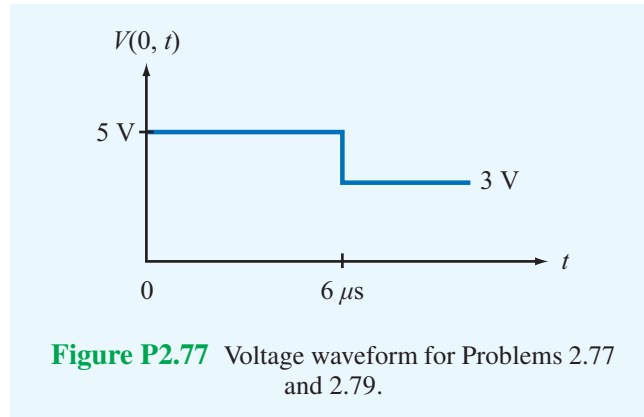


2.77 In response to a step voltage, the voltage waveform shown in Fig. P2.77 was observed at the sending end of a lossless transmission line with $R_g = 50 \Omega$, $Z_0 = 50 \Omega$, and $\epsilon_r = 2.25$. Determine the following:

- (a) The generator voltage.
- (b) The length of the line.
- (c) The load impedance.



Solution:

- (a) From the figure, $V_1^+ = 5 \text{ V}$. Applying Eq. (2.149b),

$$V_1^+ = \frac{V_g Z_0}{R_g + Z_0} = \frac{V_g Z_0}{Z_0 + Z_0} = \frac{V_g}{2},$$

which gives $V_g = 2V_1^+ = 10 \text{ V}$.

- (b) $u_p = \frac{c}{\sqrt{\epsilon_r}} = \frac{3 \times 10^8}{\sqrt{2.25}} = 2 \times 10^8 \text{ m/s}$. The first change in the waveform occurs at $\Delta t = 6 \mu\text{s}$. But $\Delta t = 2l/u_p$. Hence,

$$l = \frac{\Delta t u_p}{2} = \frac{6 \times 10^{-6}}{2} \times 2 \times 10^8 = 600 \text{ m}.$$

- (c) Since $R_g = Z_0$, $\Gamma_g = 0$. Hence $V_2^+ = 0$ and the change in level from 5 V down to 3 V is due to $V_1^- = -2 \text{ V}$. But

$$V_1^- = \Gamma_L V_1^+, \quad \text{or} \quad \Gamma_L = \frac{V_1^-}{V_1^+} = \frac{-2}{5} = -0.4.$$

From

$$Z_L = Z_0 \left(\frac{1 + \Gamma_L}{1 - \Gamma_L} \right) = 50 \left(\frac{1 - 0.4}{1 + 0.4} \right) = 21.43 \Omega.$$