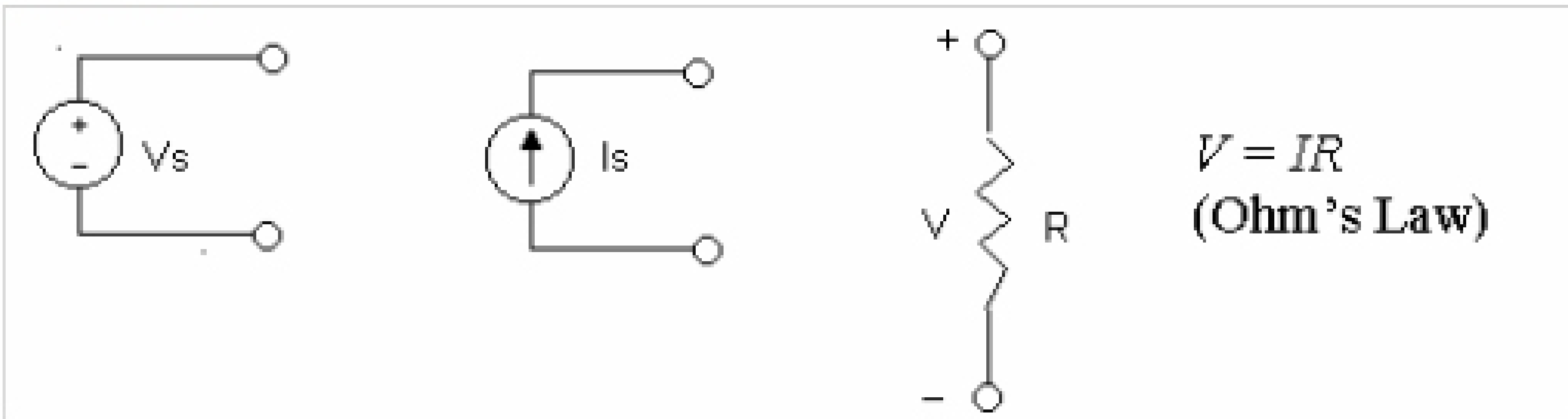
# Applications of the Laplace Transform

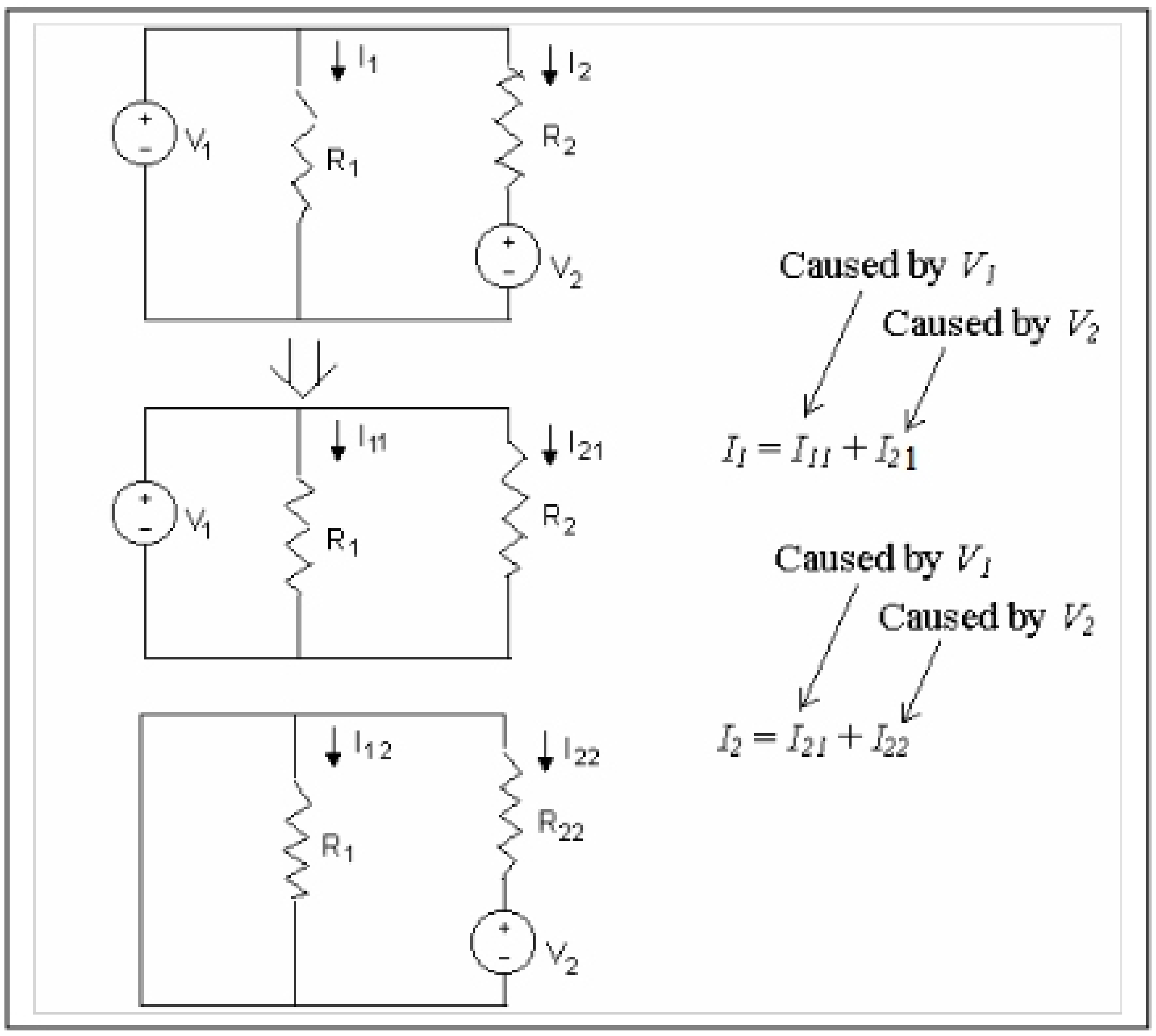
## Application in Circuit Analysis

1. Review of Resistive Network

