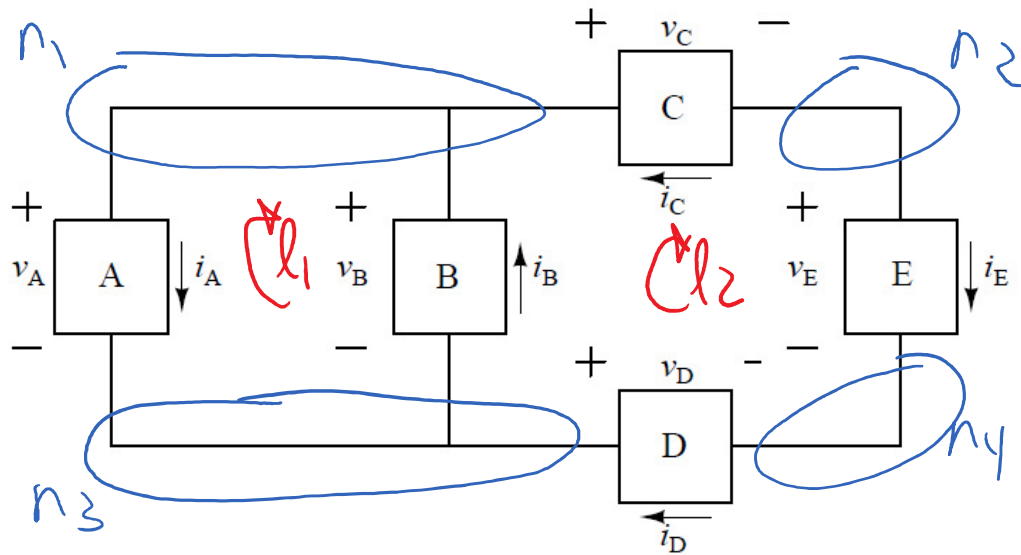


# Problem 1

Monday, October 17, 2022

Name	Variable	Units	Equation
charge	$q$	$C$	$N/R$
conductance	$G$	$\mathcal{V}, S$	$N/R$
work / energy	$w / E$	$J$	$N/R$
resistance	$R$	$\Omega$	$v/i$
power	$p$	$W, J/s$	$v \cdot i$
current	$i$	$A, C/s$	$\frac{dq}{dt}$
voltage	$v$	$V$	$\frac{dw}{dq}$

## Problem 2



Element	Conv.	Voltage $v$ , V	Current $i$ , A	Power Absorbed $p_{\text{abs}}$ , W
A	P	10	1	10
B	A	10	6	-60
C	A	5	-5	25
D	A	-2	5	10
E	P	3	5	15

