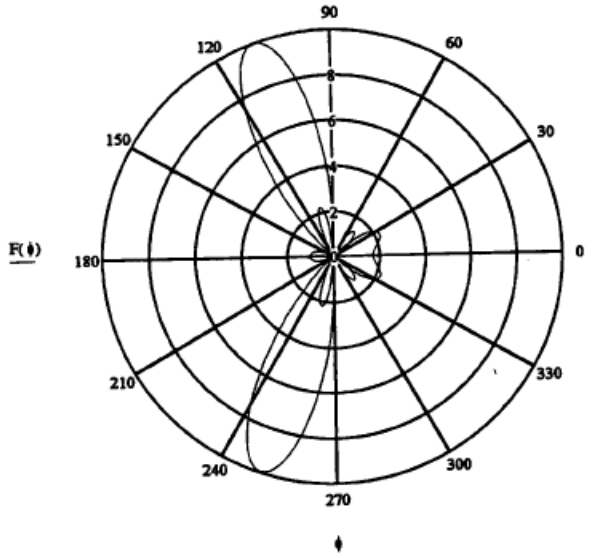
Homework # 8 solution

Exercise 11.15

$$\phi := 0, \frac{\pi}{500} .. 2\cdot\pi \qquad \beta d := \frac{\pi}{2} \qquad \delta := \frac{\pi}{6} \qquad n := 10 \qquad \alpha(\phi) := \beta d \cdot \cos(\phi) + \delta$$

$$F(\phi) := \frac{\sin(n\cdot\alpha(\phi)\cdot 0.5)}{\sin(\alpha(\phi)\cdot 0.5)}$$



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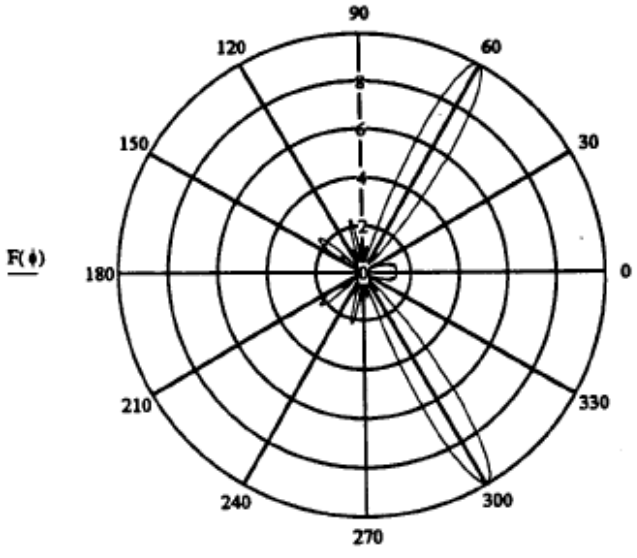
Exercise 11.16

$$\phi := 0, \frac{\pi}{500} .. 2\cdot\pi \qquad \beta d := \pi \qquad \delta := -\left(\frac{\pi}{2}\right) \qquad n := 10 \qquad \alpha(\phi) := \beta d \cdot \cos(\phi) + \delta$$

$$F(\phi) := \frac{\sin(n\cdot\alpha(\phi)\cdot 0.5)}{\sin(\alpha(\phi)\cdot 0.5)}$$



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Exercise 11.18 $f = 600\ MHz$ $\omega = 2\pi f$ $\lambda = \frac{3}{f} = 0.5\ m$ $l = \frac{\lambda}{2} = 0.25\ m$

$\delta = \frac{1}{\alpha} = \sqrt{\frac{1}{\pi f \mu_0 \sigma_{cu}}} = 2.698\ \mu m$, $a = 406.5\ \mu m$ $a \gg \delta$ $A_{cu} = 2\pi a \delta$

$R_c = \frac{l}{2\pi a \delta \sigma_{cu}} = 0.626\ \Omega$ $R_{rad} = 73.14\ \Omega$ $\eta = \frac{73.14}{73.14 + 0.626} = 0.9915$ or 99.15%

Exercise 11.20 $D_T = 10^{1.2} = 15.85$ $D_t = 10^2 = 100$

Since $\theta = 90^\circ$ $G_R = D_T = 15.85$ $G_t = D_t = 100$ $R = 100\lambda$ $P_T = 10\ \mu W$

From (11.112), $P_{rad} = \frac{P_R}{G_t G_R (\lambda/4\pi R)^2} = 9.96\ mW$

Problem 11.17 $\frac{l}{\lambda} = 0.1$ $\beta l = \frac{2\pi}{\lambda} \cdot \frac{\lambda}{10} = \pi/5$

