

2.80 A generator circuit with $V_g = 200 \text{ V}$ and $R_g = 25 \Omega$ was used to excite a 75Ω lossless line with a rectangular pulse of duration $\tau = 0.4 \mu\text{s}$. The line is 200 m long, its $u_p = 2 \times 10^8 \text{ m/s}$, and it is terminated in a load $R_L = 125 \Omega$.

- (a) Synthesize the voltage pulse exciting the line as the sum of two step functions, $V_{g_1}(t)$ and $V_{g_2}(t)$.
- (b) For each voltage step function, generate a bounce diagram for the voltage on the line.
- (c) Use the bounce diagrams to plot the total voltage at the sending end of the line.

Solution:

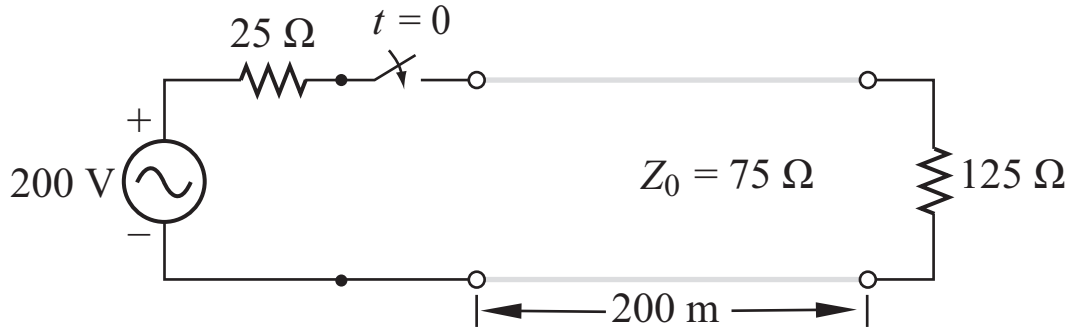


Figure P2.80 (a) Circuit for Problem 2.80.

- (a) pulse length = $0.4 \mu\text{s}$.

$$V_g(t) = V_{g_1}(t) + V_{g_2}(t),$$

with

$$V_{g_1}(t) = 200U(t) \quad (\text{V}),$$

$$V_{g_2}(t) = -200U(t - 0.4 \mu\text{s}) \quad (\text{V}).$$

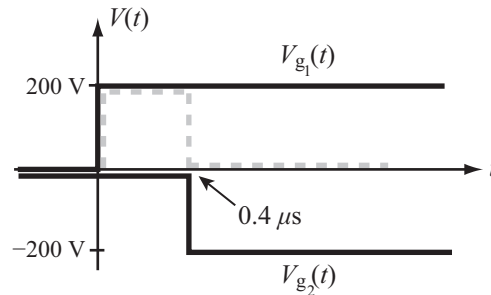


Figure P2.80 (b) Solution of part (a).

(b)

$$T = \frac{l}{u_p} = \frac{200}{2 \times 10^8} = 1 \mu s.$$

We will divide the problem into two parts, one for $V_{g_1}(t)$ and another for $V_{g_2}(t)$ and then we will use superposition to determine the solution for the sum. The solution for $V_{g_2}(t)$ will mimic the solution for $V_{g_1}(t)$, except for a reversal in sign and a delay by $0.4 \mu s$.

For $V_{g_1}(t) = 200U(t)$:

$$\Gamma_g = \frac{R_g - Z_0}{R_g + Z_0} = \frac{25 - 75}{25 + 75} = -0.5,$$

$$\Gamma_L = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{125 - 75}{125 + 75} = 0.25,$$

$$V_1^+ = \frac{V_1 Z_0}{R_g + Z_0} = \frac{200 \times 75}{25 + 75} = 150 \text{ V},$$

$$V_\infty = \frac{V_g Z_L}{R_g + Z_L} = \frac{200 \times 125}{25 + 125} = 166.67 \text{ V}.$$

(i) $V_1(0, t)$ at sending end due to $V_{g_1}(t)$:

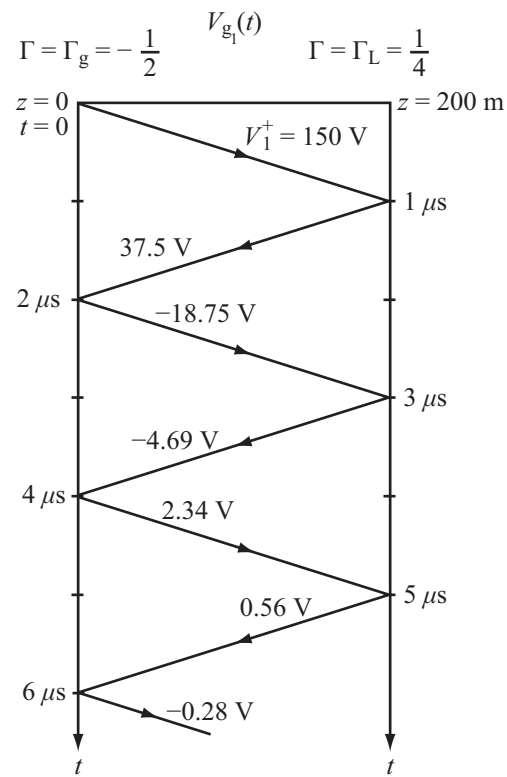


Figure P2.80 (c) Bounce diagram for voltage in reaction to $V_{g_1}(t)$.

