For the plexiglass parallel plate transmission line in 1), calculate: a) propagation constant, b) attenuation constant (both Np/m and dB/m), c) phase constant, d) characteristic impedance (both polar & rectangular forms), e) wavelength, and f) phase velocity.

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We have made a parallel plate transmission line by cutting a 0.75" wide strip from a 0.25" thick plexiglass board from Ace Hardware covered with lead tape (24 μm thick). If the transmission line is operated at 3 GHz at room temperature, determine: a) the effective conductivity and complex permittivity of the plexiglass, and b) skin depth & distributed parameters *R*, *L*, *G*, & *C* of the transmission line. [Hint: Appendices E, F, & G.]

From 1),

$$L = 4.1888\times10^{-7}\ \text{H/m} = 418.88\ \text{nH/m},\quad C = 6.9063\times10^{-11}\ \text{F/m} = 69.063\ \text{pF/m},$$

$$R = 5.35044\ \Omega\text{/m},\quad \text{and}\quad G = 7.4203\times10^{-3}\ \text{S/m} = 7.4203\ \text{mS/m}$$

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a) Per (2.5),

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

$$= \sqrt{\left[5.35 + j2\pi(3\times10^{9})4.189\times10^{-7}\right]\left[7.420\times10^{-3} + j2\pi(3\times10^{9})6.906\times10^{-11}\right]}$$

$$\Rightarrow \underline{\gamma = 0.323293 + j101.383776\ 1/\text{m}}.$$

b) $\alpha = \text{Re}(\gamma) = \text{Re}(0.323293 + j101.383776)$ $\Rightarrow$ $\underline{\alpha = 0.32329\ \text{Np/m}}$.

In dB/m , $\alpha = \alpha * 20 * \log(e) = 0.323293(8.686)$ $\Rightarrow$ $\underline{\alpha = 2.80808\ \text{dB/m}}$.

c) $\beta = \text{Im}(\gamma) = \text{Im}(0.323293 + j101.383776)$ $\Rightarrow$ $\underline{\beta = 101.3838\ \text{rad/m}}$.

d) Per (2.7),

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

$$= \sqrt{\frac{5.35 + j2\pi(3\times10^{9})4.189\times10^{-7}}{7.420\times10^{-3} + j2\pi(3\times10^{9})6.906\times10^{-11}}}$$

$$\Rightarrow \underline{Z_0 = 77.8785 + j0.19556\ \Omega = 77.8788\angle 0.1439^\circ\ \Omega}.$$

e) Per (2.10), $\lambda = 2\pi/\beta = 2\pi/101.3838$ $\Rightarrow$ $\underline{\lambda = 0.061974\ \text{m} = 6.1974\ \text{cm}}$.

f) Per (2.11), $v_p = \omega/\beta = 2\pi(3\times10^{9})/101.3838$ $\Rightarrow$ $\underline{v_p = 1.85923\times10^{8}\ \text{m/s}}$.