Diagnostic Ultrasound Imaging: Inside Out by T. L. Szabo
Problem Set 5 for Chapter 6

1.

(a) Compare the FWHM and outermost –20 dB full beamwidths in the farfield of the xz plane for the following line aperture functions (L = aperture length):

(1) Unapodized (L = aperture length along x)

(2) Triangle function $A \wedge (x/L)$ with a base 2L

(3)Truncated Cosine $A(\varsigma/\Gamma) = B\prod(x_0/L)\cos(\pi x_0/L)$.

(b) Estimate the far field falloff with axial distance for these apertures (hint: assume that the area is the square of the integral of the aperture functions).

(c) What must the amplitudes in cases 2 and 3 be to make farfield amplitude falloffs in part b similar?

2.

(a) For an unapodized line aperture of length L = 10 mm along the x axis at a frequency of 5 MHz (assume c=1.5mm/us), at what distance would the natural focus be (be more exact than approximate)?

(b) If the FWHM = W at this distance, where would the natural focus be if the aperture was doubled?

(c) If the FWHM $=2x_6$ for the conditions of part b, what is FWHM for part b?

3.

(a) For a circularly symmetric focusing aperture of radius a = 10mm and a frequency of 4.5 MHz and a focal length of F = 40 mm, find the two transition distances that separate the three zones.

(b) What is the focal gain of this transducer?

(c) What would the distance to the natural focus be if there were no lens?

(d) Where would the equivalent distance of the natural focus occur with the lens before the focal length?

(e) For the focusing case in part (a), estimate the FWHM beamwidth at z = F/2.