THE OPEN UNIVERSITY OF SRI LANKA

BACHELOR OF SCIENCE DEGREE PROGRAMME–LEVEL 04

FINAL EXAMINATION 2021/2022

OPTICS–PYU 2164/PHU4302

Duration: TWO HOURS (2 hrs)

324

Date: 10th October 2022 **Time 9.30 am -11.30 am**

Answer Four (4) questions only

1. (a). Two waves travelling together along the same line are given by $y_1 = 6 \sin(\omega t + \pi/4)$ and $y_2 = 8 \sin(\omega t + \pi/3)$. Draw them in a phasor diagram and determine the mathematical expression for the resultant wave. **(25 marks)**

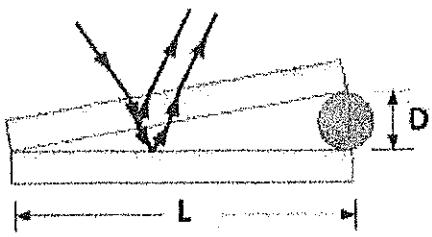
(b). Derive an expression for fringe width in an interference pattern of a double slit and show that the fringes are uniformly spaced. **(25 marks)**

(c). Light of wavelength 590 nm mixed with an unknown wavelength, illuminates Young's double slit and gives rise to two overlapping interference pattern on a screen. The central maximum of both lights coincide. It is observed that the third bright fringe of known light coincide with the forth bright fringe of the unknown light. Calculate the wavelength of the unknown light. **(25 marks)**

(d). A double slit experiment is performed with light of wavelength 500 nm. A thin film of thickness 2 μm and refractive index of 1.5 is introduced in the path of the upper beam. Find the new location of the central maximum. **(25 marks)**

2. (a). A parallel beam of sodium light of wavelength 5880 Å is incident on a thin glass plate of refractive index 1.5 such that the angle of refraction in the plate is 60°. Calculate the smallest thickness of the plate which will make it appear dark by reflection. **(25 marks)**

(b). A wedge shaped film of air is produced by placing a fine wire of diameter D between the ends of two flat glass plates of length L=20 cm as shown in the figure below. When the air film is illuminated with light of wavelength 550 nm, there were 12 dark fringes per centimeter. Find the diameter of the wire D?



(25 marks)

(c). The lower surface of a lens resting on a plane glass plate has a radius of curvature of 400 cm. When illuminated by monochromatic light, the arrangement produces Newton's rings and the 15^{th} bright ring has a diameter of 1.16 cm. Calculate the wavelength of the monochromatic light. **(25 marks)**

(d). Newton's rings arrangement is used with a monochromatic source of light of wavelength 5460 A. with the thin film of air formed between the lens and the plate, the distance between two dark rings of order 5 and 15 is found to be 2.30 mm. When the space between the lens and the plate is filled with a liquid, the distance between rigs of the same order becomes 1.76 mm. Determine the refractive index of the liquid. **(25 marks)**

3. (a) . Show that the area of each half period zone is approximately equal and their radii are proportional to the square root of the natural numbers. **(25 marks)**

(b). Light of 500 Å is incident on a circular hole of radius of 1 cm. How many half period zones are contained in the circle if the screen is placed at a distance of 1 m to observe the diffraction? **(25 marks)**

(c). Find the radius of the first zone in a zone plate of focal length 25 cm for light of wavelength 5000 Å. **(25 marks)**

(d). Compare a zone plate with a convex lense giving two similerities and dissimilarities. **(25 marks)**

4. (a). Distinguish between Fresnel's and Fraunhofer's classes of diffraction. **(25 marks)**

(b). A single slit is illuminated by white light. The first minimum from red light of wavelength 6500Å falls at an angle of 30 °. What is the value of slit width? **(25 marks)**

(c). In a double slit Fraunhofer diffraction pattren, the screen is placed 170 cm from the slits. The width of the slits is 0.08 mm and the slits are 0.40 mm apart. Calculate the wavelength of light, if the fringe widthe is 0.25 cm. Also find the missing order/s? **(25 marks)**

(d). Mercury light is normally incident on a grating. The diffraction angle in the first order spectrum for a green spectral line of wavelength 5460 Å is 20°. Find the number of lines per cm of grating. **(25 marks)**

5. (a) What do you understand by polarization of light? Distinguish between polarized and unpolarized light? **(25 marks)**

(b). Three polarizing sheets are placed together such that the transmission axis of the second sheet is oriented at 25° to the axis of the first, whereas the transmission axis of the third sheet is oriented at 40° to the axis of the first. What fraction of the intensity of an incident unpolarized beam is transmitted by the combination? **(25 Marks)**

(c). A parallel beam of unpolarized light is incident at an angle of 58° on a plane glass surface. The reflected beam is completely polarized. Calculate the refractive index of glass.

(25 Marks)

(d). Explain the terms (i) Double refraction (ii) Optic axis (iii) Positive and negative crystals.

(25 Marks)

6. (a). Explain the use of a quarter wave plate in the production of circularly and elliptically polarized light. **(25 Marks)**

(b). What is a half wave plate? Deduce its thickness for a given wavelength in terms of its reflective indices. **(25 marks)**

(c). Calculate the minimum thickness of a quarter wave plate made up of calcite to use at a wavelength of 500 nm. Given that the refractive indices of calcite for ordinary and extraordinary rays are 1.6584 and 1.4864 respectively. **(25 Marks)**

(d). A 200 mm long tube containing 48 cm^3 of sugar solution produces an optical rotation of 11° when places in a polarimeter. If the specific rotation of sugar solution is 66°, calculate the quantity of sugar contained in the tube in the form of a solution. **(25 marks)**

----------END----------