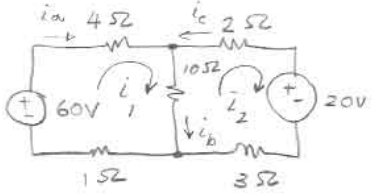
HW # 5

4.31



a) KVL around mesh 1:

$$-60 + 4i_1 + 10(i_1 - i_2) + 1 \times i_1 = 0$$

$$15i_1 - 10i_2 = 60 \quad (1)$$

KVL around mesh 2:

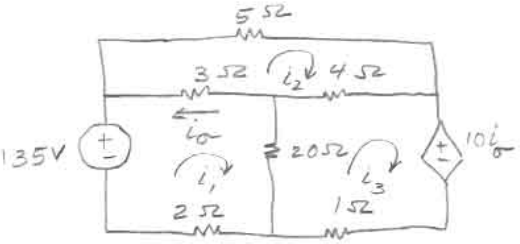
$$10(i_2 - i_1) + 2i_2 + 20 + 3i_2 = 0$$

$$-10i_1 + 15i_2 = -20 \quad (2)$$

Solving $\Rightarrow$ $i_1 = 5.6\,A$ & $i_2 = 2.4\,A$

$$i_a = i_1 = 5.6\,A \;, \quad i_b = i_1 - i_2 = 5.6 - 2.4 = 3.2\,A, \quad i_c = -i_2 = -2.4\,A$$

4.33



M1 $\Rightarrow$

$$-135 + 3(i_1 - i_2) + 20(i_1 - i_3) + 2i_1 = 0$$

$$25i_1 - 3i_2 - 20i_3 = 135 \quad (1)$$

M2 $\Rightarrow$ $5i_2 + 4(i_2 - i_3) + 3(i_2 - i_1) = 0$

$$-3i_1 + 12i_2 - 4i_3 = 0 \quad (2)$$

M3 $\Rightarrow$ $20(i_3 - i_1) + 4(i_3 - i_2) + 10i_o + i_3 = 0$ (a)

& $i_o = i_2 - i_1$ (b)

Substitute (b) into (a) $\Rightarrow$

$$20(i_3 - i_1) + 4(i_3 - i_2) + 10(i_2 - i_1) + i_3 = 0$$

$$\therefore \quad -30i_1 + 6i_2 + 25i_3 = 0 \quad (3)$$

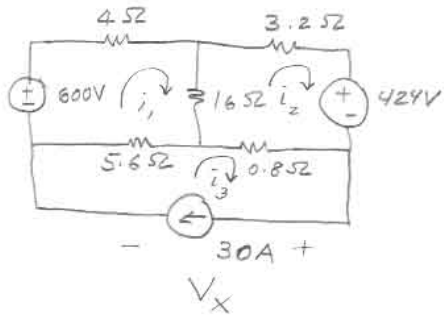
Solving $\Rightarrow$ $i_1 = 64.8\,A$, $i_2 = 39\,A$, $i_3 = 68.4\,A$

$$P_{20\Omega} = (i_1 - i_3)^2(20) = (64.8 - 68.4)^2(20) = 259.2\ W$$

4.37

a)

$i_3 = 30\ A$



M1 $\Rightarrow -600 + 4i_1 + 16(i_1 - i_2) + 5.6(i_1 - 30) = 0$

$$25.6i_1 - 16i_2 = 768 \quad (1)$$

M2 $\Rightarrow 16(i_2 - i_1) + 3.2i_2 + 424 + 0.8(i_2 - 30) = 0$

$$-16i_1 + 20i_2 = -400 \quad (2)$$

Solving $\Rightarrow i_1 = 35\ A$ & $i_2 = 8\ A$.