(ii) $V_2(0, t)$ at sending end due to $V_{g_2}(t)$:

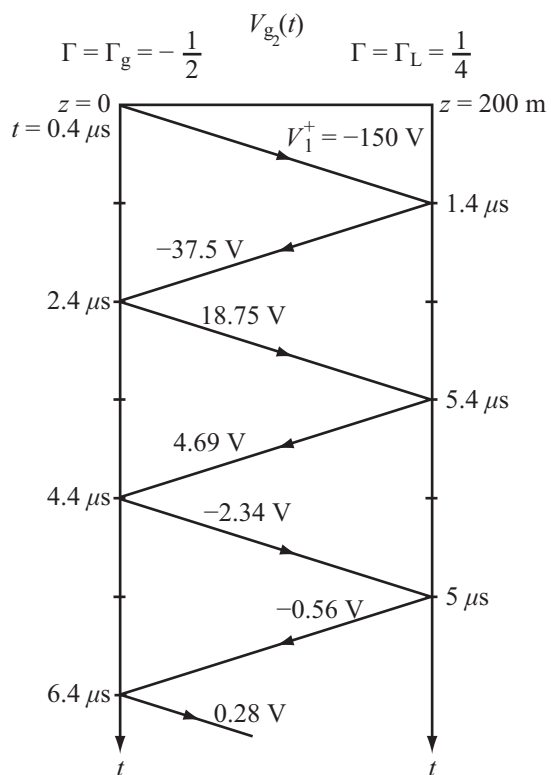


Figure P2.80 (d) Bounce diagram for voltage in reaction to $V_{g_2}(t)$.

(b)

(i) $V_1(0, t)$ at sending end due to $V_{g_1}(t)$: see Fig. P2.80(e).

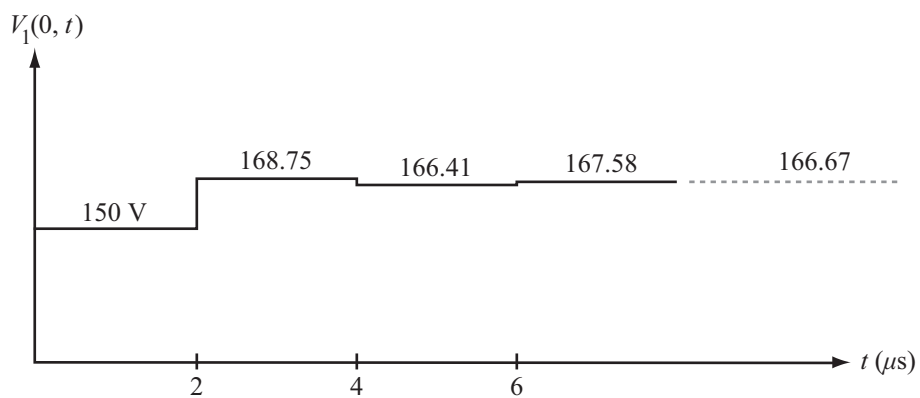


Figure P2.80 (e) $V_1(0, t)$.

(ii) $V_2(0, t)$ at sending end: see Fig. P2.80(f).

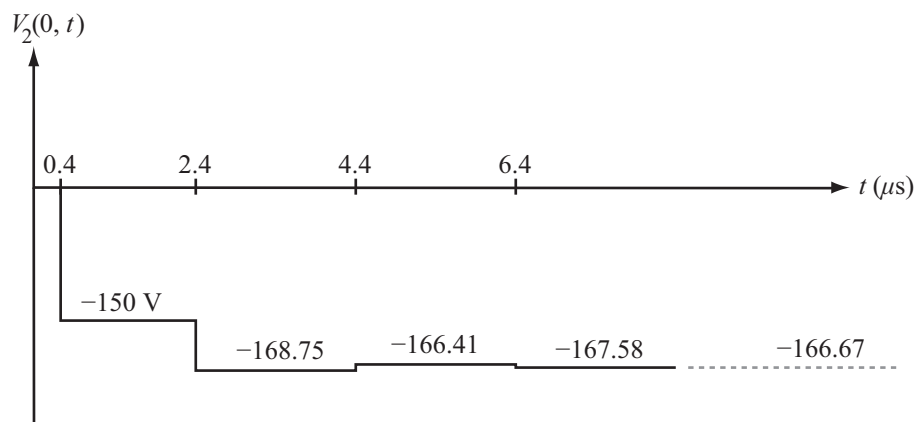


Figure P2.80 (f) $V_2(0, t)$.

(iii) Net voltage $V(0, t) = V_1(0, t) + V_2(0, t)$: see Fig. P2.80(g).

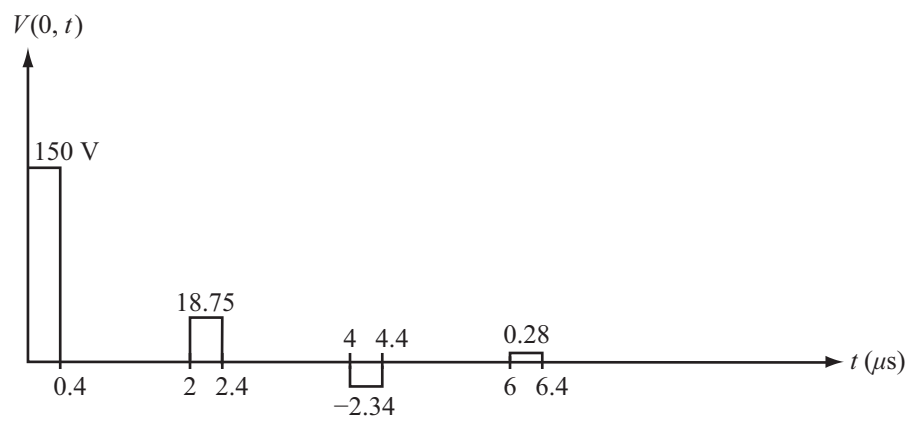


Figure P2.80: (g) Net voltage $V(0, t)$.