The Open University of Sri Lanka
B.Sc. Degree Programme - Level 05
Final Examination – 2006/2007
PHU 3141/ PHE 5141 – Physical Optics
Duration: Two and Half (2 1/2) hours

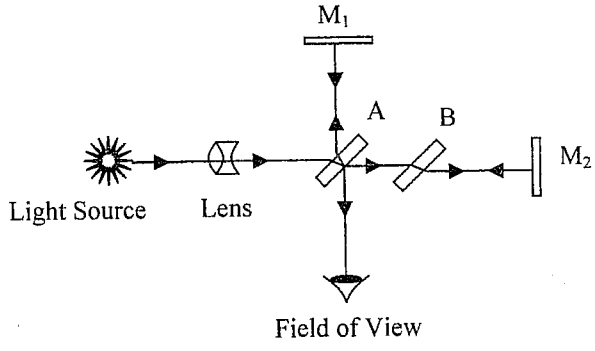
Date: 05th May 2007 **Time: 1.30 pm to 4.00 pm**

ANSWER FOUR QUESTIONS ONLY

1. The interference of light, which means action of two or more wave trains simultaneously at one point in a medium, verifies the validity of wave nature of light.

   (i) What is a coherent source?
   (ii) Describe Young's double slit experiment and derive an expression for the path difference?
   (iii) What do you expect the central fringe to be in this experiment?
   (iv) What are the conditions to get a bright fringe and a dark fringe at distance x from the central fringe?
   (v) In Young's double slit experiment the separation of the slits is 0.2 mm and fringes are observed on a screen placed 1 m away. It is found that with a certain source of light the forth bright fringe is 1 cm from the central fringe. Calculate the wavelength of the light.

2. The interferometers are kind of instruments work based on the principle of interference of light. Following figure illustrates a Michelson interferometer consisting of two mirrors M_1 and M_2 perpendicular to each other and two plane glass plates A and B placed parallel to each other.

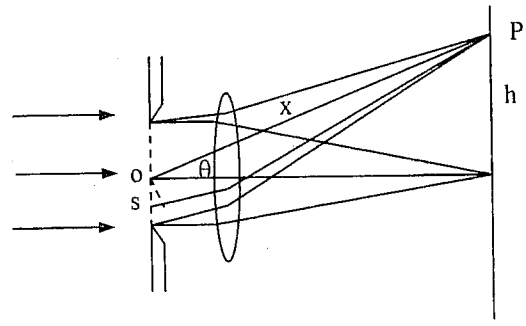


   (i) Explain briefly the working principle of Michelson interferometer.
   (ii) What is the purpose of glass plate B placed in between A and M_2?
   (iii) How does the field of view look like when the two rays travel a) equal path length and b) different path length?
   (iv) Derive a relation for the path difference between the two beams of the Michelson interferometer when it is illuminated with a monochromatic light of wavelength, λ.
   (v) The M_1 mirror in the Michelson interferometer was moved through a distance of 0.1474 mm. During the movement, the observer counted 500 fringes cross the center of the field of view. Calculate the wavelength of the monochromatic light source.

3. Diffraction is mutual interference of secondary wavelets propagated from various elements of a single continuous wave front at any point in space.

(i) How do you explain the diffraction phenomenon very simply?
(ii) What is the difference between Fresnel and Fraunhofer diffraction?
(iii) Write down the assumptions made in the Fresnel diffraction.
(iv) A wave front is divided into Fresnel's half zones and the effect of these zones is observed at a point, distance d perpendicularly along the center of the first zone. Show that the radius, r of the n^{th} zone, $r_n = \sqrt{dn\lambda}$.
(v) A laser beam passes through a circular opening of adjustable radius. If a screen is placed on the axis of the hole 50 cm away, the intensity of the light spot reached the maximum for the first time when the radius of the opening is 0.56 mm. Calculate the wavelength of the laser beam.

4. The displacement at point P due to wavelet coming from element ds, situated at origin, o is given as $dy_o = a\frac{ds}{x}\sin(\omega t - kx)$ in the following figure that illustrates Fraunhofer diffraction by a single slit.



(i) Write down the disturbance at point P at height h from the center, due to element ds at distance s below the origin.
(ii) Write down the total disturbance at P cause by elements at o and s.
(iii) Hence calculate the overall displacement due to the whole slit.
(iv) If the lens is placed close to the slit show that $h = \frac{n\lambda f}{b}$ where f is the focal length of the lens, λ is wavelength and b is the width of the slit.
(v) Parallel light of wavelength 6563 Å is incident normally on a slit of 0.3850 mm of width. A lens with a focal length of 50 cm is located just behind the slit bringing the diffraction pattern to focus on a white screen. Find the distance from the center of the principal maximum to 1^{st} minimum.

5. In ordinary light electric vector or magnetic vector is randomly oriented so that they have perfect symmetry, but they are oriented in one direction at particular time in polarized light.

(i) What are the two methods of producing polarize light?
(ii) Explain briefly what is meant by (a) plane polarized light, (b) Circularly polarized light and, (c) elliptically polarized light.
(iii) Write down the Brewster's law for producing polarized light by reflection.
(iv) Show from the above law that when light is incident on a transparent substrate at the Brewster's angle, the refractive index of the transparent medium, $\mu = \tan \alpha$, where α is the angle of incident.
(v) Light reflected from surface of glass is tested with an analyzer for polarized light. It was noticed that when the angle of incident is 57° the total reflected light is plane polarized. Calculate the refractive index of the glass and the angle of refraction.

6. Discuss any three of the followings

(i) Behaviour of zone plate as a thin lens.
(ii) Analysis of diffraction pattern by Cornu's spiral.
(ii) Determination of state of polarization of light.
(iv) Optical activity of solids and liquids.
(v) Principle of laser action and properties of laser.