Exercise session 5

Tuesday Oct 5, 2021

Problems with odd numbers will be solved in class

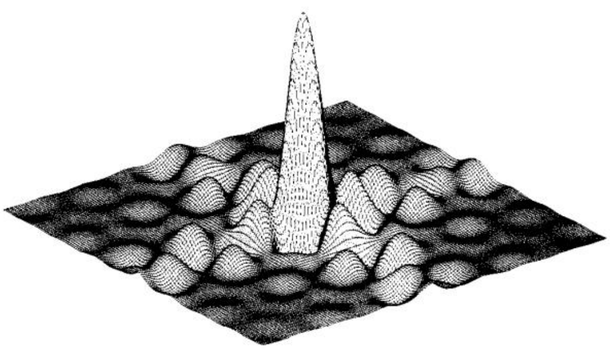
1- A single slit in an opaque screen 0.10 mm wide is illuminated (in air) by plane waves from a krypton ion laser (lambda = 461.9 nm). If the observing screen is 1.0 m away. determine whether or not the resulting diffraction pattern will be of the far-field variety and then compute the angular width of the central maximum.

2- A narrow single slit (in air) in an opaque screen is illuminated by infrared from a He-Ne laser at 1152.2 nm. and it is found that the center of the tenth dark band in the Fraunhofer pattern he5 at an angle of 6.2 degrees off the central axis. Please determine the width of the slit. At what angle will the tenth minimum appear if the entirc arrangement is immersed in water (n= 1.33) rather than air (n = 1.00029)'?

3- Two long slits 0.10 mm wide. separated by 0.2 mm, in an opaque screen are illuminated by light with a wavelength of 500 nm. If the plane of observation is 2.5 m away. will the pattern correspond to Fraunhofer or Fresnel diffraction'! How many Young's fringes will be seen within the central bright band'?

4- A collimated beam of microwaves impinges on a metal screen that contains a long horizontal slit that is 20 cm wide. A detector moving parallel to the screen in the far-field region locates the first minimum of irradiance at an angle of 36.87 degrees above the central axis. Determine the wavelength of the radiation.

5- The following figure shows the electric-field distribution in the far field for a hole of some sort in an opaque screen. Describe the aperture that would give rise to such a pattern and give your reasoning in detail.



6- No lens can focus light down to a perfect point because there will always be some diffraction. Estimate the size of the minimum spot of light that can be expected at the focus of a lens. Discuss the relationship among the focal length, the lens diameter, and the spot size. Take the f-number of the lens to be roughly 0.8 or 0.9.

7- The Mount Palomar telescope has an objective mirror with a 508-cm diameter. Determine its angular limit of resolution at a wavelength of 550 nm. in radians, degrees, and seconds of arc. How far apart must two objects be on the surface of the Moon if they are to be resolvable by the Palomar telescope? The Earth-Moon distance is 3.844E08 m; take lambda = 550 nm. How far apart must two objects be on the Moon if they are to be distinguished by the eye? Assume a pupil diameter of 4.00 mm.

8- White light falls normally on a transmission grating that contains 1000 lines per centimeter. At what angle will red light (lambda = 650 nm) emerge in the first-order spectrum'?

9- Light from a laboratory sodium lamp has two strong yellow components at 589.5923 nm and 588.9953 nm. How far apart in the first-order spectrum will these two lines be on a screen 1.00 m from a grating having 10000 lines per centimeter'?

10- What is the total number of lines a grating must have in order just to separate the sodium doublet (lambda 1 = 589.59 nm, lambda 2 = 589.00 nm) in the third order?

11- Show that the Fourier transform $F[1] = 2\pi\delta(k)$

12- Given $F[f(x)]$ show that the fourier transform of a shifted function in space $F[f(x-x_0)]$, has the same Fourier transform with a difference of a phase factor.

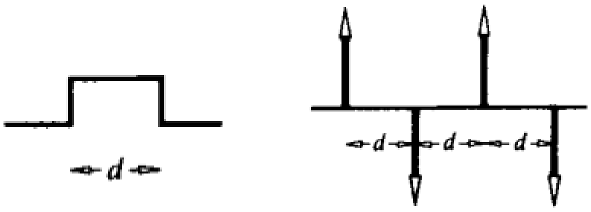
13- Suppose we have a single slit along the y-direction of width b where the aperture function is constant across it at a value of A. What is the diffracted field if we now apodize the slit with a cosine function amplitude mask? In other words, we cause the aperture function to go from A at the center to 0 at +/- b/2 via a cosinusoidal dropoff

14- Determine the Fourier transform of

$E(x) = \sin(kx)$ for abs(x)< L and zero elsewhere

Make a sketch of the Fourier transform

15- Make a sketch of the function arising from the convolution of the two functions depicted in the following figures.



16-Compute the Fourier transform of the triangular pulse shown in the following figure. Make a sketch of your answer, labeling all the pertinent values on the curve.