6.8 Design a *uniform broadside* linear array of N elements placed along the z-axis with a uniform spacing $d = \lambda/10$ between the elements. Determine the *closest integer number* of elements so that in the *elevation plane* the

(a) Half-power beamwidth of the array factor is approximately 60°.

(b) First-null beamwidth of the array factor is 60°.

a) Per Table 6.2, $\theta_h \cong 2\left[\pi/2 - \cos^{-1}\left(\frac{1.391\lambda}{\pi N d}\right)\right]$ $\frac{\pi d}{\lambda} << 1$

$\frac{\pi(\lambda/10)}{\lambda} = \pi/10 << 1$ (kinda iffy) $60° \rightarrow \pi/3$

$\pi/3 = 2\left[\pi/2 - \cos^{-1}\left(\frac{1.391\lambda}{\pi N(\lambda/10)}\right)\right]$

$\hookrightarrow \cos^{-1}\left(\frac{1.391(10)}{\pi N}\right) = \pi/2 - \pi/6 = \pi/3$

$\frac{13.91}{\pi N} = \cos(\pi/3) = 1/2$

$N = \frac{2(13.91)}{\pi} = 8.855 \Rightarrow \underline{\underline{N = 9}}$

b) Per Table 6.2, $\theta_n = 2\left[\pi/2 - \cos^{-1}\left(\frac{\lambda}{Nd}\right)\right]$

$\pi/3 = 2\left[\pi/2 - \cos^{-1}\left(\frac{\lambda}{N(\lambda/10)}\right)\right]$

$\hookrightarrow \cos^{-1}\left(\frac{10}{N}\right) = \pi/2 - \pi/6 = \pi/3$

$\frac{10}{N} = \cos(\pi/3) = 1/2$

$\hookrightarrow \underline{\underline{N = 20}}$