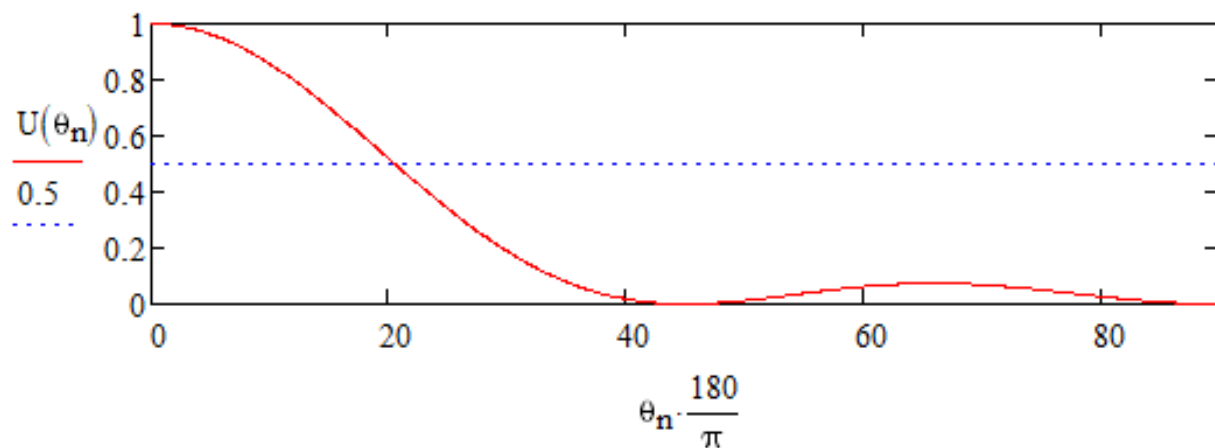


**2.5** Find the half-power beamwidth (HPBW) and first-null beamwidth (FNBW), *in radians and degrees*, for the following normalized radiation intensities:

$$(b) U(\theta) = \cos^2 \theta \cos^2(2\theta) \quad (0 \leq \theta \leq 90^\circ, 0 \leq \phi \leq 360^\circ)$$

Using MathCAD, plot  $U(\theta)$  below.

$$U(x) := (\cos(x))^2 \cdot (\cos(2 \cdot x))^2 \quad n := 0..900 \quad \theta_n := 0.1 \cdot n \cdot \frac{\pi}{180}$$



Using the graph as a starting point, find the angle  $\theta_h$  where  $U(\theta_h) = 0.5$  by trial and error to determine the HPBW.

$$\theta_{hdeg} := 20.49267 \quad \theta_{hrad} := \theta_{hdeg} \cdot \frac{\pi}{180} \quad U(\theta_{hrad}) = 0.5$$

$$\text{HPBW} := 2 \cdot \theta_{hrad}$$

HPBW = 0.71533	radians
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$\text{HPBW} \cdot \frac{180}{\pi} = 40.98534$	degrees
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Using the graph as a starting point, find the angle  $\theta_n$  where  $U(\theta_n) = 0$  by trial and error to determine the FNBW **OR** observe that  $\cos(2\theta)$  is zero when  $2\theta = 90$  deg &  $\theta = 45$  deg.

$$\theta_{ndeg} := 45 \quad \theta_{nrad} := \theta_{ndeg} \cdot \frac{\pi}{180} \quad U(\theta_{nrad}) = 0$$

$$\text{FNBW} := 2 \cdot \theta_{nrad}$$

FNBW = 1.5708	radians
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$\text{FNBW} \cdot \frac{180}{\pi} = 90$	degrees
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