KVL around mesh 3 $\Rightarrow 5.6(i_3 - i_1) + 0.8(i_3 - i_2) + V_x = 0$

$\therefore V_x = -5.6(i_3 - i_1) - 0.8(i_3 - i_2) = -5.6(30 - 35) - 0.8(30 - 8)$

$= 28 - 17.6 = 10.4\ A$

$\therefore P_{30A} = +i_3 V_x = 30(10.4) = 312\ W$

$\therefore$ The 30 A source absorbs 312 W

(or it delivers $-312\ W$)

b) $P_{600V} = -i_1(600) = -35(600) = -21000\ W$

$P_{424V} = +i_2(424) = 8(424) = 3392\ W$

$\therefore$ only the 600V actually delivers power.

∴ The power developed in the circuit is 21000W

c) $P_{30A} = 312W$ (abs)

$P_{600V} = -21000W$ (del)

$P_{424} = 3392W$ (abs)

$P_{4\Omega} = i_1^2 \times 4 = 35^2 \times 4 = 4900W$ (abs)

$P_{3.2\Omega} = i_2^2 \times 3.2 = 8^2 \times 3.2 = 204.8$ (abs)

$P_{16\Omega} = (i_1 - i_2)^2 \times 16 = (35-8)^2 \times 16 = 11664W$ (abs)

$P_{5.6\Omega} = (i_1 - i_3)^2 \times 5.6 = (35-30)^2 \times 5.6 = 140W$ (abs)

$P_{0.8\Omega} = (i_2 - i_3)^2 \times 0.8 = (8-30)^2 \times 0.8 = 387.2W$ (abs).

$\sum P_{abs} = 312 + 3392 + 4900 + 204.8 + 11664 + 140 + 387.2$

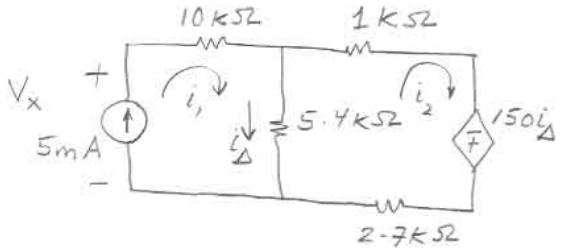
$= 21000W$

$= \sum P_{del}$

4.38

a)

$i_1 = 5\,mA$



M2 ⇒

$5400(i_2 - i_1) + 1000 i_2 - 150 i_\Delta + 2700 i_2 = 0 \quad (a)$

$i_\Delta = i_1 - i_2 \quad (b)$. Subtitute (b) into (a) ⇒

$5400(i_2 - i_1) + 1000 i_2 - 150(i_1 - i_2) + 2700 i_2 = 0$

$-5500 i_1 + 9250 i_2 = 0 \Rightarrow i_2 = \frac{5500 i_1}{9250} = \frac{5500 \times 5 \times 10^{-3}}{9250}$

$\therefore i_2 = 2.973\,mA$

$\therefore i_\Delta = i_1 - i_2 = (5 - 2.973)\,mA = 2.03\,mA$

b) $V_x = 10000 i_1 + 5400 i_\Delta = 10000(5 \times 10^{-3}) + 5400 \times 2.03 \times 10^{-3}$

$= 60.962\,V$

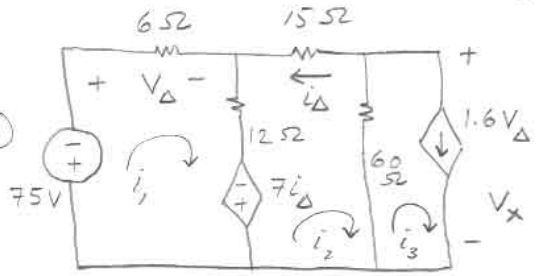
$\therefore P_{5mA} = -(5 \times 10^{-3})(60.962) = -0.305\,W$

$= -305\,mW$ (del.).

c) $P_{150 i_\Delta} = -i_2(150 i_\Delta) = -2.973 \times 10^{-3}(150)(2.03 \times 10^{-3})$

$= -0.905\,mW$ (del.)

