1. Consider the 4f imaging system depicted in figure 1. The limiting pupil function is described by the function \( p(x,y) \).
   a. Find the OTF of the system.
   b. Two point sources are located at the input plane of the system separated by the Rayleigh resolution distance. Assume a circular pupil function of radius \( R \). Plot a cross-section of the intensity distribution at the imaging plane if the two point sources are incoherent. Compare with the coherent case (problem 5 HW #4).
   c. Repeat part (b) for the case of two partially coherent quasi-monochromatic point sources with normalized mutual intensity \( g = 0.5 \).

![Figure 1](image1.png)

2. An object with a square-wave amplitude transmittance \( t(x,y) = t(x) \) (see figure 2), is imaged by a lens with a circular pupil function. The focal length of the lens is 10cm, the fundamental frequency of the square wave is 100cycles/mm, the object distance is 20 cm, and the wavelength is 1 micron. Design a lens with minimum diameter \( D \), that is determine \( D \), that will yield any variations of the intensity across the image plane for the cases of:
   a. Coherent object illumination?
   b. Incoherent object illumination?

![Figure 2](image2.png)

3. The \textit{F}-number (\( F\# \)) of a lens with a circular aperture is defined as the ratio of the focal length to the lens diameter. Show that when the object distance is infinite, the cutoff frequency for a coherent imaging system using this lens is given by \( f_0 = \frac{1}{2\lambda F\#} \).
What is the cutoff frequency for the same system when used with incoherent quasi-monochromatic light of central wavelength $\lambda$?

4. The Strehl ratio is a measure of the significance of the aberrations of an optical system. It is defined as the ratio of the light intensity at the maximum of the point spread function of the system with aberrations to that same maximum for that system in the absence of aberrations. Both maxima are assumed to exist on the optical axis.
   a. Prove that $S$ is equal to the normalized volume under the optical transfer function of the aberrated imaging system; that is
   \[
   S = \frac{\iiint_{-\infty}^{\infty} H(f_x, f_y)_{\text{WithAber}} df_x df_y}{\iiint_{-\infty}^{\infty} H(f_x, f_y)_{\text{WithoutAber}} df_x df_y}
   \]