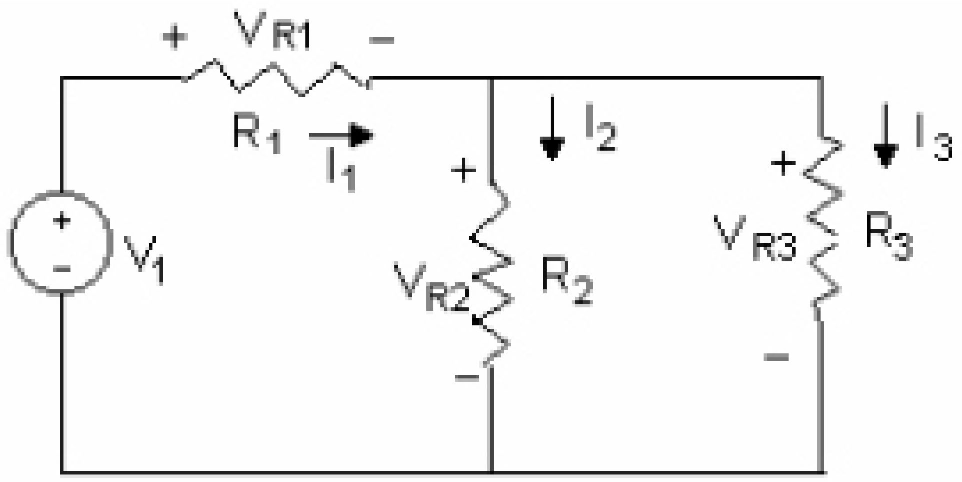
1) Elements




2) Superposition



3) KVL and KCL – Select a node for ground. Watch out for signs!



