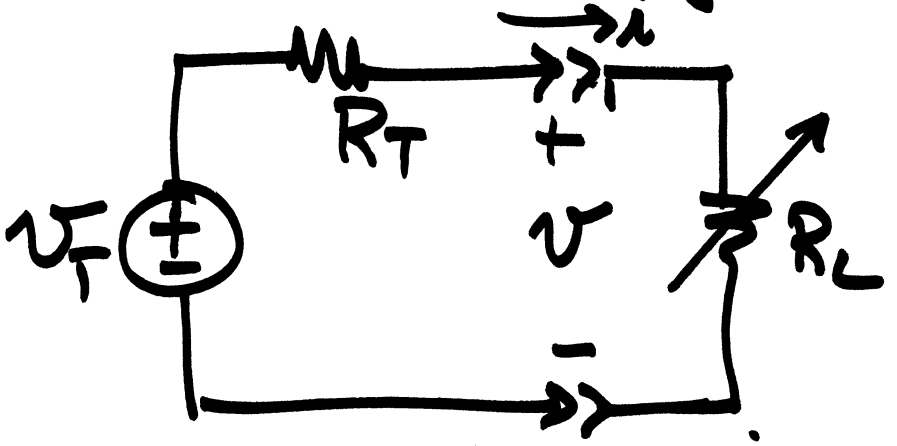
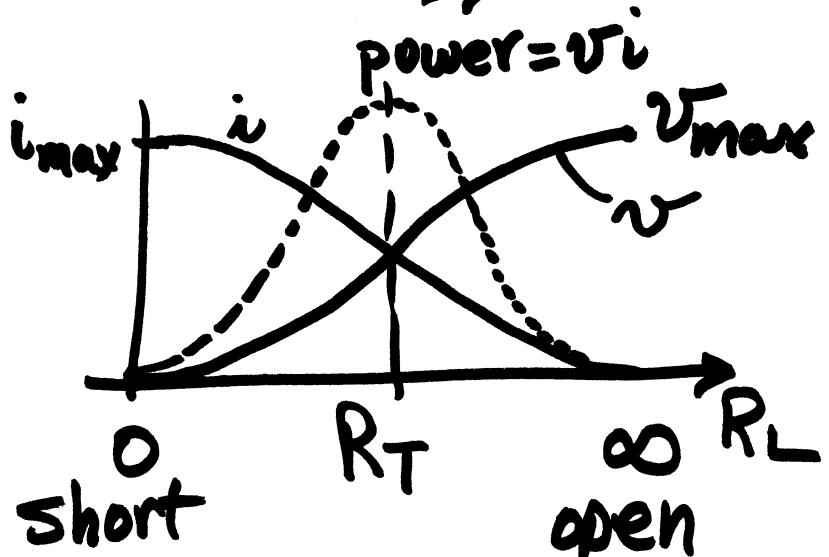
# 3.5 Maximum signal transfer




$$i = \frac{v_T}{R_T + R_L}$$




$$v = \frac{R_L}{R_T + R_L} v_T$$

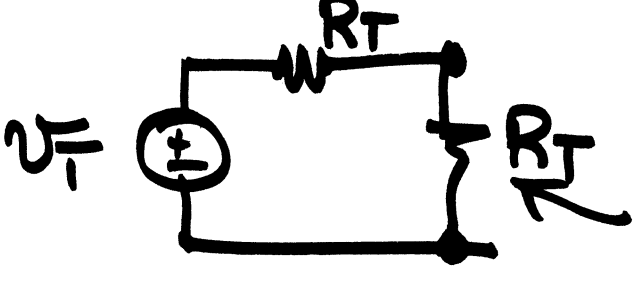
$$P = vi = \frac{R_L}{R_T + R_L} v_T \frac{v_T}{R_T + R_L} = \frac{R_L v_T^2}{(R_T + R_L)^2}$$

what $R_L$ maximizes P?

