Ex. Belden 9085 is/was a common twin lead transmission line used for radio and radio applications. It has 22 AWG stranded copper conductors separated by 7.4 mm and polyethylene insulation. At 100 MHz, determine the skin depth δ, resistance per-unit-length *R*, inductance per-unit-length *L*, conductance per-unit-length *G*, and capacitance-per-unit-length *C*.

Quantities that we look-up or are given:

$\varepsilon 0 := 8.85412 \cdot 10^{-12}$ F/m $\quad \mu 0 := 4 \cdot \pi \cdot 10^{-7}$ H/m $\quad f := 100 \cdot 10^{6}$ Hz

$a := 0.5 \cdot \left(0.644 \cdot 10^{-3}\right)$ $\quad a = 3.22 \times 10^{-4}$ m $\quad d := 7.4 \cdot 10^{-3}$ m

$\sigma\_cu := 5.1 \cdot 10^{7}$ S/m $\quad \varepsilon\_cu := \varepsilon 0$ $\quad \mu\_cu := \mu 0$

$\sigma\_poly := 1.65 \cdot 10^{-5}$ S/m $\quad \varepsilon\_poly := 2.26 \cdot \varepsilon 0$ $\quad \mu\_poly := \mu 0$

$\sigma\_eff := 0.45 \cdot \sigma\_poly$ $\quad \varepsilon\_eff := 0.55 \cdot \varepsilon 0 + 0.45 \cdot \varepsilon\_poly$

Use Table 11.1 equations, starting with skin depth

$$\delta := \frac{1}{\sqrt{\pi \cdot f \cdot \mu\_cu \cdot \sigma\_cu}} \qquad \boxed{\delta = 7.047 \times 10^{-6}} \text{ m}$$

Check if $\delta << a$ so that Table 11.1 equations are valid

$\frac{\delta}{a} = 0.022$ **Yes, $\delta << a$**

$$R := \frac{1}{\pi \cdot a \cdot \delta \cdot \sigma\_cu} \qquad \boxed{R = 2.7504} \ \Omega/\text{m}$$

$$L := \frac{\mu\_poly}{\pi} \cdot \operatorname{acosh}\left(\frac{d}{2 \cdot a}\right) \qquad \boxed{L = 1.253 \times 10^{-6}} \text{ H/m}$$

$$G := \frac{\pi \cdot \sigma\_eff}{\operatorname{acosh}\left(\frac{d}{2 \cdot a}\right)} \qquad \boxed{G = 7.446 \times 10^{-6}} \text{ S/m}$$

$$C := \frac{\pi \cdot \varepsilon\_eff}{\operatorname{acosh}\left(\frac{d}{2 \cdot a}\right)} \qquad \boxed{C = 1.391 \times 10^{-11}} \text{ F/m}$$