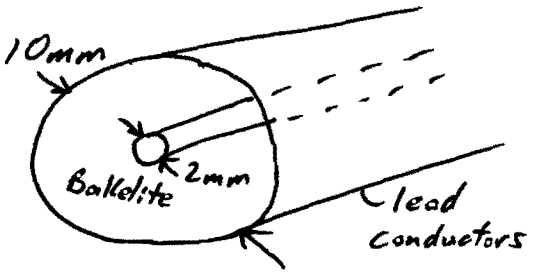
A novel coaxial transmission line is made with lead conductors, a center wire of diameter 2 mm and shield of diameter 10 mm, separated by a Bakelite insulator (AKA: polyoxybenzylmethylenglycolanhydride). It is connected to a signal generator operating at 103.5 MHz. Find the skin depth as well as the resistance per-unit-length R, inductance per-unit-length L, conductance per-unit-length G, and capacitance-per-unit-length C.



lead (App'dix B)	Bakelite
$\sigma_{Pb} = 5\times10^{6}$ S/m	$\sigma = 10^{-10}$ S/m
$\mu = 0.9999831\,\mu_0$	$\mu = \mu_0$
$\epsilon = \epsilon_0$	$\epsilon = 5\epsilon_0$

From Table 11.1, use equations to calculate δ, R, L, G, & C

$$\delta = \frac{1}{\sqrt{\pi f \mu_c \sigma_c}} = \frac{1}{\sqrt{\pi(103.5\times10^{6})0.9999831(4\pi\times10^{-7})5\times10^{6}}} = 2.2124\times10^{-5}\ \text{m}$$

(σ_c: lead)

$$R = \frac{1}{2\pi\delta\sigma_c}\left[\frac{1}{a}+\frac{1}{b}\right] = \frac{1}{2\pi(2.2124\times10^{-5})5\times10^{6}}\left[\frac{1}{1\times10^{-3}}+\frac{1}{5\times10^{-3}}\right]$$

(σ_c: lead)

$$R = 1.7265\ \Omega/\text{m}$$

(Bakelite)

$$L = \frac{\mu}{2\pi}\ln(b/a) = \frac{4\pi\times10^{-7}}{2\pi}\ln\left(\frac{5\text{mm}}{1\text{mm}}\right) = 3.21888\times10^{-7}\ \text{H/m}$$

$$L = 321.888\ \text{nH/m}$$

(Bakelite)

$$G = \frac{2\pi\sigma}{\ln(b/a)} = \frac{2\pi\,10^{-10}}{\ln(5/1)} = 3.90396\times10^{-10}\ \text{S/m} = 390.396\ \text{pS/m}$$

$$C = \frac{2\pi\epsilon}{\ln(b/a)} = \frac{2\pi\,5(8.8541878\times10^{-12})}{\ln(5/1)} = 1.7283\times10^{-10}\ \text{F/m}$$

$$C = 172.832\ \text{pF/m}$$