Boise State University
Electrical Engineering Department

EE 210: Circuits I

Solution 1

Let R_0 = combination of three 12Ω resistors in parallel

$$\frac{1}{R_o} = \frac{1}{12} + \frac{1}{12} + \frac{1}{12} \longrightarrow R_o = 4$$

$$R_{eq} = 30 + 60 \| (10 + R_0 + R) = 30 + 60 \| (14 + R)$$

$$50 = 30 + \frac{60(14 + R)}{74 + R} \longrightarrow 74 + R = 42 + 3R$$

or R = **16 Ω**

Solution 2

(a) $R_{ab} = 5 \| 20 + 10 \| 40 = \frac{5x20}{25} + \frac{400}{50} = 4 + 8 = \underline{\mathbf{12\ \Omega}}$

(b) $60 \| 20 \| 30 = \left(\frac{1}{60} + \frac{1}{20} + \frac{1}{30} \right)^{-1} = \frac{60}{6} = 10\Omega$

$R_{ab} = 80 \| (10 + 10) = \frac{80 + 20}{100} = \underline{\mathbf{16\ \Omega}}$

Solution 3

(a) 10//40 = 8, 20//30 = 12, 8//12 = 4.8

$R_{ab} = 5 + 50 + 4.8 = \underline{59.8\Omega}$

(b) 12 and 60 ohm resistors are in parallel. Hence, 12//60 = 10 ohm. This 10 ohm and 20 ohm are in series to give 30 ohm. This is in parallel with 30 ohm to give 30//30 = 15 ohm. And 25//(15+10) = 12.5. Thus

$R_{ab} = 5 + 12.8 + 15 = \underline{32.5\Omega}$

Solution 4

Applying KCL to the upper node,

$$10 = \frac{v_0}{10} + \frac{v_o}{20} + \frac{v_o}{30} + 2 + \frac{v_0}{60} \longrightarrow \quad v_0 = \underline{\mathbf{40\ V}}$$

$$i_1 = \frac{v_0}{10} = \underline{\mathbf{4\ A}}\ ,\ i_2 = \frac{v_0}{20} = \underline{\mathbf{2\ A}},\ i_3 = \frac{v_0}{30} = \underline{\mathbf{1.3333\ A}},\ i_4 = \frac{v_0}{60} = \underline{\mathbf{666.7\ mA}}$$

Solution 5

$$-2 + \frac{V_x - 0}{10} + \frac{V_x - 0}{20} + 0.2V_x = 0$$

$0.35V_x = 2$ or $V_x = \underline{\mathbf{5.714\ V}}$.

Substituting into the original equation for a check we get,

0.5714 + 0.2857 + 1.1428 = 1.9999 checks!

