11.22 A distortionless transmission line satisfies $RC = LG$. If the line has $R = 10\ \text{m}\Omega/\text{m}$, $C = 82\ \text{pF/m}$, and $L = 0.6\ \mu\text{H/m}$, calculate its characteristic impedance and propagation constant. Assume that the line operates at 80 MHz.

- Also, calculate the conductance G per-unit-length and attenuation constant α (Np/m & dB/m).

Using $RC = LG$, $G = RC/L = 10\times10^{-3}\,(82\times10^{-12})/0.6\times10^{-6}$

$$\Rightarrow \quad \underline{\boldsymbol{G = 1.3667\times10^{-6}\ \text{S/m} = 1.3667\ \mu\text{S/m}}}$$

Per (11.19) & (11.23b),

$$Z_0 = \sqrt{\frac{R+j\omega L}{G+j\omega C}} = \sqrt{\frac{0.01 + j(2\pi 80\bullet 10^6)0.6\bullet10^{-6}}{1.36667\bullet10^{-6} + j(2\pi 80\bullet10^6)82\bullet10^{-12}}}$$

$$= \sqrt{\frac{L}{C}} = \sqrt{\frac{0.6\bullet10^{-6}}{82\bullet10^{-12}}}$$

$$\Rightarrow \quad \underline{\boldsymbol{Z_0 = 85.54\ \Omega}}$$

Per (11.11), the propagation constant is

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

$$= \sqrt{[0.01 + j(2\pi 80\bullet10^6)0.6\bullet10^{-6}][1.36667\bullet10^{-6} + j(2\pi 80\bullet10^6)82\bullet10^{-12}]}$$

$$\Rightarrow \quad \underline{\boldsymbol{\gamma = 0.0001169 + j\ 3.52575724\ 1/\text{m}}}$$

Per (11.23a) $\alpha = \sqrt{RG} = \sqrt{[0.01]1.36667\bullet10^{-6}}$ or $\alpha = \text{Re}(\gamma)$

$$\Rightarrow \quad \underline{\boldsymbol{\alpha = 0.0001169\ \text{Np/m}}}$$

α (dB/m) = α (Np/m) (8.686 dB/Np) $\Rightarrow$ $\underline{\boldsymbol{\alpha = 0.0010154\ \text{dB/m}}}$