BIRZEIT UNIVERSITY

Physics Department **Physics 335**

Homework 2 Due: April 10^{th}, 2014 Dr.Aziz Shawabkeh

1. Chapter 3, Problems: 7, 22, 25.
2. Chapter 18, Problems: 1, 6, 8.
3. An object is placed 25 cm from the vertex of a double convex thick lens having radii of 40 and 20 cm respectively, a thickness of 2 cm and an index of refraction 1.5.

   (a) Find the effective focal length of the lens.

   (b) Using ABCD matrix method, find the cardinal points of the system.

   (c) Find the image distance from the second cardinal point.

   (d) If the object is 5 cm long, what is the magnification and the image length? is the image real or virtual?

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Homework 3 Due: April 16^{th}, 2015 Dr.Aziz Shawabkeh

1. Wave equation, Problems: 7, 15. CH4
2. Superposition of waves, Problems: 2, 8. CH5
3. Interference of light, Problems: 1, 20. CH7
4. Optical interferometry, Problems: 3, 10. CH8

Step 2 of 2

The formula for n^{th} minimum is given by

$$y_n = \frac{(2n-1)}{2}\frac{\lambda L}{a}$$

And the formula for n^{th} maxima is given by

$$y_n = n\frac{\lambda L}{a}$$

Given that 4th minimum of first source coincides with the 3^{rd} maximum of second source i.e.

$$\frac{(2(4)-1)}{2}\frac{\lambda_1 L}{a} = 3\frac{\lambda_2 L}{a}$$

$$\frac{7\lambda_1}{2} = 3\lambda_2$$

$$\lambda_2 = \frac{7}{6}\times\lambda_1$$

$$= \frac{7}{6}\times 436$$

$$= 508.67 nm$$

There fore wavelength of the second source of light is **509 nm**

Comments

Step 2 of 2

But, in Newton's rings experiment, the condition for bright band is given by

$$r^2 = \frac{(2n-1)}{2}\lambda R$$

Where R is the radius of curvature of lens used.

By substituting the given values in above equation, we get

$$\left(3.945\times10^{-3}\right)^2 m^2 = \frac{\left[2(10)-1\right]}{2}\left[546.1\times10^{-9}\, m\times R\right]$$

$$\Rightarrow \quad R = (3.945)^2\times10^{-6}\times\frac{2}{19}\times\frac{1}{546.1\times10^{-9}}\, m$$

$$\equiv 1.499999\times 2\, m$$

$$= 2.999998\, m$$

$$\simeq 3\, m$$

$\therefore$ Radius of curvature of lens used $= \boxed{3\text{ m}}$

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Useful information & formulae

- Transfer matrix of a curved refracting surface

$$M = \begin{pmatrix} 1 & 0 \\ \frac{n_1 - n_2}{n_2 R} & \frac{n_1}{n_2} \end{pmatrix}$$

- Distance of principal planes of an optical system from vertices

$$r = \frac{D - n_0/n_f}{C}, \qquad s = \frac{1 - A}{C}$$

- Double slits interference

$$I = I_m\left(\frac{\sin\beta}{\beta}\right)^2 \cos^2\alpha, \quad \beta = \frac{\pi}{\lambda} a \sin\theta, \quad \alpha = \frac{\pi}{\lambda} b \sin\theta$$

- Jones matrices

$$M_{45} = \frac{1}{2}\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}, M_h = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, M_v = \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix}$$

- Trigonometric identity

$$\sin^2\theta = \frac{1}{2}(1 - \cos 2\theta)$$

- minimum resolution angle

$$\theta_{min} = 1.22 \frac{\lambda_0}{D}$$

- Classical wave equation

$$\frac{\partial^2 \psi(x,t)}{\partial x^2} = \frac{1}{v^2} \frac{\partial^2 \psi(x,t)}{\partial t^2}$$

[redacted]

$I = \frac{I_0}{\beta^2}\left(\frac{1}{2}(1 - \cos 2\alpha)\right)$

$= \frac{I_0}{\beta^2}\left(\frac{1}{2} - \frac{\cos 2\alpha}{2}\right)$

$(1 - \cos 2\alpha)$

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Final Exam	Second Semester 2014	Time: 2:30 hours

(1) (a) Show that the function $S(x,t) = Ae^{(2x-3t)}$ is a solution of the classical wave equation. What is the velocity of the wave and its wavelength. In what direction it is propagating?

(b) A small illuminated object is placed 200 cm on top of a + 2.50 diopter lens, which is placed directly on top of a water tank ($n = 1.34$). Find the image distance of the illuminated object.

(2) A spherical droplet of paraffine ($n_p = 1.5$) having a radius of 2 mm is found in air.

(a) Find the effective focal length of the droplet

(b) Describe the image resulting from a 10 mm tall object placed 5.8 cm from the vertex of the droplet and find the image size.

(3) (a) Two slits are illuminated by light that consists of two wavelengths. one wavelength is known to be 436 nm. On a screen, the fourth minimum of the 436 − nm light coincides with the third maximum of the other light. What is the wavelength of the other light?

(b) Newton's rings are formed between a spherical lens surface and an optical flat. If the tenth bright ring of green light (546.1 nm) is 7.89 mm in diameter, what is the radius of curvature of the lens surface?

(4) (a) A linear polarizer at 45° is inserted now between two perpendicular polarizers, the first is horizontally and the second is vertically oriented. If a horizontally polarized light enters the system, What is the Jones vector of the transmitted field? How does the final intensity compare to initial intensity?

(b) The linear polarizer at 45° is now replaced by An ideal polarizer rotating at a rate ω. Show that the emerged intensity will be modulated at four times the rotational frequency; i.e, show that

$$I(\omega) = \frac{I_o}{8}(1 - \cos 4\omega t),$$

where I_o is the intensity after passing the horizontal linear polarizer.

(5) (a) Calculate the limiting angle of resolution for the eye, assuming a pupil diameter of 2.0 mm, a wavelength of 500 nm in air and an index of refraction of the eye 1.33.

(b) The Hα line of hydrogen has a wavelength of 656.2 nm. It differs from the corresponding line in deuterium by 0.18 nm. Determine the minimum number of lines a grating must have to resolve these lines in the second order?