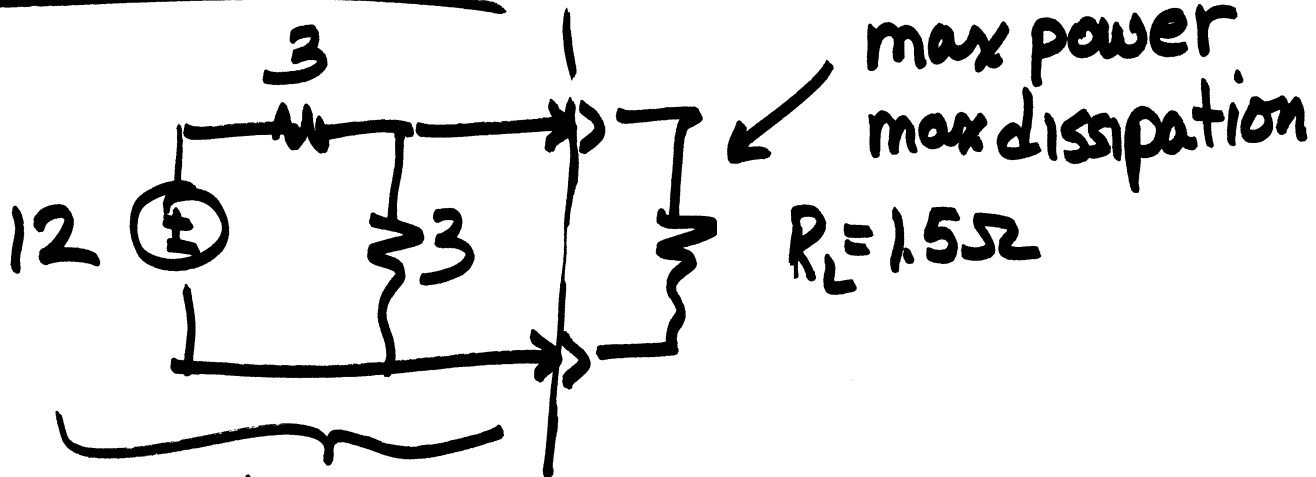
$$\frac{\partial P}{\partial R_L} = 0$$

$$\frac{v_T^2}{(R_T + R_L)^2} + \frac{R_L v_T^2 (-2)}{(R_T + R_L)^3} = 0$$

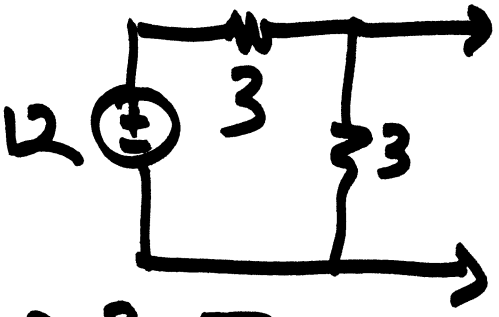
$$R_L = R_T$$



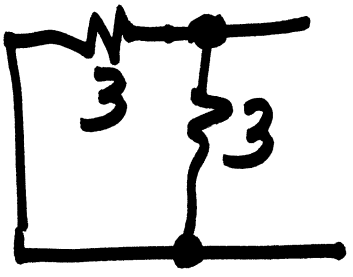
# Example




Thevenin's Theorem




Find $R_T$? Turn off all sources and compute $R_{EQ} = R_T$




