A twin-lead transmission line, made with perfectly conducting wires of diameter 2 mm and a center-to-center spacing of 12 mm, is in a vacuum chamber. It is connected to a signal generator operating at 105.1 MHz. Find (a) the resistance per-unit-length *R*, inductance per-unit-length *L*, conductance per-unit-length *G* & capacitance-per-unit-length *C*, (b) phase constant β, (c) wavelength λ, (d) phase velocity, and (e) characteristic impedance Z_0 of the transmission line.

a) perfectly conducting $\Rightarrow \sigma_c \to \infty$.

From Table 11.1

$$R = \frac{1}{\pi a \delta \sigma_c} \xrightarrow{\sigma_c \to \infty} = 0$$

(vacuum)

$$L = \frac{\mu}{\pi} \cosh^{-1}\left(\frac{d}{2a}\right) = \frac{4\pi \times 10^{-7}}{\pi} \cosh^{-1}\left(\frac{12 \times 10^{-3}}{2 \times 10^{-3}}\right)$$

$$L = 0.991\ \mu H/m = 991.1555\ nH/m$$

$$G = \frac{\pi \sigma}{\cosh^{-1}(d/2a)} \xrightarrow{\sigma \to 0 \text{ (vacuum)}} = 0$$

$$C = \frac{\pi \epsilon}{\cosh^{-1}(d/2a)} = \frac{\pi (8.95412 \times 10^{-12})}{\cosh^{-1}\left(\frac{12 \times 10^{-3}}{2 \times 10^{-3}}\right)}$$

$$C = 11.2257\ pF/m$$

b) (11.21a) $\beta = \omega\sqrt{LC}$

$$= 2\pi (105.1 \times 10^6)\sqrt{991.2 \times 10^{-9} (11.23 \times 10^{-12})}$$

$$\beta = 2.2027\ rad/m$$

c) $\lambda = \frac{2\pi}{\beta} = \frac{2\pi}{2.2027} = 2.8525\ m$

d) $u = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{991.2\times10^{-9}(11.23\times10^{-12})}}$ (11.21b)

$u = 2.9979\times10^{8}\ m/s$

e) (11.21c) $z_0 = \sqrt{\frac{L}{C}} = \sqrt{\frac{991.2\times10^{-9}}{11.23\times10^{-12}}}$

$z_0 = 297.142\ \Omega$