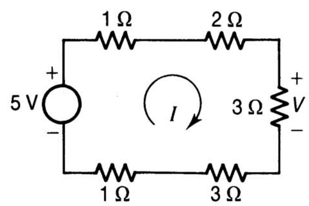
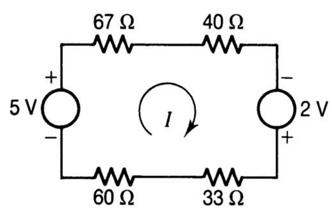
PROBLEMS CHAPTER 2.

P.2.1. Find the indicated voltage V using mesh formulation



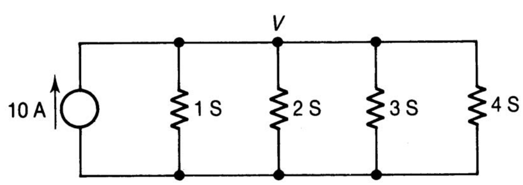
$R = 1 + 2 + 3 + 3 + 1 = 10$. Then $I = 5/10$ and $V = 3I = 15/10$.

P.2.2. Find the current I using one mesh equation



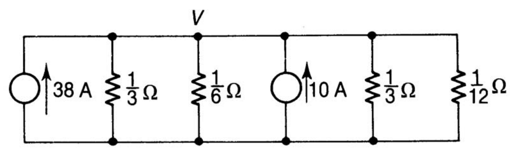
The network is described by the equation $7 = (67 + 40 + 60 + 33)I$, from which $I = 7/200$.

P.2.3. Find the voltage V using one nodal equation



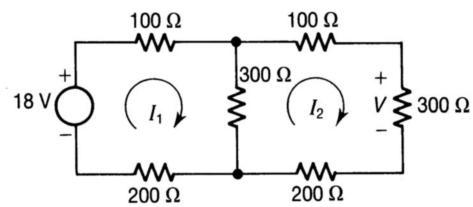
The equation is $(1 + 2 + 3 + 4)V = 10$. Solution: $V = 1$

P.2.4. Find the voltage V using one nodal equation



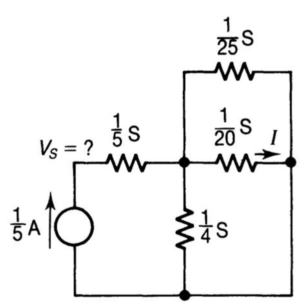
The equation is $48 = (3+6+3+12)V$. Solution: $V = 48/24 = 2$.

P.2.5. Write the mesh equations and find the voltage V



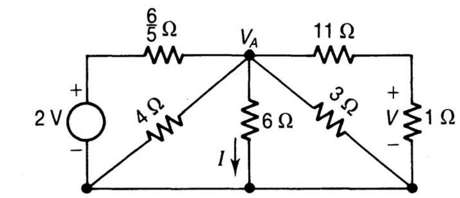
The equations are $600I_1 - 300I_2 = 18$ and $-300I_1 + 900I_2 = 0$. The second equation is simplified to $I_1 = 3I_2$ and inserted into the first. $I_2 = 18/1500$ and $V = I_2 \times 300 = 18/5$.

P.2.6. Connecting an element in series with a current source is not typical because the current forced through the element is known and for the rest of the network the voltages are the same as if the element was a short circuit. The only difference is the voltage formed across the current source. Use this information, apply nodal formulation and calculate the current I. Also obtain the voltage across the current source.



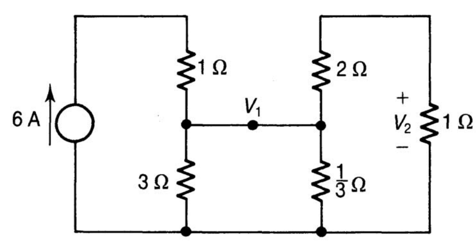
Without the first conductance $(1/4 + 1/20 + 1/25)V = 1/5$ and $V = 20/34$. The current is $I = VG = \frac{20}{34} \times \frac{1}{20} = \frac{1}{34}$. $V_J = V + J \times 5 = 20/34 + 1 = 54/34$.

