BACHELOR OF MECHANICAL ENGINEERING EXAMINATION, 2025

(1st Year, 1st Semester)

PHYSICS

Time : Three hours Full Marks : 100

Answer any TEN questions

1. (a) Write down differential equation of damped vibration mentioning important terms. Considering the motion within a viscous medium. **(b)** Find out its solution for light damping. [3+7]

2. (a) Write down the differential equation of forced vibration under the application of periodic driving force $F_0 e^{ipt}$. Deduce the general solution of this equation. [3+7]

3. **(a)** Differentiate Restoring force and Retarding force of a Damped Vibration. **(b)** What do you mean by quality factor? **(c)** Distinguish Free and Damped Vibration. [4+2+4]

4. **(a)** Define group velocity and phase velocity. **(b)** Find out their relationship with each other.

5. (a) What do you mean by an ideal fluid? **(b)** State and prove Bernoulli's theorem in hydrodynamics. [3+7]

6. (a) Define coefficient of viscosity of a liquid. (b) Deduce the relation of rate of flow of liquid through a capillary tube of radius **r** and of length ***l*** for streamline flow of liquid having coefficient of viscosity η. [2+8]

7. (a) State Stoke's law for motion of a body through viscous medium. **(b)** Define terminal velocity **. (c)** A drop of water of radius 0.01m is falling through medium of density, 1.2 Kg/m^3 and coefficient of viscosity, 1.8×10^{-5} Nsm^{-2}. Find the terminal velocity of the drop. [3+3+4]

8. (a) Mention the processes how coherent sources may be generated.

   (b) In case of a Young's double slit experiment, establish the expression for fringe width. How can the location of the central maxima be determined in this experiment?

   (c) In Young's double slit experiment, the distance between slit and screen is halved. If the fringe width remains same, how is the separation of slits varied? $2 + (4 + 2) + 2$

9. (a) Give a brief explanation of temporal coherence. Define (i) Coherence length and (ii) Coherence time.

   (b) How is the coherence time related to frequency bandwidth? $(4 + 2 + 2) + 2$

10. (a) Write down the differences between Fraunhofer diffraction and Fresnel diffraction.

    (b) Write down the intensity distribution as a function of angle of incidence in case of single slit diffraction and hence determine the positions of principal and other maxima.

    (c) Fraunhofer diffraction is observed for a light of 500 nm wavelength due to a single slit of width 0.2 mm. Find out the distance between the first two maxima on the screen placed at the focal plane of the convex lens of focal length 20 cm. $2 + 4 + 4$

11. (a) Write down the condition for the location of principal maxima for diffraction through a grating. Hence explain that the total number of principal maxima must be finite.

    (b) State Brewster's law and show the Brewster angle in a schematic ray diagram.

    (c) 'A circularly polarised wave incident at the Brewster angle will be reflected as linearly polarised wave' – Explain. $(2 + 3) + 2 + 3$

12. (a) What is the difference between polarized light and unpolarized light?

    (b) The state of polarization of an EM wave may be explained by considering two mutually perpendicular oscillations superposed on each other. In which condition the final state of polarization is circular?

    (c) Find out the states of polarization when the components of electric field are given by:

    (i) $E_x = E_0 \cos(\omega t + kz)$ and $E_y = E_0 \cos(\omega t + kz + \frac{\pi}{2})$

    (ii) $E_x = \frac{E_0}{2} \cos(\omega t - kz)$ and $E_y = \frac{\sqrt{3}E_0}{2} \cos(\omega t - kz + \pi)$ $2 + 2 + (3 + 3)$

13. (a) Write down the position-momentum and energy-time uncertainty relations.

    (b) What is wave-particle duality? Give examples. What is the principle for determining the wavelength of a matter wave?

    (c) If the de Broglie wavelength of a moving particle changes from 0.4 Å to 0.2 Å, calculate the change in momentum. Given, $h = 6.63 \times 10^{-34}$ J s, $e = 1.6 \times 10^{-19}$ C, $m_e = 9.11 \times 10^{-31}$ kg. $2 + (3 + 2) + 3$

14. A particle of mass m and energy E is restricted to move along x-axis from $x = 0$ to $x = a$.

    (a) Solve the Schrödinger equation to find out the wavefunction in the n-th energy state. Find out the normalization constant.

    (b) Find out the energy difference between levels $n = 2$ and $n = 3$. $(5 + 2) + 3$