UNIVERSITY OF CALIFORNIA
College of Engineering
Department of Electrical Engineering
and Computer Scences
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Problem Set No. 3

Problem Number one)Cardinal points of a lens (This is a modification of 6.18 of the text)
A thick biconvex lens has radii of 20 cm and is 5 cm thick. The lens refractive index is 1.5.
a) Find the ABCD parameters (help! The numbers are 1.0133, .0378, .8 and 1.0167)
b) Deduce the cardinal points in terms of the ABCD parameters generally. (I get the nodal points are N_o and N_i (A-1)/C and (1-D)/C, respectively. The ffl= - D/C The unit planes are -(A-1)/C for the image and (-1+D)/C for the object). Of what use are these?
c) What are the cardinal points for the above lens?

Problem Number two) The microscope and the telescope contrasted
a) The pupillary diameter of the typical eye is 2mm and the objective lens of the telescope is imaged on the eye. If the objective is 20 mm in diameter and the focal length is 250 mm What is the magnification of the telescope?
What focal length ocular (eyepiece) should be used?
Find the position of the exit pupil.
What would be the diameter of the exit pupil if the ocular gave a magnification increased by 50 percent ? Decreased by 50 percent ?
b) The first microscope was a clear glass marble resting on the object to be magnified. (van Leeuwenhoek (1632-1723)). What is the power (1/f in m^{-1} of a marble 1cm in diameter (n = 1.5)?

Problem Number three) A re-entrant confocal resonator cavity
Hecht Problem 6.24. Is the cavity stable? The confocal configuration is popular as an optical spectrum analyzer. We hope to discuss this.

Problem Number four) Lens correction of the eye.
A myopic individual has his far-point of best vision at 16.6 cm and his near -point at about 6.5 cm. What is his range of accomodation (in D's)? What spectacle correction will restore his far-point to infinity? What will then be his new near-point? (Comparable to text prob 5.85 and 5.86)

Problem Number five) Oil immersion objective.
Consider a transparent sphere of radius R and index n. Show that a point P at radius R/n is perfectly imaged to a point Q at radius n R and in fact a spherical surface of radius R/n is imaged to a sphere of radius n R. The points P and Q are called aplanatic points. This is the basis of the oil emersion microscope (see page 255 -257 of text) (reference Sears Optics third ed.)

Problem Number six) Off axis focal distances.
a) Show that for a thin lens with an on-axis focal length, for a point off the axis by θ (w.r.t the optic axis), the sagittal and tangential ray bundles focal lengths are $f/cos\theta$ and $fcos\theta$ respectively.
b) Similarly establish that the sagittal and tangential ray bundles traversing a Brewster window travel effective distances given by

$$d_x = t(n^2 + 1)^{1/2}/n^2$$

and

$$d_y = t(n^2 + 1)^{1/2}/n^4$$