

1.3

$$U(\theta, \phi) = 1 \quad \text{for } 0^\circ \leq \theta \leq 20^\circ$$

$$U(\theta, \phi) = 0.342 \cdot \csc(\theta) \quad \text{for } 20^\circ \leq \theta \leq 60^\circ$$

$$U(\theta, \phi) = 0 \quad \text{for } 60^\circ \leq \theta \leq 180^\circ$$

$$\begin{aligned} P_{\text{RAD}} &= \int_0^{2\pi} \left[\int_0^\pi U(\theta, \phi) \cdot \sin(\theta) \, d\theta \right] d\phi \\ &= 2\pi \cdot \int_{0^\circ}^{60^\circ} U(\theta, \phi) \cdot \sin(\theta) \, d\theta \\ &= 2\pi \left[\int_{0^\circ}^{20^\circ} \sin(\theta) \, d\theta + \int_{20^\circ}^{60^\circ} 0.342 \cdot \csc(\theta) \cdot \sin(\theta) \, d\theta + \int_{60^\circ}^{180^\circ} 0 \cdot \sin(\theta) \, d\theta \right] \\ &= 2\pi \left[-\cos(\theta) \right]_{0^\circ}^{20^\circ} + 2\pi \cdot 0.342 \cdot \left[\theta \right]_{20^\circ = \pi/9}^{60^\circ = 3\pi/9} \\ &= -2\pi (0.94 - 1) + 2\pi \cdot 0.342 \left(\frac{3\pi}{9} - \frac{\pi}{9} \right) \\ &= 1.88 \, \text{W} \end{aligned}$$

$$D_0 = \frac{4\pi \cdot U_{\text{max}}}{P_{\text{RAD}}} = \frac{4\pi}{1.88} = 6.687 = 8.25 \, \text{dB}$$