13-1) An afocal adapter can be used to change the field of view seen by the detector/film in a camera with a given camera lens. A Galilean or reverse-Galilean telescope is simply placed in front of the camera lens to change the FOV. The afocal adapter is specified by its magnifying power MP, and this use of MP is the same as for a visual telescope.

If the focal length of the original camera lens is $f_C$, what is the focal length of the combination of the afocal adapter and the camera lens? You are required to provide a derivation of this result.

Hint: Sketch the marginal ray path through the system with and without the adapter and use the definition of focal length (assume an object at infinity).

13-2) A light source is to produce a spot of light on a distant wall. A 250 mm focal length lens with a diameter of 50 mm is to be used. The light emitting source is 4 mm in diameter (consider this to be the diameter of a flat source), and the wall is 25 m away.

a) This extended source is “collimated” by placing the source at the front focal point of the lens. What is the total spot size illuminated on the wall?

b) The lens is now used to image the source directly onto the wall. What is the resulting source size?

c) The source produces a total output power of 10 Watts. Using the imaging configuration of Part b), what is the irradiance on the wall?
13-3) A biconvex lens is formed by polishing identical convex surfaces of radius \( R = 50 \text{ mm} \) on both ends of a glass rod of index \( n = 1.5 \).

a) For an object at infinity, sketch plots of the system focal length and paraxial image location as a function of the length of the rod (measure the image location relative to the rear vertex, and consider positive thicknesses from 0 to 500 mm only).

Hint: To simplify the calculations, first solve for the focal length and image location in terms of the reduced thickness of the rod.

b) As the rod length changes, several classes of two-element optical instruments are generated. Identify these classes as well as specific systems and qualitatively explain their image-forming operation in terms of an equivalent pair of thin lenses. Ignore all reflections.

13-4) You are to design a microscope objective. The objective is for a microscope with an Optical Tube Length OTL of 160 mm. In order to be parfocal with other objectives, the distance from the object plane to the rear focal point of the objective must be 60 mm.

Section A

Provide the first-order design of an objective with the following specifications:

5X
Working Distance = 15 mm

The objective is to be designed as two separated thin lenses in air.

Section B

The numerical aperture of the objective is 0.25, and the objective is telecentric in object space.

The field stop of the microscope is 20 mm in diameter. This field stop at the intermediate image plane defines the FOV of the objective, and the system must be unvignetted over this FOV.

Determine the stop position, stop size and the required element diameters. Also determine the maximum object size corresponding to the FOV defined by the field stop.

IMPORTANT -- The problem is to be worked in sections. Each section must start on a new page of your solution. In addition, a summary page with a diagram of the system is attached where all of the pertinent details of your design must be shown. This summary page is to be used as the cover page of your solution.
Cover Sheet for Solution

Sections A and B

Objective Focal Length =

Principal Plane Locations: $d =$ $d' =$