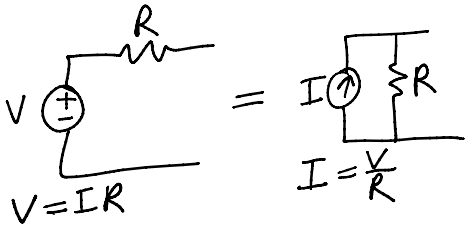
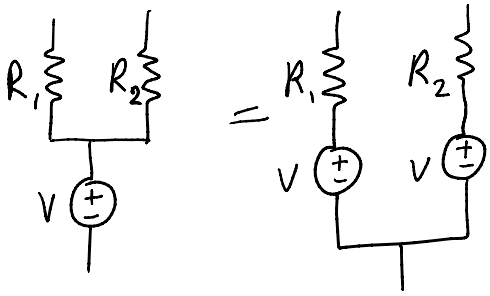
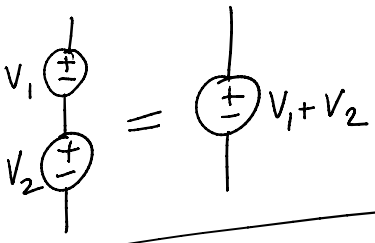
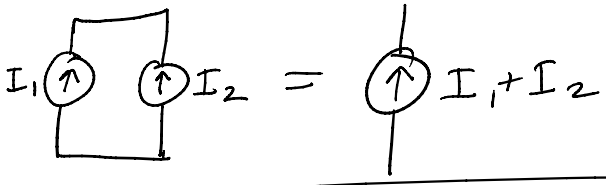
Discussion 2 Notes

