HW#8 - Selected solution

10-9. The angle between the half-power points of the main beam of the radiation pattern of an antenna is often called the beamwidth of the pattern. Find the beamwidth of the E-plane pattern of (a) a Hertzian dipole, and (b) a half-wave dipole.

a) From (10-11), $E_\theta(\theta,\phi)_n = |\sin\theta|$

Maximum radiation field: $E_{\max} = E_\theta(\pi/2,\phi)_n = 1$

Half-power points: $E_\theta(\theta_1,\phi)_n = E_{\max}/\sqrt{2} = 1/\sqrt{2} \longrightarrow |\sin\theta_1| = 1/\sqrt{2} \longrightarrow \theta_1 = \pi/4, 3\pi/4$

$$\therefore \Delta\theta = 3\pi/4 - \pi/4 = \pi/2$$

b) From (10-38), $F(\theta) = \dfrac{\cos\left(\dfrac{\pi}{2}\cos\theta\right)}{\sin\theta}$

$F(\theta)_{\max} = F(\pi/2) = 1$

$$F(\theta_1) = F(\theta)_{\max}/\sqrt{2} = 1/\sqrt{2} \longrightarrow \frac{\cos\left(\dfrac{\pi}{2}\cos\theta_1\right)}{\sin\theta_1} = 1/\sqrt{2} \longrightarrow \theta_1 = 0.283, 0.717$$

$$\therefore \Delta\theta = 0.717 - 0.283 = 0.434$$

10-20. The antenna of a 120-(kW) monostatic radar operating at 3 (GHz) has a directive gain of 20 (dB). Suppose that it tracks a target 8 (km) away and that the backscatter cross section of the target is 15 (m^2). Determine

a) The magnitude of the electric intensity at the target,
b) The amount of power intercepted by the target, and
c) The amount of the reflected power absorbed by the antenna at the radar.

a) Power density at the target: $P_{av} = \frac{P_t}{4\pi r^2} G_D = \frac{E_T^2}{2\eta_0}$

$$\longrightarrow \quad E_T = \left[\frac{2\eta_0 P_t}{4\pi r^2} G_D \right]^{1/2} \approx 3.35 \quad (V/m)$$

b) Power intercepted by target $= \sigma_{bs} P_{av} \approx 0.22 \quad (W)$

c) Absorbed power by the antenna from (10-83)

$$P_L = \frac{\sigma_{bs} \lambda^2}{(4\pi)^3 r^4} G_D^2 p_t \approx 22 \ (pW)$$