

ECE 110 F2015 Test I

Note Title

$$I) 1) F(A, B, C, D) = \overset{0}{\bar{A}\bar{B}\bar{C}\bar{D}} + \overset{4}{\bar{A}B\bar{C}\bar{D}} + \overset{12}{A\bar{B}\bar{C}\bar{D}} + \overset{1}{A\bar{B}\bar{C}D} + \overset{5}{\bar{A}B\bar{C}D} + \overset{9}{\bar{A}B\bar{C}D} + \overset{6}{\bar{A}B\bar{C}D} + \overset{14}{A\bar{B}\bar{C}D}$$

(a) $\sum_i m(0, 1, 4, 5, 6, 9, 12, 14)$

(b)

AB \ CD	00	01	11	10
00	1	1	0	0
01	1	1	0	1
11	1	0	0	1
10	0	1	0	0

(c)

$$F = \bar{A}\bar{C} + B\bar{D} + \bar{B}\bar{C}D$$

(d)

AB \ CD	00	01	11	10
00	1	1	0	0
01	1	1	0	1
11	1	0	0	1
10	0	1	0	0

$$\bar{F} = CD + \bar{B}\bar{C} + A\bar{B}\bar{D} + AB\bar{D}$$

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

2)

$$g(J, K, L) = \bar{L} + JK + \bar{J}K$$

JK \ L	0	1
00	1	0
01	1	1
11	1	0
10	1	1

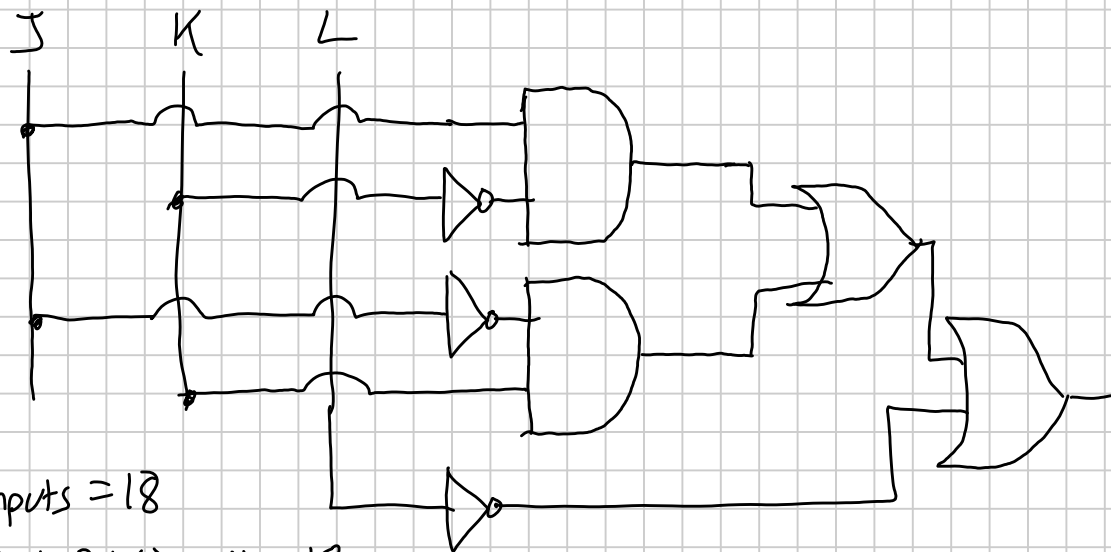
minterms:

minterms	0	1
2	3	3
6	3	3
4	5	5

(a)

$$\sum_i m(0, 2, 3, 4, 5, 6)$$

b)



c)

$$7 \text{ gates} + 11 \text{ inputs} = 18$$

$$3 \times (4 \text{ and/or}) + 2 \times (3 \text{ not}) = 18$$

$$\text{II) 1) } R_{ab} = \left(\left(\left((R_6 + R_2) \parallel R_5 \right) + R_7 \right) \parallel R_4 \right) + R_1$$

$$R_{cd} = \left(\left(\left((R_4 + R_7) \parallel R_5 \right) + R_2 \right) \parallel R_6 \right) + R_3 + R_8 + R_9$$

