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THE OPEN UNIVERSTY OF SRI LANKA

BACHELOR OF SCIENCE DEGREE PROGRAMME – LEVEL 05

FINAL EXAMINATION 2010/2011

PHYSICAL OPTICS -PHU 3141/PHE 5141

Duration: TWO AND HALF HOURS (2 ½ hrs)

Date 4st July 2011 **Time 1.30 pm – 4.00 pm**

Answer Four (4) questions only

1. (a) Explain briefly the formation of Newton's rings on the basis of wave theory of light and give a clear- labeled diagram of an arrangement that may be used for its demonstration. [40 marks]

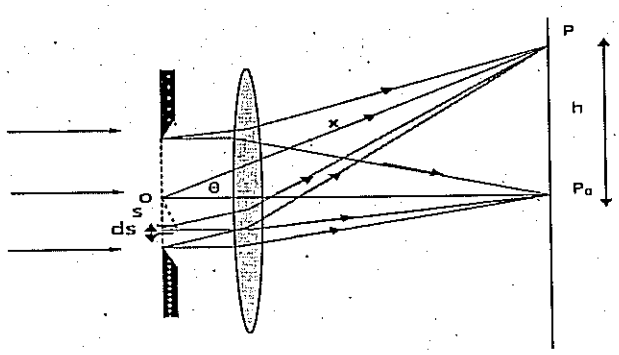
(b) The diameter of the 10th bright ring in a Newton's ring apparatus changes from 1.40 cm to 1.27 cm when a liquid is introduced between the lens and the plate. Find the index of refraction of the liquid. Derive any formula you may use. [60 marks]

2. (a) In an experiment carried out with reflected (multiple reflection) and transmitted light from a plane parallel thin film, it is often considered only two rays to discuss the interference phenomenon. Show that the condition for maximum due to the two rays reflected are given by

$2\mu t \, Cos\, r = (n+1/2)\lambda$, take the angle of incidence $i = sin^{-1}(\mu \sin r)$, where the thickness of the film is t , the refraction index of the film is μ (>1), n = 0,1,2,3,4, and λ is the wavelength of the incident light. [50 marks]

(b) A wedge shaped air film was formed between two thin parallel sided glass plates by means of a straight piece of wire. The two plates are in contact along one edge of the film and the wire is parallel to this edge. Light of wavelength 589 nm is made normally incident on the upper plate. The distance between the 7th and the 167th dark fringes was 26.3 mm. The distance between the junction of the glass plates and the wire was 35.6 mm. Calculate the angle of the wedge and the diameter of the wire. [50 marks]

3.(a) Obtain an expression for the intensity on the screen at point P due to the single slit Fraunhofer diffraction as shown in the following figure. You may start from the expression for the displacement $dy_0 = a\,(ds/X)\,Sin\,(\omega t - kX)$ of the wavelet at P coming from the element ds, situated at the origin. where "a" is the amplitude at ds, X is the distance traversed by the wavelet and k (= $2\pi/\lambda$) is the wave number and "ω " is the angular frequency. [60 marks]



(b) The Fraunhofer diffraction pattern of a single slit of width 0.05 cm is observed on the screen in the focal plane of a lens of focal length 1.0 m. When the incident light contains wavelengths λ_1 and λ_2, it is found that the fourth minimum corresponding to λ_1 and the fifth minimum corresponding to λ_2 coincide at 0.5 cm from the centre. Calculate λ_1 and λ_2?

[40 marks]

4.(a) What is a diffraction grating? Name two main types of gratings. [20 marks]

(b) For light incident normal to a diffracting grating, the condition for the m^{th} order interference maxima is $d \sin\theta = m \lambda$, where symbols have their usual meanings.
Show that the angular dispersion of light, D, in the m^{th} order due to the grating is given by

$$D = m / (d^2 - m^2\lambda^2)^{1/2}$$

[40 marks]

(c) A diffraction grating has 2500 ruling per cm. If this grating is to resolve the two sodium lines of wavelengths 589.0 nm and 589.6 nm in second order, find the minimum number of rulings of this grating that must be illuminated. [40 marks]

5. (a) Explain what is meant by polarization of light and name three types of polarization? [40 marks]

(b) Briefly explain how a quarter wave plate can convert plane polarized light into circularly polarized light. [30 marks]

(c) A quarter wave plate is made from a transparent mineral with indices of refraction $\mu_e = 1.732$ and $\mu_o = 1.456$ for light of free space wavelength $\lambda = 589$ nm. Calculate the minimum thickness required for the plate used to be at this wavelength.

[30 marks]

6. Briefly discuss <u>any three</u> of the followings [100 marks]

(a) It is impossible to obtain interference pattern from two separate sources such as two lamp filaments set side by side.

(b) What happens when white light is used in the Newton's ring experiment?

(c) Optical activity of solids and liquids.

(d) State which property of the lasers suit medical applications very well and why? Name three examples of the uses of lasers in medicine.

(e) The light reflected from the surface of a compact disc is multi-colored.

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