RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

Bachelor of Science in Applied Sciences
Second Year Semester II Examination – Jan/Feb 2023

PHY 2204 – PHYSICAL OPTICS

Time: Two (02) hours

Answer All Questions.
Calculators will be provided.

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1. a) What is meant by polarized light and what are the different types of polarized light?

    (04 marks)

    b) When an unpolarized light of a known wavelength is incident on a transparent substance surface, it experiences maximum plane polarization (completely polarized) at the angle of incidence (i) as shown in the figure below.
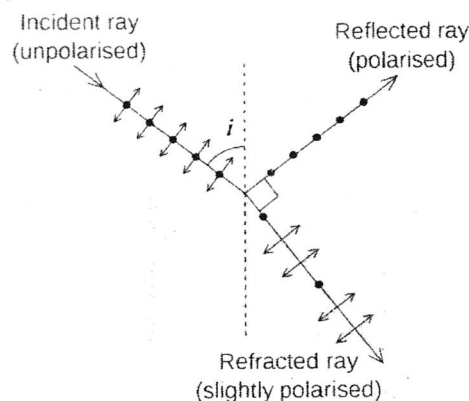
    i.   Show that the tangent of incident angle (i) is equal to the refractive index (η) of the substance for the wavelength.
    ii. If the incident angle is 58° for a plane glass surface, calculate the refractive index of glass and angle of refraction of the transmitted beam.

    (06 marks)

    c) Three linear polarizing sheets are placed together such that when only first and third sheets exist, no light can pass through it. The transmission axis of the second sheet is oriented at 45° to the axis of the first. What fraction of the intensity of an incident unpolarized beam is transmitted by the combination?

    (05 marks)

Contd.

d) Calculate the least thickness of a plate (quarter wave plate) of calcite to produce circular polarizer for the use at a wavelength of 500 nm, given that the refractive indices of calcite for ordinary and extraordinary rays are 1.65 and 1.50 respectively.

(05 marks)

2. a) Derive the conditions for dark and bright regions in young's double slit experiment interference pattern.

(04 marks)

b) A glass chamber is placed in one arm of the Michelson interferometer. The space inside the container has a width of t. When the initially empty chamber is filled with a gas, a count of m fringes have moved past the reference line. The wavelength of the light used is λ. Obtain an equation for the refractive index η of this gas.

(06 marks)

c) In a double-slit experiment sodium light of 589 nm is used. A very thin film of glass with refractive index 1.4 for sodium light is inserted normally in the path of one of the interfering waves as shown in the Figure. The central bright fringe shifts to the position of 6th bright fringe. Calculate the thickness of the glass slide.
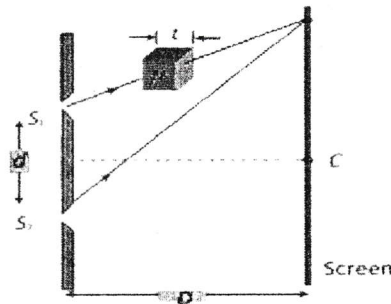
(10 marks)

3. a) An observer looks at the water tank and according to him, half of the tank is filled with water. If the height of the tank is 180 cm, find the real height of the water in the tank. Refractive index of water is 1.33.
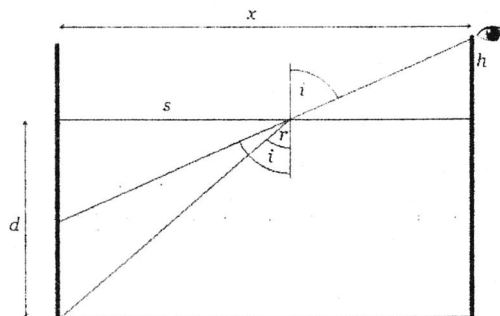
(06 marks)

Contd.

b) One ray of light in air strikes a quartz and another ray strikes a piece of silicone. In each case the angle of incidence is 40°. Angles of refraction in quartz and silicone are 15^0 and 25^0 respectively. What is the best material for the inner layer (Core) to construct a fibre optic cable among them and what is the critical angle for the green light passing through the fibre optic cable?

(06 marks)

c) An object and two lenses are arranged so that the object is to the left and 7 cm from a converging lens. The focal length of the first lens is 5 cm. A second converging lens is 10 cm to the right of the first lens and its focal length is 3 cm. Find the location of the final image relative to the original object, the overall magnification, and characteristics of the final image.

(08 marks)

4. a) What are two main types of diffraction gratings and what type is best for optical instrument applications? Explain your answer.

(02 marks)

b) Briefly explain the resolving power of optical instruments.

(02 marks)

c) Light of wavelength 550 nm is used to observe an object under a microscope. If the aperture of the objective lens has a diameter of 0.6 cm, what is the limiting angle of resolution?

(06 marks)

d) Draw the graph of Normalized Intensity versus α for a multiple slit diffraction grating of $N = 8$ and for small angles of θ, where $\alpha = kd \sin \theta$, k is integer and d is the slit width.

(10 marks)

...End...