$$2) \quad R_{\text{left}} = R_1 + R_2 + (R_3 \parallel R_4)$$

$$V_x = V_S \frac{R_1}{R_{\text{left}}}$$

$$V_w = -V_S \frac{R_3 \parallel R_4}{R_{\text{left}}}$$

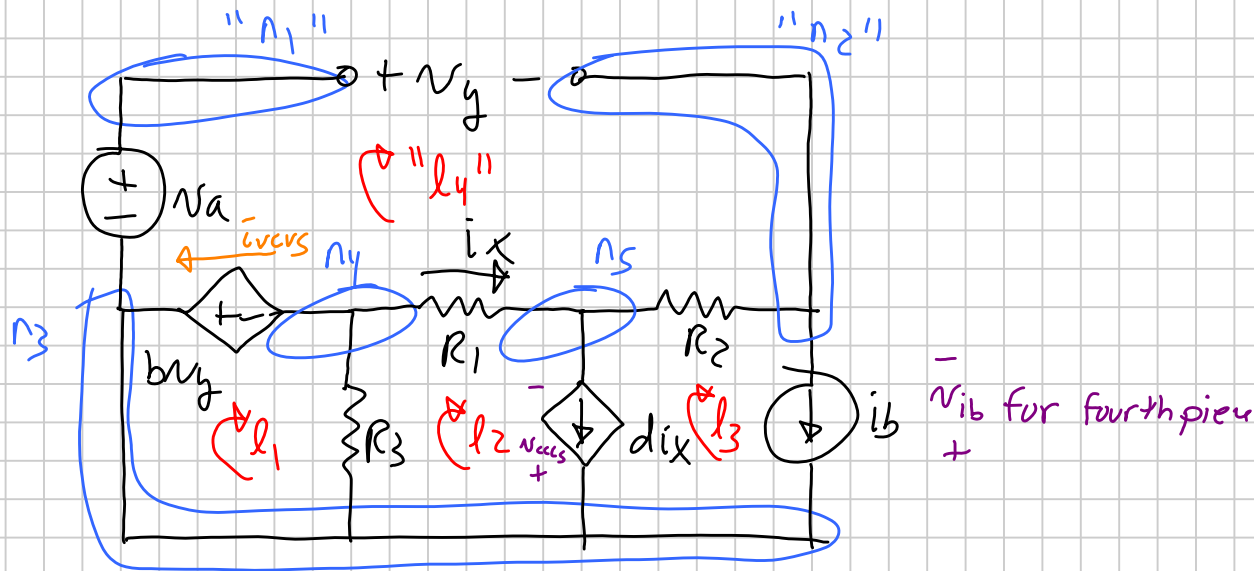
$$3) \quad R_{\text{left}} = R_1 + R_2 + (R_3 \parallel R_4)$$

$$i_1 = -\frac{i_p R_5}{R_{\text{left}} + R_5} \quad \text{or} \quad -i_p \frac{(R_5 \parallel R_{\text{left}})}{R_{\text{left}}}$$

$$i_2 = -i_g \frac{R_4}{R_3 + R_4} \quad \text{or} \quad -i_g \frac{(R_3 \parallel R_4)}{R_3}$$

$$\text{so } i_2 = i_p \frac{R_5}{R_{\text{left}} + R_5} \frac{R_4}{R_3 + R_4} = i_p \frac{(R_5 \parallel R_{\text{left}})}{R_{\text{left}}} \frac{(R_3 \parallel R_4)}{R_3}$$

III)



• KCL, sh_{s2} : $-i_x + d i_x + i_b = 0 \quad i_x = \frac{i_b}{1-d}$

• KVL, l_4 : $-v_a + v_y - R_2 i_b - R_1 i_x - b v_y = 0$

$$v_y = \frac{v_a + R_2 i_b + R_1 i_x}{1-b}$$

• $P_{abs, R_3} = \frac{v^2}{R_3} = \frac{(b v_y)^2}{R_3}$

• P_{del, i_b} : KVL, sh_{1234} : $-v_a + v_y - v_{ib} = 0 \quad v_{ib} = v_y - v_a$

or KVL, sh_{23} : $b v_y + R_1 i_x + R_2 i_b - v_{ib} = 0 \quad v_{ib} = b v_y + R_1 i_x + R_2 i_b$

$$P_{del, i_b} = i_b v_{ib}$$

• $P_{del, ccs}$: KVL, pl_{12} : $b v_y + R_1 i_x - v_{ccs} = 0 \quad v_{ccs} = b v_y + R_1 i_x$