P.2.7. Find the indicated V and I. Use simplifications of the network to get to the result more easily



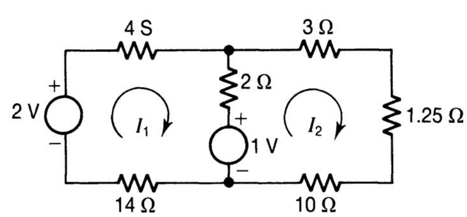
For the combination we have $G = 1/4 + 1/6 + 1/3 + 1/12$ or $R = 6/5$. Total network resistance is $R_{tot} = 6/5 + 6/5 = 12/5$. $I_E = 10/12$, $V_A = 2 - I_E \times 6/5 = 1$. The current $I = V_A/6 = 1/6$ and $V = V_A \times 1/12 = 1/12$

P.2.8. Calculate the indicated voltages V_1 and V_2 using any method or simplifications.



The equation is $(1/3 + 3 + 1/3)V = 6$, $V_1 = 18/11$ and $V_2 = 18/33$

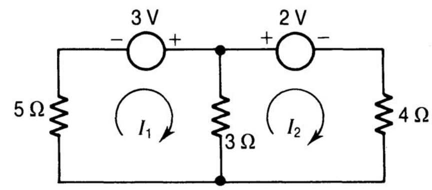
P.2.9. Use mesh formulation to obtain the indicated currents



$$\begin{bmatrix} 16.25 & -2 \\ -2 & 16.25 \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 2-1 \\ 1 \end{bmatrix}$$

The determinant is $D = 260.0625$. By Cramer's rule
$I_1 = I_2 = 18.25/D = 0.070175$.

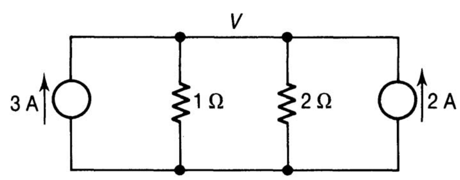
P.2.10. Use mesh formulation to obtain the currents



$$\begin{bmatrix} 8 & -3 \\ -3 & 7 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 3 \\ -2 \end{bmatrix}$$

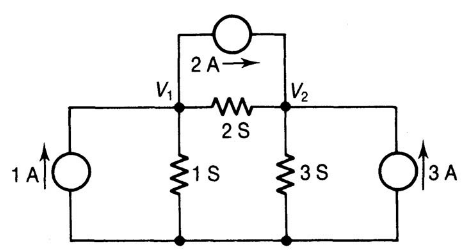
The determinant is $D = 47$, $I_1 = 15/47$, $I_2 = 7/47$.

P.2.11. Calculate the voltage V using nodal formulation.



$(1 + \frac{1}{2})V = 5$, $V = 10/3$.

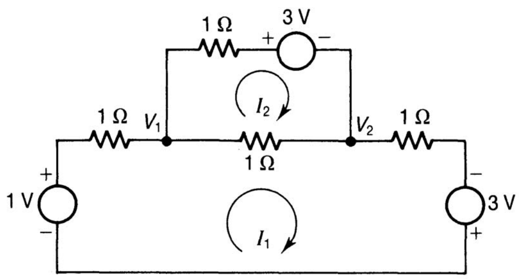
P.2.12. Calculate the nodal voltages V_1 and V_2



$$\begin{bmatrix} 3 & -2 \\ -2 & 5 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} -1 \\ 5 \end{bmatrix}$$

The determinant is $D = 11$, $V_1 = 5/11$, $V_2 = 13/11$.

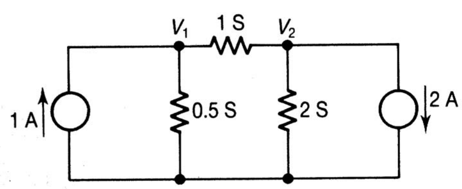
P.2.13. Use mesh formulation to get the currents. Also calculate the nodal voltages V_1 and V_2.



$$\begin{bmatrix} 3 & -1 \\ -1 & 2 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 4 \\ -3 \end{bmatrix}$$

