The Open University of Sri Lanka
B.Sc. Degree Programme - Level 05
Final Examination – 2007/2008
PHU 3141/ PHE 5141 – Physical Optics
Duration: Two and half (2 1/2) hours

016

Date: 13th June 2008 **Time: 2.00 pm to 4. 30 pm**

ANSWER FOUR QUESTIONS ONLY

1. (a) Define the terms a, ω, k and δ of the wave equation $y = a \sin(\omega t - kx + \delta)$.

   (b) State the principle of superposition and explain how it applies to interference of light.

   (c) What is the resultant disturbance due to interference of following two waves? $y_1 = a_1 \sin(\omega t - kx + \delta_1)$ and $y_2 = a_2 \sin(\omega t - kx + \delta_2)$

   (d) Derive an expression for the path difference between the two light beams of Young's double slit experiment. Hence show that the central bright fringe is shifted by a distance $(\mu\text{-}1)\, t\, D/b$ when a glass plate of refractive index μ with thickness t is placed on one of the slit, where b is the separation of the slits and D is the distance to the screen from the slits.

2. (a) Discuss how Newton's rings are formed when a convex lens is placed on a flat glass plate and illuminated from the top.

   (b) In Newton's ring experiment, explain why the center appears dark for the reflected light from the glass plate and why it is bright for the light transmitted through the glass plate.

   (c) A convex lens made of crown glass ($\mu = 1.52$) is placed on a flat plate of flint glass ($\mu = 1.63$) and an oil is introduced in between them. Find the limits for the value of the refractive index of oil to produce (i) center bright and (ii) center dark.

   (d) Suppose the center is bright after introducing oil in the above case and the radius of the 5th dark ring is 7 mm. Calculate the refractive index of oil when the radius of curvature of the lens is 25 m and source of illumination is sodium light of wavelength 589.3 nm.

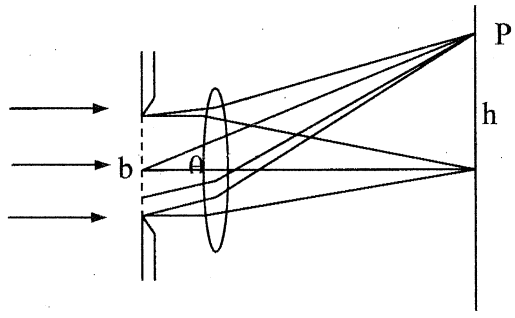
3. (a) Explain what is meant by Fresnel's half zones of (i) spherical wave front and (ii) cylindrical wave front?

   (b) Draw the Cornu's spiral for the first five of the upper and lower half zones from the center of a cylindrical wave front.

   (c) Discuss the intensity variation due to diffraction at a straight edge using the Cornu's spiral and plot the intensity variation of the screen.

   (d) What are the numerical values of x and y coordinates of Fresnel's integrals of unobstructed wave front? The x and y values corresponding to $\sqrt{} = 1.5$ are given as 0.4453 and 0.6975 respectively in the table of Fresnel's integrals. Calculate the exact intensity at the point.

4. (a) Explain the conditions necessary for Fraunhofer diffraction to take place.



   (b) Plane wave front emerging from a slit of width b is focused on a screen by a lens of focal length f placed close to the slit as shown in the figure. Show that the phase difference between the two rays emerge from an edge and the center of the slit which fall on point P of the screen is $\frac{kb}{2}\sin\theta$.

   (c) If the phase difference equal to $n\pi$ for the n^{th} minimum, show that $\frac{n\lambda}{b} = \frac{h}{f}$.

   (d) Parallel light of wavelength 6563 $\mathring{A}$ is incident normally on a slit of width 0.3850 mm. A lens with a focal length of 50 cm is located just behind the slit bringing the diffraction patterns to focus on a screen. Find the distance from the center of the principle maximum to the first minimum.

5. (a) What do you understand by birefringence or double refraction?

   (b) Define the terms optical axis, principle section and principle plane of a crystal.

   (c) How did Huygen explain the birefringence in a crystal?

   (d) A ray of unporlarized light falls on a surface of a calcite crystal, which is parallel to the optical axis. The angle of incident is 32° and the pane of incidence coincides with the principle section of the crystal. Find the thickness of the crystal if the separation between the *O* ray and *E* ray for green mercury line is 0.01 mm. The refractive index of *E* ray and O ray are 1.662 and 1.488 respectively.

6. Write short notes on any two of the following.

   (a) Applications of Michelson Interferometer.

   (b) The action of Zone plate similar to a thin lens.

   (c) Analysis of polarized light.