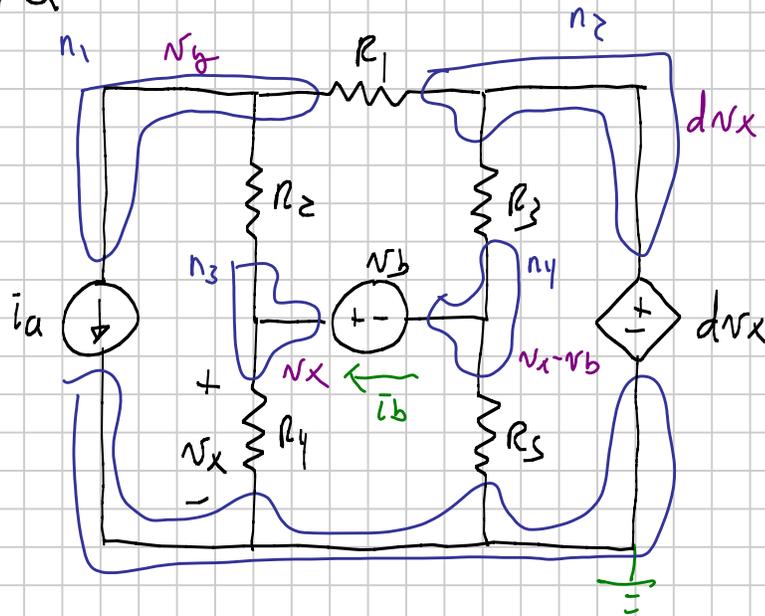


Problem 2:



1) pick ground

2) label nodes

3) label voltages using knowns/labeled unknowns/new units.

4) KCL, avoiding voltage sources (make supernode if need be)

Pick 2

$$\begin{cases} \text{KCL, } n_1: & i_a + \frac{v_g - v_x}{R_2} + \frac{v_g - d v_x}{R_1} = 0 \\ \text{KCL, } n_{3,4}: & \frac{v_x - v_g}{R_2} + \frac{v_x - 0}{R_4} + \frac{(v_x - v_b) - d v_x}{R_3} + \frac{(v_x - v_b) - 0}{R_5} = 0 \\ \text{KCL, } n_{2,5}: & -i_a + \frac{0 - v_x}{R_4} + \frac{0 - (v_x - v_b)}{R_5} + \frac{d v_x - v_g}{R_1} + \frac{d v_x - (v_x - v_b)}{R_3} = 0 \end{cases}$$

(b)
$$P_{abs, R_2} = \frac{v_{R_2}^2}{R_2} = \frac{(v_g - v_x)^2}{R_2}$$

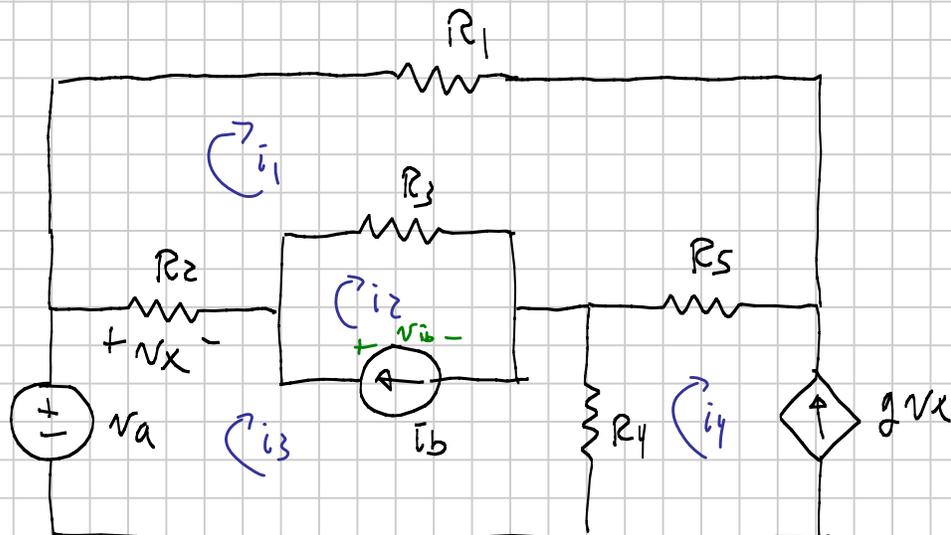
(c)
$$P_{del, v_b} = v_b i_b$$
 get i_b from KCL, n_3 or KCL, n_4

