BACHELOR OF MECHANICAL ENGINEERING EXAMINATION, 2025

(1st Year, 1st Semester)

PHYSICS

Time : Three hours | Full Marks : 100

Answer any TEN questions

1. (a) What do you mean by free vibration and damped vibration
(b) Distinguish Retarding and Restoring force.
(c) write down the differential equation of motion of a simple pendulum and find out its general solution. [3+3+4]

2. (a) Suppose a body of mass m executing a damped harmonic motion in subject to an external periodic force $F_0 e^{ipt}$ where p is frequency. Write down the equation of force of such motion.
(b) Find out the general solution of this equation. [2+8]

3. **(a)** Solve the equation: $\frac{d^2x}{dt^2} + 2k\frac{dx}{dt} + \omega^2 x = 0$, for the case K<ω where K represents damping constant and ω is frequency of restoring force.
(b) By defining Quality factor (Q), show that Q = ω/2K for above damping harmonic motion. [7+3]

4. **(a)** What do you mean by streamline motion?
(b) In case of an ideal fluid establish Bernoulli's theorem to define equation of state at different points in the fluid.
(c) Water flos into a horizontal pipe whose one end is closed with a valve and the reading of pressure gauge attached to the pipe is $3x10^5$ N/m^2. This reading of pressure gauge falls to 10^5 N/m^2 when the valve is opened. Calculate the speed of water flowing into the pipe. [2+5+3]

5. (a) Define fluid?
(b) What do you mean by viscosity?
(c) Whether ideal fluid has any viscosity?
(d) Establish the mass continuity equation of hydrodynamics. [2+2+1+5]

6. (a) Establish the law of Stoke for the motion of a body through viscous medium.
(b) Define terminal velocity?
(c) A drop of water of radius 10^{-5} m is falling through medium of density, 1.21 Kg/m^3 and coefficient of viscosity, $1.8x10^{-5}$ Nsm^{-2}. Find the terminal velocity of the drop. [5+2+3]

7. (a) 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. Consider pressure difference between the ends is P.
(b) Calculate the mass of water flowing in 10 minutes through a tube of 0.1 cm in diameter, 40 cm long, if there is a constant pressure head of 20cm of water. The coefficient of viscosity of water is $8.9x10^{-4}$ Nsm^{-2}. [7+3]

8. (a) Establish the theory of constructive and destructive interference in Young's double slit experiment.

   (b) In Young's double-slit experiment, the fringe width with the light of wavelength 600 nm is 3 mm. What will be the value of fringe width when the wavelength of light is changed to 400 nm? $7 + 3$

9. (a) What are coherent sources?

   (b) Give brief explanations of temporal coherence and spatial coherence. $2 + (4 + 4)$

10. Establish the theory of intensity distribution in case of single slit diffraction. How are the maxima and minima positions determined? $6 + 4$

11. (a) Write down the conditions for the formation of principal maxima and secondary maxima in case of plane diffraction grating. Show that the number of principal maxima cannot be increased infinitely.

    (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) Light of wavelength 500 nm passes through a slit of 0.2 mm wide. The diffraction pattern is formed on a screen 60 cm away. Determine the distance between the central maximum and the second minimum. $(2 + 4) + 4$

12. (a) Write down the expression of the intensity distribution as a function of the angle of incidence in case of a plane diffraction grating. Explain that the single slit diffraction pattern is present in the intensity expression along with the multi-slit interference pattern.

    (b) Show that in case of incidence of light in Brewster's angle, the reflected and transmitted rays are at right angles to each other. $(3 + 3) + 4$

13. (a) The state of polarization of an EM wave may be explained by considering two mutually perpendicular oscillations superposed on each other. Find out the conditions when the final state of polarization is (i) linear and (ii) circular.

    (b) Find out the state of polarization when the components of electric field are given by:
    $E_x = E_0 \cos\left(\omega t + kz - \frac{\pi}{2}\right)$ and $E_y = E_0 \cos\left(\omega t + kz + \frac{\pi}{2}\right)$ $(3 + 3) + 4$

14. (a) Give a brief explanation of Heisenberg's uncertainty principle.

    (b) If an electron and a proton have the same kinetic energy, which one will have the largest de Broglie wavelength and why?

    (c) Calculate the de Broglie wavelength of a beam of electrons accelerated by a potential difference of 1000 volts. $3 + 4 + 3$

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

    (a) Write down the boundary conditions to be satisfied by the wave function.

    (b) Solve the Schrodinger equation to find out the energy of the particle in the third energy state for $m = 1$ unit and $a = 2$ unit. $3 + 7$