# Blast From the Past!

Final Exam

Spring 2009

## Problem 2

A 75 [Ω] coaxial line used for TV has an outer radius of $b = 0.25$ [cm] and an inner radius of $a = 0.039$ [cm]. The coax is filled with Teflon (nonmagnetic, with $\varepsilon_r = 2.2$) that has a loss tangent of 0.001. The conductors are made of copper, which is nonmagnetic. The conductivity of copper is $3.0 \times 10^7$ [S/m]. Assume that the transmission line is operating at a UHF frequency of 500 [MHz].

a) Calculate the parameters $R$, $L$, $G$, $C$ for the line.

b) Calculate the attenuation on the transmission line, in both nepers/m and dB/m.

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## Solution

Part (a)

$$C = \frac{2\pi\varepsilon_0\varepsilon_r}{\ln\left(\frac{b}{a}\right)} \quad [\text{F/m}]$$

$$L = \frac{1}{2\pi}\ln\left(\frac{b}{a}\right)\mu_0\mu_r \quad [\text{H/m}]$$

$$G = (\omega C)\tan\delta_d \quad [\text{S/m}]$$

$$R = \left(\frac{R_{sa}}{2\pi a} + \frac{R_{sb}}{2\pi b}\right) \quad [\Omega/\text{m}]$$

$$R_{sa} = \frac{1}{\sigma_{ma}\delta_a} = \sqrt{\frac{\omega\mu_a}{2\sigma_{ma}}}$$

$$R_{sb} = \frac{1}{\sigma_{mb}\delta_b} = \sqrt{\frac{\omega\mu_b}{2\sigma_{mb}}}$$

$$\mu_a = \mu_b = \mu_0$$

$$\delta_a = \sqrt{\frac{2}{\omega\mu_{ma}\sigma_{ma}}}$$

$$\delta_b = \sqrt{\frac{2}{\omega\mu_{mb}\sigma_{mb}}}$$

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Part (a)

$R = 3.827\ [\Omega/\mathrm{m}]$

$L = 3.716\times10^{-7}\ [\mathrm{H/m}]$

$G = 2.070\times10^{-4}\ [\mathrm{S/m}]$

$C = 6.588\times10^{-11}\ [\mathrm{F/m}]$

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Part (b)

$$\gamma = \alpha + j\beta = \sqrt{(R + j\omega L)(G + j\omega C)}$$

$\alpha =$ attenuation constant (np / m)

$$\text{Attenuation (dB / m)} = 8.686\alpha$$

$$\gamma = 0.033243 + j15.543 \text{ [1/m]}$$

$$\alpha = 0.033247 \text{ [nepers/m]}$$

Attenuation = 0.289 [dB/m]