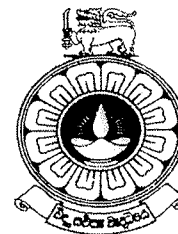


THE OPEN UNIVERSITY OF SRI LANKA
 BACHELOR OF SCIENCE DEGREE PROGRAMME-LEVEL 04
 FINAL EXAMINATION 2025/2026
 OPTICS-PHU4302



Duration: TWO HOURS (2 Hrs.)

Date: 05 JANUARY 2026

Time: 1.30 pm - 3.30 pm

Answer any Four (4) questions only

1.

- a) Two coherent waves of equal amplitude, $A_1=A_2=1.5$ m, arrive at a double-slit and interfere. If the path difference between the two waves is 0.010λ , determine the corresponding phase difference between them. Using this phase difference, calculate the resultant amplitude produced by their superposition at the point of observation. **(25 marks)**
- b) In a Young's double-slit interference experiment, monochromatic light of wavelength 520 nm is used, and the fringe width on the observation screen is found to be 1.5 mm, when the screen is positioned 1.2 m from the slits. The screen is subsequently shifted to a distance of 1.8 m, while all other parameters remain unchanged. Under these conditions, determine the new fringe width formed on the screen. **(25 marks)**
- c) In a Young's double-slit interference experiment, monochromatic light of wavelength 500 nm is used to produce an interference pattern. A thin mica sheet of thickness $3.00\ \mu\text{m}$ and refractive index 1.58 is then placed over one of the slits, introducing an additional optical path. Considering this change, determine how far the central fringe shifts in the resulting interference pattern. **(25 marks)**
- d) In a Fresnel bi-prism interference experiment, two virtual coherent sources are formed with a separation of 0.05 cm. The screen is positioned 80 cm from the bi-prism, while the virtual sources are located 5 cm from it. Monochromatic sodium light of wavelength 600 nm is used as the illumination source. Based on these experimental conditions, determine the resulting interference fringe width. **(25 marks)**

2.

- a) A thin film of oil on the surface of water often shows a range of colours when viewed from above. What causes these colours to appear, and how does the interaction of light with the oil film produce this effect? Explain the mechanism briefly. **(25 marks)**
- b) A parallel beam of sodium light with a wavelength of $5880 \text{ \AA}$ is incident on a thin glass plate of refractive index 1.5, such that the angle of refraction inside the plate is 30° . Determine the minimum thickness of the plate required for it to appear completely dark in reflected light. **(25 marks)**
- c) In the interference pattern formed by a thin air wedge between two glass plates, a dark fringe appears at the point where the plates touch. Why does a dark fringe occur at the point of contact instead of a bright fringe? Explain the reason briefly. **(25 marks)**
- d) A beam of monochromatic light with a wavelength of $5.82 \times 10^{-7} \text{ m}$ is incident normally on a glass wedge having a wedge angle of 20 seconds of arc. Given that the refractive index of the glass is 1.5, estimate the fringe width of the interference pattern and hence determine the number of dark fringes formed per centimeter along the length of the wedge. **(25 marks)**

3.

- a) Show that the diameters of Newton's dark rings are proportional to the square roots of natural numbers. **(25 marks)**
- b) In a Newton's rings experiment, why does the central fringe appear dark instead of bright? Explain the reason. **(25 marks)**
- c) In a Newton's rings experiment using reflected light of wavelength $5.9 \times 10^{-5} \text{ cm}$, the radius of the 10th dark ring is measured to be 0.5 cm. Determine the radius of curvature of the plano-convex lens and the corresponding thickness of the air film at this ring. **(25 marks)**
- d) In a Newton's rings experiment, the diameter of the 12th dark ring decreases from 1.50 cm to 1.35 cm when the air film is replaced by a thin layer of liquid. Calculate the refractive index of the liquid. **(25 marks)**

4.

- a) A zone plate has a first ring of diameter 1 mm. If it is illuminated by plane waves of wavelength 500 nm, at what distance from the zone plate should a screen be placed so that the light is focused at the brightest spot? **(25 marks)**
- b) A narrow single slit is illuminated by light of wavelength 600 nm. On a screen placed 150 cm from the slit, the first diffraction minima are observed at 5 mm on either side of the central maximum. Determine the width of the slit. **(25 marks)**
- c) In a double-slit experiment using sodium light of wavelength 589.3 nm, the interference pattern is observed on a screen 100 cm away. If the center of the tenth dark fringe lies 12 mm from the central maximum, determine the separation between the slits. **(25 marks)**
- d) A diffraction grating has 620 rulings per millimeter and a total width of 0.5 mm. Determine the smallest wavelength interval that can be resolved in the third diffraction order for light of wavelength 481 nm. **(25 marks)**

5.

- a) What is meant by polarization of light? **(25 marks)**
- b) Explain Brewster's law and discuss the behavior of light when it strikes a transparent surface at Brewster's angle. Calculate the Brewster's angle for light incident from air onto water with a refractive index of 1.33. **(25 marks)**
- c) Plane-polarized light of intensity 200 W m^{-2} passes through an analyzer, and the transmitted intensity is measured to be 150 W m^{-2} . Determine the angle between the polarization direction of the light and the axis of the analyzer. **(25 marks)**

- d) A light beam enters a birefringent crystal slab of thickness 2.0 cm as shown in figure (1) below. The ordinary and extraordinary rays travel inside with refractive indices $n_o=1.60$ and $n_e=1.50$. If the incident angle is 35° , calculate the lateral separation (y) between the two rays as they emerge from the back face of the slab. **(25 marks)**

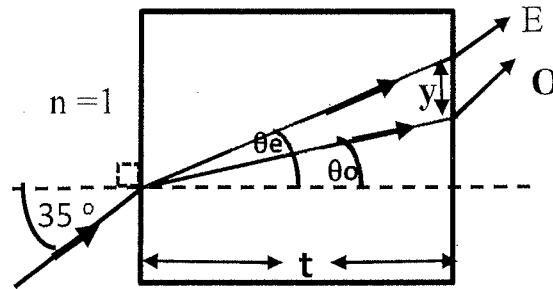


figure (1)

- 6.
- Explain followings in briefly,
 - Optic axis of a crystal,
 - Nicol prism,
 - Double refraction of crystals.**(25 marks)**
 - Find the thickness of a quartz plate with refractive indices $n_o= 1.544$ and $n_e = 1.553$ required to act as a quarter wave plate for light of wavelength 600 nm. **(25 marks)**
 - What is meant by *specific rotation* in the context of optically active substances? Provide two examples of substances that exhibit optical activity. A solution of an optically active compound is placed in a 20 cm polarimeter tube. When plane-polarized light passes through the solution, the observed rotation is 6.0° . If the concentration of the solution is 0.25 g/ml, calculate the specific rotation of the compound. **(25 marks)**
 - What is the population inversion in laser operation, and why is it essential for the generation of coherent laser radiation? **(25 marks)**

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