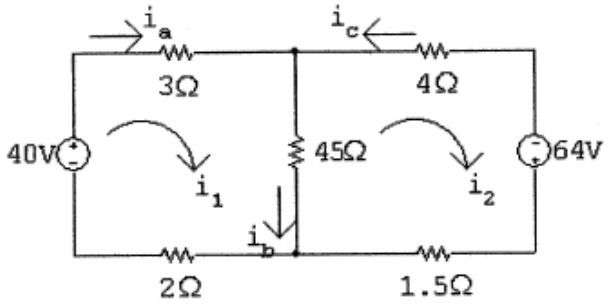
EGR 260 - Circuit Analysis
File: N260H5BS

Solution to HW#5 – Mesh Analysis

Problem Assignment:

Mesh analysis problems: 31a, 32a, 33, 35, 41a, 42, 47, 15 (using mesh equations)

P 4.31 [a]



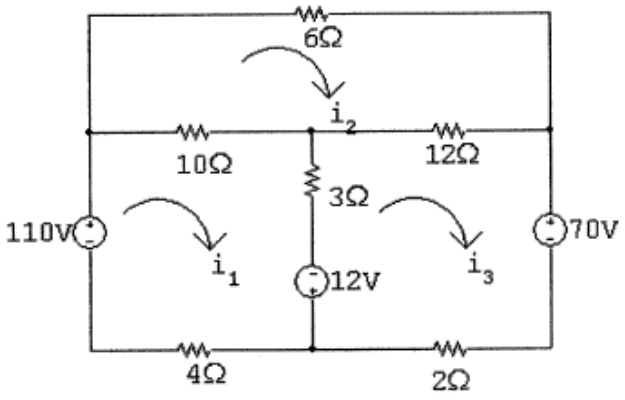
$$40 = 50i_1 - 45i_2$$

$$64 = -45i_1 + 50.5i_2$$

Solving, $i_1 = 9.8$ A; $\quad i_2 = 10$ A

$$i_a = i_1 = 9.8 \text{ A}; \quad i_b = i_1 - i_2 = -0.2 \text{ A}; \quad i_c = -i_2 = -10 \text{ A}$$

P 4.32 [a]



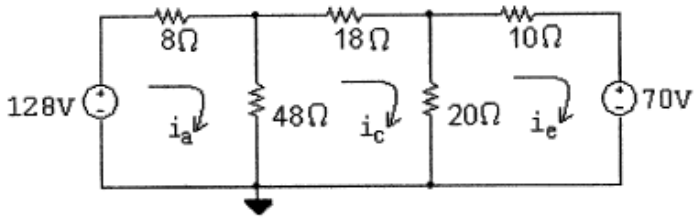
$$110 + 12 = 17i_1 - 10i_2 - 3i_3$$

$$0 = -10i_1 + 28i_2 - 12i_3$$

$$-12 - 70 = -3i_1 - 12i_2 + 17i_3$$

Solving, $i_1 = 8$ A; $\quad i_2 = 2$ A; $\quad i_3 = -2$ A

P 4.33 [a]



The three mesh current equations are:

$$-128 + 8i_a + 48(i_a - i_c) = 0$$

$$18i_c + 20(i_c - i_e) + 48(i_c - i_a) = 0$$

$$70 + 20(i_e - i_c) + 10i_e = 0$$

Place these equations in standard form:

$$i_a(8 + 48) + i_c(-48) + i_e(0) = 128$$

$$i_a(-48) + i_c(18 + 20 + 48) + i_e(-20) = 0$$

$$i_a(0) + i_c(-20) + i_e(20 + 10) = -70$$

Solving, $i_a = 4$ A; $i_c = 2$ A; $i_e = -1$ A
Now calculate the remaining branch currents:

$$i_b = i_a - i_c = 2 \text{ A}$$

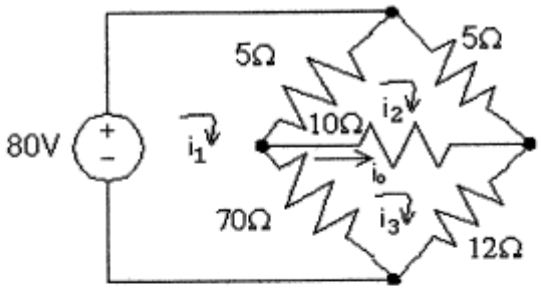
$$i_d = i_c - i_e = 3 \text{ A}$$

[b] $p_{\text{sources}} = p_{128\text{V}} + p_{70\text{V}} = -(128)i_a + (70)i_e$

$$= -(128)(4) + (70)(-1) = -512 - 70 = -582 \text{ W}$$

Thus, the power developed in the circuit is 582 W. Note that the resistors cannot develop power!

