Mid-Term Exam 1 – PHYS 355 - OPTICS

Mendes, Fall 2009, Sept 25

Start time: 10:00 a.m.

End time: 10:50 am

Open textbook, notes, homeworks, and quizzes

Calculators allowed; no other electronic device allowed

Where it is appropriate, make sure to provide physical units to your numerical answer
1) Consider a symmetrical bi-concave lens, where the radius of curvature of each surface is \( |R| = 52 \text{ mm} \) and the central thickness is 3.0 mm. The lens was manufactured from glass of refractive-index = 1.52. This lens is to work immersed in an oil tank of refractive-index of 1.82. Under those operating conditions, do you expect that a collimated light beam will converge or diverge right after passing through this lens? Clearly justify your answer with a conclusive numerical calculation.
2) A bi-convex lens is made from a glass of refractive index = 1.62 and has radii of curvature given by $|R_1| = 8 \text{ cm}$ and $|R_2| = 100 \text{ cm}$. The central thickness of the lens is 3 cm, which is too thick for the thin-lens approximation. The lens is surrounded by air.

a) Compute the effective focal length of the lens.

b) Determine the back focal length and the front focal length of the lens.
c) If surface “1” of radius of curvature $|R_1| = 8 \text{ cm}$ is facing a small light source, what should be the distance between the light source and the surface to get a collimated light beam?

![Diagram of surface 1]


d) If surface “2” of radius of curvature $|R_2| = 100 \text{ cm}$ is now facing a small light source, what should be the distance between the light source and the surface to get a collimated light beam?

![Diagram of surface 2]
3) Consider a monochromatic light wave that, when propagating in a medium of refractive index = $n_1$, has the following properties: angular frequency = $\omega_1$, wave-number = $k_1$, wavelength = $\lambda_1$, period = $\tau_1$, frequency = $\nu_1$, and phase velocity = $c_1$.

Now, suppose this light wave enters into a different medium; this new medium has a refractive index = $n_2$. In the expressions below, $A$, $B$, $C$, $D$, $E$, $F$ are constants describing how a particular property in one medium is related to the corresponding property in the other medium. Find the value for each constant: $A$, $B$, $C$, $D$, $E$, and $F$.

$$\omega_2 = A \omega_1$$

$$k_2 = B k_1$$

$$\lambda_2 = C \lambda_1$$

$$\tau_2 = D \tau_1$$

$$\nu_2 = E \nu_1$$

$$c_2 = F c_1$$