KCL, n_3 :
$$\frac{v_x - 0}{R_4} + \frac{v_x - v_b}{R_2} - i_b = 0 \quad i_b = v_x \left(\frac{1}{R_4} + \frac{1}{R_2} \right) - \frac{v_b}{R_2}$$

or KCL, n_4 :
$$\frac{(v_x - v_b) - 0}{R_5} + \frac{(v_x - v_b) - d v_x}{R_3} + i_b = 0$$

$$i_b = v_b \left(\frac{1}{R_5} + \frac{1}{R_3} \right) + \frac{d v_x}{R_3} - v_x \left(\frac{1}{R_5} + \frac{1}{R_3} \right)$$

Problem 3



1) label meshes / mesh currents

2) KVL, avoiding current sources (use superloop if need be)

$$\text{KVL, } \ell_1: R_2(i_1 - i_3) + R_1(i_1) + R_5(i_1 - i_4) + R_3(i_1 - i_2) = 0$$

$$\text{KVL, } \ell_{23}: -v_a + R_2(i_3 - i_1) + R_3(i_2 - i_1) + R_4(i_3 - i_4) = 0$$

$$\text{AUX } i_b: i_b = i_2 - i_3$$

$$\text{AUX vccs: } g v_x = -i_4$$

$$\text{CONTROL: } v_x = R_2(i_3 - i_1)$$

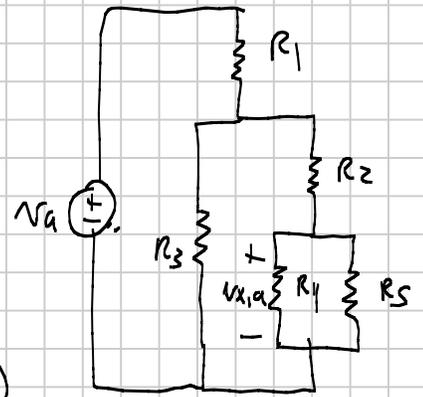
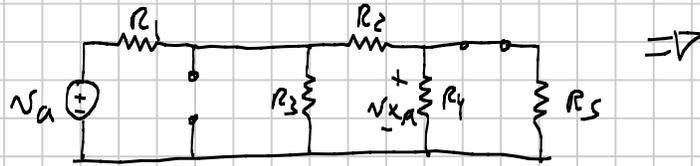
$$b) \quad p_{\text{abs}, R_4} = i_{R_4}^2 R_4 = (i_3 - i_1)^2 R_4$$

$$\begin{aligned} p_{\text{del}, i_b} &= v_{i_b} i_b \quad \text{and} \quad v_{i_b} = R_3(i_2 - i_1) \quad \text{or} \\ &= R_3(i_2 - i_1) i_b \end{aligned}$$

* Note: if you try a source conversion on the $R_3 \parallel i_b$ combo, you lose the ability to directly determine v_{i_b} ...