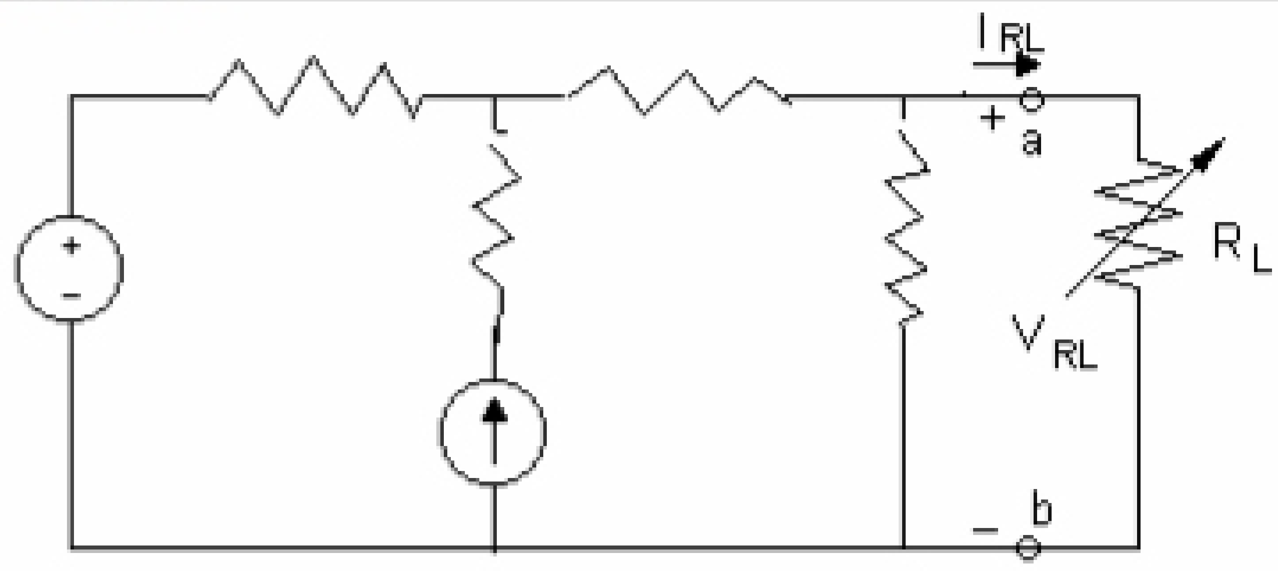

KVL: $V_1 = V_{R1} + V_{R2}$

$V_1 = V_{R1} + V_{R3}$

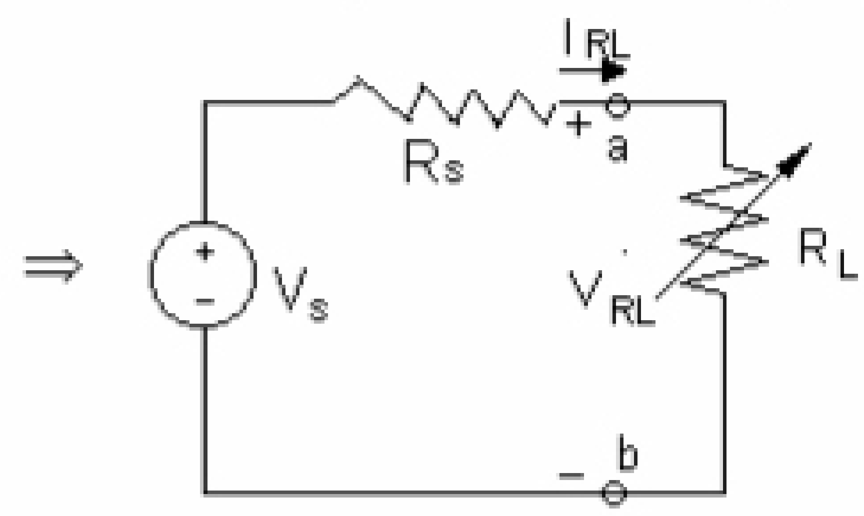
$V_{R2} = V_{R3}$

KCL: $I_1 = I_2 + I_3$

4) Equivalent Circuits



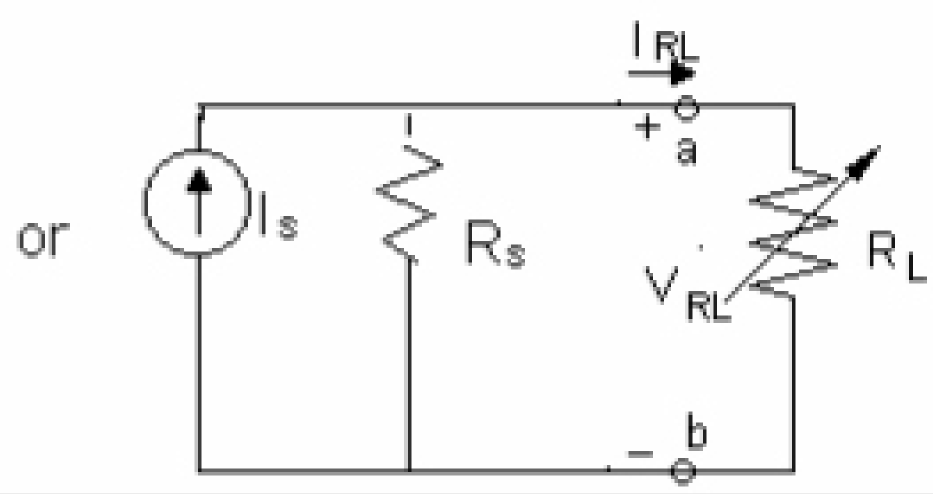

Thevenin Equivalent Circuit




$V_s = V_{OC}$ = Open Circuit Voltage

$R_s$ = Equivalent Resistance

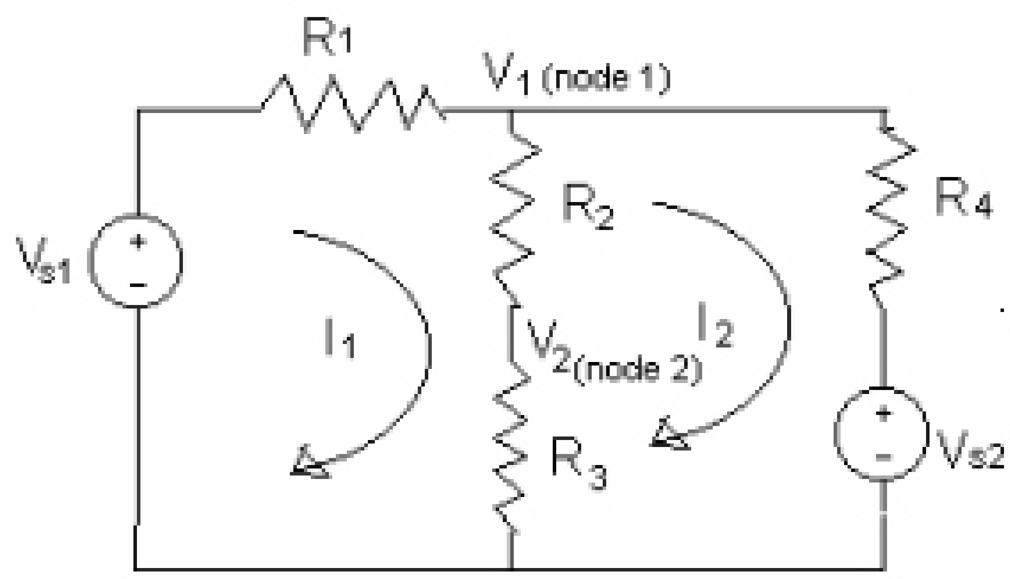
Norton Equivalent Circuit




$I_s = I_{SC}$ = Short Circuit Current

$R_s$ = Same as before

5) Nodal Analysis and Mesh Analysis




**Nodal Analysis** (Use KCL)

$$\begin{cases} \dfrac{V_{S1}-V_1}{R_1}+\dfrac{V_2-V_1}{R_2}+\dfrac{V_{S2}-V_1}{R_4}=0 \\ \dfrac{V_1-V_2}{R_2}+\dfrac{0-V_2}{R_3}=0 \end{cases}$$

