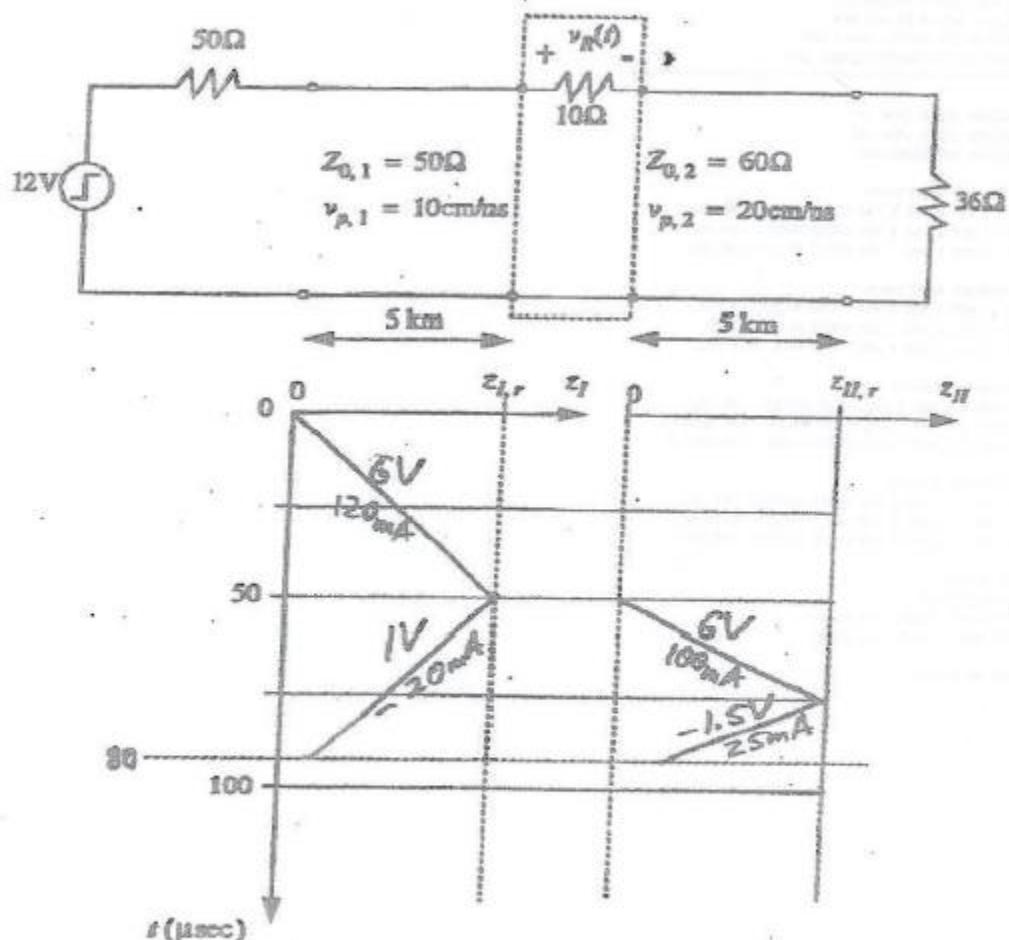


Two lossless transmission lines are connected in tandem through a series resistance, as shown below.



- (a) Determine the delay time of each line.

$$t_{r,I} = \frac{2l}{v_{p,1}} = \frac{5 \times 10^3 \text{ m}}{1 \times 10^8 \text{ m/s}} = \boxed{50 \mu\text{sec}}$$

$$\begin{aligned} t_{r,II} &= \frac{2l_2}{v_{p,2}} = \frac{5 \times 10^3}{2 \times 10^8} \\ &= \boxed{25 \mu\text{sec}} \end{aligned}$$

- (b) Determine the reflection coefficients at the source and load side (i.e., input of line 1 and end of line 2).

$$S_G = 0 \quad (\text{matched})$$

$$S_T = \frac{36 - 60}{36 + 60} = -\frac{24}{96} = \boxed{-\frac{1}{4}}$$

- (c) Determine the reflection and transmission coefficients ($\rho_{11}, \rho_{22}, \rho_{12}, \rho_{21}$) at the connection network between the two lines.

