Hours **Full Marks: 60**

Answer any SIX questions including Question No.1 which is compulsory.

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable and all parts of a question should be answered at one place only.

1. i) Calculate the spacing between (100) and (111) planes of a [2 × 10 cubic system of lattice parameter **a**.

   ii) A vector field is given by $\mathbf{A} = yz\,\hat{i} + xz\,\hat{j} + xy\,\hat{k}$. Show that it is both irrotational and solenoidal.

   iii) What force is required to stretch a wire to increase its length by 10%. Given area of cross section of the wire = $2cm^2$, Young's modulus = 2×10^{11} N/m^2.

   iv) Write the relation between phase velocity and group velocity in a dispersive and non-dispersive medium.

   v) In an interference pattern with two coherent sources, the amplitude of intensity variation is found to be 10% of the average intensity. Calculate the relative intensities of the interfering sources.

vi) The temperature of 10gm of air is raised from 0 to 2°C. What is the increase in internal energy of air if work done by the gas is equal to 2 Joules. Given that $C_v = 0.172$cal $gm^{-1}{}^{o}C^{-1}$ and $J = 4.18 \times 10^7$erg/cal.

vii) Differentiate between displacement current and conduction current.

viii) A plane diffraction grating of width 2.5 cm has 12000 rulings. Monochromatic light of wavelength 6250A° is incident normally on it. Find the angle at which the first order and second order principal maxima occurs.

ix) Compare the wavelength of photon and electron having same momentum.

x) Draw refractive index profile for step-index and graded index optical fibre.

2. a) Explain with neat diagrams the construction and working principle of Ruby laser. [6

b) A light ray enters from air to a fibre. The fibre has refractive index of core is 1.5 and that of cladding is 1.48. Calculate the fractional refractive index and acceptance angle. [2

3. a) Starting from Maxwell's electromagnetic equations in free space, obtain electromagnetic wave equations for electric field and magnetic field. Show that in charge-free space the velocity of an electromagnetic wave is equal to the velocity of light in vacuum. [6

b) Determine the displacement current density in a material having relative permittivity 2.45. The electric field in the material is given by $E = 4 \times 10^{-6}\sin(5 \times 10^9\, t)$V/m. [2

4. a) Derive an expression for the normalized wave function and energy of a particle confined in a one-dimensional potential box using Schrodinger's wave equation. [6

   b) Apply Heisenberg's uncertainty principle to explain non-existence of electrons within the nucleus. [2

5. a) Derive the expression for Newton's Ring diameter in reflection configuration and hence explain how you can determine the refractive index of an unknown liquid. [6

   b) Write the differential equation of a damped harmonic oscillator and explain the symbols. [2

6. a) With neat diagram determine atomic packing factor for SC, BCC and FCC structure. [6

   b) X-ray of wave length 1.4A° is found to be Bragg reflected from the (111) plane of an FCC structure. If the lattice parameter of the crystal is 5A°. Find the angle at which the X-ray is incident on the (111) plane of the crystal. [2

7. a) Establish Maxwell's thermodynamic relations from thermodynamic potentials. [6

   b) Show that for any reversible cyclic change of a system, the total change in entropy is zero. [2

8. a) Derive the following relation connecting elastic constants K , Y and σ where the terms have their usual meaning. [6

$$K = Y/ 3(1-2\sigma)$$

b) A block of material having the dimension of front is 6cm×3cm. If a force of 2N is applied tangentially to the upper surface of the block produces a displacement of 3mm relative to the lower surface. Calculate the modulus of rigidity of the material of the body. [2

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Given

$h = 6.62 \times 10^{-34}$ J.s

$C = 3 \times 10^{8}$ m.s^{-1}

Mass of electron: 9.1×10^{-31} kg

Mass of proton: 1.67×10^{-27} kg

$e = 1.6 \times 10^{-19}$ C

$\varepsilon_0 = 8.854 \times 10^{-12} C^2/Nm^2$
