11.17 A distortionless line operating at 120 MHz has $R = 20\ \Omega/\text{m}$, $L = 0.3\ \mu\text{H/m}$, and $C = 63\ \text{pF/m}$. (a) Determine γ, u, and Z_o. (b) How far will a voltage wave travel before it is reduced to 20% of its initial magnitude? (c) How far will it travel to suffer a 45° phase shift?

a) (11.22) $G = \frac{RC}{L} = \frac{(20)63\times10^{-12}}{0.3\times10^{-6}} = 0.0042\ \text{S/m}$

(11.11) $\gamma = \sqrt{(R+j\omega L)(G+j\omega C)} = \sqrt{(20+j2\pi(120\times10^6)0.3\times10^{-6})(0.0042+j\omega\,63\times10^{-12})}$

$\gamma = 0.28983 + j3.2779\ \text{m}^{-1}$

(11.14) $u = \omega/\beta = \frac{2\pi(120\times10^6)}{3.2779} = 2.3002\times10^8\ \text{m/s}$

$Z_o = \sqrt{L/C} = 69\ \Omega$ (11.23b)

b) $e^{-\alpha d} = 0.20$ (exponential decay term)

$d = -\frac{1}{\alpha}\ln 0.2 = -\frac{1}{0.28983}\ln 0.2$

$d = 5.55\ \text{m}$

c) $\beta d = 45°$ or $\pi/4$ (phase shift term)

$d = \frac{\pi/4}{3.2779} = 0.2396\ \text{m}$