P 4.35



The three mesh current equations are:

$$-80 + 5(i_1 - i_2) + 70(i_1 - i_3) = 0$$

$$5i_2 + 10(i_2 - i_3) + 5(i_2 - i_1) = 0$$

$$12i_3 + 70(i_3 - i_1) + 10(i_3 - i_2) = 0$$

Place these equations in standard form:

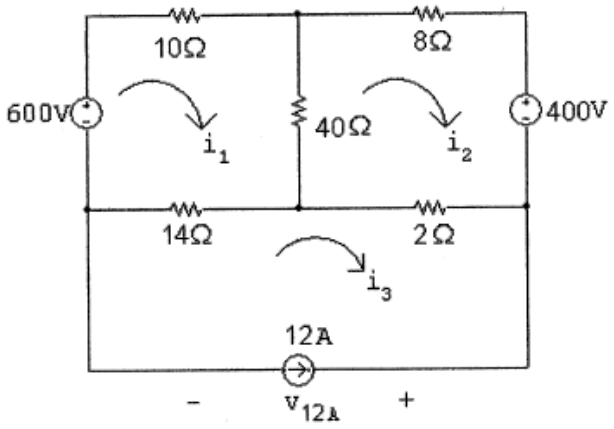
$$i_1(5 + 70) + i_2(-5) + i_3(-70) = 80$$

$$i_1(-5) + i_2(5 + 10 + 5) + i_3(-10) = 0$$

$$i_1(-70) + i_2(-10) + i_3(12 + 70 + 10) = 0$$

Solving, $i_1 = 6$ A; $i_2 = 4$ A; $i_3 = 5$ A
Thus, $i_o = i_3 - i_2 = 1$ A.

P 4.41



$$600 = 64i_1 - 40i_2 - 14i_3$$

$$-400 = -40i_1 + 50i_2 - 2i_3$$

$$-12 = i_3$$

Solving, $i_1 = 2.9$ A; $\quad i_2 = -6.16$ A; $\quad i_3 = -12$ A

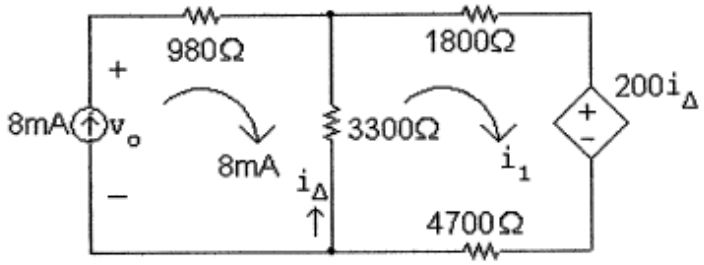
[a] $v_{12A} = 2(12 - 6.16) + 14(12 + 2.9)$

$= 220.28$ V

$p_{12A} = -12v_{12A} = -12(220.28) = -2643.36$ W

Therefore, the 12 A source delivers 2643.36 W.

P 4.42 **[a]**

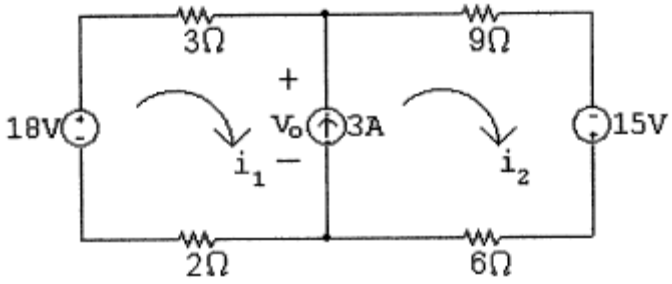


The mesh current equation for the right mesh is:
$3300(i_1 - 0.008) + 6500i_1 + 200(i_1 - 0.008) = 0$
Solving, $\quad 10{,}000i_1 = 28 \quad \therefore \quad i_1 = 2.8$ mA
Then, $\quad i_\Delta = i_1 - 0.008 = -5.2$ mA