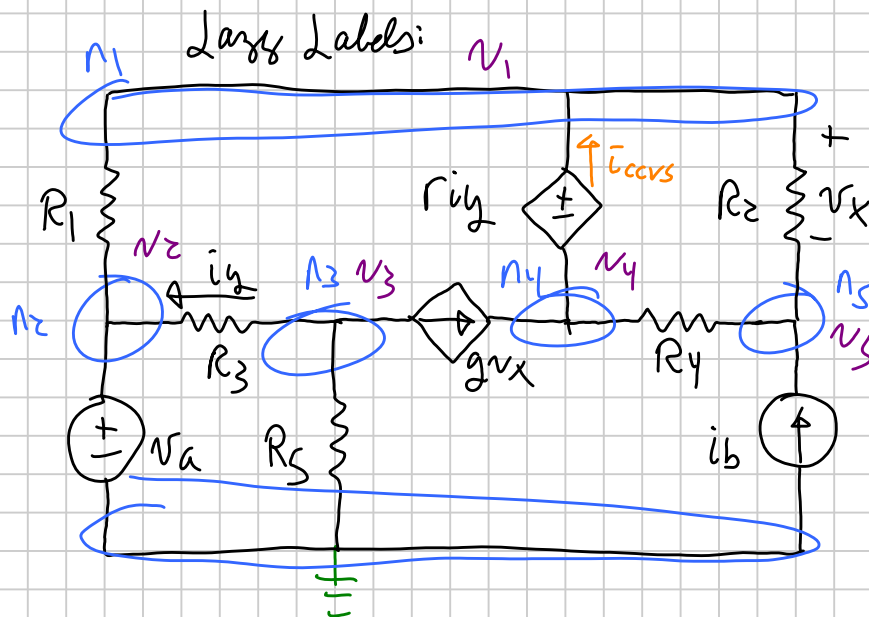
$$P_{del, ccs} = d i_x (b v_y + R_1 i_x)$$

• $P_{del, vcvs}$: KCL, n_4 : $\bar{i}_{vcvs} + \frac{(-b v_y)}{R_3} + i_x = 0$

$$\bar{i}_{vcvs} = \frac{b v_y}{R_3} - i_x$$

$$P_{del, vcvs} = (b v_y) \left(\frac{b v_y}{R_3} - i_x \right)$$

IV



Unknowns:

v_1 v_2 v_3 v_4 v_5
 v_x i_g

6 nodes - 1 - 2 $v_{source} = 3$ KCL

$$\text{KCL, } n_3: \frac{v_3 - v_2}{R_2} + \frac{v_3}{R_3} + g v_x = 0$$

$$\text{KCL, } n_5: \frac{v_5 - v_1}{R_1} + \frac{v_5 - v_4}{R_4} - i_b = 0$$

$$\text{KCL, } n_4: \frac{v_1 - v_2}{R_1} + \frac{v_1 - v_5}{R_2} - g v_x + \frac{v_4 - v_5}{R_4} = 0$$

SRC v_a : $v_a = v_2$

SRC i_{ccvs} : $r_{iy} = v_1 - v_4$

MEAS v_x : $v_x = v_1 - v_5$

MEAS i_g : $i_g = \frac{v_3 - v_2}{R_3}$

• $P_{abs, R_4} = (v_4 - v_5)^2 / R_4$

• $P_{del, v_{ccs}} = (g v_x)(v_4 - v_3)$

• $P_{del, ccvs}$: $r_{iy} i_{ccvs}$

$$\text{KCL, } n_1: -i_{ccvs} + \frac{v_1 - v_2}{R_1} + \frac{v_1 - v_5}{R_2} = 0 \quad i_{ccvs} = \frac{v_1 - v_2}{R_1} + \frac{v_1 - v_5}{R_2}$$

or

$$\text{KCL, } n_4: i_{ccvs} - g v_x + \frac{v_4 - v_5}{R_4} = 0 \quad i_{ccvs} = g v_x - \left(\frac{v_4 - v_5}{R_4} \right)$$

The diagram shows a circuit with nodes n_1 through n_5 circled in blue. The circuit includes a voltage source v_a in series with R_1 and R_3 connected to node n_1 . A resistor R_2 is connected to node n_1 and node n_5 . A resistor R_4 is connected to node n_2 and node n_5 . A resistor R_5 is connected to node n_3 and the bottom reference node. A dependent current source $g v_x$ is connected between node n_2 and node n_4 . A dependent voltage source $v_s + v_x - r_{iy}$ is connected between node n_4 and node n_5 . A resistor r_{iy} is in series with the dependent voltage source. A current source i_b is connected to node n_5 from the bottom reference node. The voltage v_x is the voltage across R_2 . The current i_y flows through R_3 . The current i_{ccvs} flows through the dependent voltage source. The bottom reference node is connected to ground.