$$R_{EQ} = \frac{3 \cdot 3}{3+3} = 1.5\Omega$$

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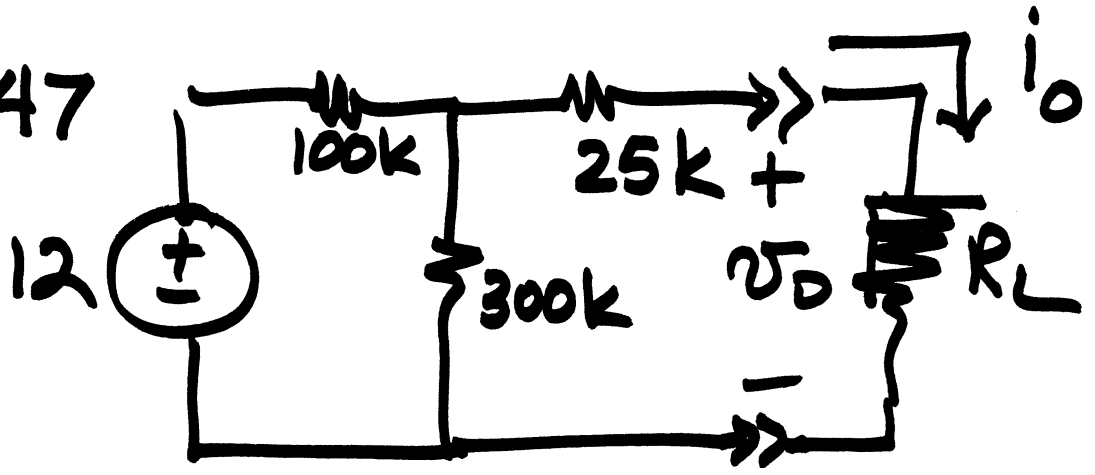
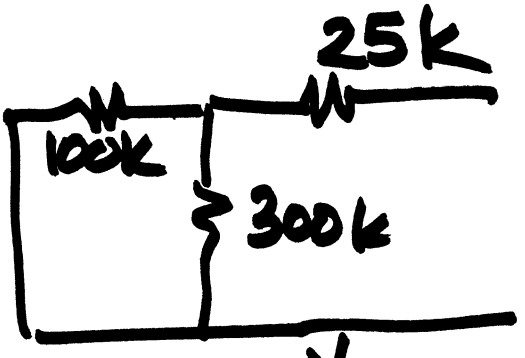
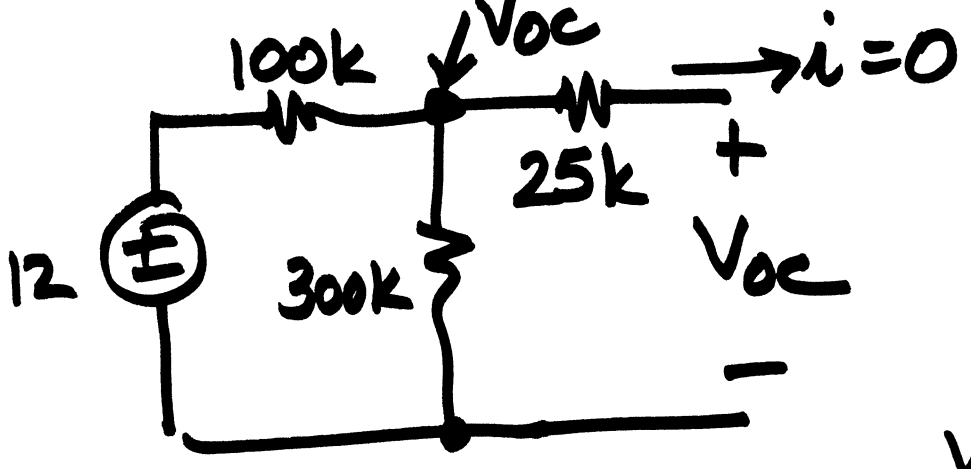


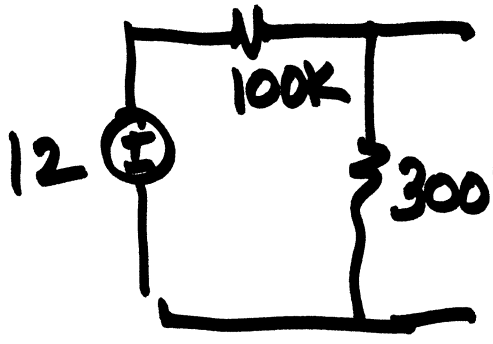

Thevenin equivalent circuit

$R_T$




$V_{oc}$:

