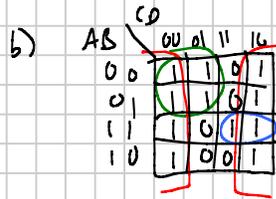


# ECE 110 Spring 2018 Test 1

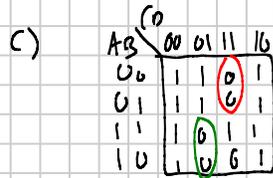
Note Title

I) As written,  $m(0, 1, 2, 4, 5, 6, 12, 15, 14, 8, 10)$

a) So,  $\Sigma: m(0, 1, 2, 4, 5, 6, 8, 10, 12, 14, 15)$



$$\bar{D} + \bar{A}\bar{C} + ABC$$



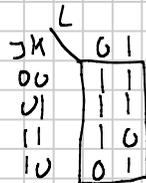
$$\bar{f} = \bar{A}CD + A\bar{C}D + \begin{matrix} \nearrow \bar{A}\bar{B}D \\ \text{or} \\ \bar{B}CD \end{matrix}$$

either works.

$$f = (A + \bar{C} + \bar{D})(\bar{A} + C + \bar{D})(\bar{A} + \bar{B} + D)$$

$$(A + \bar{C} + \bar{D})(\bar{A} + C + \bar{D})(B + \bar{C} + \bar{D})$$

2)  $g = \bar{J} + K\bar{L} + \bar{K}L$

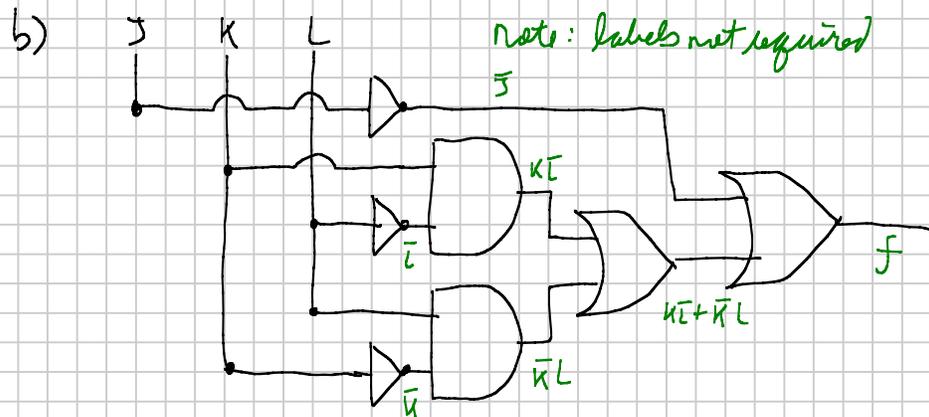


so  $\Sigma m(0, 1, 2, 3, 5, 6)$

note:  $\bar{J} = \bar{J}\bar{K}\bar{L} + \bar{J}\bar{K}L + \bar{J}K\bar{L} + \bar{J}KL$

$K\bar{L} = \bar{J}K\bar{L} + J\bar{K}\bar{L}$

$\bar{K}L = \bar{J}\bar{K}L + J\bar{K}L$

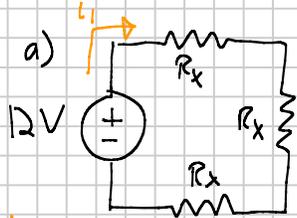


c) 7 gates + 11 inputs = 18

2x3 NOT + 3x4 OTHER = 18

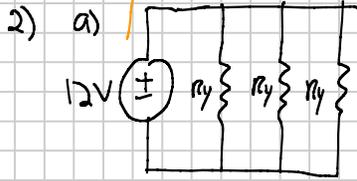
\* Note:  $\overline{AB} \neq \bar{A}\bar{B}$ ; be sure gap is clear

II) 1)



b)  $p = v i_1$   $i_1 = P/v = .096/12 = 8 \text{ mA}$

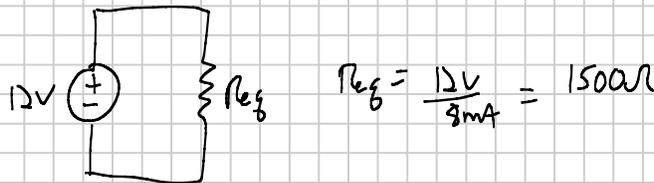
c)  $v = 3R_x i_1$  so  $R_x = \frac{v}{3i_1} = 500 \Omega$   
 $= \frac{12}{(3 \times .008)} = \frac{12}{.024}$



