2.1 A 75 Ω coaxial line has a current $i(t, z) = 1.8\cos(3.77 \times 10^9\, t - 18.13z)$ mA. Determine (a) the frequency, (b) the phase velocity, (c) the wavelength, (d) the relative permittivity of the line, (e) the phasor form of the current, and (f) the time domain voltage on the line.

a) From the equation of $i(t,z)$, we get

$$\omega = 3.77 \times 10^9 \text{ rad/s}$$

$$f = \omega/2\pi = \frac{3.77 \times 10^9}{2\pi} \Rightarrow \underline{f = 600.01 \text{ MHz}}$$

b) From $i(t,z)$, we see $\beta = 18.13$ rad/m

$$v_p = \frac{\omega}{\beta} = \frac{3.77 \times 10^9}{18.13} = \underline{2.0794 \times 10^8 \text{ m/s}}$$

c) $$\lambda = v_p/f = \frac{2\pi}{\beta} = \frac{2\pi}{18.13} = \underline{0.34656 \text{ m}}$$

d) For a lossless TL made w/ non-magnetic materials, $v_p = c/\sqrt{\epsilon_r} \Rightarrow \epsilon_r = (c/v_p)^2$

$$\epsilon_r = \left(\frac{2.9979 \times 10^8}{2.0794 \times 10^8}\right)^2 \Rightarrow \underline{\epsilon_r = 2.0785}$$

e) $$\underline{I(z) = 1.8\, e^{-j18.13z} \text{ mA}}$$

f) Since we only have a forward prop. wave,

$$V(z) = I(z)\, z_0 = 1.8\, e^{-j18.13z}(75) \times 10^{-3}$$
$$= 0.135\, e^{-j18.13z} \text{ V}$$

$$\Rightarrow \underline{v(t,z) = 0.135\cos(3.77 \times 10^9 t - 18.13z) \text{ V}}$$