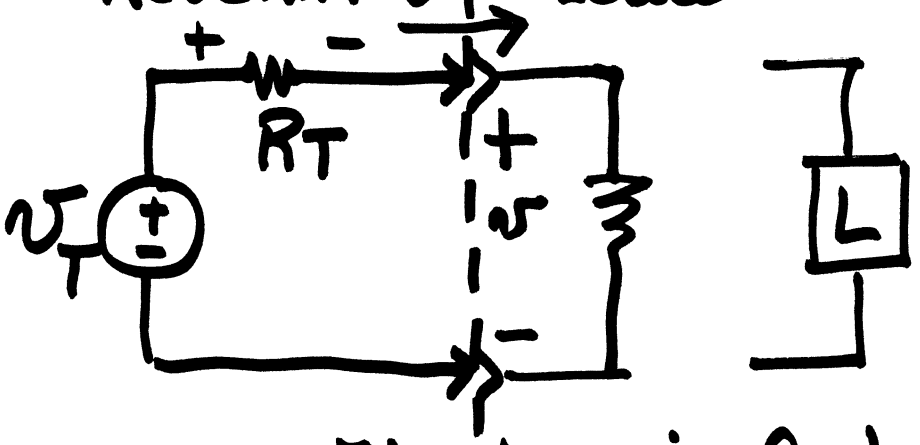



voltage divider

$V_{oc} = \frac{300k}{100k+300k} \cdot 12$

Thevenin



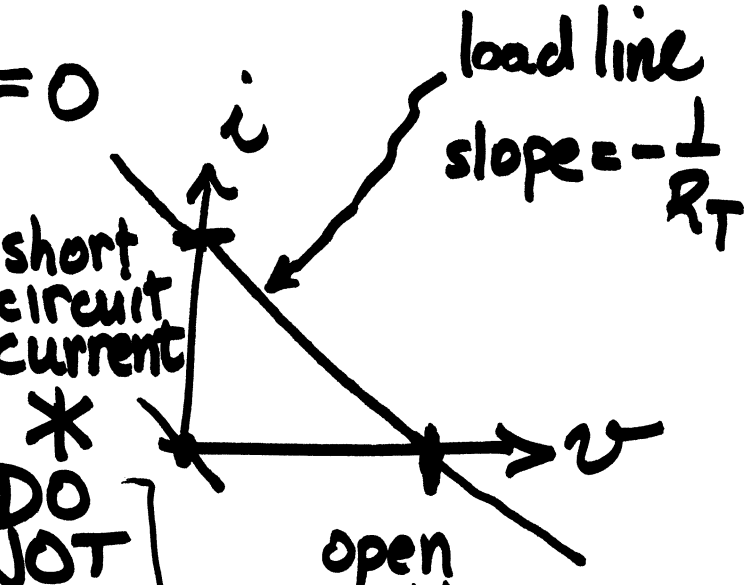

v, i, terminal characteristics

series circuit $\Rightarrow$ KVL

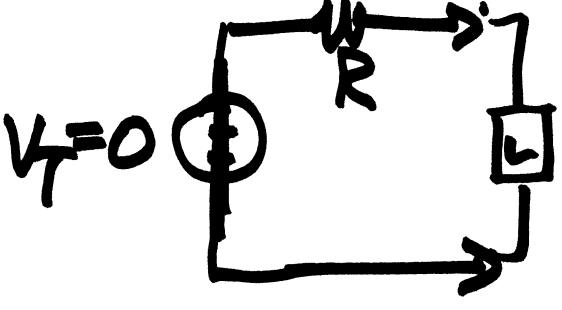
$$-v_T + iR_T + v = 0$$

