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B. Tech
BSCP 2101

Second 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.

1. Answer the following questions : 2×10
- (a) Two waves each of equal amplitude and equal frequency pass through a point in the medium in the same direction with phase difference of 60° . Calculate the amplitude of the resultant wave at this point.

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- (b) Newton's ring experiment was conducted first in air medium then in water medium (i.e. water is inserted in between the plano-convex lens and glass plate.) What happens to the diameter of a particular ring ?
- (c) A particle is trapped in an infinite deep potential well has de Broglie wavelength λ in the ground state. What is the wavelength of the particle in the next excited state ?
- (d) In a Nicol prism μ_E and μ_O are the refractive indices for E-ray and O-ray respectively. If μ_B is the refractive index of the Canada balsam, write a relation between μ_E , μ_O and μ_B .
- (e) In single slit diffraction pattern orange light is replaced by red light without changing the experimental setup. What will happen to the diffraction pattern ?

- (f) The parallel plate capacitor has plates each of area 2m^2 and the plates are separated by a dielectric of thickness 1 mm, dielectric constant 3. The potential difference and conduction current in the connecting wire at certain instant of time is 100 V and 2 mA respectively. Find out the displacement current flowing between the two plates of the capacitor.
- (g) Prove that plasma frequency is approximately equal to $9\sqrt{N}$, where 'N' is the electron density in the plasma medium.
- (h) Write down the time independent Schrödinger's equation for a free particle of mass m and energy E moving in XY-plane
- (i) Compute the de Broglie wavelength of bike having mass 100kg and moving with speed 100km/hour.

- (j) Explain why in potential step problem time independent Schrödinger's equation is taken.
2. (a) Give a comparison between conduction current and displacement current. 3
- (b) Give a graphical comparison among the following four types of harmonic motions: 3
- Simple harmonic motion
 - Under damped harmonic motion
 - Over damped harmonic motion
 - Critically damped harmonic motion.
- (c) How you will know with naked eye the given specimen is an ordinary glass piece or a grating? 2
- (d) The critical angle in certain substance is given to be 42° . Calculate the polarizing angle. 2
3. (a) What is the color of the central fringe in Young's double slit experiment when white light source is used? 2

- (b) The electric vector component of a plane electromagnetic vector propagating in a non-magnetic medium is given by $\vec{E} = \hat{y} 60 \cos(10^8 t + 2z) \text{V/m}$ Symbols have their usual meanings. Find the relative permittivity of the medium and magnetic vector component of the wave. 4
- (c) What do you mean by wave function? What are the characteristic of wave function of matter wave? 1+3
4. (a) Explain the presence of only odd numbered foci a zone plate. 3
- (b) The shapes of the interference fringes obtained in Young's double slit experiment are actually hyperbolae. Derive an approximate expression for eccentricity of the hyperbolic fringe. 5
- (c) The electric component vector of a plane electromagnetic wave propagating in a

nonmagnetic medium is given by $\vec{E} = \hat{y} 40 \cos(10^8 t + 4z) \text{ V/m}$. Find the direction of propagation. 2

5. (a) Describe in detail the construction and working of a Laurent's half-shade polarimeter. Explain how you would use it to determine the specific rotation of sugar solution. 6

(b) An electron is trapped completely in a one dimensional region of width 1 \AA . How much energy must be supplied to excite the electron from ground state to first excited state? 2

(c) How does quantum physics differs from classical physics in potential step problems. 2

6. (a) In Newton's ring experiment in laboratory sodium vapor lamp having two wavelengths 5890 \AA and 5896 \AA is used. If it is found that n th dark ring due to 5860 \AA

coincides with $(n+2)$ nd dark ring due to 5890 \AA , then calculate the radii of n th dark rings due to 5896 \AA and 5890 \AA . The radius of curvature of the plano-convex lens used is 200 cm . 4

(b) Explain how displacement and velocity graph of a simple harmonic oscillator is elliptical. 3

(c) Derive a relation between magnitudes of electric vector and magnetic vector. 3

7. (a) A sodium vapour light containing two wavelengths 5890 \AA and 5896 \AA is incident normally on a plane transmission grating having 15000 lines/inch . A lens of focal length 100 cm is used to observe the spectrum on a screen. Calculate the distance between the two lines in the first order spectrum. 5

(b) How can you get a scalar function from a vector field and how can you get a vector function from a scalar field? Give physical examples of both the cases. 3

(c) An electromagnetic wave is propagating in a medium in such a manner that electric vector of the wave satisfies the differential

wave equation $\nabla^2 E = \mu\epsilon \frac{\partial^2 E}{\partial t^2}$. How

much energy will be absorbed by the medium in 20 seconds? 2

8. (a) If μ is refractive index of a potential step for the case $E > V_0$ then prove that the transmission coefficient for the incident

particles $\left| \frac{4\mu}{(1+\mu)^2} \right|$. 4

(b) What is the physical significance of gradient of a scalar function? 2

(c) Two simple harmonic oscillators of different masses oscillate separately under the action of same restoring force at frequencies 3Hz and 5Hz. Calculate the ratio of their masses. 2

(d) Distinguish between plane of polarization and plane of vibration. 2