1)  $v_B = v_A = 10 \text{ V}$

2)  $i_E = i_D = 5 \text{ A}$

3)  $i_C = -i_E = -5 \text{ A}$

4)  $p_{\text{abs},B} = -v_B i_B = -60 \text{ W}$

5)  $v_C = -p_{\text{abs},C} / i_C = 5 \text{ V}$

6)  $p_{\text{abs},E} = v_E i_E = 15 \text{ W}$

7) KCL,  $n_1$ :  $i_A - i_B - i_C = 0$ ,  $i_A = i_B + i_C = 1 \text{ A}$

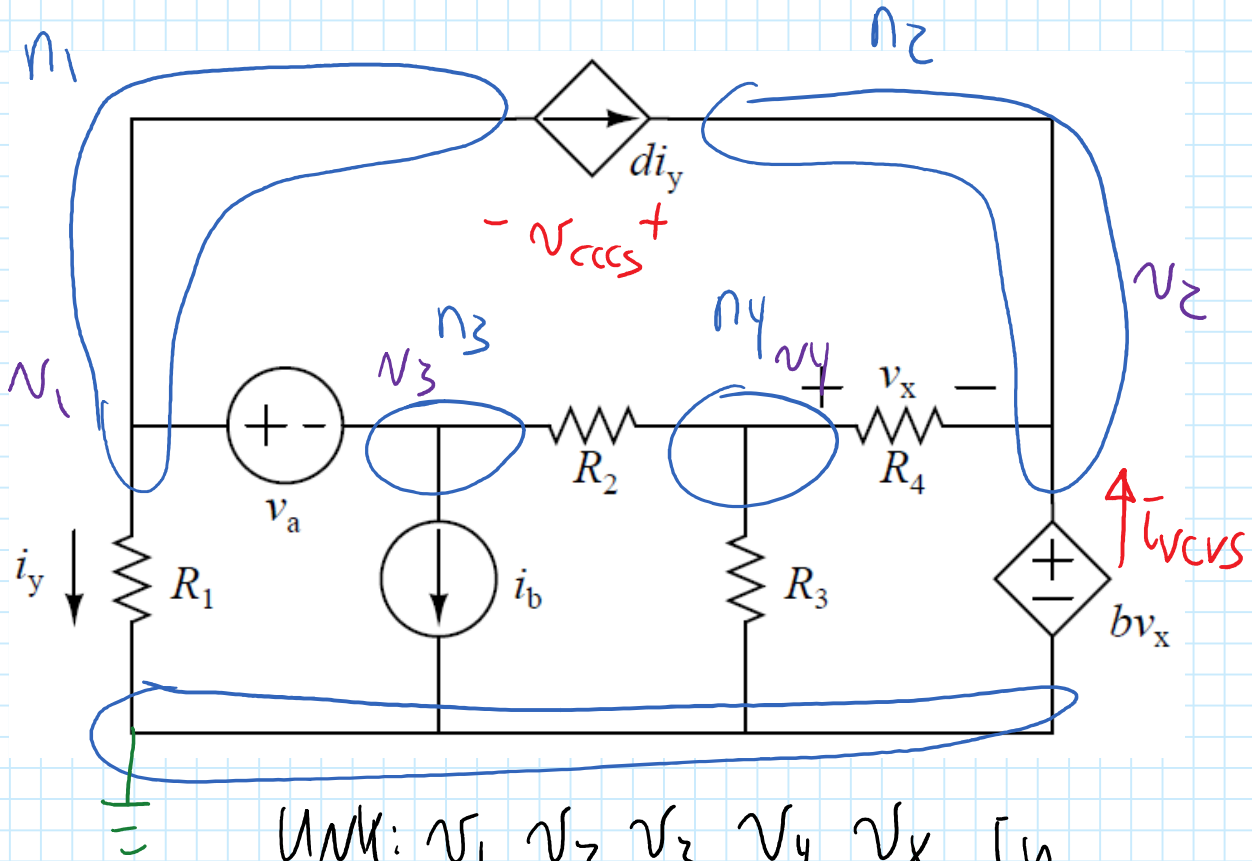
8)  $p_{\text{abs},A} = v_A i_A = 10 \text{ W}$

9) KVL,  $l_2$ :  $-v_B + v_C + v_E - v_D = 0$   
 $v_D = -v_B + v_C + v_E = -2 \text{ V}$

10)  $p_{\text{abs},D} = -v_D i_D = 10 \text{ W}$

CHECK:  $\sum p_{\text{abs}} = 10 - 60 + 25 + 10 + 15 = 0 \checkmark$

### Problem 3 - lazy



UNK:  $v_1$   $v_2$   $v_3$   $v_4$   $v_x$   $v_y$

$$\# KCL = 5 \text{ nodes} - 1 \text{ gnd} - 2 \text{ v. src} = 2$$

$$\text{KCL, } n_4: \frac{v_4 - v_3}{R_2} + \frac{v_4 - 0}{R_3} + \frac{v_4 - v_2}{R_4} = 0$$