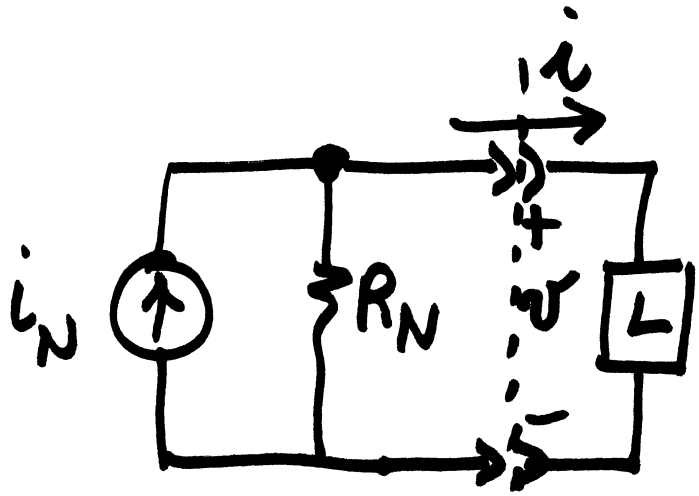
$$iR_T = v_T - v$$

$$i = \frac{v_T}{R_T} - \frac{1}{R_T} v$$




* DO NOT DO IN LAB

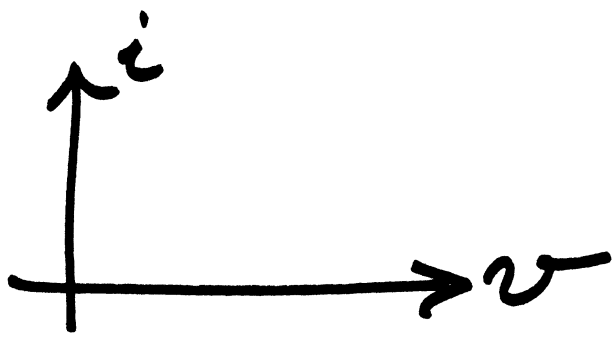





KCL

$$\sum i = 0$$

$$+i_N - \frac{v}{R_N} - i = 0$$




Norton:

$$i = i_N - \frac{v}{R_N}$$

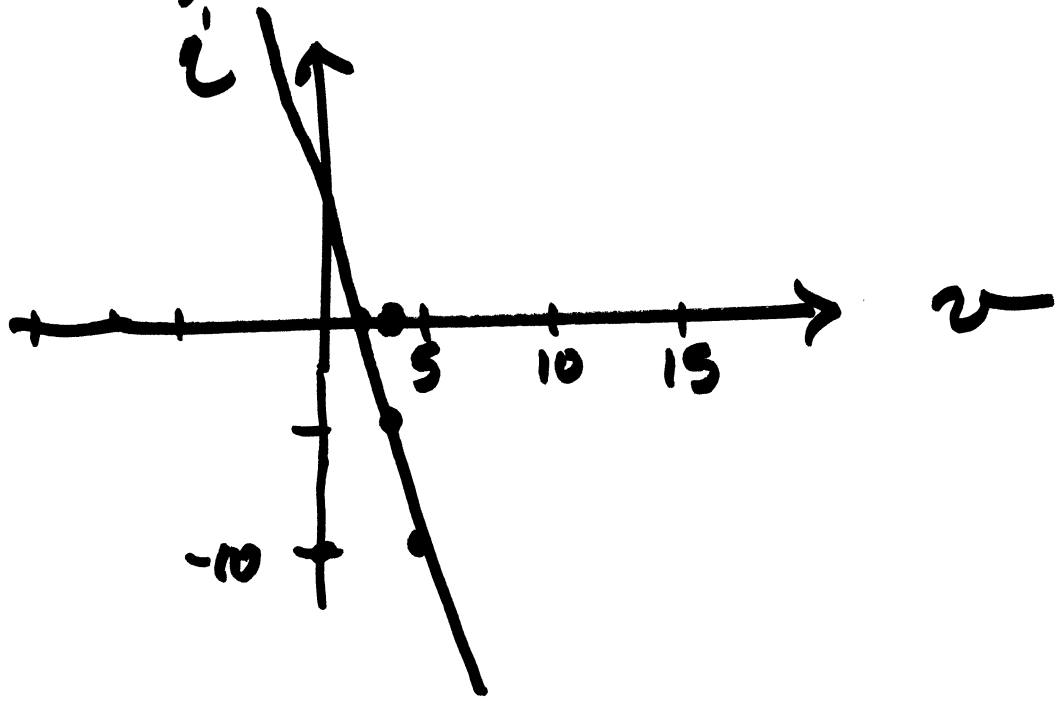
Thevenin:

