

3-6

$$a) \quad \boxed{V_A = V_1} \quad \boxed{V_B = V_A + V_2 = V_1 + V_2}$$

KCL @ C

$$i_1 = i_x + i_2$$

$$\frac{V_A - V_C}{R_1} = \frac{V_C - V_B}{R_3} + \frac{V_C}{R_2}$$

$$\boxed{\frac{1}{R_1} V_A + \frac{1}{R_3} V_B + \left(-\frac{1}{R_3} - \frac{1}{R_2} - \frac{1}{R_1}\right) V_C = 0}$$

$$b) \quad V_1 = V_2 = 5V \quad V_3 = 15V$$

$$R_1 = R_2 = 10k\Omega \quad R_3 = 40k\Omega \quad R_4 = 20k\Omega$$

$$V_x = V_C - 0 \quad i_x = \frac{V_C - V_B}{R_3}$$

$$V_A = 5V \quad V_B = 10V \quad V_C = 3.33V \quad \leftarrow \text{Solve eqns from part a)}$$

$$\boxed{V_x = 3.33V} \quad \boxed{i_x = -167\mu A}$$

$$c) \quad P_1 = ? \quad P = i_x V_1 = \frac{V_1^2}{R_1} = \frac{(V_A - V_C)^2}{R_1} = \frac{(5 - 3.33)^2}{10k}$$

$$\boxed{P_1 = 278\mu W}$$

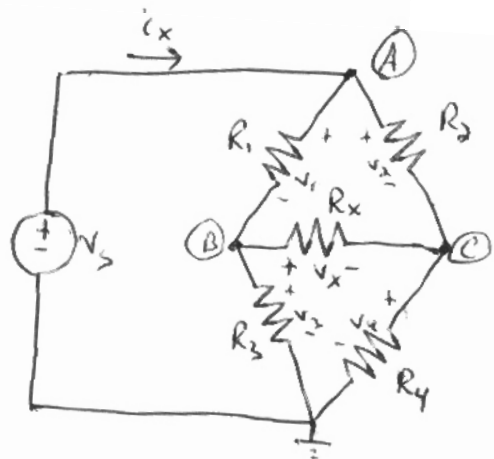
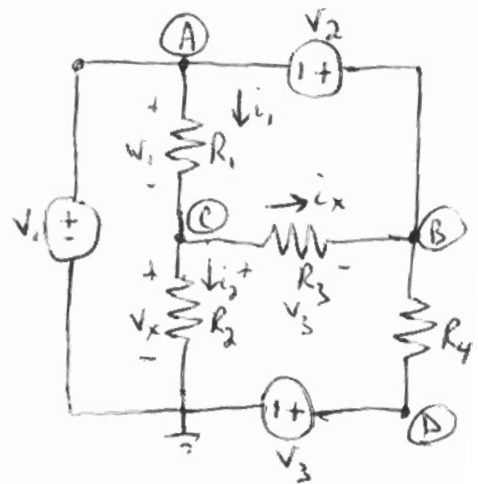
$$3-8 \quad a) \quad \boxed{V_A = V_5}$$

$$\text{KCL @ B} \quad i_1 = i_{R_x} + i_3 = \frac{V_A - V_B}{R_1} = \frac{V_B - V_C}{R_x} + \frac{V_B}{R_3}$$

$$\text{KCL @ C} \quad i_2 + i_x = i_4 \quad \frac{V_A - V_C}{R_2} + \frac{V_B - V_C}{R_x} = \frac{V_C}{R_4}$$

$$\boxed{\frac{1}{R_1} V_A - \left(\frac{1}{R_1} + \frac{1}{R_3} + \frac{1}{R_x}\right) V_B + \frac{1}{R_x} V_C = 0}$$

$$\boxed{\frac{1}{R_2} V_A + \frac{1}{R_x} V_B - \left(\frac{1}{R_2} + \frac{1}{R_4} + \frac{1}{R_x}\right) V_C = 0}$$



3-8 cont...

b) $R_1 = 10k$ $R_2 = 20k$ $R_3 = 60k$ $R_4 = 20k$ $R_x = 3k$ $V_s = 15V$

$$V_x = V_B - V_C \quad i_x = i_1 + i_2 = \frac{V_A - V_B}{R_1} + \frac{V_A - V_C}{R_2}$$

$V_A = 15V$

$V_B = 10.728V$

$V_C = 9.983V$

← Solving Eqs from part a)

$V_x = 0.745V$

$i_x = \frac{4.277}{R_1} + \frac{5.017}{R_2}$

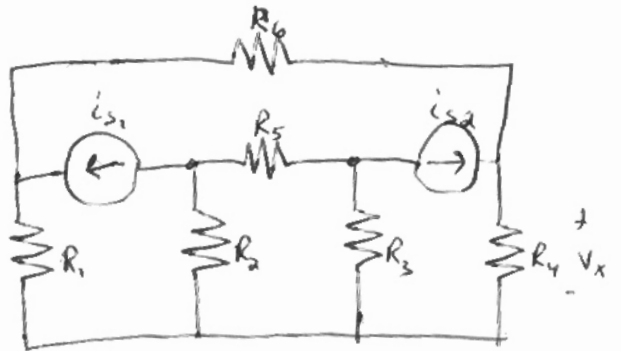
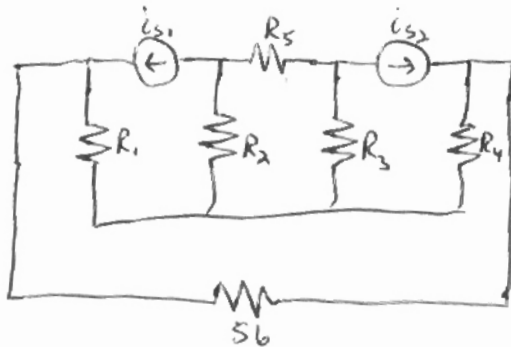
$i_x = 0.678mA$

c) $P_a = i_2 V_a = \frac{V_2^2}{R_2} = \frac{(V_A - V_C)^2}{R_2} = \frac{(5.017)^2}{20k}$

$P_a = 1.26mW$

3-14

a) Current sources in "internal" loops are bad.

