

**9.8** Determine the frequency dependence of the radiation efficiency of the short dipole, and plot it over the range from 600 kHz to 60 MHz. The dipole is made of copper, its length is 10 cm and its circular cross section has a radius of 1 mm.

**Solution:**

$$R_{\text{rad}} = 80\pi^2 \left( \frac{l}{\lambda} \right)^2 = \frac{80\pi^2 (0.1)^2}{c^2} f^2 = 8.77 \times 10^{-17} f^2,$$

$$R_{\text{loss}} = \frac{l}{2\pi a} \sqrt{\frac{\pi f \mu_c}{\sigma_c}} = \frac{0.1}{2\pi \times 10^{-3}} \sqrt{\frac{\pi f \times 4\pi \times 10^{-7}}{5.8 \times 10^7}} = 4.15 \times 10^{-6} \sqrt{f},$$

$$\xi = \frac{R_{\text{rad}}}{R_{\text{rad}} + R_{\text{loss}}}.$$

The plot below displays  $\xi$  as a function of frequency from 600 kHz to 60 MHz.