$$KCl, Sn_{13}: \frac{v_1 - 0}{R_1} + d_{ig} + i_b + \frac{v_3 - v_4}{R_2} = 0$$

SRC,  $v_a$ :  $v_a = v_1 - v_3$

SRC, VCVC:  $bv_x = v_z - 0$

MEAS,  $\nu_X$ :  $\nu_X = \nu_Y - \nu_Z$

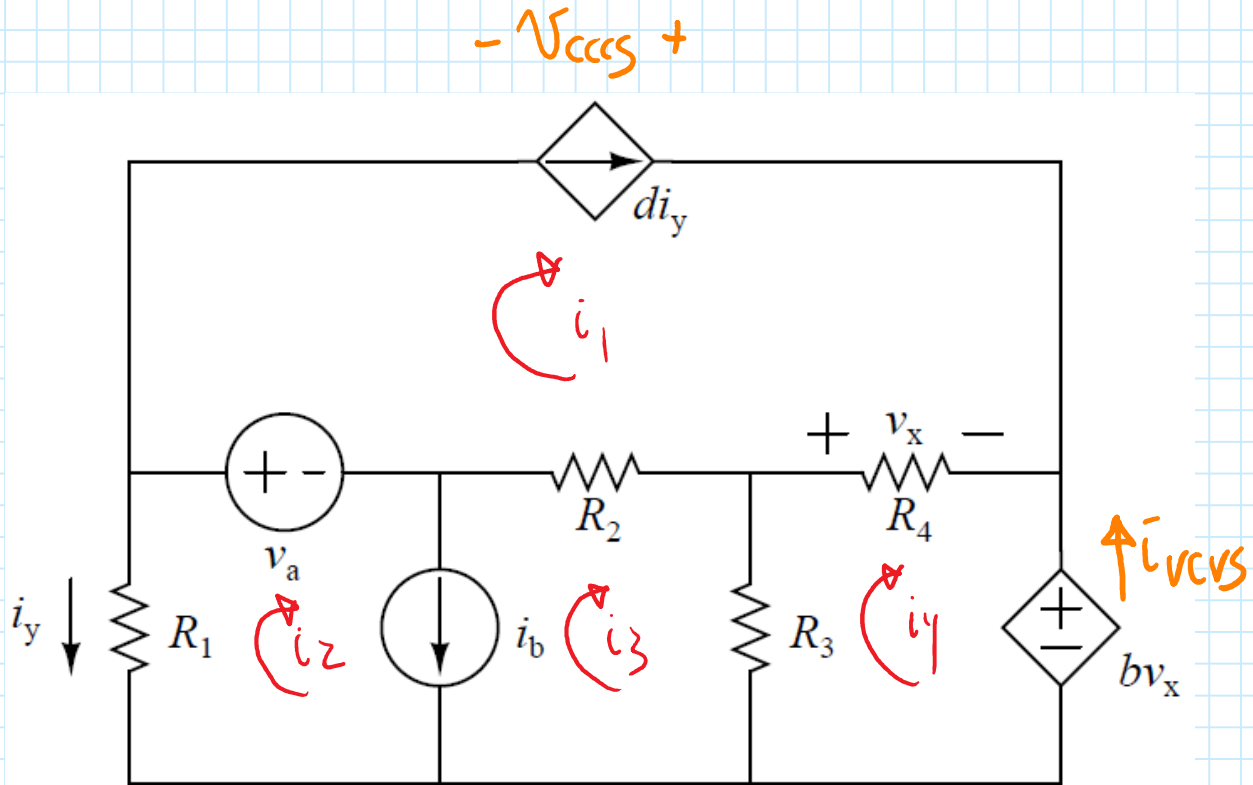
MEAS,  $i_y$ :  $i_y = \frac{v_1 - 0}{R_1}$

$$P_{abs, R_2} = (v_3 - v_4)^2 / R_2$$

$$P_{del, CCS} = (v_2 v_1) \text{ dig}$$

$$P_{del, VCVS} = b v_x \left( \frac{v_2 - v_1}{R_1} - \text{diag} \right)$$

# Problem 4 - MCM

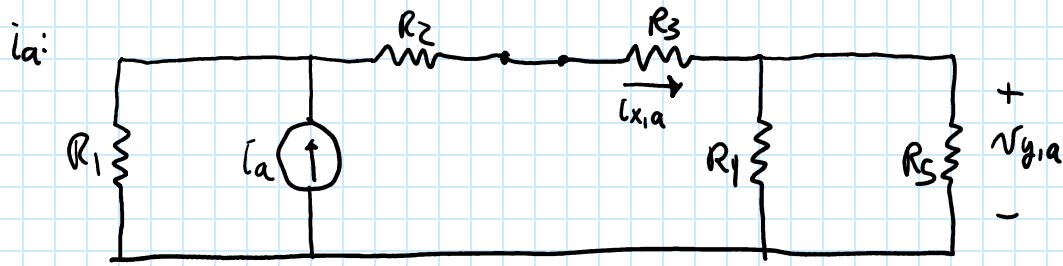


UNK:  $i_1, i_2, i_3, i_4, v_x, i_y$   
 # KVL: 4 mesh - 2 i. src = 2  
 KVL,  $l_y$ :  $R_3(i_4 - i_2) + R_4(i_4 - i_1) + bv_x = 0$   
 KVL,  $sl_{23}$ :  $R_1(i_2) + v_a + R_2(i_3 - i_1) + R_3(i_3 - i_4) = 0$   
 SRC,  $i_b$ :  $i_b = i_2 - i_3$   
 SRC,  $cccs$ :  $di_y = i_1$   
 MEAS,  $i_y$ :  $i_y = -i_2$   
 MEAS,  $v_x$ :  $v_x = R_4(i_4 - i_1)$

