9.7 Repeat Problem 9.6 for a 20 cm long antenna operating at 5 MHz.

Solution:

(a) At 5 MHz, $\lambda = c/f = 3 \times 10^8/(5 \times 10^6) = 60$ m. As $l/\lambda = 0.2/60 = 3.33 \times 10^{-3}$, the antenna length satisfies the condition of a short dipole. From Eqs. (9.35), (9.32), and (9.31),

$$R_{\text{rad}} = 80\pi^2 \left(\frac{l}{\lambda}\right)^2 = 80\pi^2 \times (3.33 \times 10^{-3})^2 = 8.76 \qquad (\text{m}\Omega),$$

$$R_{\text{loss}} = \frac{l}{2\pi a}\sqrt{\frac{\pi f u_{\text{c}}}{\sigma_{\text{c}}}} = \frac{0.2}{2\pi \times 10^{-3}}\sqrt{\frac{\pi \times 5 \times 10^6 \times 4\pi \times 10^{-7}}{5.8 \times 10^7}} = 18.57 \qquad (\text{m}\Omega),$$

$$\xi = \frac{R_{\text{rad}}}{R_{\text{rad}} + R_{\text{loss}}} = \frac{8.76}{8.76 + 18.57} = 0.32, \quad \text{or } 32\%.$$

(b) For Hertzian dipole, $D = 1.5$, and $G = \xi D = 0.32 \times 1.5 = 0.48 = -3.2$dB.

(c) From Eq. (9.30a),

$$I_0 = \sqrt{\frac{2P_{\text{rad}}}{R_{\text{rad}}}} = \sqrt{\frac{2 \times 80}{8.76 \times 10^{-3}}} = 135.2 \text{ A}.$$