$$i = \frac{v_T}{R_T} - \frac{v}{R_T}$$

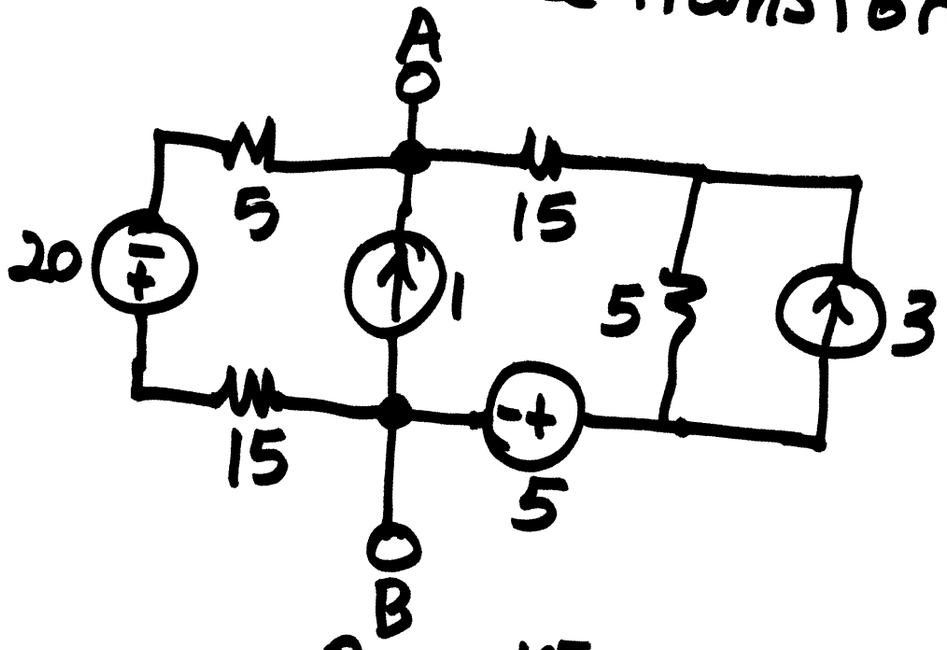
$$i_N = \frac{v_T}{R_T} \qquad R_T = R_N$$

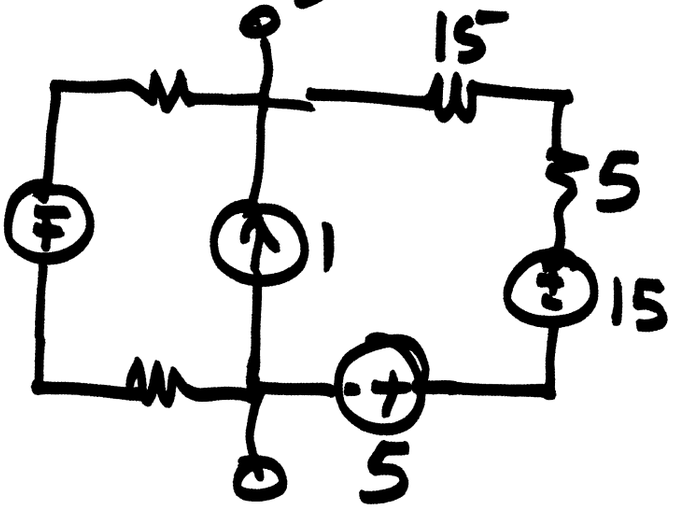
# 3-44 math. equation

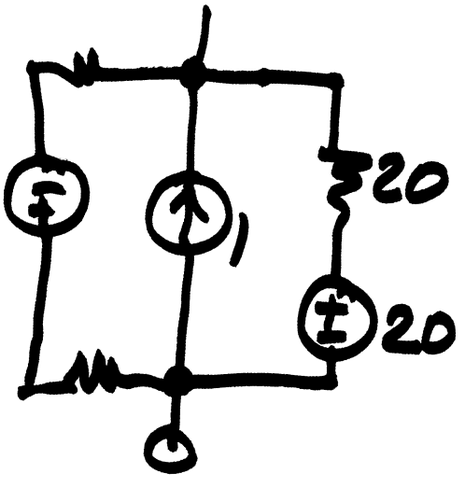
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $i$ (mA) | -10 | -5 | 0 | +5 | +10 | 12 | 13 | 14 |
| $v$ (V) | +5 | +4 | +3 | +2 | +1 | 0 | -1 | -2 |