---

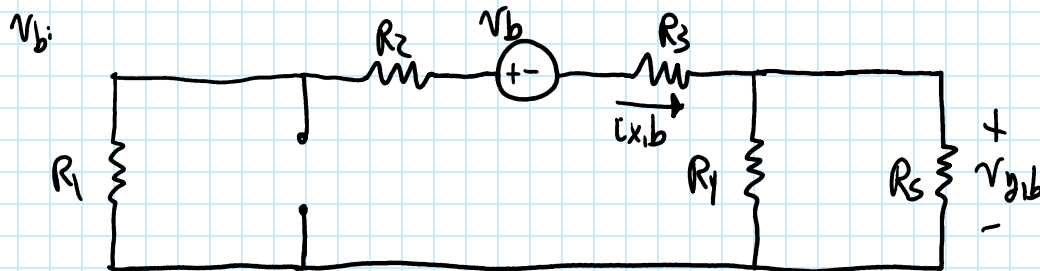
$P_{abs, R_2} = (i_1 - i_3)^2 R_2$   
 $P_{del, vcrs} = -bv_x i_y$   
 KVL,  $l_1$ :  $-V_{cccs} - v_x + R_2(i_1 - i_3) - v_a = 0$   
 $V_{cccs} = -v_x + R_2(i_1 - i_3) - v_a$   
 $P_{del, ccsc} = di_y V_{cccs}$

# Problem 5



From  $i_a$ 's PERSPECTIVE,  $R_{12345} = R_1 \parallel (R_2 + R_3 + (R_4 \parallel R_5))$

$$i_{x,a} = \frac{i_a R_{12345}}{R_2 + R_3 + (R_4 \parallel R_5)} \quad v_{y,a} = i_{x,a} (R_4 \parallel R_5)$$

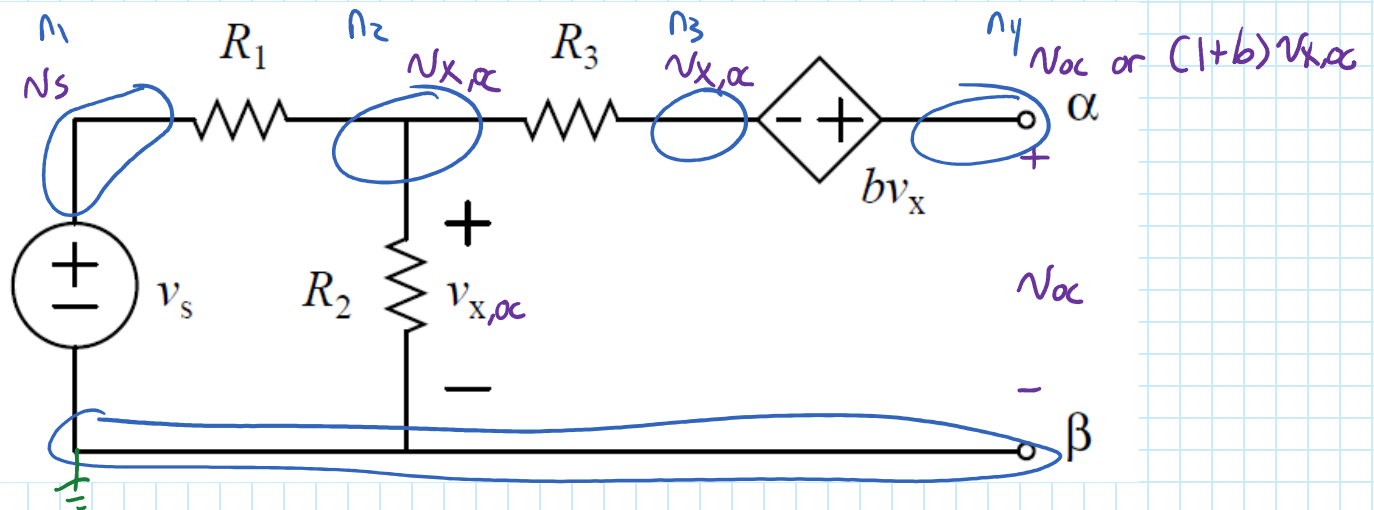


From  $v_b$ 's PERSPECTIVE,  $R_{12345} = R_1 + R_2 + R_3 + (R_4 \parallel R_5)$

$$v_{y,b} = \frac{-v_b (R_4 \parallel R_5)}{R_{12345}} \quad i_{x,b} = \frac{-v_b}{R_{12345}}$$

