E14086622 操之晴.

$l = 20\ km$

$Z_0 = 45.5\ \Omega$

$u = 0.7c$

$\mu_r = 1$

(a)

In loseless line =

$$\begin{cases} Z_0 = \sqrt{\frac{L}{C}} \\ \sqrt{LC} = \sqrt{\mu\varepsilon} = \frac{1}{u} \end{cases} \Rightarrow \begin{cases} \sqrt{L} = 45.5\sqrt{C} \\ \sqrt{LC} = \frac{1}{0.7c} \end{cases} \Rightarrow 45.5C = \frac{1}{0.7 \cdot 3 \cdot 10^8}$$

$$\therefore \begin{cases} C = 104.66 \cdot 10^{-12} \ (F/m) \\ L = 2.1667 \cdot 10^{-7} \ (H/m) \end{cases} \#.$$

(b)

$L = \frac{\mu}{2\pi} \ln\left(\frac{b}{a}\right)$ in coxial line

$2.1667 \cdot 10^{-7} = \frac{1.4\pi \cdot 10^{-7}}{2\pi} \ln\left(\frac{b}{a}\right)$

$\ln\left(\frac{b}{a}\right) = 1.0833$

$\frac{b}{a} = 2.9545$ #.

(c)

$C = \frac{2\pi\varepsilon}{\ln(b/a)}$ in coxial line

$104.66 \cdot 10^{-12} = \frac{2\pi \cdot \varepsilon_r \cdot 8.842 \cdot 10^{-12}}{1.0833}$, $\varepsilon_r = 2.0408$ #.

or

$\frac{1}{u^2} = \mu\varepsilon = \mu_0 \cdot \varepsilon_r \varepsilon_0$

$\frac{1}{(0.7c)^2} = \varepsilon_r \cdot \frac{1}{c^2}$, $\varepsilon_r = \frac{1}{0.49} = 2.0408$

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$\begin{cases} Air = \varepsilon_0 \cdot \mu_0 \cdot \sigma = 5 \cdot 10^{-7}\ S/m \\ conductors = \varepsilon_0 \cdot \mu_0 \cdot \sigma_c = 5.7 \cdot 10^{5}\ S/m \end{cases}$

$2a = 0.02\ m$

$d = 1\ m$

$f = 1.6\ MHz$

(a)

for two-wire line at high freq.

$R = \frac{1}{\pi a \delta \sigma_c} = \frac{1}{\pi \cdot 0.01 \cdot \delta \cdot 5.7 \cdot 10^5}$

$= 0.106\ (\Omega/m)$ #. , where skin depth $\delta = \frac{1}{\sqrt{\pi f \mu_0 \sigma_c}} = 5.27 \cdot 10^{-4}$

$G = \frac{\pi \sigma}{\cosh^{-1}(d/2a)} = 3.411 \cdot 10^{-7}\ (S/m)$ #.

$C = \frac{\pi \varepsilon}{\cosh^{-1}(d/2a)} = 6.032 \cdot 10^{-12}\ (F/m)$ #.

$L = \frac{\mu \varepsilon}{C} = \frac{1}{(3 \cdot 10^8)^2} \frac{1}{C} = 1.84 \cdot 10^{-6}\ (H/m)$ #.

(b)

propagation const $\gamma = \sqrt{(R+j\omega L)(G+j\omega C)}$, $\omega = 2\pi f = 3.2\pi M$

$= 0.00019 + 0.0335j$. #

characteristic impedance $Z_0 = \sqrt{(R+j\omega L)/(G+j\omega C)}$

$= 55\times.304 - 0.029j.\ (\Omega)$ #.

(c)

In distortionless line.

$\frac{R}{L} = \frac{G}{C}$, $\frac{0.106}{1.84 \cdot 10^{-6} + \Delta L} = \frac{3.411 \cdot 10^{-7}}{6.032 \cdot 10^{-12}}$

$\Delta L = 3.45 \cdot 10^{-8}\ (H/m)$ #.