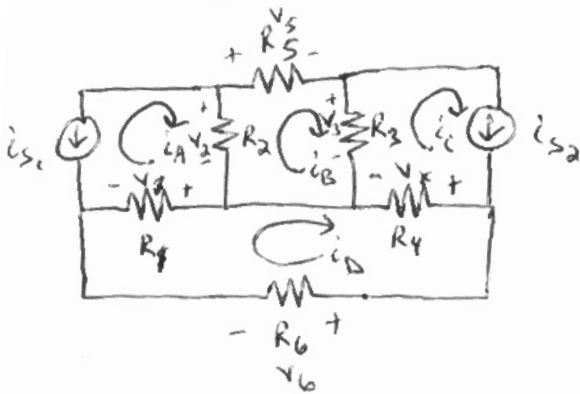


b) $i_A = -i_{s1}$ $i_C = i_{s2}$

KVL for i_B $-(i_A - i_B)R_2 + i_B R_5 + (i_B - i_C)R_3 = 0$

KVL for i_D $-(i_A - i_D)R_1 - (i_C - i_D)R_4 + i_D R_6 = 0$

OR



$-R_2 i_A + (R_2 + R_3 + R_5) i_B - R_3 i_C = 0$
 $-R_1 i_A - R_4 i_C + (R_1 + R_4 + R_6) i_D = 0$

3-14 cont.

c) $R_1 = R_2 = R_3 = R_4 = 2k$ $R_5 = R_6 = 1k$ $i_{s1} = 40mA$ $i_{s2} = 20mA$

$V_x = ? = (i_c - i_B) 2k$

$i_A = -40mA$ $i_c = 20mA$

$-(-40mA)(2k) + 5ki_B - (20mA)(2k) = 0$

$5ki_B = -40$

$i_B = -8mA$

$V_x = (20mA - -8mA) 2k = (28mA)(2k)$

$V_x = 56V$

$-(-40mA)(2k) - (20mA)(2k) + 5ki_B = 0$

$5ki_B = -40$

$i_B = -8mA$

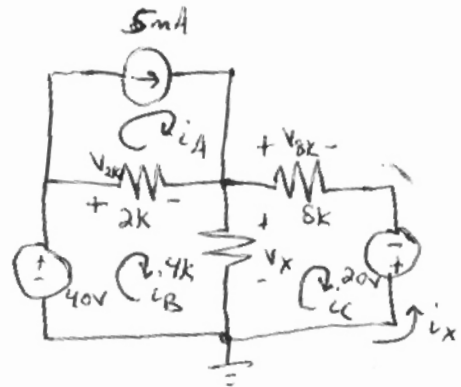
3-15

a) $i_A = 5mA$

KVL for i_B $-40V + (i_B - i_A) 2k + (i_B - i_c) 4k = 0$

KVL for i_c $-(i_B - i_c) 4k + i_c 8k - 20V = 0$

$2ki_A - 6ki_B + 4ki_c = -40$
 $4ki_B - 12ki_c = -20$



b) $i_x = -i_c$ $V_x = (i_B - i_c) 4k$

$i_x = -5.71mA$

$18ki_B - 12ki_c = 150$
 $+ -4ki_B + 12ki_c = 20$

 $14ki_B = 170$

$V_x = (12.14mA - 5.71mA) 4k$

$V_x = 25.7V$

$i_B = 12.14mA$ $i_c = 5.71mA$

3-15 cont...

$$c) P_{tot} = \sum iV = \sum i^2 R = (i_B - i_A)^2 2k + (i_B - i_C)^2 4k + i_C^2 (8k)$$

$$= (7.14m)^2 (2k) + (6.43m)^2 4k + (5.71m)^2 (8k)$$

$$P_{tot} = 0.53 W$$

3-20

$$-6 - 12 + (i_A - i_B) 6k = 0$$

$$i_C 4k - (i_B - i_C) 2k + 12 = 0$$

$$-(i_A - i_B) 6k + (i_B - i_C) 2k + i_B 8k = 0$$

$$① \quad 6ki_A - 6ki_B = 18$$

$$② \quad 2ki_B - 6ki_C = 12$$

$$③ \quad 6ki_A - 16ki_B + 2ki_C = 0$$

$$①-③ \quad 10ki_B - 2ki_C = 18 \quad \times 3 \Rightarrow \begin{matrix} 30ki_B - 6ki_C = 54 \\ -(2ki_B - 6ki_C = 12) \end{matrix}$$

$$28ki_B = 42$$

$$i_B = 1.5 mA$$

$$i_C = -1.5 mA$$

$$i_A = 4.5 mA$$