$$S_{11}: \quad \begin{array}{c} \text{---} \\ | \\ \text{---} \end{array} \xrightarrow[60\Omega]{m} \begin{array}{c} \text{---} \\ | \\ \text{---} \end{array} \quad S_{11} = \frac{70 - 50}{70 + 50} = \frac{20}{120} = \boxed{\frac{1}{6}}$$

$$S_{22}: \quad \begin{array}{c} \text{---} \\ | \\ \text{---} \end{array} \xrightarrow[50\Omega]{m} \begin{array}{c} \text{---} \\ | \\ \text{---} \end{array} \quad S_{22} = 0 \quad (\text{matched})$$

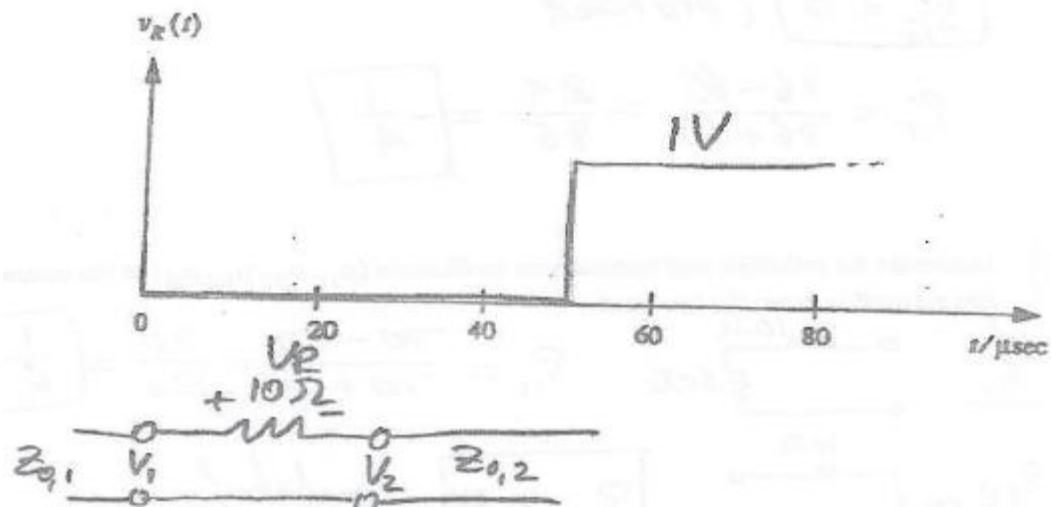
$$\frac{S_{21}}{V_{q1}^I(1+S_{11})} = \frac{10}{60} V_{q1}^{II} \quad V_{q1}^{II} = \frac{60}{70} V_{q1}^I (1 + S_{11}) = V_{q1}^I \frac{6}{7} \frac{7}{6} : \\ \Rightarrow S_{21} = \frac{V_{q1}^{II}}{V_{q1}^I} = \boxed{1}$$

$$S_{12}: \quad \begin{array}{c} \text{---} \\ | \\ \text{---} \end{array} \xrightarrow[50\Omega]{m} \begin{array}{c} \text{---} \\ | \\ \text{---} \end{array} \quad V_{q2}(1+S_{22}) \quad V_{q1} = \frac{50}{60} V_{q2}(1+S_{22}) \\ \Rightarrow S_{12} = \frac{V_{q1}}{V_{q2}} = \boxed{\frac{5}{6}}$$

- (d) Complete the lattice diagram for $t \leq 80 \mu\text{sec}$, and add the numerical voltage and current values for the individual wave components.

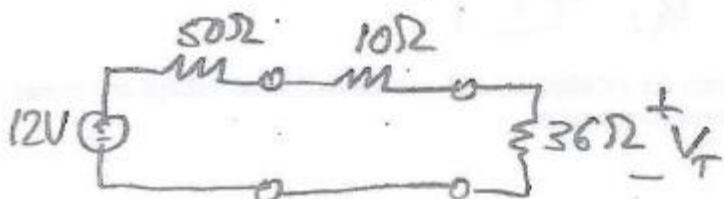
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- (e) Sketch the voltage across the 10Ω series resistance as a function of time for $t \leq 80\mu\text{sec}$.



$$\text{from lattice diagram: } \left. \begin{array}{l} V_1 = 7V \\ V_2 = 6V \end{array} \right\} \Rightarrow V_T = 13V$$

- (f) What is the steady-state voltage across the 36Ω load resistor?



$$V_T = 12V \frac{36}{50+10+36} = 12V \frac{36}{96} = \boxed{4.5V}$$