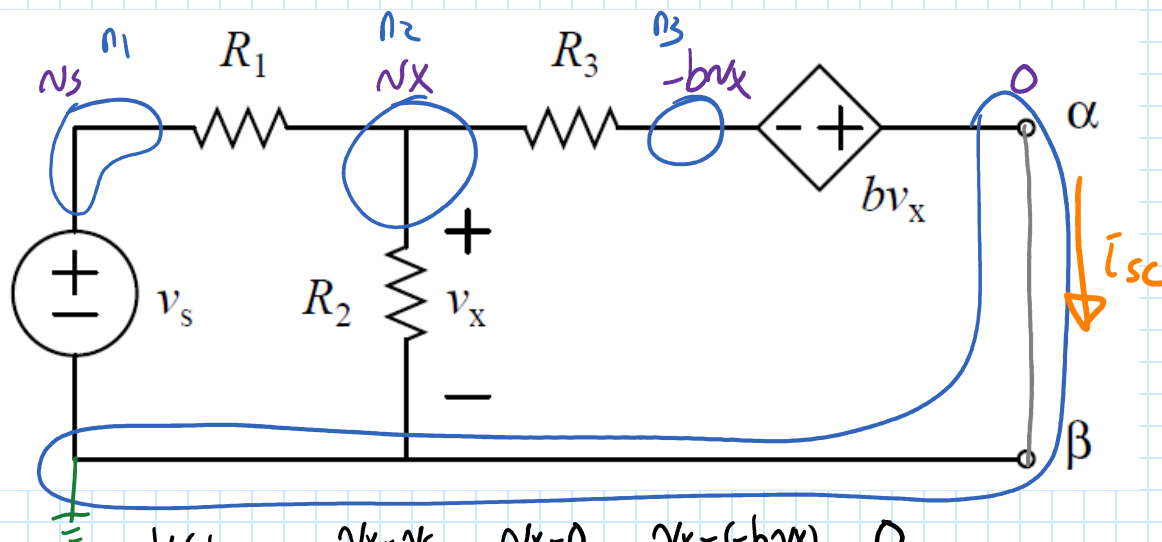
## Problem 6

20 WDEP & >1 DEP → FWD  $N_{ac}$  AND  $i_{sc}$



$$\text{KCL, } n_2: \frac{v_{x,ac} - v_s}{R_1} + \frac{v_{x,ac} - 0}{R_2} = 0 \quad v_{x,ac} = \frac{\frac{v_s}{R_1}}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{v_s R_2}{R_1 + R_2}$$

$$v_{ac} = (1+b)v_x = \frac{v_s (1+b) R_2}{R_1 + R_2}$$



$$\text{KCL, } n_2: \frac{v_x - v_s}{R_1} + \frac{v_x - 0}{R_2} + \frac{v_x - (-bv_x)}{R_3} = 0$$

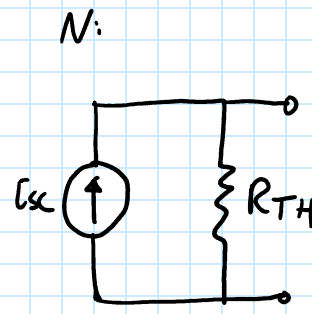
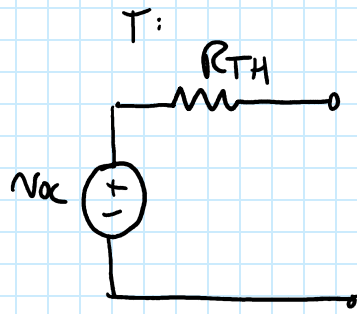
$$v_x \left( \frac{1}{R_1} + \frac{1}{R_2} + \frac{1+b}{R_3} \right) - \frac{v_s}{R_1} = 0$$

$$v_x = \frac{\frac{v_s}{R_1}}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1+b}{R_3}} = \frac{R_2 R_3 v_s}{R_1 R_2 (1+b) + R_1 R_3 + R_2 R_3}$$

$$\text{Ohm's } R_3: i_{sc} = \frac{v_x - (-bv_x)}{R_3} = \frac{(1+b)v_x}{R_3} = \frac{(1+b) R_2 v_s}{R_1 R_2 (1+b) + R_1 R_3 + R_2 R_3}$$

## Problem 6 (cont)

$$R_{TH} = \frac{V_{oc}}{i_{sc}}$$



MAX P:  $R_L = R_{TH}$  ,  $P_{max} = \frac{V_{oc}^2}{4R_{TH}} = \frac{i_{sc}^2 R_{TH}}{4}$