EE383P
MFB
Spring 1999

NAME: ______________________________

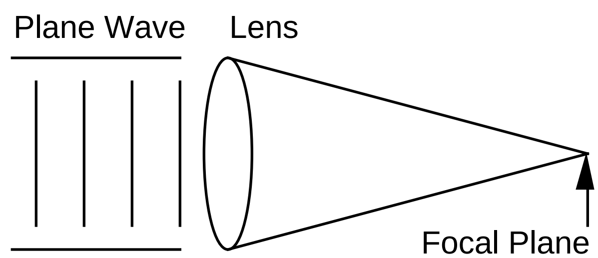
Fourier Optics EE383P

EXAM #2

April 12, 1999

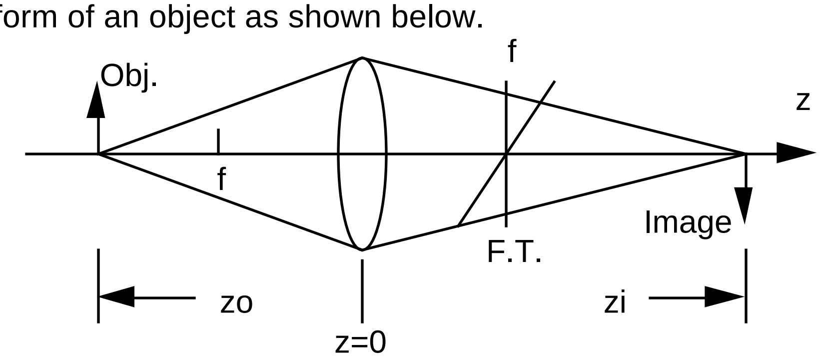
This is a closed book, open note sheet exam (two pages 8.5x11"; sheet from Exam #1 and a new page). The time limit is 1.5 hours. Do your work on these pages attach extra sheets only if needed.

1. (25 points) A coherent plane wave is incident on a positive focal length lens as shown below.



a.) What is the nature of the wave just to the right of the lens? Give an equation.
b.) How does the wave in a.) relate to a spherical wave of radius of curvature R? (R can be positive for waves concave to the left - i.e. converging, and negative for waves concave to the right - i.e. diverging.)

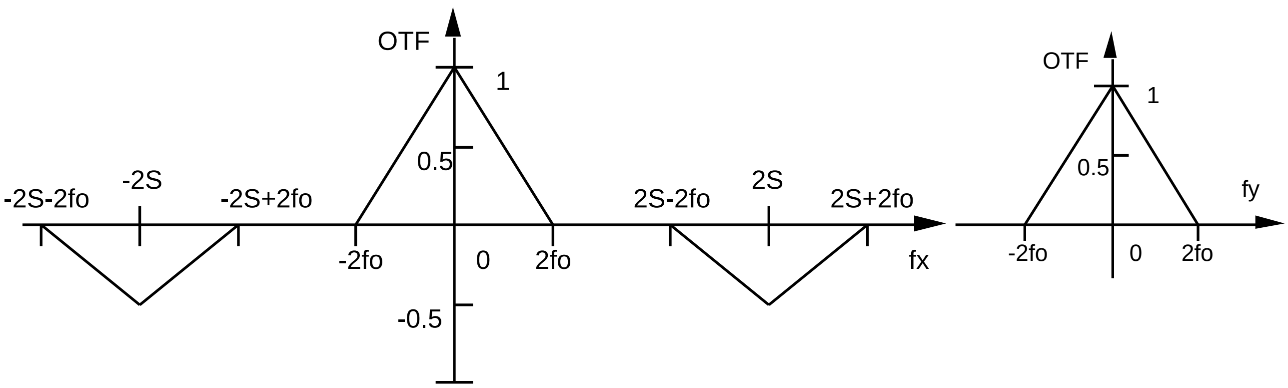
2. (40 points) A positive focal length lens, of diameter d, can give both an image and an approximate Fourier transform of an object as shown below.

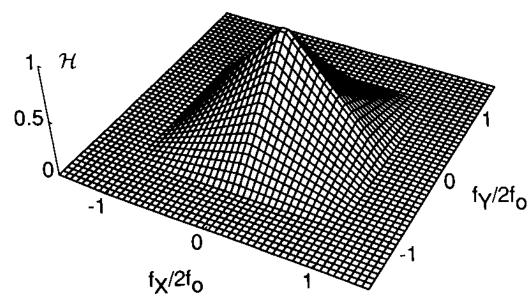


a.) Although the Fourier transform is not exact in the plane z = f, an exact transform can be obtained if the Fourier transform is projected onto a curved surface that intersects the z-axis at z = f. What is the surface and how much is it curved?
b.) Sketch on the diagram above the direction of curvature of the exact Fourier transform surface.
c.) What are the disadvantages of obtaining an exact Fourier transform in this way?

d.) What is the cutoff frequency of this imaging system if the illumination is coherent light at wavelength λ? Be careful to tell whether you are referencing the cutoff frequency to spatial frequencies in the object or the image.

3. (35 points) The OTF for an optical system is shown below. The section in the f_X direction has two negative peaks of peak value -0.5. Each peak has the same pyramid-like shape as is shown below in 3-D (only the 2 negative ones are multiplied by -0.5). The f_y section is shown for only the center peak, the others are similar but inverted.





a.) This OTF is due only to the pupil function and not aberrations. What pupil functions(s) generated this OTF? Give a sketch; a precise function is not required.

b.) How could this pupil be realized physically?

c.) What is the impulse response, h, of this imaging system?