EE 381 Quiz #1 (Fall 2017)

Name Key A

Instructions: Closed book & notes. Place answers in indicated spaces and show all work for credit.

Useful equations: $u = f\lambda = \frac{\omega}{\beta} = \frac{1}{\sqrt{LC}}$, $LC = \mu\varepsilon$, $\beta = \omega\sqrt{LC} = \frac{\omega}{u}$, $\lambda = \frac{u}{f} = \frac{2\pi}{\beta}$, $Z_0 = \frac{V_0^+}{I_0^+} = \sqrt{\frac{L}{C}}$

A lossless 28 cm-long transmission line has a characteristic impedance of 50 Ω and velocity of propagation of 2.1×10^8 m/s. Determine the inductance and capacitance per unit length. If operated at 550 MHz, calculate the phase constant, wavelength, and length (in terms of wavelength) of the transmission line.

$$\frac{Z_0}{u} = \frac{\sqrt{L/C}}{1/\sqrt{LC}} = L = \frac{50}{2.1\times10^8} = 2.38095\times10^{-7}\ H/m$$

$$\frac{1}{uZ_0} = \frac{1}{\frac{1}{\sqrt{LC}}\sqrt{L/C}} = C = \frac{1}{50(2.1\times10^8)} = 9.52381\times10^{-11}\ F/m$$

$$\beta = \omega\sqrt{LC} = \frac{\omega}{u} = \frac{2\pi(550\times10^6)}{2.1\times10^8} = 16.456\ rad/m$$

$$\lambda = u/f = \frac{2.1\times10^8}{550\times10^6} = 0.38\overline{1}\ m = 38.\overline{18}\ cm$$

$$\frac{\ell}{\lambda} = \frac{28\ cm}{38.\overline{18}\ cm} = 0.7\overline{3} \Rightarrow \ell = 0.7\overline{3}\lambda$$

capacitance per unit length = 95.238 pF/m

inductance per unit length = 238.095 nH/m

phase constant = 16.456 rad/m

wavelength = $38.\overline{18}$ cm

transmission line length (in terms of wavelength) = $0.7\overline{3}\lambda$

EE 381 Quiz #1 (Fall 2017)

Name Key B

Instructions: Closed book & notes. Place answers in indicated spaces and show all work for credit.

Useful equations: $u = f\lambda = \frac{\omega}{\beta} = \frac{1}{\sqrt{LC}}$, $LC = \mu\varepsilon$, $\beta = \omega\sqrt{LC} = \frac{\omega}{u}$, $\lambda = \frac{u}{f} = \frac{2\pi}{\beta}$, $Z_0 = \frac{V_0^+}{I_0^+} = \sqrt{\frac{L}{C}}$

A lossless 42 cm-long transmission line has a characteristic impedance of 50 Ω and velocity of propagation of 2.2×10^8 m/s. Determine the inductance and capacitance per unit length. If operated at 450 MHz, calculate the phase constant, wavelength, and length (in terms of wavelength) of the transmission line.

$$\frac{Z_0}{u} = \frac{\sqrt{L/C}}{1/\sqrt{LC}} = L = \frac{50}{2.2\times10^8} = 2.\overline{27}\times10^{-7}\ H/m$$

$$\frac{1}{uZ_0} = \frac{1}{\frac{1}{\sqrt{LC}}\sqrt{L/C}} = C = \frac{1}{50(2.2\times10^8)} = 9.\overline{09}\times10^{-11}\ F/m$$

$$\beta = \omega/u = \frac{2\pi(450\times10^6)}{2.2\times10^8} = 12.85197\ rad/m$$

$$\lambda = u/f = \frac{2.2\times10^8}{450\times10^6} = 0.4\overline{8}\ m = 48.\overline{88}\ cm$$

$$\frac{\ell}{\lambda} = \frac{42\ cm}{48.\overline{88}\ cm} = 0.85909\overline{09} \Rightarrow \ell = 0.85909\overline{09}\,\lambda$$

capacitance per unit length = $90.\overline{90}$ pF/m phase constant = 12.852 rad/m

inductance per unit length = $227.\overline{27}$ nH/m wavelength = $48.\overline{88}$ cm

transmission line length (in terms of wavelength) = 0.8591λ