Optics, Spring 2024

Submit your answers as a PDF file via Google Classroom before deadline (29.02.2024 at 10.00).
If problems, contact the course assistant joonas.mustonen@helsinki.fi.

Exercise 5

1. The lens equation (Hecht 5th ed., Ch. 5.2) (2p.)

a) Derive the Newtonian form of the lens equation $x_0x_i = f^2$ from the Gaussian lens equation.

b) Derive the Newtonian expression for the transverse magnification: $M_T = -x_i/f = -f/x_0$.

2. Single lens (Hecht 5th ed., Ch. 5.2) (3p.)

a) A 5-mm tall object is observed through a magnifying glass (biconvex lens). The focal length of the lens is 25 cm and the lens-object distance is 10 cm. Determine the image location, type (real or virtual) and size. Draw a ray diagram.

b) Suppose that an object positioned 10 cm to the left of a positive lens is imaged 30 cm to the right of the lens. Where will the image appear, if the object is moved to a distance of 2.5 cm from the lens? Calculate image size and type in both cases.

c) A 1 cm tall object is located 40 cm left from a biconvex lens (f = 20 cm). A biconcave lens (f = -50 cm) is placed on the right side of the first lens at a distance of 10 cm. Calculate the image location, size, orientation and type. Draw a ray diagram.

3. Angular magnification (Ch 5.7) (2p.)

a) Explain why optical instruments (microscopes, telescopes etc) designed for visual use form the image at infinity.

b) Calculate the angular magnification for a refracting telescope having objective and eyepiece focal lengths of 1000 mm and 25 mm respectively. Calculate the exit pupil diameter, if the diameter of the objective lens is 15 cm.