EE381 HW 2

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2.2

(a)

$$G' = \frac{\pi\sigma}{\ln\left[D/d + \sqrt{(D/d)^2 - 1}\right]}$$

$$= \frac{2\text{E-}6\,\frac{S}{m} \times \pi}{\ln\left[\frac{3\text{cm}}{2\text{mm}} + \sqrt{\left(\frac{3\text{cm}}{2\text{mm}}\right)^2 - 1}\right]}$$

$$= 1.85\ \mu S/m$$

$$C' = \frac{G'\epsilon}{\sigma} = \frac{G'\epsilon_r\epsilon_0}{\sigma}$$

$$= \frac{G' \times 2.6 \times 8.85\times10^{-12}\,F/m}{2\times10^{-6}\,\frac{S}{m}}$$

$$= 21.3\ pF/m$$

$$L' = \frac{\mu\epsilon}{C'} = \frac{\mu_0\epsilon_r\epsilon_0}{C'}$$

$$= \frac{4\times10^{-7}\,\frac{H}{m} \cdot 2.6\epsilon_0}{C'}$$

$$= 1.36\ \mu H/m$$

$$\sigma_c = 5.8\times10^7$$

$$R' = \frac{2R_s}{\pi d}$$

$$R_s = \sqrt{\frac{\pi f \mu_0}{\sigma_c}}$$

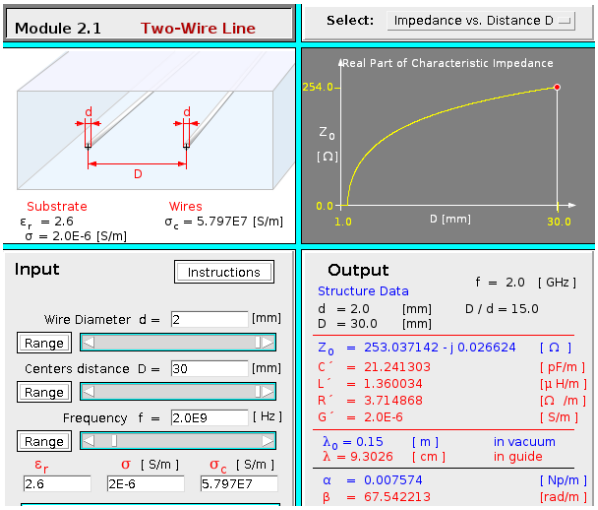
$$= \sqrt{\frac{\pi \cdot 2\times10^9 \cdot 4\pi\times10^{-7}}{5.8\times10^7}}$$

$$= 11.7\ m\Omega$$

$$= \frac{2 \cdot 11.7\cdot10^{-3}}{\pi \cdot 2\times10^{-3}}$$

$$= 3.72\ \Omega/m$$

(b)



2.6

a	0.5cm
b	1cm
ϵ_r	4.5
σ	$10^{-3}\text{S}\,\text{m}^{-1}$
f	1GHz

(a)

$$G' = \frac{2\pi\sigma}{\ln(b/a)}$$

$$= \boxed{0.091\text{S}\,\text{m}^{-1}}$$

$$C' = \frac{G'\epsilon}{\sigma}$$

$$= \frac{G' \cdot 4.5\epsilon_0}{10^{-3}}$$

$$= \boxed{361\text{pF}\,\text{m}^{-1}}$$

$$L' = \frac{\epsilon\mu}{C'}$$

$$= \frac{4.5\epsilon_0\mu_0}{C'}$$

$$= \boxed{139\text{nH}\,\text{m}^{-1}}$$

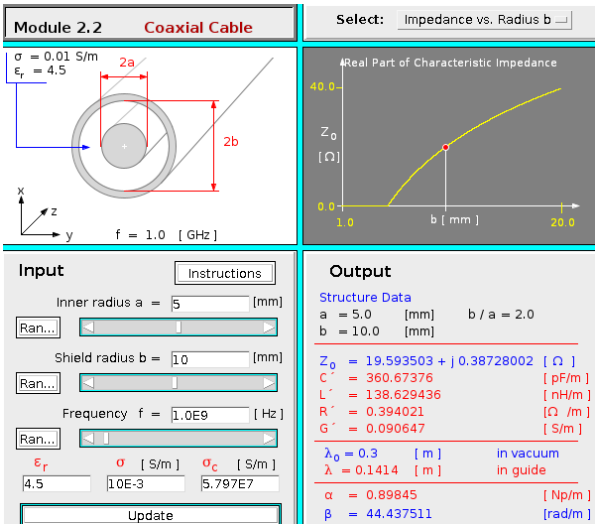
$$R_s = \sqrt{\frac{\pi \cdot 1\text{GHz} \cdot \mu_0}{5.8\times10^7}}$$

$$= 0.00825\Omega$$

$$R' = \frac{R_s}{2\pi}\left(\frac{1}{a} + \frac{1}{b}\right)$$

$$= \boxed{0.394\Omega\,\text{m}^{-1}}$$

(b)



2.13

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

$$= \sqrt{R'\left(1 + j\omega \frac{L'}{R'}\right) G'\left(1 + j\omega \frac{C'}{G'}\right)}$$

$$= \sqrt{R'G'} \cdot \left(1 + j\omega \frac{C'}{G'}\right)$$

$$= \sqrt{R'G'} + j\sqrt{R'G'}\,\omega \frac{C'}{G'}$$

$$\alpha = \mathrm{Re}\{\gamma\} = \sqrt{R'G'} \quad \checkmark$$

$$\leftarrow G' = \frac{R'C'}{L'}$$

$$= \sqrt{[R']^2 \frac{C'}{L'}}$$

$$= R'\sqrt{\frac{C'}{L'}} \quad \checkmark$$

$$\beta = \mathrm{Im}\{\gamma\} = \omega\sqrt{R'G' \cdot \frac{[C']^2}{[G']^2}}$$

$$= \omega\sqrt{\frac{R'[C']^2}{G'}}$$

$$\leftarrow G' = \frac{R'C'}{L'}$$

$$= \omega\sqrt{L'C'} \quad \checkmark$$

$$Z_0 = \sqrt{\frac{R' + j\omega L'}{G' + j\omega C'}}$$

$$= \sqrt{\frac{R'\left(1 + j\omega \frac{L'}{R'}\right)}{G'\left(1 + j\omega \frac{C'}{G'}\right)}}$$

$$= \sqrt{\frac{R'}{G'}}$$

$$= \sqrt{\frac{L'}{C'}} \quad \checkmark$$

2.20

$$\Gamma = \frac{Z_L - 1}{Z_L + 1}$$

$$z_L = \frac{Z_L}{Z_0}$$

$$= \frac{R + j\omega L}{Z_0}$$

$$= \frac{600\Omega + j2\pi \cdot 5\mathrm{Mhz} \cdot 0.02\mathrm{mH}}{300\Omega}$$

$$\leftarrow = [2 + j2.09]\Omega$$

$$= \frac{2 + j2.09 - 1}{2 + j2.09 + 1}$$

$$= \frac{1 + j2.09}{3 + j2.09}$$

$$= 0.552 + j0.313$$

$$= 0.634 \angle 29.4^\circ$$

$$S = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$

$$= \frac{1 + 0.634}{1 - 0.634}$$

$$= 4.46$$

S: RATIO OF $|\tilde{V}|_{max}$ TO $|\tilde{V}|_{min}$, VOLTAGE STANDING-WAVE RATIO ("mismatch" BETWEEN LOAD & TRANSMISSION LINE)