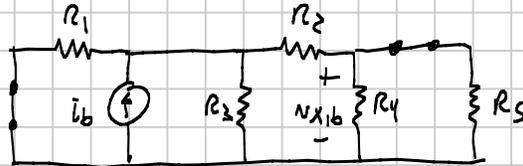
Problem 4

From v_a



$$v_{x,a} = v_a \left(\frac{R_3 \parallel (R_2 + (R_4 \parallel R_5))}{R_1 + (R_3 \parallel (R_2 + (R_4 \parallel R_5)))} \right) \left(\frac{R_4 \parallel R_5}{R_2 + (R_4 \parallel R_5)} \right)$$

From i_b

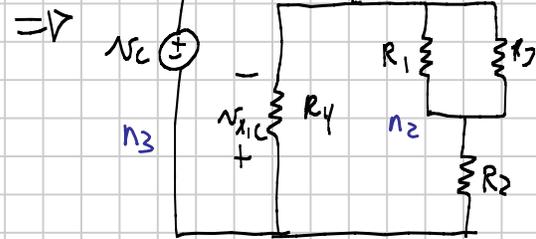
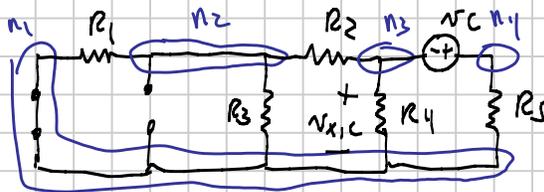


$$v_{x,b} = i_b \underbrace{(R_1 \parallel R_3 \parallel (R_2 + (R_4 \parallel R_5)))}_{v_{i_b}} \left(\frac{R_4 \parallel R_5}{R_2 + (R_4 \parallel R_5)} \right)$$

-or- $v_{x,b} = i_b \frac{R_1 \parallel R_3}{(R_1 \parallel R_3) + (R_2 + (R_4 \parallel R_5))} \underbrace{(R_4 \parallel R_5)}_{\text{equivalent } R}$

divide current

From v_c

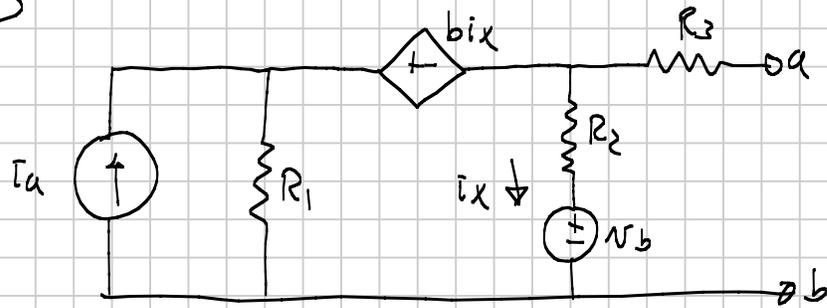


$$v_{x,c} = -v_c \frac{R_4 \parallel (R_2 + (R_1 \parallel R_3))}{R_5 + (R_4 \parallel (R_2 + (R_1 \parallel R_3)))}$$

$$v_x = v_{x,a} + v_{x,b} + v_{x,c}$$

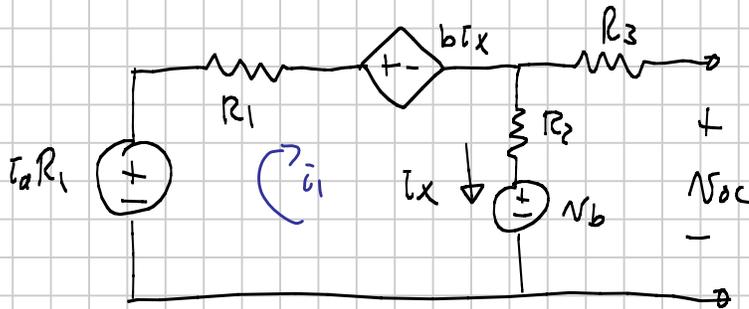
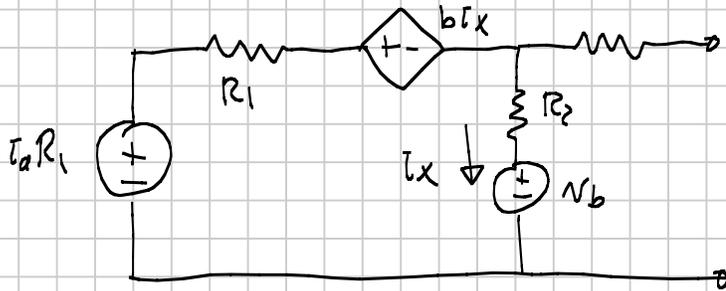
Note: there are other ways to use division above that will have the same values; they may look different symbolically but would reduce to the same expression.