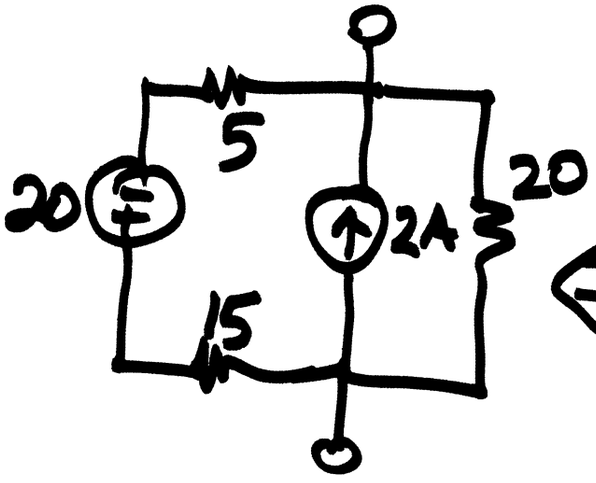


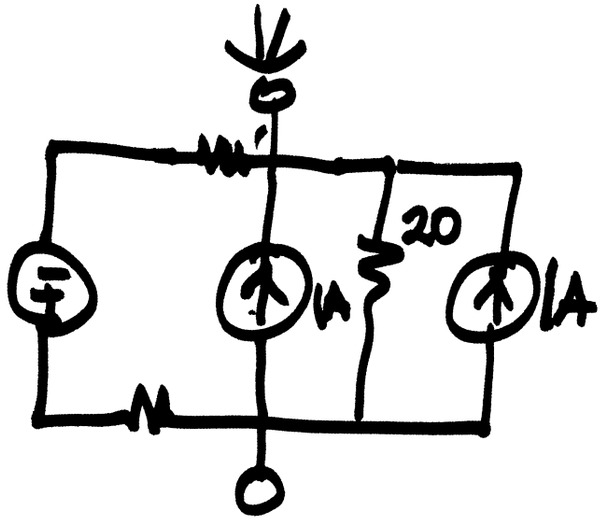
3-46 source transformations



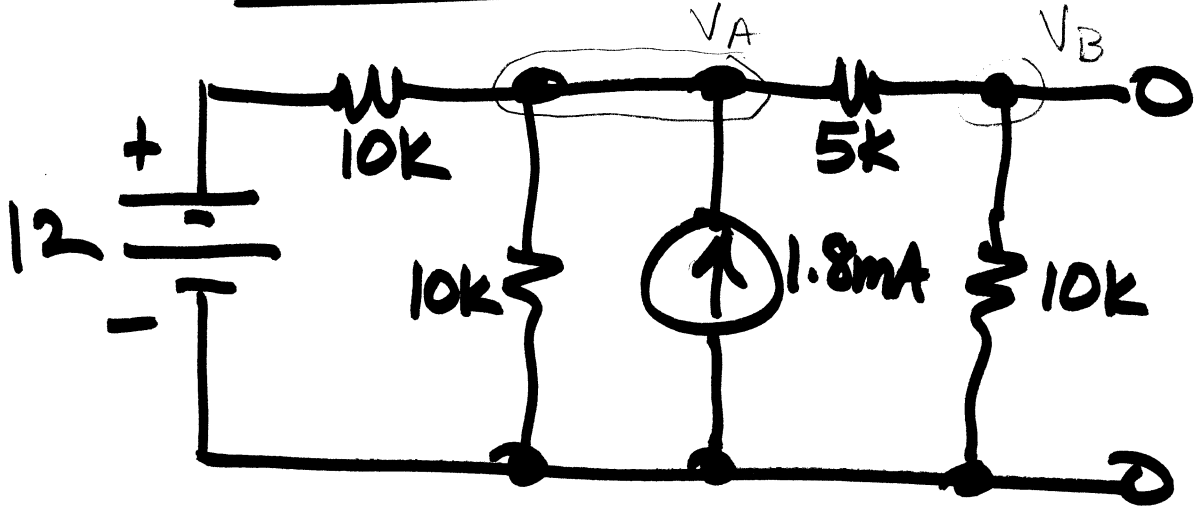



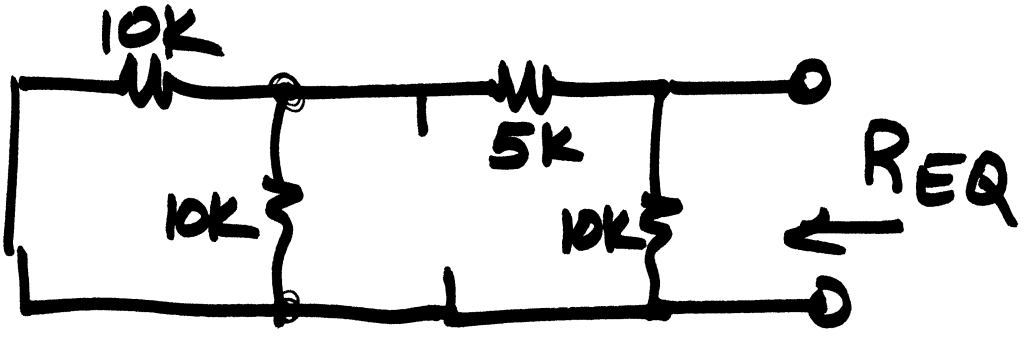



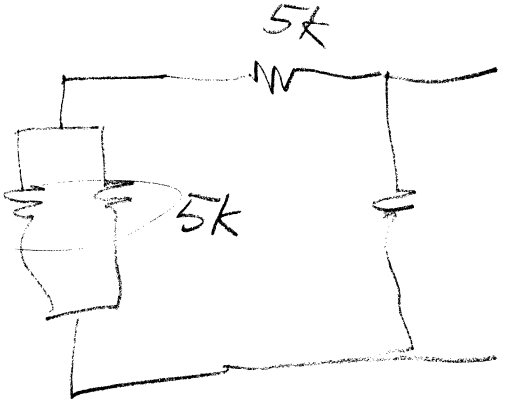



