Advanced Optics Final Exam practice questions

1a. Each lens has a radius of 1 cm. Where is the image?
b. Is it real or virtual?
c. Where is the aperture stop?
d. Where is the entrance pupil?
e. Where is the entrance window?

2a. To demux 1501.0 and 1501.8 nm in a fiber Mach Zehnder IF, what should be the path difference? Note the fibers are glass, with index 1.5.
b. What is the field and energy transmission through each arm for 1502.6 nm light?

3a. Maxima & nodes in a slab waveguide. What is the highest mode of 400 nm light that can propagate in a slab of thickness 1 micron, n=1.5, with air surrounding?
b. Moving across the slab, how many nodal lines are there for this mode?

4a. An extended source of 500 nm light illuminates a Fabry Perot IF, which has a nominal gap of 1 mm. The transmitted light is focused on a screen with a lens. Describe the pattern on the screen… give the positions of the rings. How many rings have a radius < f/100?
b. Suppose the smallest ring is actually a double ring; the difference in diameters is 2%. What could be the 2nd wavelength? Assume the rings are the same order.
c. Does the extended source need to be perfectly spatially coherent? If so, what is the highest radius ring that can be seen? If it doesn’t need to be perfectly spatially coherent, how coherent must it be?
5. Umpolarized light passes through a linear polarizer with TA 60° from vertical, then through a QWP with SA horizontal, then through a linear polarizer with TA vertical. Determining, using Jones matrices, the polarization of the light after a) the QWP and b) the final polarizer.

6. A pin is placed parallel to a razor blade edge. They are illuminated by a point source. 
   a. Use a Cornu spiral to find the maximum intensity on a screen behind, compared to the unobstructed intensity.
   b. Approximately where would such an intensity be found?

7. A Fresnel zone plate is to placed halfway between a point source and screen that are 2 cm apart.
   a. If the wavelength is 500 nm, what is the radius of the fifth zone?
   b. If zones 1, 3, and 5 are used, what is the intensity at the center of the screen, compared with unobstructed intensity?

8. A reflective diffraction grating is to have a grating spacing of 3 microns.
   a. If you want the 2nd order 450 nm to be retroreflected (Littrow mount), what is the blaze angle?
   b. What is the angle between the 450 nm 2nd order and 451 nm 2nd order reflections?
   c. How large must the grating be to resolve these two wavelengths?

9a. Draw the phasor diagram for interference from 3 equal slits, for minima & maxima. How many of each are there in between the principal maxima?
   b. Suppose that, owing to diffraction, the 5th side maximum (NOT the 5th principal maximum) is absent. What is the ratio of the slit wide to the slit separation?

10a. Consider that airplanes have lights on each wing, approximately 100 m apart, while flying saucers have only a single headlight. How large a telescope is necessary to determine whether a luminous object on the moon is an airplane or a flying saucer? (Use 500 nm light.)
   b. After determining that the object in question is, in fact, a flying saucer, one wishes to measure the size of its headlight using a Michelson stellar interferometer. Does this need to have a baseline larger or smaller than the telescope diameter? If the headlight is 2 m in diameter, what baseline is needed?