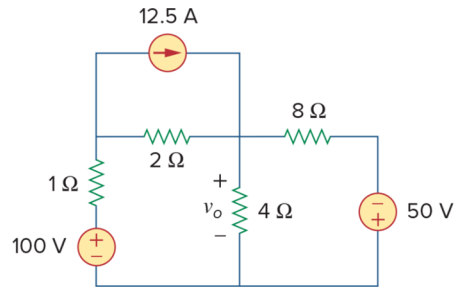


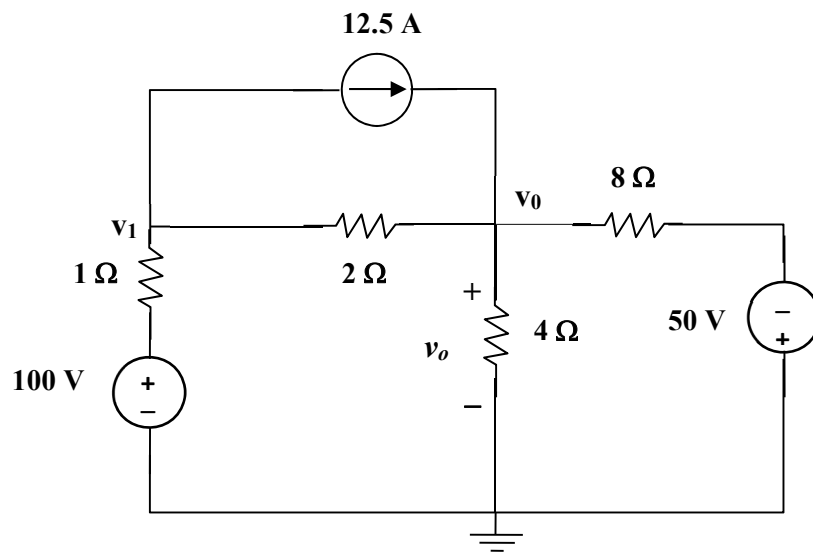
EE1002 Tutorial 5 Solution

(Problems extracted from the Textbook by Alexander & Sadiku, 7th edition)

1. Using nodal analysis, find v_o in the following circuit:



Solution



At node 1,

$$[(v_1 - 100)/1] + [(v_1 - v_o)/2] + 12.5 = 0 \text{ or } 3v_1 - v_o = 200 - 25 = 175 \quad (1)$$

At node o,

$$[(v_o - v_1)/2] - 12.5 + [(v_o - 0)/4] + [(v_o + 50)/8] = 0 \text{ or } -4v_1 + 7v_o = 50 \quad (2)$$

Adding 4x(1) to 3x(2) yields,

$$4(1) + 3(2) = -4v_o + 21v_o = 700 + 150 \text{ or } 17v_o = 850 \text{ or}$$

$$v_o = \mathbf{50 \text{ V.}}$$

Checking, we get $v_1 = (175 + v_o)/3 = 75 \text{ V.}$

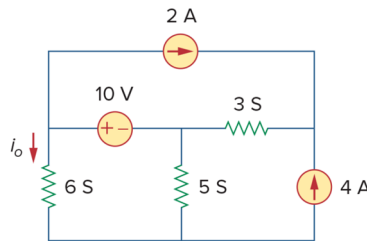
At node 1,

$$[(75 - 100)/1] + [(75 - 50)/2] + 12.5 = -25 + 12.5 + 12.5 = 0!$$

At node o,

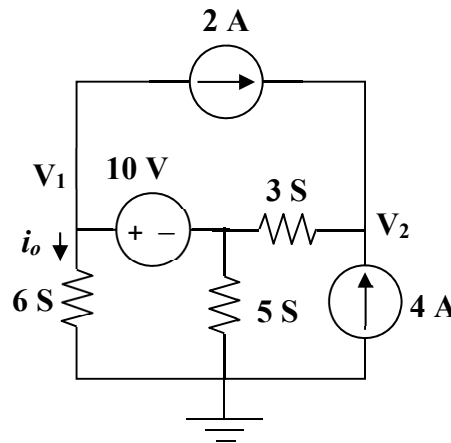
$$[(50 - 75)/2] + [(50 - 0)/4] + [(50 + 50)/8] - 12.5 = -12.5 + 12.5 + 12.5 - 12.5 = 0!$$

2. Apply nodal analysis to find i_o and the power dissipated in each resistor in the circuit of the following figure (the unit of S is called Seimens, which is the reciprocal of the unit Ω , e.g., $1/(0.5\text{S}) = 2\Omega$):



Solution

Step 1. First pick a reference node and write the appropriate node equations. In addition, we will need a constraint equation to solve for i_o . Then solve for the node voltages.



$$[6(V_1-0)] + 2 + [5(V_1-10-0)] + [3(V_1-10-V_2)] = 0; [3(V_2-(V_1-10))] - 2 - 4 = 0; \text{ and } i_o = 6(V_1-0).$$

Step 2. $(6+5+3)V_1 - 3V_2 = -2 + 50 + 30$ or $14V_1 - 3V_2 = 78$ and $-3V_1 + 3V_2 = -24$.