[b] $v_o = (0.008)(980) - (-0.0052)(3300) = 25$ V
$p_{8mA} = -(25)(0.008) = -200$ mW
Thus, the 8 mA source delivers 200 mW

[c] $200i_\Delta = 200(-0.0052) = -1.04$ V
$p_{\text{dep source}} = 200i_\Delta i_1 = (-1.04)(0.0028) = -2.912$ mW
The dependent source delivers 2.912 mW.

P 4.47



$$-18 + 3i_1 + 9i_2 - 15 + 6i_2 + 2i_1 = 0; \quad i_2 - i_1 = 3$$

Solving, $i_1 = -0.6$ A; $\quad i_2 = 2.4$ A

$p_{18V} = -18i_1 = 10.8$ W (diss)

$p_{3\Omega} = (-0.6)^2(3) = 1.08$ W

$p_{2\Omega} = (-0.6)^2(2) = 0.72$ W

$p_{9\Omega} = (2.4)^2(9) = 51.84$ W

$p_{6\Omega} = (2.4)^2(6) = 34.56$ W

$\sum p_{\text{diss}} = 99$ W

$v_o = 15i_2 - 15 = 36 - 15 = 21$ V

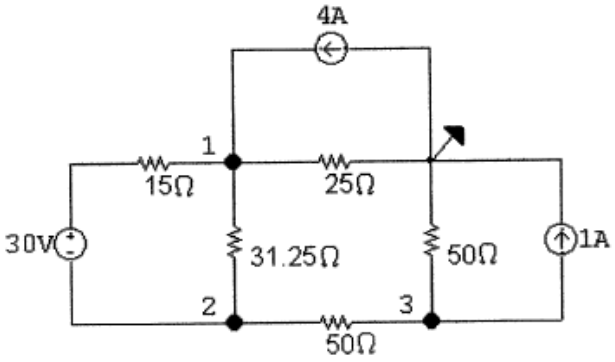
$p_{3A} = -3v_o = -63$ W (dev)

$p_{15V} = -15i_2 = -36$ W (dev)

$\sum p_{\text{dev}} = 99$ W $= \sum p_{\text{diss}}$

4.15 using mesh equations (to be added later)

P 4.15



$$\frac{v_1-(v_2+30)}{15}+\frac{v_1-v_2}{31.25}+\frac{v_1}{25}-4=0$$

$$-\left[\frac{v_1-(v_2+30)}{15}\right]+\frac{v_2-v_3}{50}+\frac{v_2-v_1}{31.25}=0$$

$$\frac{v_3-v_2}{50}+\frac{v_3}{50}+1=0$$

Solving, $v_1=76$ V; $\quad v_2=46$ V; $\quad v_3=-2$ V; $\quad i_{30\text{V}}=0$ A

$$p_{4\text{A}}=-4v_1=-4(76)=-304 \text{ W} \quad \text{(del)}$$

$$p_{1\text{A}}=(1)(-2)=-2 \text{ W} \quad \text{(del)}$$

$$p_{30\text{V}}=(30)(0)=0 \text{ W}$$

$$p_{15\Omega}=(0)^2(15)=0 \text{ W}$$

$$p_{25\Omega}=\frac{v_1^2}{25}=\frac{76^2}{25}=231.04 \text{ W}$$

$$p_{31.25\Omega}=\frac{(v_1-v_2)^2}{31.25}=\frac{30^2}{31.25}=28.8 \text{ W}$$

$$p_{50\Omega}(\text{lower})=\frac{(v_2-v_3)^2}{50}=\frac{48^2}{50}=46.08 \text{ W}$$

$$p_{50\Omega}(\text{right})=\frac{v_3^2}{50}=\frac{4}{50}=0.08 \text{ W}$$

$$\sum p_{\text{diss}}=0+231.04+28.8+46.08+0.08=306 \text{ W}$$

$$\sum p_{\text{dev}}=304+2=306 \text{ W} \qquad \text{(CHECKS)}$$