An RG-6 coaxial transmission line has the following parameters/specifications at 700 MHz: L = 0.093 μH/ft, C = 16.5 pF/ft, u = 0.82074c, and α = 6.6 dB/100ft. (a) Determine the propagation constant, conductance per-unit-length and characteristic impedance of the transmission line if R = 0.9 Ω/ft. (b) If a 3.6 m length of this line is terminated with a 145 + j30 Ω load and is driven by a source where $v_g(t) = 100\cos(\omega t)$ V and Z_g = 75 + j5 Ω, determine the input impedance, input reflection coefficient, input voltage, input current, and time-average power delivered to the line. (c) Also, find the load voltage, load current, and time-average power delivered to the load. (d) How much power was dissipated in the transmission line? What fraction of the input power was delivered to the load? What fraction was lost in the transmission line?

Given:

$\mu 0 := 4\cdot\pi\cdot 10^{-7}$ H/m $\varepsilon 0 := 8.8541878\cdot 10^{-12}$ F/m $c := \frac{1}{\sqrt{\varepsilon 0\cdot\mu 0}}$

$f := 700\cdot 10^{6}$ Hz $u := 0.82074\cdot c$ $\alpha := \frac{6.6}{100\cdot 0.3048\cdot(20\cdot\log(e))}$

$R := \frac{0.9}{0.3048}$ Ω/m $L := \frac{0.093\cdot 10^{-6}}{0.3048}$ H/m $C := \frac{16.5\cdot 10^{-12}}{0.3048}$ F/m

a) Propagation constant, conductance per unit length, & characteristic impedance

$\omega := 2\cdot\pi\cdot f$ $\beta := \frac{\omega}{u}$ $\alpha = 0.02493$ np/m $\beta = 17.87523$ rad/m

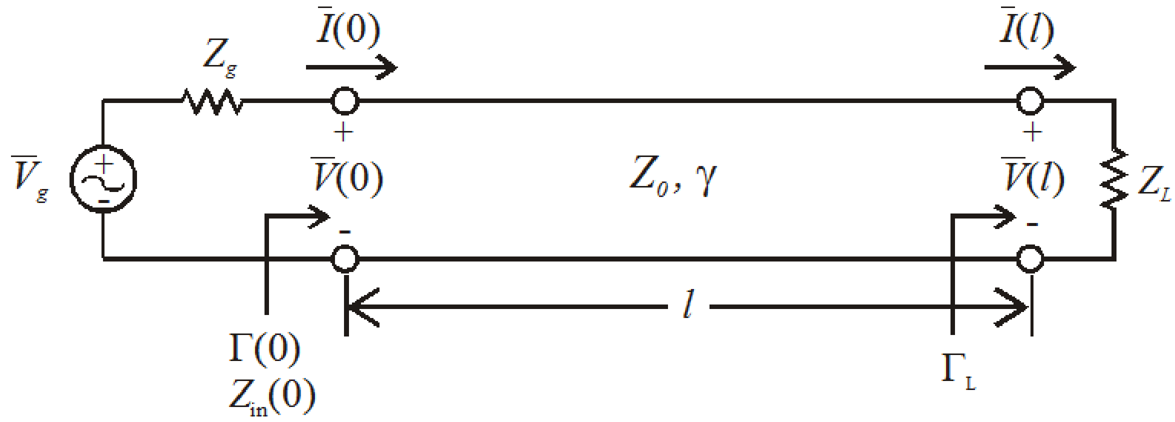
$\gamma := \alpha + j\cdot\beta$ $\gamma = 0.02493 + 17.87523i$ 1/m

$G := \mathrm{Re}\left(\frac{\gamma^2}{R + j\cdot\omega\cdot L}\right)$ $G = 1.40238\times 10^{-4}$ S/m

$Z0 := \sqrt{\frac{(R + j\cdot\omega\cdot L)}{(G + j\cdot\omega\cdot C)}}$ $Z0 = 75.07578 - 0.06048i$ Ω

$|Z0| = 75.0758$ Ω $\arg(Z0)\cdot\frac{180}{\pi} = -0.0462$ deg

b) Input impedance, reflection coefficient, voltage, current, time-average power delivered to the line.



$Vg := 100 \cdot e^{j \cdot 0}$ V $\quad Zg := 75 + j \cdot 5$ Ω $\quad ZL := 145 + j \cdot 30$ Ω $\quad l := 3.6$ m

$\Gamma L := \frac{ZL - Z0}{ZL + Z0}$ $\quad |\Gamma L| = 0.34269$ $\quad \arg(\Gamma L) \cdot \frac{180}{\pi} = 15.5158$ deg

$\Gamma 0 := \Gamma L \cdot e^{-2 \cdot \gamma \cdot l}$ $\quad |\Gamma 0| = 0.28638$ $\quad \arg(\Gamma 0) \cdot \frac{180}{\pi} = -158.5453$ deg

$Zin0 := Z0 \cdot \frac{(1 + \Gamma 0)}{(1 - \Gamma 0)}$ $\quad Zin0 = 42.66374 - 9.77265i$ Ω

$|Zin0| = 43.7687$ Ω $\quad \arg(Zin0) \cdot \frac{180}{\pi} = -12.90172$ deg

$I0 := \frac{Vg}{Zg + Zin0}$ $\quad |I0| = 0.8492$ A $\quad \arg(I0) \cdot \frac{180}{\pi} = 2.3227$ deg

$V0 := \frac{Vg \cdot Zin0}{Zg + Zin0}$ $\quad |V0| = 37.1676$ V $\quad \arg(V0) \cdot \frac{180}{\pi} = -10.579$ deg

Power into trans. line $\quad P0 := 0.5 \cdot Re\left(V0 \cdot \overline{I0}\right)$ $\quad P0 = 15.3826$ W

c) Load voltage, current, time-average power delivered to the load.

$V0\_fwd := \frac{V0}{1 + \Gamma 0}$ $\quad V0\_fwd = 50.11923 - 2.14556i \;\; V$

$VL := V0\_fwd \cdot e^{-\gamma \cdot l} \cdot (1 + \Gamma L)$ $\quad |VL| = 61.1464 \;\; V$ $\quad \arg(VL) \cdot \frac{180}{\pi} = -85.54 \;\; deg$

$IL := \frac{V0\_fwd}{Z0} \cdot e^{-\gamma \cdot l} \cdot (1 - \Gamma L)$ $\quad |IL| = 0.413 \;\; A$ $\quad \arg(IL) \cdot \frac{180}{\pi} = -97.229 \;\; deg$

Power delivered to load- $\quad PL := 0.5 \cdot Re\left(VL \cdot \overline{IL}\right)$ $\quad PL = 12.3635 \;\; W$

d) Power lost in transmission line, %delivered to the load, and % lost in line.

$Plost := P0 - PL$ $\quad Plost = 3.0191 \;\; W$

$Power\_delivered\_fraction := \frac{PL}{P0} \cdot 100$ $\quad Power\_delivered\_fraction = 80.373 \;\; \%$