

Problem 7.26 The inner and outer conductors of a coaxial cable have radii of 0.5 cm and 1 cm, respectively. The conductors are made of copper with $\epsilon_r = 1$, $\mu_r = 1$, and $\sigma = 5.8 \times 10^7$ S/m, and the outer conductor is 0.5 mm thick. At 10 MHz:

- (a) Are the conductors thick enough to be considered infinitely thick as far as the flow of current through them is concerned?
- (b) Determine the surface resistance R_s .
- (c) Determine the ac resistance per unit length of the cable.

Solution:

- (a) From Eqs. (7.72) and (7.77b),

$$\delta_s = [\pi f \mu \sigma]^{-1/2} = [\pi \times 10^7 \times 4\pi \times 10^{-7} \times 5.8 \times 10^7]^{-1/2} = 0.021 \text{ mm}.$$

Hence,

$$\frac{d}{\delta_s} = \frac{0.5 \text{ mm}}{0.021 \text{ mm}} \approx 25.$$

Hence, conductor is plenty thick.

- (b) From Eq. (7.92a),

$$R_s = \frac{1}{\sigma \delta_s} = \frac{1}{5.8 \times 10^7 \times 2.1 \times 10^{-5}} = 8.2 \times 10^{-4} \Omega.$$

- (c) From Eq. (7.96),

$$R' = \frac{R_s}{2\pi} \left(\frac{1}{a} + \frac{1}{b} \right) = \frac{8.2 \times 10^{-4}}{2\pi} \left(\frac{1}{5 \times 10^{-3}} + \frac{1}{10^{-2}} \right) = 0.039 \text{ } (\Omega/\text{m}).$$
