Problem 2.14 For a distortionless line [see Problem 2.13] with $Z_0 = 50\ \Omega$, $\alpha = 20$ (mNp/m), $u_{\rm p} = 2.5 \times 10^8$ (m/s), find the line parameters and λ at 100 MHz.

Solution: The product of the expressions for α and Z_0 given in Problem 2.6 gives

$$R' = \alpha Z_0 = 20 \times 10^{-3} \times 50 = 1 \quad (\Omega/\text{m}),$$

and taking the ratio of the expression for Z_0 to that for $u_{\rm p} = \omega/\beta = 1/\sqrt{L'C'}$ gives

$$L' = \frac{Z_0}{u_{\rm p}} = \frac{50}{2.5 \times 10^8} = 2 \times 10^{-7}\ (\text{H/m}) = 200 \quad (\text{nH/m}).$$

With L' known, we use the expression for Z_0 to find C':

$$C' = \frac{L'}{Z_0^2} = \frac{2 \times 10^{-7}}{(50)^2} = 8 \times 10^{-11}\ (\text{F/m}) = 80 \quad (\text{pF/m}).$$

The distortionless condition given in Problem 2.6 is then used to find G'.

$$G' = \frac{R'C'}{L'} = \frac{1 \times 80 \times 10^{-12}}{2 \times 10^{-7}} = 4 \times 10^{-4}\ (\text{S/m}) = 400 \quad (\mu\text{S/m}),$$

and the wavelength is obtained by applying the relation

$$\lambda = \frac{\mu_{\rm p}}{f} = \frac{2.5 \times 10^8}{100 \times 10^6} = 2.5\ \text{m}.$$