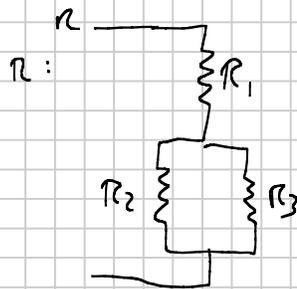
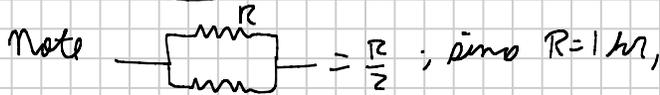
b)  $p = v i_2$  so  $i_2 = 8 \text{ mA}$  as before!

c)  $R_{eq} = \frac{1}{\frac{1}{R_y} + \frac{1}{R_y} + \frac{1}{R_y}} = \frac{R_y}{3}$   
 $v = \frac{R_y i_2}{3}$  so  $R_y = \frac{3v}{i_2} = 4500 \Omega$

3) Since  $p = 50 \text{ mW}$  again,  $i = 8 \text{ mA}$  again



$R_{eq} = \frac{12V}{8 \text{ mA}} = 1500 \Omega$



$i_{R_1} = 8 \text{ mA}$  so  $p_{abs, R_1} = i^2 R_1 = 64 \text{ mW}$

$i_{R_2} = i_{R_3} = 4 \text{ mA}$  (current division)  
 $p_{abs, R_2} = p_{abs, R_3} = i^2 R_{1,2} = 16 \text{ mW}$

Note  $\Sigma p_{abs} = 96 \text{ mW}$

4)  $N_w = v_s \frac{R_1 + R_2}{R_2 + R_1 + R_3}$

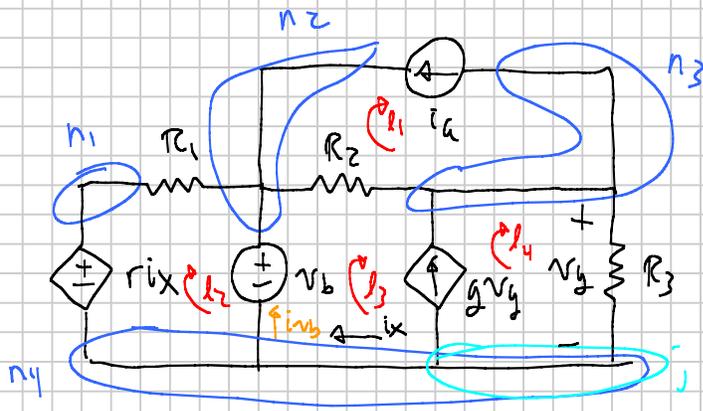
$v_x = -v_s \frac{R_3 \parallel R_1}{R_3 + (R_2 \parallel R_1)}$

5)  $i_y = i_p \frac{R_3 \parallel (R_2 + (R_4 \parallel R_5))}{R_2 + (R_4 \parallel R_5)}$

same as current going left-to-right in  $R_2$ .

$i_z = -i_y \frac{R_4 \parallel R_5}{R_5}$

11)



$$\text{KCL, } n_3: i_a + \frac{v_y - v_b}{R_2} - g v_y + \frac{v_y}{R_3} = 0$$

$$v_y = \frac{-i_a + \frac{v_b}{R_2}}{\frac{1}{R_2} + \frac{1}{R_3} - g} \quad \text{or} \quad \frac{-R_2 R_3 i_a + R_3 v_b}{R_2 + R_3 - g R_2 R_3}$$

$$\text{KCL, } i_j: i_x + g v_y - \frac{v_y}{R_3} = 0 \quad i_x = v_y \left( \frac{1}{R_3} - g \right)$$

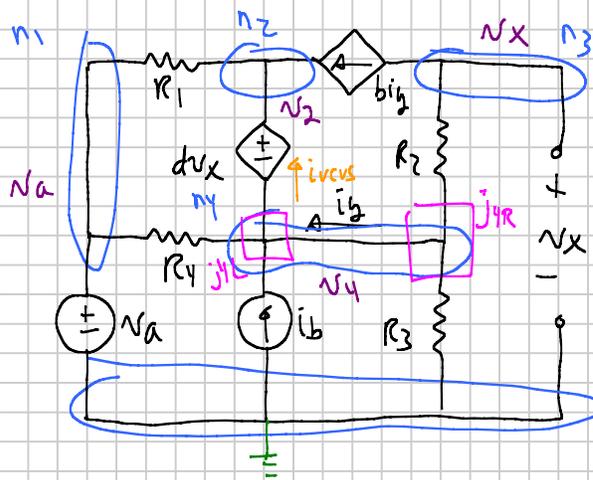
$$P_{\text{abs}, R_2} = (v_b - v_y)^2 / R_2 \quad \text{or} \quad (i_a + i_x)^2 R_2$$

$$P_{\text{del}, V_b} = v_b i_{v_b} \quad \text{KCL, } n_2: i_{v_b} = \frac{v_b - r_{ix}}{R_1} + \frac{v_b - v_y}{R_2} - i_a$$

$$P_{\text{del}, \text{CVS}} = (r_{ix}) \left( \frac{r_{ix} - v_b}{R_1} \right)$$

$$P_{\text{del}, \text{VCS}} = g v_y v_y = g v_y^2 \quad \text{labeled actively relative to } g v_y$$

