22.058, Principles of Medical Imaging
Fall 2002
Homework #3

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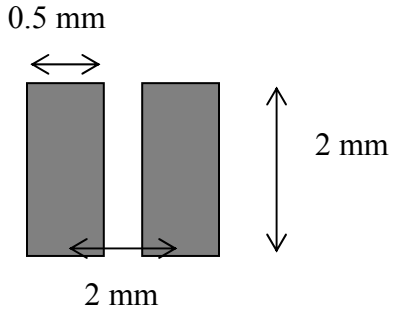
1. Define aliasing, bandwidth limiting and the Nyquist condition.

2. Using your knowledge of Fourier convolution, calculate the Fourier transforms of the following functions and draw both the real and imaginary spectra. k_0 is a real number.

a. $\cos^2(k_0 z)$
b. $\sin^3(k_0 z)$

3. The spot size of an X-ray source typically looks like 2 rectangles. Below is a schematic representation of a X-ray source. We expect that the image resolution will depend on this source distribution. Recall that we typically assume that the source is a infinitesimal point source radiating in all directions, here the source is a distributed source with each infinitesimal element radiating in all directions.



a. Describe how you would use a pin-hole camera to measure the spot size. In your analysis forget about the off axis effects (no oblique angle correction).

b. Given a detector with 1 mm x 1 mm spatial resolution and that you desire to characterize the spot size to a resolution of 100 μm, how will you set up the measurement (distances from source to pin-hole to detector, size of pin-hole).

c. What is the 2-dimensional Fourier Transform of the 2-dimensional function describing the above X-ray source distribution? Draw this and label the axes.

d. The Fourier Transform of the X-ray source has pronounced oscillations. To remove these oscillations one can file down the edges which replaces a sharp edge by a triangular edge:

Show that in k-space the trapezoid function falls off faster than the TopHat function with increasing k (wave-number). You do not have to calculate the actual Fourier Transform to answer this.