Problem 5



One method:

Simplify with source transformation



$$\text{KVL } i_1: -i_a R_1 + R_1 i_1 + b i_x + R_2 i_1 + V_b = 0$$

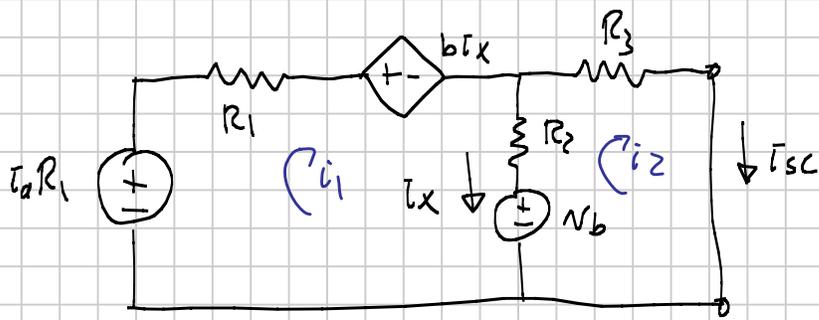
$$\text{Control: } i_x = i_1 \quad \Leftrightarrow$$

$$-i_a R_1 + R_1 i_x + b i_x + R_2 i_x + V_b = 0$$

$$i_x = \frac{i_a R_1 - V_b}{b + R_1 + R_2}$$

$$V_{oc} = V_b + R_2 i_x$$

$$= \frac{(b + R_1) V_b + i_a R_1 R_2}{b + R_1 + R_2}$$



$$\text{KVL}_{i_1}: -i_a R_1 + R_1 i_1 + b i_x + R_2 (i_1 - i_2) + v_b = 0$$

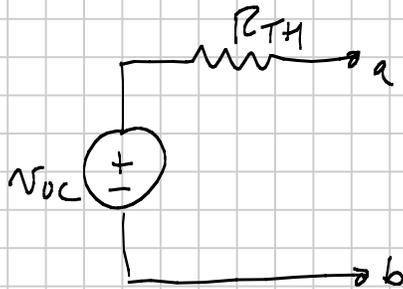
$$\text{KVL}_{i_2}: -v_b + R_2 (i_2 - i_1) + R_3 i_2 = 0$$

$$\text{CTRL}: i_x = i_1 - i_2$$

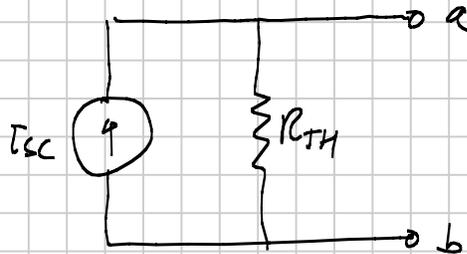
$$\text{AUX}: i_{sc} = i_2$$

solve for i_{sc}

$$R_{TH} = V_{oc} / i_{sc}$$

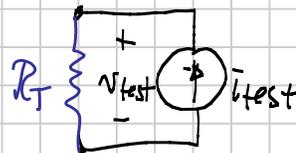
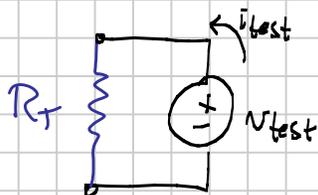


Thevenin



Note: Not required to use source transformation

2) could find v_{oc} and then just i_o/v_o + apply test current (or voltage), determine resulting voltage (or current) and note $R_T = v_{test} / i_{test}$ as long as sign convention for test is active:



Active sign convention on test sources relate to passive sign convention for R_T