4.42



a) M1 ⇒

$75 + 6i_1 + 12(i_1 - i_2) - 7i_\Delta = 0$ ①

$i_\Delta = -i_2$ ⑥

Subtitute ⑥ into ① ⇒

$75 + 6i_1 + 12(i_1 - i_2) + 7i_2 = 0$

$18i_1 - 5i_2 = -75$ ④

M2 ⇒ $7i_\Delta + 12(i_2 - i_1) + 15i_2 + 60(i_2 - i_3) = 0$

$\therefore -7i_2 + 12(i_2 - i_1) + 15i_2 + 60(i_2 - i_3) = 0$

$\therefore -12i_1 + 80i_2 - 60i_3 = 0$ ②

M3 ⇒ $i_3 = 1.6V_\Delta = 1.6(6i_1)$ ⇒

$9.6i_1 - i_3 = 0$ ③

solving ④ & ② & ③ ⇒

$i_1 = 4A$, $i_2 = 29.4A$, $i_3 = 38.4A$

$P_{75V} = i_1 \times 75 = 4 \times 75 = 300W$ (abs).

$P_{7i_\Delta} = (i_2 - i_1)(7i_\Delta) = (29.4 - 4)(7)(-29.4) = -5227.32W$ (gen)

$V_x = 60(i_2 - i_3) = 60(29.4 - 38.4) = -540V$

$$P_{1.6V_\Delta} = (1.6V_\Delta)V_x = 1.6(6i_1)(V_x)$$

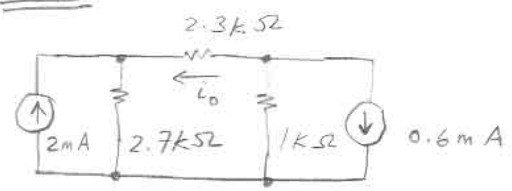
$$= 1.6 \times 6 \times 4 \times (-540) = -20736\,W \text{ (gen.)}$$

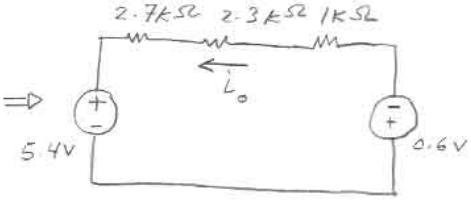
∴ The two dependent sources $7i_\Delta$ & $1.6V_\Delta$ generate power. The independent source 75V absorbs power.

The total power generated in the circuit is:

$$5227.32 + 20736 = 25963.32\,W = 25.96\,KW$$

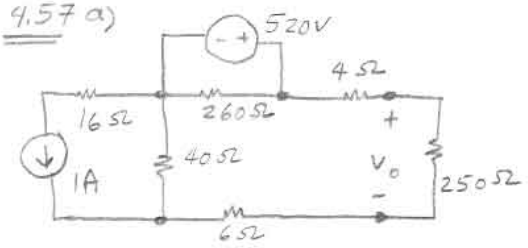
4.55 a)

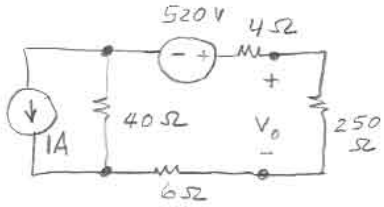


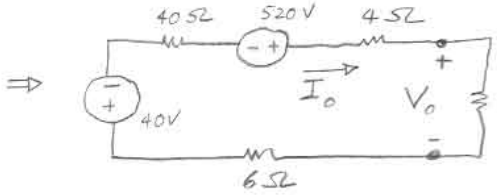


$$i_o = -\frac{6}{6K} = -1\,mA$$

4.57 a)







$$40 + 40I_o - 520 + 4I_o + 250I_o + 6I_o = 0$$

$$\therefore I_o = 1.6\,A$$

$$\therefore V_o = 250I_o = 400\,V$$