Sunday, April 10, 2022 10:33 PM

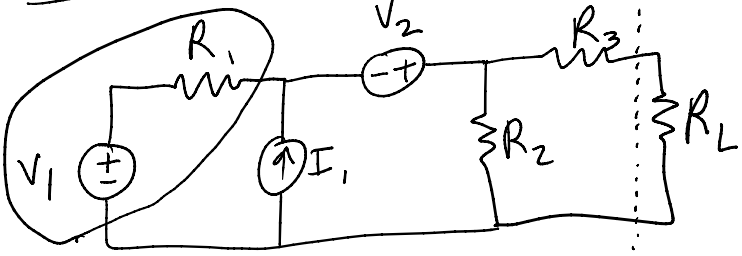


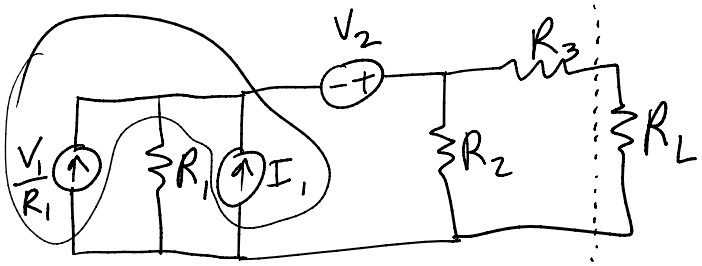


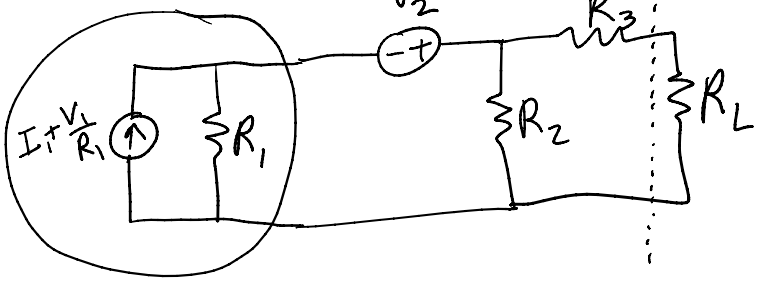


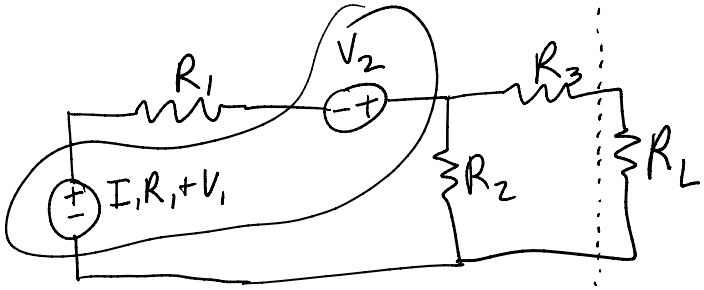


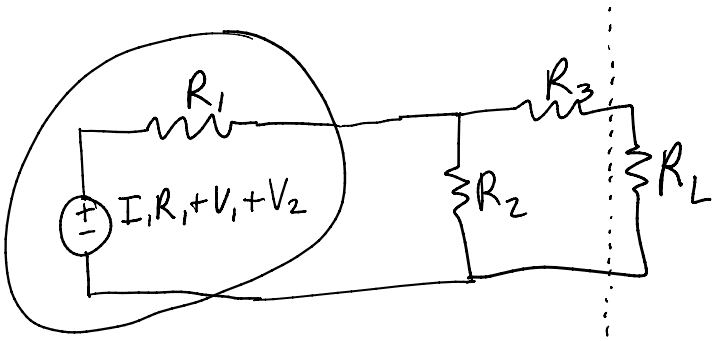
Example

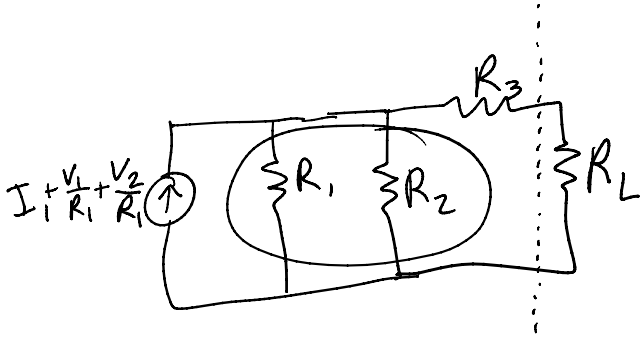


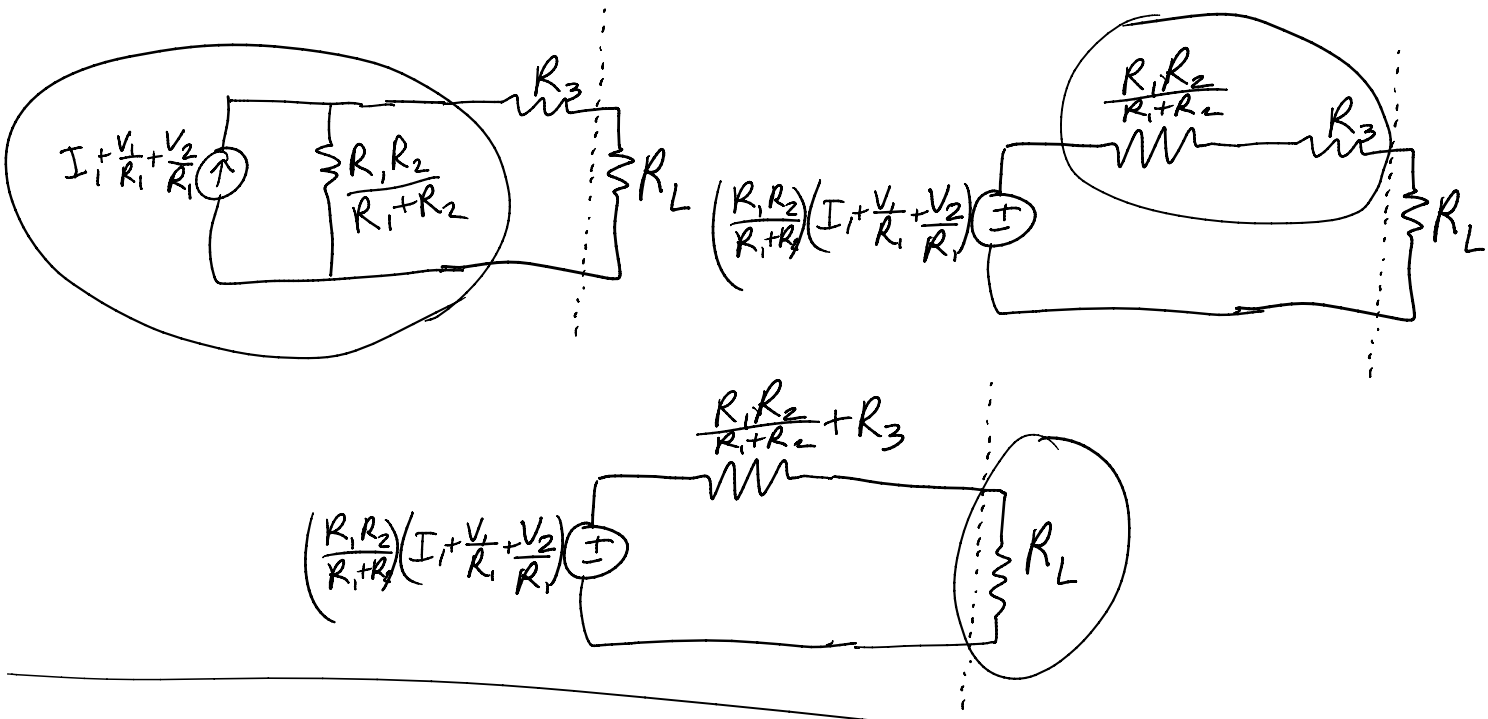