IV)  
 1) GND  
 2) Nodes  
 3) V, V<sub>node</sub>



Note: I used smart labels for  $n_1, n_3$  - lazy labels for  $n_2, n_4, \dots$

$j \cdot i_g$   
 $j \cdot i_g$  not part of NMM  
 $i_{vcus}$  not part of NMM

$$\#KCL = 5 \text{ nodes} - 1 \text{ gnd} - 2 \text{ vsrc} = 2$$

Unknowns:  $v_2, v_4, v_x, i_g$

$$KCL, n_3: b i_g + \frac{v_x - v_4}{R_2} = 0$$

$$KCL, n_4: \frac{v_2 - v_a}{R_1} - b i_g + \frac{v_4 - v_a}{R_4} - i_b + \frac{v_4 - 0}{R_3} + \frac{v_4 - v_x}{R_2}$$

ok if  $i_g$

$$SRC, v_{cs}: v_{cs} = v_2 - v_4$$

MEAS,  $i_g$ : best bet is right side of  $n_4$ :

$$KCL, j \cdot i_g: i_g + \frac{v_4 - v_x}{R_2} + \frac{v_4 - 0}{R_3} = 0$$

if lazy labels used for  $n_1, n_3$ , extra source equations:

$$SRC, v_a: v_a = v_1 - 0$$

$$MEAS, v_x: v_x = v_3 - 0$$

$$P_{abs, R_2} = \frac{(v_x - v_4)^2}{R_2}$$

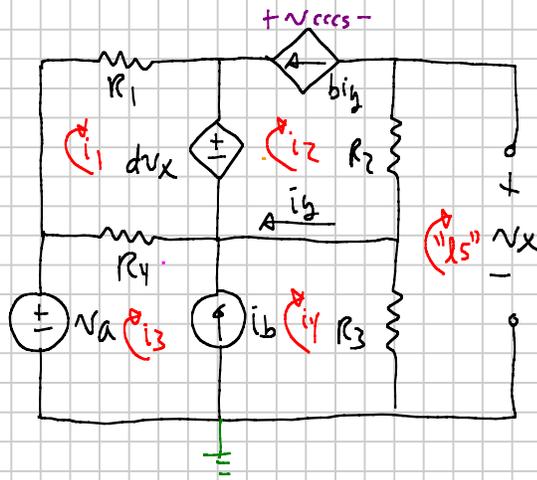
$$P_{del, v_{cs}} = v_{cs} i_{vcus} \quad i_{vcus} = -b i_g + \frac{v_2 - v_a}{R_1} \text{ from } n_2 \text{ on}$$

$$i_{vcus} = \frac{v_a - v_4}{R_4} + i_b + i_g \text{ from } j \cdot i_g \text{ on}$$

$$\frac{v_a - v_4}{R_4} + i_b + \frac{v_x - v_4}{R_2} + \frac{0 - v_4}{R_3} \text{ from } n_4$$

$$P_{del, v_{cs}} = (v_2 - v_x) b i_g$$

V)  
MCM



unk:  $i_1, i_2, i_3, i_4, i_y, v_x$

1 mesh - 2 isrc = 2 KVL

$$\text{KVL, } R_1: R_1(i_1) + v_x + R_4(i_1 - i_3) = 0$$

$$\text{KVL, } R_3, R_4: -v_x + R_4(i_3 - i_1) + R_3(i_1) = 0$$

$$\text{SRC, } i_b: i_b = i_4 - i_3$$

$$\text{SRC, } b i_y: b i_y = -i_2$$

$$\text{MEAS, } i_y: i_y = i_2 - i_3$$

$$\text{MEAS, } v_x: \text{KVL, } R_2: R_2(-i_4) + R_2(-i_2) + v_x = 0 \quad v_x = R_2 i_4 + R_2 i_2$$

$$\bullet \text{ } P_{\text{abs}, R_2} = i_2^2 R_2$$

$$\bullet \text{ } P_{\text{del}, \text{VCVS}} = (v_x)(i_2 - i_1)$$

$$\bullet \text{ } P_{\text{del}, \text{cccs}} = b i_y v_{\text{cccs}}$$

$$\text{KCL, } R_2: -v_x + v_{\text{cccs}} + R_2 i_2 = 0$$

$$v_{\text{cccs}} = v_x - R_2 i_2 \quad \checkmark$$