



## SPRING END SEMESTER EXAMINATION-2017

2<sup>nd</sup> Semester B.Tech

### PHYSICS PH-1003

(Regular-2016 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. Answer all the questions: [2 × 10]
  - (a) Distinguish between longitudinal waves and transverse waves with examples.
  - (b) If  $\vec{A}$  and  $\vec{B}$  are irrotational vectors, prove that  $(\vec{A} \times \vec{B})$  is solenoidal.
  - (c) The refractive indices of the core and cladding of an optical fibre are 1.58 and 1.51 respectively. Calculate the acceptance angle and the numerical aperture.
  - (d) How many orders would be visible if the wavelength of incident light is 589 nm and the number of lines in the grating is 104 per mm?
  - (e) Find the smallest possible uncertainty in the position of an electron moving with a velocity of  $3 \times 10^6$  m/s.
  - (f) Define wave function and mention its physical significance.
  - (g) Mention the differences between conduction current and displacement current.
  - (h) Show that the change in enthalpy during an isobaric process is equal to the heat transferred.

(1)

- (i) Differentiate between unit cell and primitive unit cell.
- (j) What is the nature of the central fringe when Newton's rings are viewed in reflected light? Justify your answer.

(a) A particle is enclosed in a one dimensional potential box of infinite height. Write down the Schrodinger's equation and solve it to find the wave function. [6]

(b) A simple harmonic wave travelling along x-axis is given by  $y = 5 \sin 2\pi(0.2t - 0.5x)$ , where  $x$  is in meter and  $t$  is in sec. Calculate its amplitude, frequency, wavelength and wave velocity. [2]

(a) Write down Maxwell's equations in differential form in free space. [2+4]  
Hence derive the wave equations for  $\vec{E}$ -field and  $\vec{B}$ -field.

(b) If an electromagnetic wave propagates through a medium of relative permittivity 4 and relative permeability 1, then calculate the velocity of the wave. [2]

(a) Derive expressions for group velocity and phase velocity. [2+4]  
Hence establish the relation between them.

(b) A proton is accelerated through a potential difference of 10 kV. Find its de Broglie wavelength. (mass of proton =  $1.67 \times 10^{-27}$  kg). [2]

(a) Define Young's modulus, Bulk modulus and Poisson's ratio. [2+4]  
Establish the relation

$$B = \frac{Y}{3(1 - 2\sigma)}$$

where the symbols have their usual meanings.

- (b) Calculate the force required to stretch a steel wire to 1.5 times to its original length having cross sectional area  $2 \text{ cm}^2$ . ( $Y=2 \times 10^{11} \text{ N/m}^2$ ) [2]
6. (a) Define 'atoms per unit cell' and 'packing fraction'. Show that the packing fraction of FCC lattice is greater than that of SC and BCC lattices. [2+4]
- (b) The Bragg angle corresponding to the first order reflection from (111) planes in a crystal is  $30^\circ$  when X-rays of wavelength  $1.75 \text{ \AA}$  are used. Calculate the interatomic spacing. [2]
7. (a) Derive Maxwell's thermodynamic relations using thermodynamic potentials. [6]
- (b) State and explain 2nd law of thermodynamics. [2]
8. (a) What do you mean by 'spontaneous emission', 'stimulated emission' and 'population inversion'? Explain with suitable diagrams. Mention the different methods of achieving population inversion. [6]
- (b) What do you mean by missing orders in a grating spectrum? Why does it happen? [2]

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You may use the following quantities:

Rest mass of electron ( $m_e$ ) =  $9.11 \times 10^{-31} \text{ kg}$ .

Free space permittivity ( $\epsilon_0$ ) =  $8.85 \times 10^{-12} \text{ Coul}^2/\text{N.m}^2$

Free space permeability ( $\mu_0$ ) =  $4\pi \times 10^{-7} \text{ Wb/A.m}$

Planck's constant ( $h$ ) =  $6.62 \times 10^{-34} \text{ J.sec}$

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