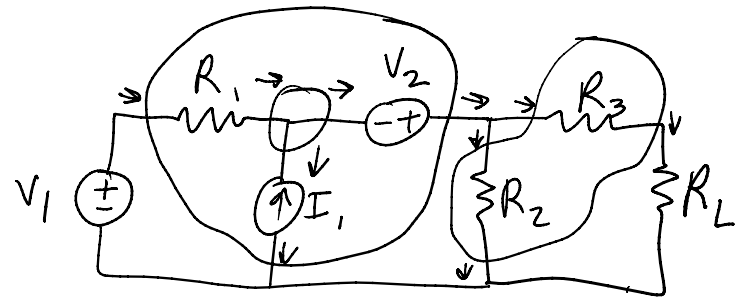




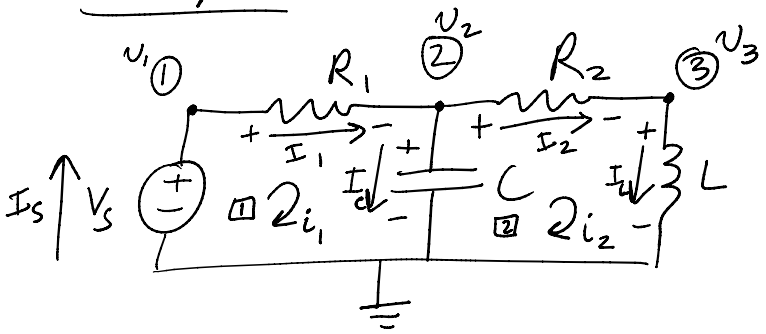








Example:



KVL:

1. $V_S = I_1 R_1 + \frac{1}{C}\int I_C dt$
2. $\frac{1}{C}\int I_C dt = I_2 R_2 + L\frac{dI_L}{dt}$

KCL:

1. $I_S = \frac{V_1}{R_1}$
2. $\frac{V_1}{R_1} = \frac{V_2}{R_2} + C\frac{dV_C}{dt}$
3. $\frac{V_2}{R_2} = \frac{1}{L}\int V_L dt$

