00337

THE OPEN UNIVERSITY OF SRI LANKA

BACHELOR OF SCIENCE DEGREE PROGRAMME–LEVEL 04

FINAL EXAMINATION 2023/2024

OPTICS– PHU4302

Duration: TWO HOURS (2 hrs)

Date: 12th October 2023 **Time 1.30 pm -3.30 pm**

Answer Four (4) questions only

1. (a) The two sources of intensity I and $4I$ are used in an interference experiment. Estimate the intensity at a point where the waves from two sources superimpose with a phase difference of $\pi/2$. **(25 marks)**

(b). A biprism is positioned 5cm away from a slit illuminated by sodium light with a wavelength of 589 nm. Calculate the width of the fringes observed in the eyepiece, located 75 cm away from the biprism, given that the distance between the virtual sources is 0.005cm. **(25 marks)**

(c). In Young's double-slit experiment, where the separation between the two slits is 0.20 mm, and interference of light from the slits creates fringes on a screen located 1.0 m away. Calculate the distance between the third dark fringe and the central fringe? The wavelength of the light used is 600 nm. **(25 marks)**

(d). What changes will occur in the fringe pattern if a thin transparent glass plate is placed in front of one of the two slits during Young's double-slit experiment using white light? **(25 marks)**

2. (a). A parallel light beam with a wavelength $\lambda = 5890$ Å strikes a glass plate ($\mu = 1.5$) in such a way that the angle of refraction within the plate is 60 degrees. Determine the minimum thickness of the plate required to make it appear dark through reflection. **(25 marks)**

(b). What is the angle, in radians, of a wedge-shaped film with a refractive index of 1.4, when light with a wavelength of 600 nm falls perpendicularly on it and produces fringes that are 2.0 mm apart? **(25 marks)**

(c). Derive an expression for the wavelength of monochromatic light source used in Newton's ring experiment in terms of diameter of rings and radius of curvature of the lens used. **(25 marks)**

(d.) In the Newton's ring experiment, when the reflected light with a wavelength of 600 nm shows consecutive rings with diameters of 2.00 cm and 2.02 cm, what is the radius of curvature of the lens surface in contact with the plane glass surface? **(25 marks)**

3. (a). What are the fundamental differences between the concepts of interference and diffraction of light? **(25 marks)**

(b). Why is the term 'half-period' used to characterize Fresnel's half-period zones? **(25 marks)**

(c). Prove that the radius of a Fresnel's half period zone is proportional to the square root of an integer. **(25 marks)**

(d). Calculate the position of the screen necessary to obtain the brightest spot when plane monochromatic light with a wavelength of 650 nm is incident normally on a zone plate with a first half-period zone radius of 0.05 cm. **(25 marks)**

4. (a). What is the width of a single narrow slit illuminated with red light of wavelength 6328 Å when a screen placed 1.60 m away from the slit displays a typical single-slit diffraction pattern with a separation of 4.0 mm between the first two minima on either side of the center? **(25 marks)**

(b). In double-slit Fraunhofer diffraction calculate the linear distance from the central maximum to the first minimum of the fringe envelope, on a screen 50 cm away from the slits, if they are illuminated with blue light (λ= 4800 Å). Slit separation is 0.1 mm and the slit width is 0.02 mm. Deduce the missing order. **(25 marks)**

(c). A diffraction grating has the value of grating constant equal to 1.5×10^{-3} cm. Calculate the position of the third order maximum for the light with wavelength $\lambda = 2.4 \times 10^{-4}$ cm. **(25 marks)**

(d) A plane transmission grating has 15,000 lines per cm. Find the smallest wavelength difference that can be resolved with a light of wavelength 600 nm in the second order. **(25 marks)**

5. (a). Unpolarized light with an intensity I_o passes through three polarizing filters. The second filter makes a 45 degree angle relative to the first one. The third filter makes a 90 degree angle relative to the first filter. Determine the intensity of light emerging from each filter in terms of I_o.

(25 marks)

(b). Describe the process of production of plane-polarized light by reflection. Hence obtain an expression for Brewster's law of polarization of light. **(25 marks)**

(c). Briefly explain the following terms

(i) Dichroism

(ii) Birefringence **(25 marks)**

(d). A plane-polarized light is incident perpendicularly on a quartz plate cut with faces parallel to optic axis. Find the thickness of quartz plate, which introduces phase difference of 60° between ***e*** and ***o*** ray. **(25 marks)**

6. (a) What is a half-wave plate used in the polarization of light? Deduce its thickness for a given λ in terms of its refractive indices. **(25 marks)**

(b). Calculate the thickness of a mica sheet required for making a quarter wave plate for the light with wavelength 500 nm. The refractive indices of O-ray and E-ray in mica are 1.586 and 1.592 respectively. **(25 marks)**

(c). Describe the process of production of circularly polarized light from unpolarized light.

(25 marks)

(d). A 200 mm long tube containing a sugar solution produces an optical rotation of 11° when placed in a polarimeter. If the specific rotation of sugar solution is 66°, calculate the concentration of the sugar solution. **(25 marks)**

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