B.Tech. (ME) 3rd Semester (G-Scheme)
Examination, November-2023
PHYSICS-II (OPTICS AND WAVES)
Paper - BSC-ME-201-G

Time allowed : 3 hours] *[Maximum marks : 75*

*Note : Attempt **five** questions in all, selecting **one** question from each Section. **Question No. 1 is compulsory.** All questions carry equal marks.*

1. (a) What are transverse and longitudinal waves? Give two examples of each.

   (b) Distinguish between interference by division of amplitude and division of wavefront.

   (c) Explain the following terms with an appropriate diagram:

   (i) Spontaneous emission

   (ii) Stimulated emission

   (d) In Young's double-slit experiment the separation of the slit is 1.9×10^{-3} m and the fringe spacing is 0.31×10^{-3} m at a distance of 1 m from the slits. Calculate the wavelength of light.

   (e) Define unit plane and nodal plane. $5\times3=15$

Section-A

2. (a) Define simple harmonic motion and obtain the differential equation for it. Establish the equation of motion for a simple pendulum and derive the expression for the time period and total energy. 10

(b) The quality factor of an undamped tuning fork of frequency 256 Hz is 10^3, Calculate the time in which its energy is reduced to (1/e) of its energy in the absence of damping. How many oscillations the tuning fork will make in this time? 5

3. (a) Assuming damping to be proportional to velocity, write the differential equation for the damped harmonic oscillator and find its solution. Discuss under damped, over damped and critically damped oscillations. 10

(b) A pendulum made of a light spring of length 10 m has a heavy mass of 2 kg. Assuming the oscillations to be of small displacements, find the period of oscillation. 5

Section-B

4. (a) Derive the wave equation for the transverse vibrations of a stretched string and show that speed of the transverse wave is given by

$$v = \sqrt{T/\rho}$$ 10

(b) A wave is represented by

$y(x, t) = [8\text{ cm}] \sin [(10\text{ rad/s})t - (10\text{ rad/cm})\, x]$

Determine the amplitude, angular frequency, wave number, wavelength and velocity of the wave. 5

5. (a) If a ray is specified by a 2×1 matrix with elements λ_1 and x_1 when it enters an optical system of refractive index n_1, and is specified by elements λ_1 and x_2 when it leaves the system. The effect of translation is given by

$$\begin{pmatrix} \lambda_2 \\ x_2 \end{pmatrix} = T \begin{pmatrix} \lambda_1 \\ x_1 \end{pmatrix}$$

Determine the elements of matrix T for translation through a distance D. 10

(b) Derive the law of refraction using Fermat's principle. 5

Section-C

6. (a) Explain the formation of Newton's rings by reflected light. Derive the expression for the diameter of the n^{th} dark ring. 10

(b) In Newton's ring experiment the diameter of the 5^{th} ring was 0.336×10^{-2} m and that of the 15^{th} ring 0.59×10^{-2} m. Find the radius of curvature of the plano-convex lens if the wavelength of light used is 5890 A°. 5

7. (a) Define dispersive power and resolving power of a plane transmission grating and derive the expression for them. 10

(b) What is the highest order spectrum which may be seen with monochromatic light of the wavelength of 4800 A° by means of transmission grating with 2500 lines per inch? 5

Section-D

8. (a) Discuss Einstein's coefficients and derive the relation between them. Explain why high-frequency lasers are not practically possible. 10

(b) Identify and explain the type of pumping source used in the following lasers:

(i) Ruby laser

(ii) He - Ne laser

(iii) Nd: YAG laser

(iv) Co_2 laser 5

9. (a) Describe the principle, construction and working of He- Ne laser with suitable diagrams. 10

(b) Explain the concept of directionality and mono-chromaticity as applied to the lasers. 5