**Solve for $V_1$ and $V_2$ and then calculate other currents and voltages.**

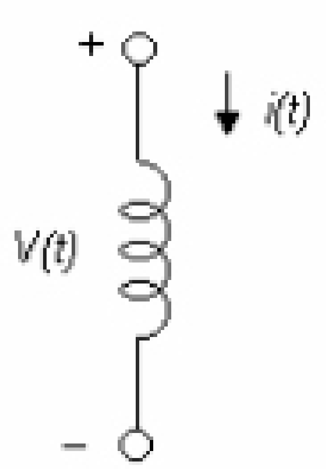
Mesh analysis (use KVL)

$$\begin{cases} V_{S1}=R_1I_1+R_2(I_1-I_2)+R_3(I_1-I_2) \\ V_{S1}=R_1I_1+R_4I_2+V_{S2} \end{cases}$$

Solve for $I_1$ and $I_2$.

2. <u>Characteristics of Dynamic Networks</u>

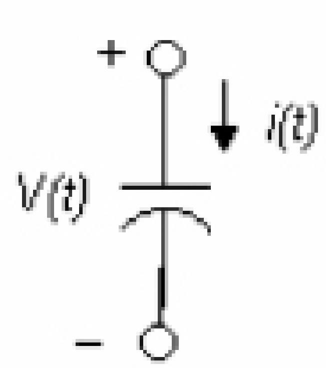
1) Inductor




$$v_L(t)=L\frac{d}{dt}i_L(t)$$

$$\text{or }\; i_L(t)=\frac{1}{L}\int_{-\infty}^{t}v_L(\tau)d\tau$$

2) Capacitor




$$i_C(t)=C\frac{d}{dt}v_C(t)$$

$$\text{or }\; v_C(t)=\frac{1}{C}\int_{-\infty}^{t}i_C(\tau)d\tau$$