Physics 712  
Chapter X Problems

4. [5] The conductivity of copper is $5.96 \times 10^7 \, \Omega^{-1}m^{-1}$. Suppose power is being transmitted at 60 Hz along a high-voltage wire. What is the skin depth $\delta$ in copper at this frequency?

Copper is not ferromagnetic, so we assume $\mu = \mu_0$. The skin depth, relevant at low frequencies, is then given by

$$\delta = \sqrt{\frac{2}{\mu \sigma \omega}} = \sqrt{\frac{2}{4\pi \times 10^{-7} \, m \cdot kg \cdot C^{-2} \left(5.96 \times 10^7 \, \Omega^{-1}m^{-1}\right) \left(2\pi \times 60 \, s^{-1}\right) \left(\frac{7.083 \times 10^{-3} \, V \cdot C^2 \cdot s}{A \cdot kg}\right)}} = \sqrt{8.42 \times 10^{-3} \, s^{-1} \cdot kg^{-1}} = 8.42 \times 10^{-3} \, m = 8.42 \, mm.$$