Solution 6

At the top node, KVL gives

$$\frac{V_o - 36}{1} + \frac{V_o - 0}{2} + \frac{V_o - (-12)}{4} = 0$$

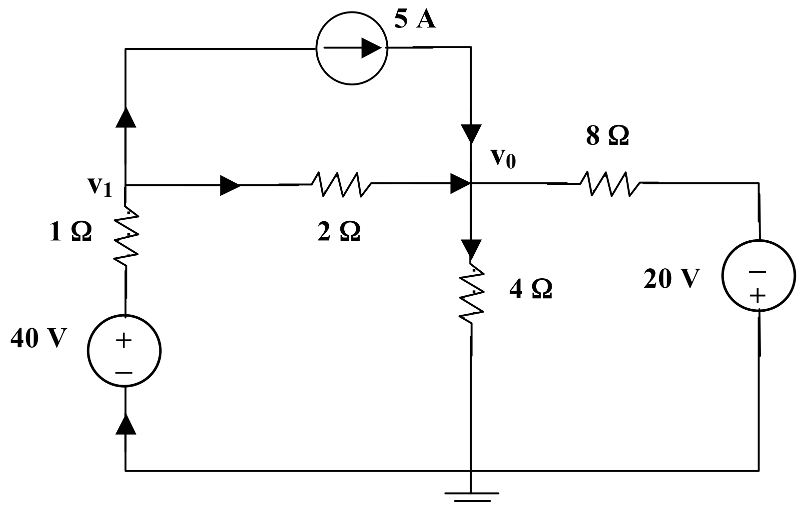
$1.75V_o = 33$ or $V_o = 18.857V$

$P_{1\Omega} = (36–18.857)^2/1 = \underline{\mathbf{293.9\ W}}$

$P_{2\Omega} = (V_o)^2/2 = (18.857)^2/2 = \underline{\mathbf{177.79\ W}}$

$P_{4\Omega} = (18.857+12)^2/4 = \underline{\mathbf{238\ W}}$.

Solution 7



Nodes 1 and 2 form a supernode so that $v_1 = v_2 + 10$ (1)

At the supernode, $2 + 6v_1 + 5v_2 = 3\,(v_3 - v_2) \longrightarrow 2 + 6v_1 + 8v_2 = 3v_3$ (2)

At node 3, $2 + 4 = 3\,(v_3 - v_2) \longrightarrow v_3 = v_2 + 2$ (3)

Substituting (1) and (3) into (2),

$$2 + 6v_2 + 60 + 8v_2 = 3v_2 + 6 \longrightarrow v_2 = \frac{-56}{11}$$

$$v_1 = v_2 + 10 = \frac{54}{11}$$

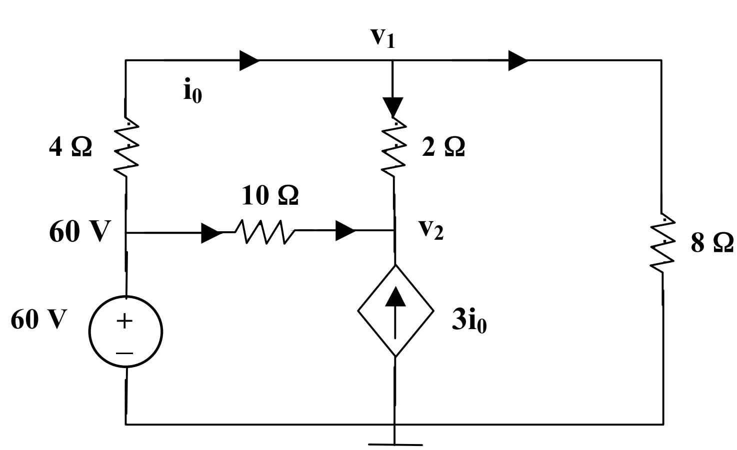
$$i_0 = 6v_i = \underline{\mathbf{29.45\ A}}$$

$$P_{65} = \frac{v_1^2}{R} = v_1^2 G = \left(\frac{54}{11}\right)^2 6 = \underline{\mathbf{144.6\ W}}$$

$$P_{55} = v_2^2 G = \left(\frac{-56}{11}\right)^2 5 = \underline{\mathbf{129.6\ W}}$$

$$P_{35} = (v_L - v_3)^2 G = (2)^2 3 = \underline{\mathbf{12\ W}}$$

Solution 8



At node 1, $\frac{60 - v_1}{4} = \frac{v_1}{8} + \frac{v_1 - v_2}{2}$ $\qquad$ $120 = 7v_1 - 4v_2$ $\qquad$ (1)

At node 2, $3i_0 + \frac{60 - v_2}{10} + \frac{v_1 - v_2}{2} = 0$

But $i_0 = \frac{60 - v_1}{4}$.

Hence

$$\frac{3(60 - v_1)}{4} + \frac{60 - v_2}{10} + \frac{v_1 - v_2}{2} = 0 \longrightarrow 1020 = 5v_1 + 12v_2 \qquad (2)$$

Solving (1) and (2) gives v_1 = 53.08 V. Hence $i_0 = \frac{60 - v_1}{4}$ = **<u>1.73 A</u>**