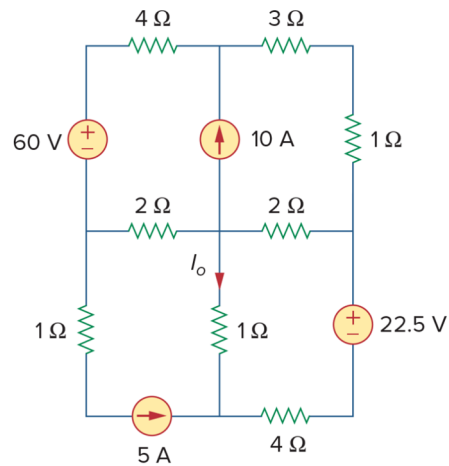
$$\begin{bmatrix} 14 & -3 \\ -3 & 3 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 78 \\ -24 \end{bmatrix} \text{ or } \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \frac{\begin{bmatrix} 3 & 3 \\ 3 & 14 \end{bmatrix}}{42-9} \begin{bmatrix} 78 \\ -24 \end{bmatrix}$$

$V_1 = 3(78-24)/33 = 4.909 \text{ V}$ and $V_2 = [(3 \times 78) - (14 \times 24)]/33 = -3.091 \text{ V}$. Let $I_3 = 3(4.909 - 10 - (-3.091)) = -6 \text{ A}$ and $I_5 = 5(4.909 - 10) = -25.455 \text{ A}$. Finally, $i_o = 6 \times 4.909$

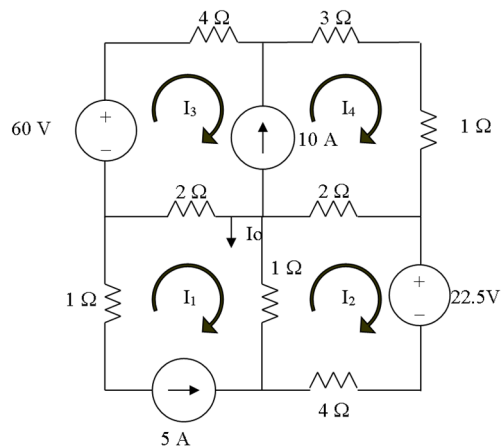
$= 29.45 \text{ A}$. This now gives us, $P_{6S} = (29.454)^2/6 = 144.6 \text{ W}$;

$P_{5S} = (-25.455)^2/5 = 129.6 \text{ W}$; and $P_{3S} = (-6)^2/3 = 12 \text{ W}$.

3. Apply mesh analysis to the following circuit and obtain I_o .



Consider the circuit below with the mesh currents.



$$I_1 = -5 \text{ A} \quad (1)$$

$$1(I_2 - I_1) + 2(I_2 - I_4) + 22.5 + 4I_2 = 0$$

$$7I_2 - 2I_4 = -27.5 \quad (2)$$

$$-60 + 4I_3 + 3I_4 + 1I_4 + 2(I_4 - I_2) + 2(I_3 - I_1) = 0 \text{ (super mesh)}$$

$$-2I_2 + 6I_3 + 6I_4 = +60 - 10 = 50 \quad (3)$$

But, we need one more equation, so we use the constraint equation $-I_3 + I_4 = 10$ (4). Solve this equation:

$$\begin{bmatrix} 7 & 0 & -2 \\ -2 & 6 & 6 \\ 0 & -1 & 1 \end{bmatrix} \begin{bmatrix} I_2 \\ I_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} -27.5 \\ 50 \\ 10 \end{bmatrix}$$

Thus,

$$I_1 = -5 \text{ A}$$

$$I_2 = -1.375 \text{ A}$$

$$I_3 = -1.0625 \text{ A}$$

$$I_4 = 8.9375 \text{ A}$$

$$I_o = I_1 - I_2 = -3.625 \text{ A}$$