Registration No. : | | | | | | | | | | |

Total number of printed pages – 7

B. Tech.

BS 1102 / BSCP 2101 (N/O)

First Semester Examination – 2010

PHYSICS – I

(New and Old Course)

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.

1. Answer the following questions : 2×10

(a) If the differential equation of motion of a freely oscillating body is $2\frac{d^2x}{dt^2} + 18\pi^2 x = 0$, calculate the natural frequency of the body.

(b) A uniform string S_1 is connected with another uniform string S_2, whose linear mass density is greater than that of S_1. A wave pulse propagating along one string meets the other at the junction where a part is transmitted and a part is reflected back, as seen in the figure. Find out in which string the wave propagated initially.

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(c) If ten sinusoidal waves of equal amplitude superpose incoherently to produce a resultant wave of intensity 0.5 watt/m^2, what would be the resultant intensity if they superpose coherently?

(d) A zone plate is to have a principal focal length of 50 cm corresponding to wavelength of light $\lambda = 6 \times 10^{-5}$cm. Find the radii of different zones.

(e) The plane of polarisation of a plane polarized light is rotated through an angle of 20° while passing through 20 cm in a sugar solution having specific rotation 45° cm^2/gm. Calculate the concentration of sugar solution used.

(f) In free space electric field intensity is given by $\vec{E} = \hat{y}\,20\,\cos(\omega t - 50\,x)$. Calculate displacement current density.

(g) Write the differential form of poynting theorem. What is the significance of poynting vector?

(h) A particle is confined to move along a line of length 'L' cm. Find the expectation value of the particle's position <x>, if its normalized wave function is given as $\psi = \sqrt{\frac{2}{L}} \sin\frac{n\pi x}{L}$.

(i) A 20g particle is moving with a speed 30 m/s. At certain instant of time its position was determined with uncertainty of 2 mm. Calculate the fractional uncertainty in its linear momentum.

(j) If the width of an infinitely deep potential well is halved, what change will be found in the de-Broglie's wavelength and energy of the particle trapped inside it ?

2. (a) Starting from the differential equation for damped oscillator, obtain the solution for under-damped motion. Graphically show the variation of amplitude with time and mention the condition for critical damping. 5

(b) The diameter of central zone of a zone plate is 0.20cm.If a point source of light of wavelength 5500 $\mathring{A}$ is placed at a distance of 50 cm from the zone plate; find the position of the strongest image. 2

(c) How much minimum energy is required for the incident radiation to produce pair production ? Why pair production cannot occur in vacuum ? 3

3. (a) Prove analytically that the shapes of the interference fringes obtained in Young's double slit experiment are hyperbolic. 4

(b) Show that the displacement current flowing between the two plates of the capacitor is equal to the conduction current utilized in charging the capacitor. 3

(c) Equation for a stationary wave is given as $\psi = 4\cos\frac{2\pi x}{13}\sin \pi t$, where '$\psi$' and 'x' are expressed in centimetre and 't' in second. Obtain the expressions for the two component waves. 3

4. (a) Explain the variation of the radius of bright fringe of Newton's rings with refractive index of the thin film enclosed between plano-convex lens and the glass plate when observed by reflected light. 3

(b) What is plasma angular cut-off frequency ? Why it is difficult for an electromagnetic wave to propagate in a highly ionized medium? 3

(c) If 'μ' is the refractive index of a potential step, in case $E > V_0$, prove that the transmission coefficient for the incident particle is, $\left|\frac{4\mu}{(1+\mu)^2}\right|$. 4

5. (a) Describe the principle, construction and working of a Nicol prism. Why the angle of incidence on Nicol prism should be around 14°. 5

(b) If $\vec{E} = \cos(y - t)\,\hat{k}$ and $\vec{B} = \cos(y - t)\,\hat{i}$, show that they constitute a possible electromagnetic field. 2

(c) Show that in normal mode of higher frequency two masses of the coupled oscillator are out of phase. 3

6. (a) The electromagnetic wave is propagating in free space with electric vector $\vec{E}(z, t) = \hat{x}\ 150 \cos(\omega t - kz)$. Find the magnetic component of the wave. How much average energy passes through a rectangular hole of length 3cm and width 1.5cm in XY- and in YZ- plane taken separately? 5

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

(c) What are the dissimilarities between a zone plate and a convex lens? 3

7. (a) Write down Maxwell's electromagnetic field equations in free space in absence of free charge and current. Starting from Maxwell's electromagnetic equations in free space, obtain the wave equation in terms of vector potential, mentioning the gauge condition used. 5

(b) A plane polarized light is incident on a piece of quartz cut parallel to the axis. Find the least thickness for which the ordinary ray and extraordinary ray combine to form the plane polarized light. Given $\mu_o = 1.5442$, $\mu_E = 1.5533$ and $\lambda = 5 \times 10^{-5}$cm. 3

(c) In a grating, opaque space is three times the slit width. Which order will be absent in the grating spectrum? 2

8. (a) In Young's double slit experiment two coherent sources are 0.02 cm apart and fringes are observed on a screen 100 cm away. It is found that 6^{th} bright fringe is situated at a distance of 1.2cm from the central fringe. Calculate the wavelength of the monochromatic light used. 4

(b) Using Gauss divergence theorem prove that, the volume of a sphere of radius 'r' is $\frac{4}{3}\pi r^3$. 3

(c) A beam of electrons is incident on a potential barrier of 8.0eV high and 0.50 nm width. Find the energy they should have, if 5% of them are to tunnel through the barrier.