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Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram

Mid Semester Examination, May 2023

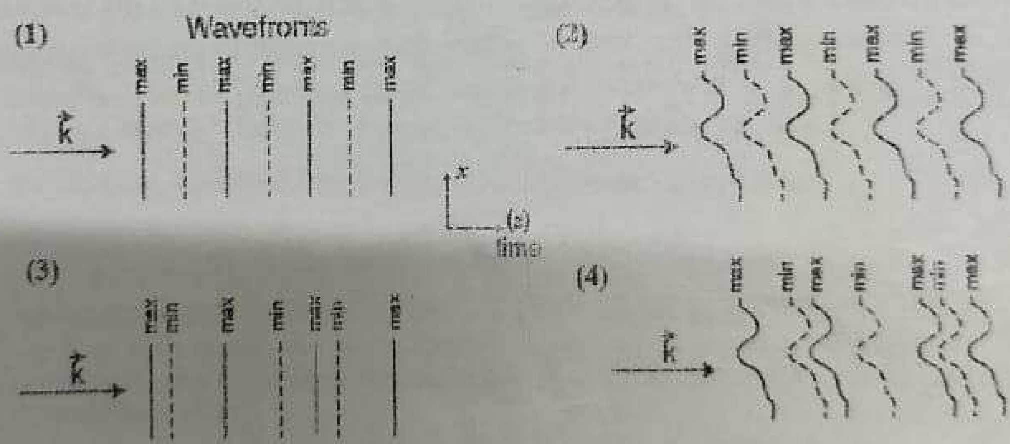
Course Code: PH2000 | **Course Title: Engineering Optics**
Category: Elective | Date of Examination: 08-05-2023
Duration: 2 hours | Max. Marks: 30

Instructions to students:

- Please read the questions carefully and answer all the questions.

1. (a) Draw the resultant wave function ψ for each of the following cases and mention the type of interference.
(i) $\psi_1 = 1.0 \sin kx$ and $\psi_2 = 0.7 \sin kx$ (ii) $\psi_1 = 0.5 \sin(kx + \pi)$ and $\psi_2 = 0.5 \sin kx$

(b) If the horizontal (z) and vertical (x) axes indicate time (temporal) and space (spatial) variations respectively for the wavefronts with propagation vector k, denote the type of coherence (or incoherence) for each of the following cases. [2+2]



2. Two parallel narrow horizontal slits in an opaque vertical screen are separated center to center by 2.5 mm. These are directly illuminated by yellow plane waves from a filtered discharge lamp. Horizontal fringes are formed on a vertical viewing screen 5 m from the aperture plane. The center of the fifth bright band is 5 mm above the center of the zeroth or central bright band.
(a) Determine the wavelength of the light in air
(b) If the entire space is filled with a liquid (n=1.47) where would the fifth fringe now appear? [4]

3. (a) In Young's double slit (S_1 and S_2) experiment, consider a point P on the screen such that $S_2P - S_1P = \frac{\lambda}{3}$. Find the ratio of the intensity at point P to that at a maximum.
(b) Consider a diffraction grating which is capable of resolving two bright lines with wavelengths 589.6 nm and 589.0 nm. What is the minimum number of slits the grating must possess? [4]

4. Consider a set of two slits each of width $b = 2.5 \times 10^{-2}$ cm and separated by a distance d = 0.25 cm, illuminated by a monochromatic light of wavelength 6×10^{-5} Å. If a convex lens of focal length 10 cm is placed beyond the double-slit arrangement, calculate (i) the number of interference minima within the first diffraction minima and (ii) the width of the central diffraction maximum. [4]

5. Discuss the state of polarization (with diagram) when x and y components of the electric field E are given by the equations
(i) $E_x = E_0 \cos(\omega t + \pi)$ and $E_y = E_0 \cos(\omega t + \pi/2)$
(ii) $E_x = E_0 \sin(kz - \omega t + \frac{\pi}{6})$ and $E_y = E_0 \cos(kz - \omega t - \frac{\pi}{3})$
(iii) $E_x = E_0 \sin(kz - \omega t)$ and $E_y = \frac{E_0}{\sqrt{2}} \sin(kz - \omega t - \frac{\pi}{4})$ [6]

6. An electric field of a 100 W/m^2 linearly polarized light beam oscillates at +40° with the vertical line in the 1st and 3rd quadrants and faces two consecutive polarizers P_1 and P_2. The pass axis of P_1 is at +50° while it is at -50° with the same vertical line for P_2. How much light emerges from the 2nd polarizer? What will happen if the polarizers are now interchanged? [4]

7. (a) Assume a plane wave ($\lambda = 5 \times 10^{-5}$ cm) to be incident on a circular aperture of radius 0.5 mm. Calculate the positions of the brightest and darkest points on the axis. (b) If white light is incident on a diffraction grating, what kind of pattern do you expect to see on the screen? For a particular order (n) which color is closer to the central fringe and why? [4]

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