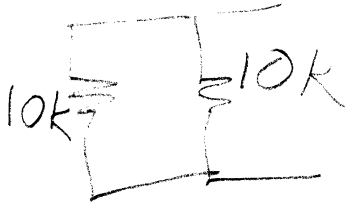
# LAST YEAR'S QUIZ

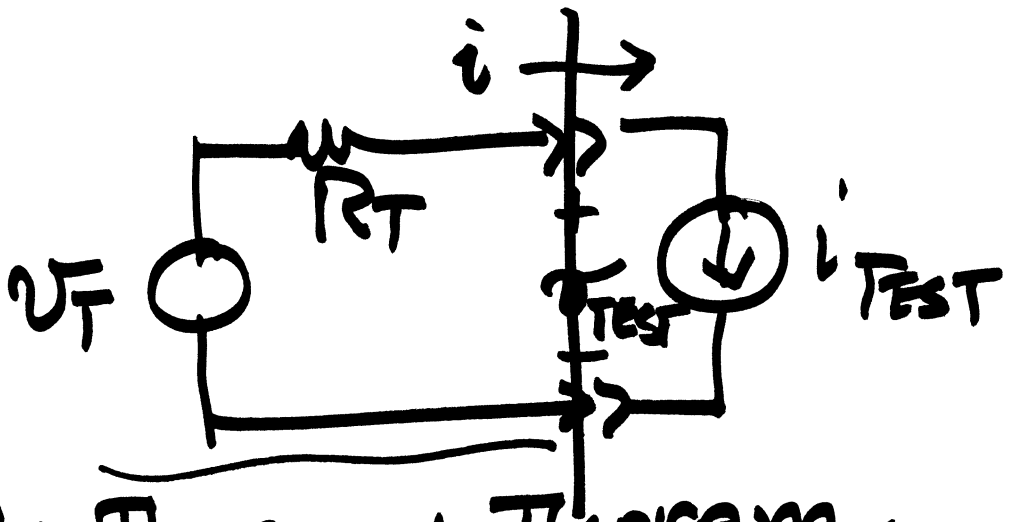



$R_T = R_{EQ} = 5$






Proof of Thevenin's Theorem.

find $v_{TEST}$ by superposition

$$v_{TEST} = v_{(volt.source)} + v_{(current\ source)}$$