Undergrads: Do HW problems 1 and design problem 1. As always, you can do the extra HW and DP for extra credit.

Remember you can work in groups if you prefer, but state clearly who else was in your group on the front page.

HW 1) Create your own yu ray tracer. A spreadsheet is convenient, but this is your tool, so use whatever works best for you. The program should fundamentally work on paraxial lens powers and spacings, however you may find it convenient to have an initial input stage (in a spreadsheet, additional rows) that calculate the paraxial powers from lens or mirror physical data. We will need the ability to trace both forwards and backwards through a system (for a backwards example, look at the problem worked in class). In a spreadsheet, this is just a different set of rows that take data from rows to the right and fill in the cells to the left.

HW 2) Telephoto lens. Consider how a camera lens focused at infinity takes bundles of parallel rays and focuses them to a spot on the film or detector. The longer the focal length of the lens, the smaller the range of ray angles it will take to fill the detector – ergo the larger the magnification. However, the user must be able to hold up the camera, putting a distinct limit on the total distance from the first surface to the film plane. Suppose you need a focal length of 1.25 meters, but the only lenses left in your supply cabinet are a +120 mm and a -20 mm. Remember that the effective focal length of a system is defined as the height of a ray coming in parallel to the axis divided by the negative of the ray angle when it exits the system. Use this guidance, the formula for the additive power of two surfaces (with the distance d included) and graphical ray tracing to design a lens with 1.25 m effective focal length but with the total camera size << than this distance. Verify your design with your yu program.

Design problem 1: Microscopes: Use your yu program to lay out the paraxial design of a microscope with a 10X objective, 160 mm tube length and an eyepiece that produces another 2X of visual magnification. For simplicity, you may put the image for the eye at infinity (as illustrated on page 77 of the notes). Illustrate the design with a graphical trace.

Design problem 2: Telescopes
First, design an astronomical telescope for use by a human (that is, the detector is an eyeball) that will result in a visual magnification of 10. Let the objective be a spherical mirror and the eyepiece be a lens. Give a concrete design (curvatures, spacings, etc). Clearly there are lots of open choices, so justify those that you make.
After completing this project, you are asked to modify your design to work with a digital camera such as a CCD. If this device has 1000 x 1000 pixels of 10 micron spacing, how will you modify your design (above) to use this camera?