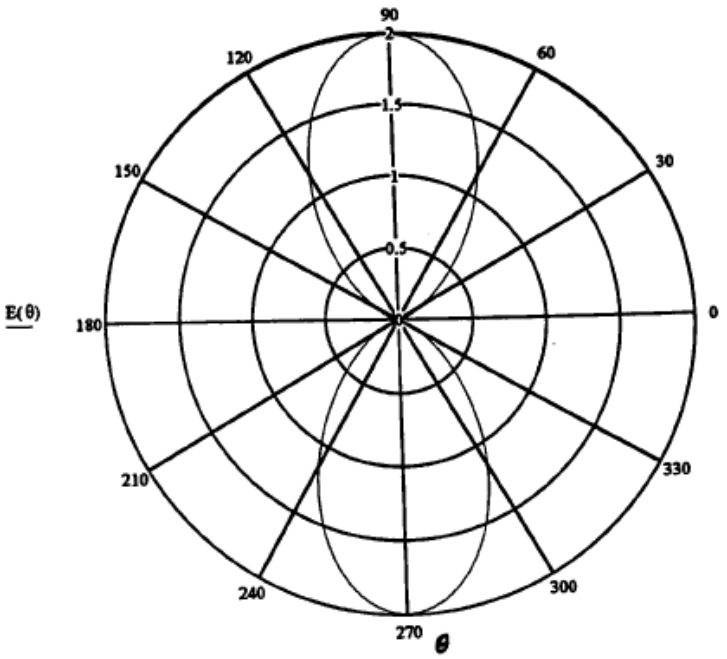
$P_{rad} = \frac{1}{2} I_0^2 R_{rad} = \frac{1}{2} I_0^2 \frac{2\pi}{120} \times 120\pi \times \left(\frac{1}{10}\right)^2$ when $P_{rad} = 100\ W$, $I_0 = 10.07\ A$

$|E| = \frac{\beta I_0 l}{8\pi r} \eta = \frac{\pi}{5} \cdot \frac{10.07}{8\pi} \cdot \frac{120\pi}{10 \times 10^3} = 9.49\ mV/m$

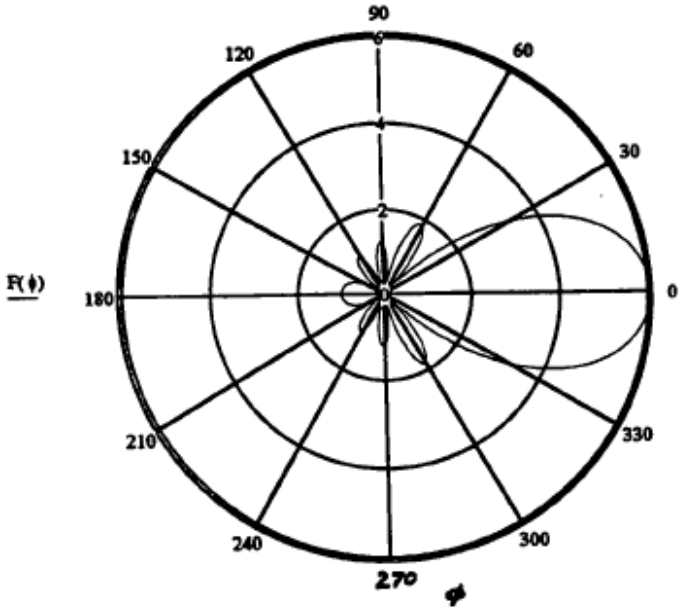
Problem 11.22

$\theta := 0, \frac{\pi}{500} .. 2 \cdot \pi$ $E(\theta) := \left| \frac{\cos(\pi \cdot \cos(\theta)) + 1}{\sin(\theta)} \right|$

Field plot of a
Full-wave Antenna



Problem 11.26



$\phi := 0, \frac{\pi}{500} .. 2\cdot\pi$ $\quad \beta d := \frac{\pi}{2}$ $\quad \delta := -\frac{\pi}{2}$ $\quad n := 8$ $\quad \alpha(\phi) := \beta d \cdot \cos(\phi) + \delta$

$$F(\phi) := \left| \frac{\sin(n\cdot\alpha(\phi)\cdot 0.5)}{\sin(\alpha(\phi)\cdot 0.5)} \right|$$

Endfire array pattern of an 8-element half-wave dipole array in the xy-plane when currents are -90° out of phase and spacing is quarter-wavelength.

Problem 11.28

$\tilde{E}_\theta = \frac{15}{r} I_0$ V/m, $\tilde{H}_\phi = \frac{15}{\eta_0 r} I_0$ A/m, $\langle \hat{S}_r \rangle = \frac{225}{\eta_0 r^2} I_0^2$ W/m²

$P_{rad} = \frac{225}{\eta_0} I_0^2 \int_0^{\pi} \sin\theta \, d\theta \int_0^{2\pi} d\phi = 7.5 I_0^2$, For $P_{rad} = 75$ kW, $I_0 = 100$ A

$\eta_0 = 120\pi\ \Omega$ Omnidirectional antenna.