Solution to Quiz 1

Part 1.

$$\gamma = \sqrt{(R' + j\omega L')(G' + j\omega C')}$$

$$= \sqrt{R'G'\left(1 + j\omega \frac{L'}{R'}\right)\left(1 + j\omega \frac{C'}{G'}\right)} \qquad \text{but } \frac{L'}{R'} = \frac{C'}{G'}$$

$$= \sqrt{R'G'\left(1 + j\omega \frac{C'}{G'}\right)^2}$$

$$= \left(1 + j\omega \frac{C'}{G'}\right)\sqrt{R'G'} = \alpha + j\beta$$

$$\alpha = \sqrt{R'G'} \quad , \quad \beta = \omega\sqrt{L'C'}$$

$$u_p = \omega/\beta = \frac{1}{\sqrt{L'C'}}$$

α and u_p are both independent of ω, line is distortionless.

Part 2

$$\frac{L'}{R'} = \frac{C'}{G'} \Rightarrow R'C' = G'L' \quad \text{or} \quad G' = \frac{R'C'}{L'}$$

$$Z_0 = \sqrt{\frac{(R' + j\omega L')}{(G' + j\omega C')}} = \sqrt{\frac{R'}{G'}\frac{(1 + j\omega L'/R')}{(1 + j\omega C'/G')}} = \sqrt{\frac{R'}{G'}} = \sqrt{\frac{L'}{C'}}$$

$$\alpha = \sqrt{R'G'} = R'\sqrt{\frac{L'}{C'}} = R'/Z_0 \Rightarrow R' = \alpha Z_0 = 20\times10^{-3}\cdot 60 = 1.2\ \frac{\Omega}{m}$$

$$Z_0 = \sqrt{L'/C'} \quad \text{and} \quad u_p = \omega/\beta = \frac{1}{\sqrt{L'C'}}$$

$$L' = Z_0/u_p = \frac{60}{0.6(3\times10^8)} = 333\ \frac{nH}{m}$$

$$G' = \frac{\alpha^2}{R'} = \frac{400\times10^{-6}}{1.2} = 333\ \frac{\mu S}{m}$$

$$u_p Z_0 = \frac{1}{C'}$$

$$C' = 1/u_p Z_0 = \frac{1}{0.6(3\times10^8)\cdot 60} = 92.59\ \frac{pF}{m}$$