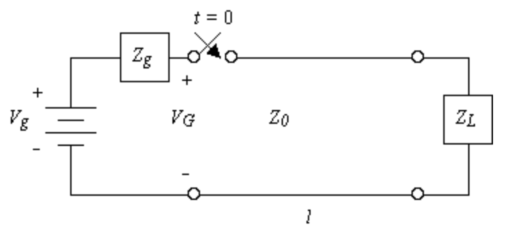
EE331—EXAMPLE #11: BOUNCE DIAGRAM

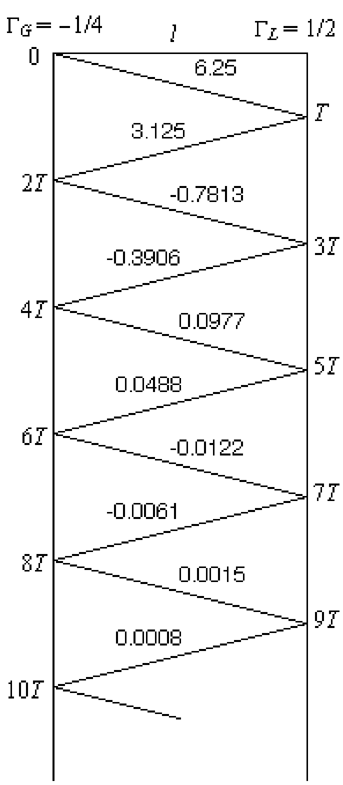
At $t = 0$ we flip the switch on a circuit with a real load of 150 Ω attached to a 50-Ω transmission line 300 m long. If our generator is a DC source of 10 V with a resistance of 30 Ω, and the wave velocity is 3×10^8 m/s, (a) use a bounce diagram to sketch the voltage at the load as a function of time for $0 \le t \le 10$ μs. (b) Find the steady-state voltage.

(a) First make a sketch of the transmission line and identify the quantities.



Find the period T, the reflections coefficients Γ_L and Γ_G, and V_1^+:

$$
\begin{aligned}
T &= \frac{l}{u} = \frac{300}{3\times10^8} = 10^{-6}\text{ s} = 1\ \mu\text{s} \\
\Gamma_L &= \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{150-50}{150+50} = \frac{1}{2} \\
\Gamma_G &= \frac{Z_g - Z_0}{Z_g + Z_0} = \frac{30-50}{30+50} = -\frac{1}{4} \\
V_1^+ &= \frac{Z_0}{Z_g + Z_0} V_g = \left(\frac{50}{30+50}\right) 10 = 6.25\text{ V}
\end{aligned}
$$



$$0 \le t < T: \quad V_L = 0$$

$$
\begin{aligned}
T \le t < 3T: \quad V_L &= V_1^+ + V_1^- \\
&= 6.25 + 3.125 = 9.375\text{ V}
\end{aligned}
$$

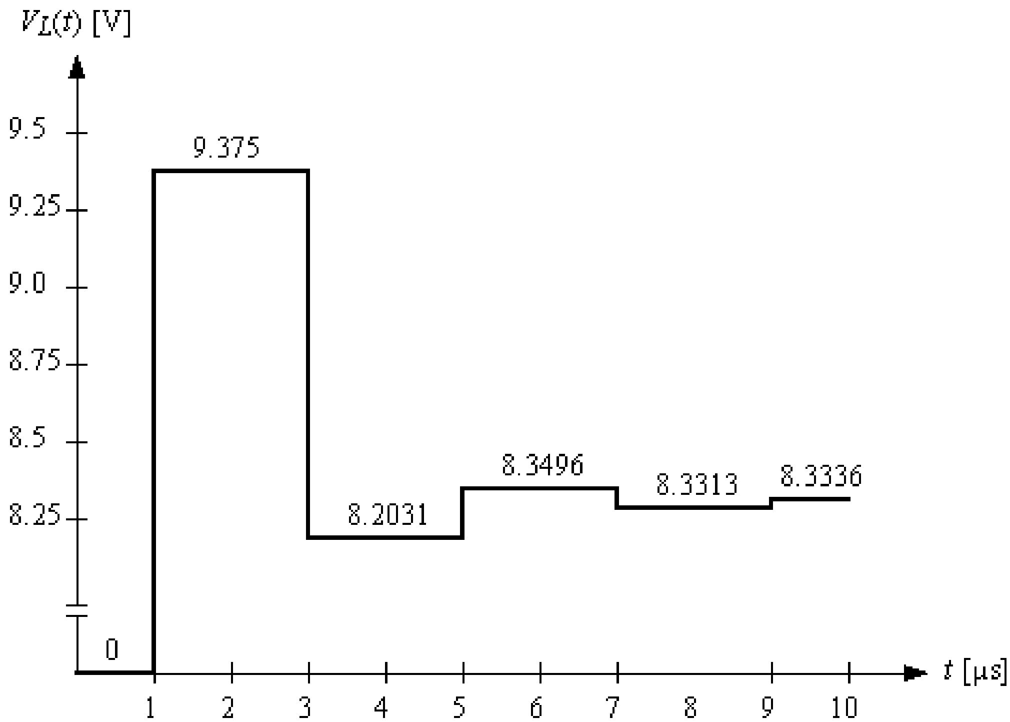
$$
\begin{aligned}
3T \le t < 5T: \quad V_L &= 9.375 + V_2^+ + V_2^- \\
&= 9.375 - 0.7813 - 0.3906 = 8.2031\text{ V}
\end{aligned}
$$

$$
\begin{aligned}
5T \le t < 7T: \quad V_L &= 8.2031 + V_3^+ + V_3^- \\
&= 8.2031 + 0.0977 + 0.0488 = 8.3496\text{ V}
\end{aligned}
$$

$$
\begin{aligned}
7T \le t < 9T: \quad V_L &= 8.3496 + V_4^+ + V_4^- \\
&= 8.3496 - 0.0122 - 0.0061 = 8.3313\text{ V}
\end{aligned}
$$

$$
\begin{aligned}
9T \le t < 11T: \quad V_L &= 8.3313 + V_5^+ + V_5^- \\
&= 8.3313 + 0.0015 + 0.0008 = 8.3336\text{ V}
\end{aligned}
$$

Now sketch $V_L(\mathrm{t})$:



(b) At steady state:

$$V_L = V_\infty = \frac{Z_L}{Z_g + Z_L} V_g = \left(\frac{150}{30 + 150} \right) 10 = 8.3333 \text{ V}$$