

THE OPEN UNIVERSITY OF SRI LANKA
B.Sc. DEGREE PROGRAMME-LEVEL - 04
PYU2164/PHU4302 - OPTICS
FINAL EXAMINATION- 2017/2018



Duration: Two (02) HOURS

Date 14th September 2018

Time 9.30 am – 11.30am

Answer four (04) questions only

1. (a) Briefly explain the following terms.
 (i) Wavefront (ii) Wavepacket (iii) Huygen's Principle (iv) Coherent source
- (b) How does the Huygen's principle apply in Young's double slit experiment to produce coherent sources of light?
- (c) Draw a labeled diagram of the experimental setup of Young's double slit experiment. Derive expressions for the positions of bright and dark fringes from the center.
- (d) In Young's double slit experiment, the separation of the double slits is 0.5 mm and distance between the double slits and the screen is 1 m. Calculate the wavelength of the monochromatic light used in this experiment if the distance to the 10th bright fringe is 5 mm from the center.
- (e) The refractive index of a thin transparent plastic sheet could be found using Young's double slit experiment by placing the sheet over one of the slits. What is the advantage of using white light in this experiment despite monochromatic light?

The central bright fringe in the experimental setup described in (d) above is shifted by 4 mm when a plastic sheet of 0.05 mm is placed over one of the slits. Calculate the refractive index of the plastic sheet.

2. (a) Write down two examples each for fringes of equal inclination and equal thickness.
- (b) When a soap film made on a wire frame is held vertically, the upper area of the film appears black and different colours could be seen in the lower part. How do you explain the darkness in the upper area and colours appearing in the bottom area of the film.
- (c) A beam of light incident on a parallel plate of refractive index μ at an angle i with the normal is partially reflected and partially transmitted by the plate. The transmitted light reflects back at the bottom of the plate and emerge out from the top surface. When the angle of refraction is r and thickness of the film is t , show that the path difference between two rays emerging from the top surface is given by $2\mu t \cos r$.
- (d) Hence derive an expression for the thickness of a non reflecting coating that has to be deposited on a surface for blooming.
- (e) Due to a wreckage tanker, oil is spilt on an ocean coastline. It is observed that the wavelengths of 360 nm and 480 nm are missing in the reflected light when observed above the sea. Calculate the minimum thickness of the oil spread on the ocean. The refractive index of oil and sea water are 1.5 and 1.6 respectively.

3. (a) How do you define the diffraction of light? Distinguish the difference between fringes produced by interference and diffraction.
- (b) Classify diffraction of light according to the wave fronts associated with them and discuss how you obtain diffraction patterns in each case with the help of diagrams.
- (c) How do you construct a zone plate? Show that the zones have equal area in a zone plate?
- (d) Light from a point source pass through a circular aperture of radius r placed at a distance a from the source and a screen is placed at a distance b from the aperture to observe the light. Show that this setup satisfies the thin lens formula with multiple foci.
- (e) Calculate the radius of the 10th zone plate of the focal length 5 m for the light 500 nm.
4. (a) Plane wave front passes through a single slit of width b and focused on a screen placed at a distance x by a convex lens. Show that the intensity distribution on the screen is given by $I = I_0 \frac{\sin^2 \beta}{\beta^2}$, where $\beta = kb/2 \sin \theta$
- (b) Hence derive the conditions for maximum and minimum intensity.
- (c) The seperation between 1st minimas of single slit diffraction pattern is 10 mm observed on a screen placed at 1.5 m from the slit. If parallel beam of sodium light ($\lambda = 589.3$ nm) is used, calculate the slit width.
- (d) Write down the intensity distribution for a double slit by modifying the equation given in part (a) defining all the variables and constants.
- (e) Estimate the missing orders in the double slit diffraction pattern where the screen is placed 170 cm away from the slit. The width of the slits is 0.08 mm which are 0.4 mm apart.
5. (a) Distinguish the diffeence between polarized and unpolarized light.
How do you clasify polarized light?
- (b) Define the terms
(i) Optic axis (ii) Principle section (iii) Principle plane
- (c) Write down Huygen' postulates on double refraction.
Hence explain what are the negative and positive crystals.
- (d) According to the Huygen's explanation of double refraction, show that the O-ray and E-ray travelling perpendicular to the optic axis do not deviate but travel with different velocities. You may show this by drawing a diagram of wave fronts of both rays for a negative crystal.
- (e) Plane polarized light of 600 nm strike nomally on a piece of quartz cut parallel to the optic axis. Calculate the least thickness for which O-ray and E-ray emerge the crystal with phase difference of $\pi/2$. $\mu_O = 1.54$, $\mu_E = 1.55$.

6. (a) How do you define the privileged directions of uniaxial crystal plate?

Hence explain what is meant by slow axis and fast axis.

(b) Distinguish the difference between quarter wave plate, half wave plate and full wave plate.

(c) What are the seven possible states of polarization of a beam of light?

(d) Plane polarized light incident on a crystal plate makes an angle θ with the optic axis.

Phase difference between the E-ray and O-ray is δ at emergence. The emergent light can be represent by;

$$\frac{x^2}{A^2 \cos^2 \theta} + \frac{2xy \cos \delta}{A^2 \sin \theta \cos \theta} + \frac{y^2}{A^2 \sin^2 \theta} = \sin \delta$$

What are the values of θ and δ to represent the emergent light as (i) Linearly polarized light (ii) Elliptically polarized light and (iii) Circularly polarized light ?

Show that the above equation simplifies to an equation of straight line , ellipse or circle when you substitute those values in the equation.

(e) If you are provided with Nicol prism and quarter wave plate, how do you differentiate plane polarized, elliptically polarized and circularly polarized light?