PHYSICS – I

Course Code: UPH101
Time: 3 Hours
Full Marks: 100

Answer any five from the following:

1. (a) A body of mass (m) vibrating in SHM, whose displacement is represented by, $x = A_0 Cos \cos \omega_0 t$. Prove that total average energy of the oscillation remains constant.

   (b) Define damp harmonic oscillation and derive an expression for displacement for underdamped motion of the body.

   (c) The differential equation for damped harmonic motion is represented by $\frac{d^2x}{dt^2} + 0.05\frac{dx}{dt} + 100x = f_o cospt$. Find the value of amplitude and velocity resonance frequency. Also discuss the phase relation among velocity, displacement and supplied force at resonance condition.

   (d) Describe the construction of Newton's ring apparatus set up and explain why Newton's fringe pattern is circular. Discuss the nature of fringe (i.e. dark or bright) when thickness of the film, t =λ/4, λ/2. [4x5]

2. (a) In single slit diffraction pattern if amplitude at any point on the screen is represented by $R = A_o \frac{sin\alpha}{\alpha}$, where symbols have their usual meaning, find the condition for maxima, minima and secondary maxima. Compare the intensity of primary maxima with secondary maxima and draw its intensity distribution pattern. [7]

   (b) For single slit diffraction pattern, slit and screen are separated by 100 cm, width of slit 3.5×10^{-5}cm and wavelength of monochromatic light used is 5.893×10^{-5} cm. Calculate the angular width and linear width of the central maxima. [3]

   (c) The plane transmission grating of width 2.54 cm. If it contains 12500 number of lines per inch determine its grating element. [2]

   (d) In above plane transmission grating the amplitude at a point on the screen is given by $R = A_o \frac{sin\alpha}{\alpha} \frac{sinN\beta}{sin\beta}$, find the condition for maxima, minima and secondary maxima and hence compare intensity of primary and secondary maxima. Also, determine the number of minima and secondary maxima in between two consecutive primary maxima. [8]

3. (a) What is LASER? Discuss the characteristics of laser radiation. [8]

   (b) Discuss the difference between spontaneous and stimulated emission for a laser in tabular form. [7]

   (c) Discuss the basic principle of laser action. [5]

4. (a) What is Ampere's law? Write a short note on displacement current [5]

   (b) Write down the Maxwell's field equations in differential and integral form and discuss their physical significance. [9]

(c) Calculate velocity of the electromagnetic wave propagating through free space. Show that electromagnetic wave is transverse in nature. [6]

5. (a) State and prove Gauss divergence theorem. [5]

(b) Show that the curl of the linear velocity is twice the angular velocity. [5]

(c) Prove that the $\nabla^2 (1/r) = 0$. [5]

(d) Establish Schrodinger's time independent equation. [5]

6. (a) In a P- V diagram, sketch the Carnot cycle. Obtain the expression for the efficiency of a Carnot engine. [6]

(b) Obtain the energies, wave functions and probability densities for a particle in a one-dimensional infinite potential box. [10]

(c) What is photoelectric effect? Write Einstein's photoelectric equation and define work function. [4]