3 KCl still

$$\text{KCLing: } \frac{-V_x + R_1 i_b}{R_1} - i_b - \frac{V_x}{R_2} = 0$$

No need for SRC or MEAS; already used to label

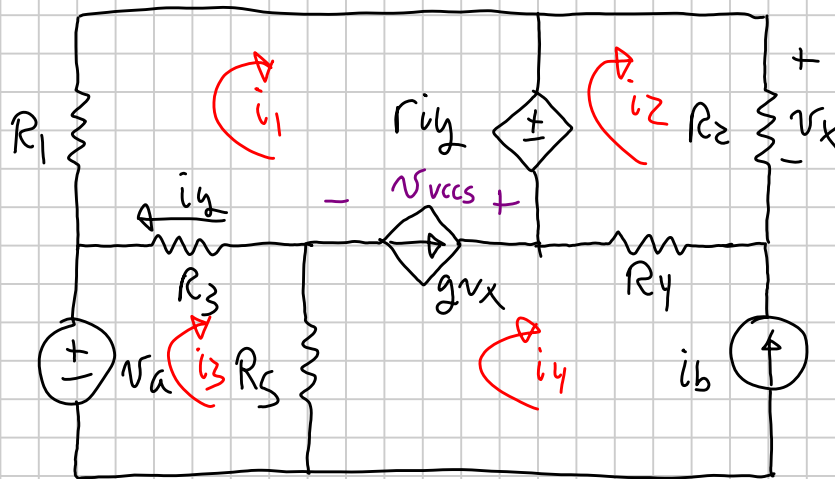
• $P_{abs, ry} = (v_x - r_{iy})^2 / R_y$

o pad,ccrs : rig icrs

$$i_{ccrs} = \frac{N_X + N_S - N_A}{R_1} + \frac{N_X}{R_2}$$

$$i_{ccs} = g v_x - \left(\frac{v_x - r_{ib}}{r_y} \right)$$

V) Mesh Current



4 mesh - 2 source = 2 KVL

Unknowns: $i_1, i_2, i_3, i_4, i_5, v_x$

$$\text{KVL}_2: -r_{i2} + R_2 i_2 + R_4 (i_2 - i_4) = 0$$

$$\text{KVL, } l_3: -v_a + R_3(i_3 - i_1) + R_5(i_3 - i_4) = 0$$

SRC, g_{vx} : $g_{vx} = i_4 - i_1$

SRC, i_b : $i_b = -i_y$

MEAS, i_y $\{y = i_1 - i_3\}$

MEAS, V_X : $V_X = R_2 i_2$

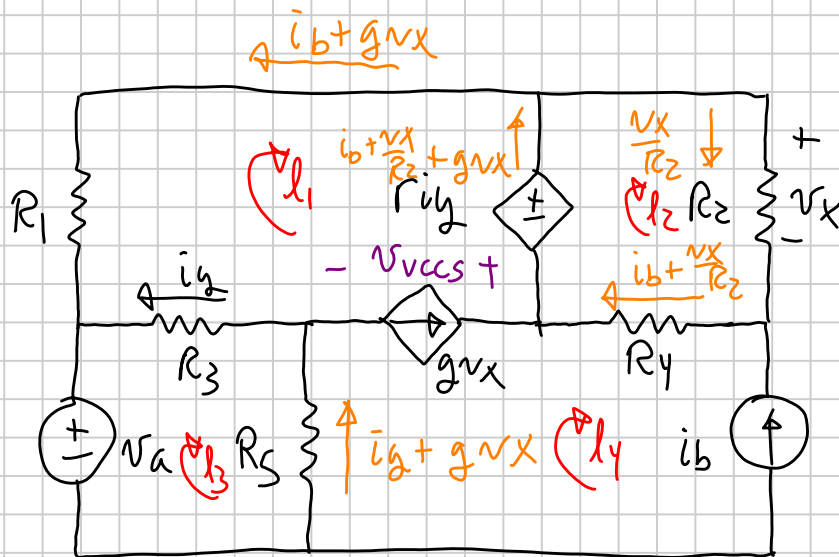
$$\bullet \rho_{abs, 124} = (i2 - i4)^2 \rho_y$$

$$\bullet P_{del, VCCS} = g_m \times V_{VCCS}$$

$$\bullet \varphi_{del, cvs} = \text{rig}(iz - i_1)$$

$$\rightarrow KVL_1: R_1 i_1 + r_{iy} + V_{VCCS} + R_3 (i_1 - i_2) = 0$$

Branch current



$\rightarrow$
 $i_y + g v_x + i_b$

Unknowns: v_x, i_y

2 KVL:

KVL, l_2 : $-r i_y + v_x + R_4 (i_b + v_x / R_2) = 0$

KVL, l_3 : $-v_a - R_3 i_y - R_5 (i_y + g v_x) = 0$

• $P_{abs, R_4} = (i_b + v_x / R_2)^2 R_4$

• $P_{del, v_{ccs}} = g v_x v_{vccs}$

KVL, l_1 : $-R_1 (i_b + g v_x) + r i_y + v_{vccs} + R_3 i_y = 0$

$v_{vccs} = R_1 (i_b + g v_x) - r i_y - R_3 i_y$

• $P_{del, ccvs} = r i_y (i_b + v_x / R_2 + g v_x)$