$I_C = C\frac{dV_C}{dt}$ $\quad V_L = L\frac{dI_L}{dt}$

$\frac{1}{C}\int I_C dt = V_C$ $\quad \frac{1}{L}\int V_L dt = I_L$

$$I_C = i_1 - i_2$$

KVL:

1. $V_S = I_1 R_1 + \frac{1}{C}\int I_C dt \rightarrow V_S = i_1 R_1 + \frac{1}{C}\int i_1 - i_2 dt$
2. $\frac{1}{C}\int I_C dt = I_2 R_2 + L\frac{dI_2}{dt} \rightarrow 0 = i_2 R_2 + L\frac{di_2}{dt} - \frac{1}{C}\int i_1 - i_2 dt$

Mesh Current Analysis

$$\begin{bmatrix} V_S \\ 0 \end{bmatrix} = \begin{bmatrix} R_1 + \frac{1}{C}\int dt & -\frac{1}{C}\int dt \\ -\frac{1}{C}\int dt & R_2 + L\frac{d}{dt} + \frac{1}{C}\int dt \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix}$$

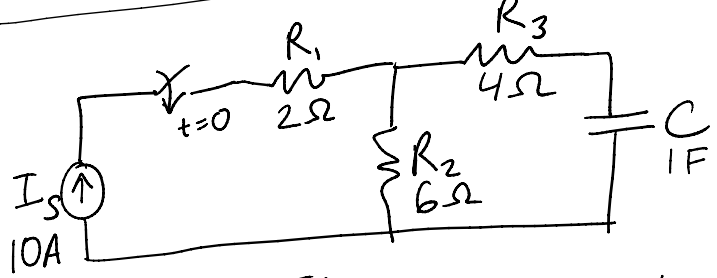
KCL:

1. $I_S = \frac{V_1}{R_1} \rightarrow I_S = \frac{v_1 - v_2}{R_1}$
2. $\frac{V_1}{R_1} = \frac{V_2}{R_2} + C\frac{dV_C}{dt} \rightarrow 0 = -\frac{v_1 - v_2}{R_1} + \frac{v_2 - v_3}{R_2} + C\frac{dv_2}{dt}$
3. $\frac{V_2}{R_2} = \frac{1}{L}\int V_L dt \rightarrow 0 = -\frac{v_2 - v_3}{R_2} + \frac{1}{L}\int v_3 dt$

Node Voltage Analysis

$$\begin{bmatrix} I_S \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} \frac{1}{R_1} & -\frac{1}{R_1} & 0 \\ -\frac{1}{R_1} & \frac{1}{R_1} + \frac{1}{R_2} + C\frac{d}{dt} & -\frac{1}{R_2} \\ 0 & -\frac{1}{R_2} & \frac{1}{R_2} + \frac{1}{L}\int dt \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix}$$

Additional Problem

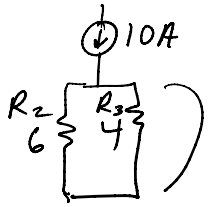


$V_{C0^+} = 0$

$V_{R_1 0^+} = 2 \cdot 10 = 20V$

$V_{R_2 0^+} = 4 \cdot 6 = 24V$

$V_{R_3 0^+} = 6 \cdot 4 = 24V$



$I_2 \cdot 6 = I_3 \cdot 4$

$I_2 = \frac{2}{3} I_3$

$I_2 + I_3 = 10$

$\frac{5}{3} I_3 = 10$

$I_3 = 6$

$I_2 = 4$

$t = t_1, I_2 = 5A$

$V_{C t1} = 10V$

$V_{R_1 t1} = 20V$

$V_{R_2 t1} = 30V$

$V_{R_3 t1} = 20V$

$t = t_2, I_3 = 1A$

$V_{C t2} = 50V$

$V_{R_1 t2} = 20V$

$V_{R_2 t2} = 9 \cdot 6 = 54V$

$V_{R_3 t2} = 4V$