

Fourier Optics (classes 15-21)

After taking this course, students will be able to:

- understand the one-to-one correspondence between the angle a paraxial plane wave makes with the z-axis and its transverse spatial frequencies (k_x, k_y) .
- make the link between harmonic functions and plane waves.
- understand how an arbitrary image function $f(x,y)$ can be built up as a fourier sum of many plane waves each traveling at a different angle that are collectively evaluated at the image plane (a fixed z).
- derive and explain the exact transfer function of free space. Understand the impulse response of free space.
- approximate the exact transfer function of free space with the Fresnel approximation and determine when the approximation is valid.
- propagate a general wave through free space using both the transfer function and the impulse response function.
- describe both mathematically and physically how the Fourier transform of an image function is formed by propagating a long distance in free space with the transform appearing in the far-field (the Fraunhofer approximation).
- derive the limit for the far-field known as the Fraunhofer Approximation
- describe both mathematically and physically how the Fourier transform of an image function at the input of a lens is formed at the focal plane of the lens.
- determine the far-field diffraction patterns of aperture functions using the convolution theorem.
- use a 4-f system to perform image processing by designing appropriate masks at the Fourier transform plane.
- appreciate the utility of optical Fourier transforms