$D = 5$, $I_1 = 5/5 = 1$, $I_2 = -5/5 = -1$. $V_1 = 1 - 1 \times I_1 = 0$, $V_2 = -3 + 1 \times I_1 = -2$

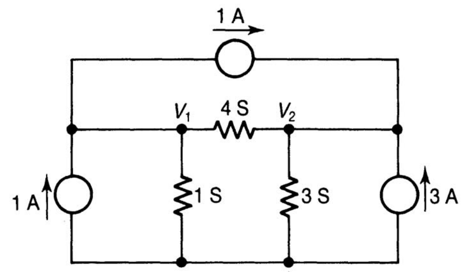
P.2.14. Calculate V_1 and V_2



$$\begin{bmatrix} 3/2 & -1 \\ -1 & 3 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$$

The determinant is $D = 7/2$, $V_1 = 2/7$, $V_2 = -4/7$.

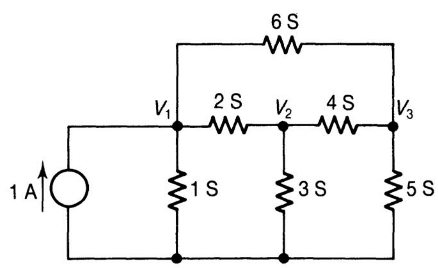
P.2.15. Calculate the indicated voltages.



$$\begin{bmatrix} 5 & -4 \\ -4 & 7 \end{bmatrix}\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 3 \end{bmatrix}$$

The determinant is $D = 19$, $V_1 = 12/19$, $V_2 = 15/19$.

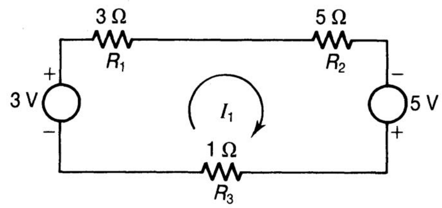
P.2.16. Calculate all three nodal voltages.



$$\begin{bmatrix} 9 & -2 & -6 \\ -2 & 9 & -4 \\ -6 & -4 & 15 \end{bmatrix}\begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$$

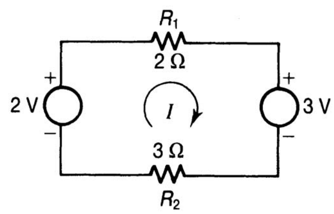
The determinant is $D = 591$, $V_1 = 119/591$, $V_2 = 54/591$, $V_3 = 62/591$.

P.2.17. Obtain the voltages across the resistors.



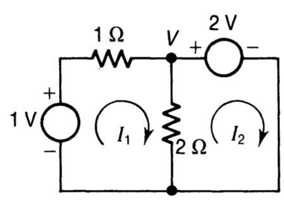
$(3+5+1)I = 3+5$ $I = 8/9$, $V_{R1} = 8/3$, $V_{R2} = 40/9$, $V_{R3} = 8/9$.

P.2.18. Obtain the voltages across the resistors



$(2+3)I = 2-3$, $I = -1/5$, $V_{R1} = 2/5$, $V_{R2} = 3/5$. The current flows in opposite direction.

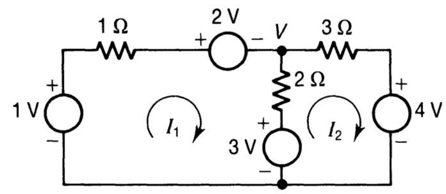
P.2.19. Calculate the currents and the voltage V.



$$\begin{bmatrix} 3 & -2 \\ -2 & 2 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$$

The determinant is $D = 2$, $I_1 = -1$, $I_2 = -2$ and from the picture $V = 2$.

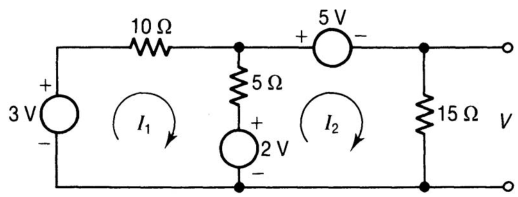
P.2.20. Calculate the currents and the voltage V



$$\begin{bmatrix} 3 & -2 \\ -2 & 5 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} -4 \\ -1 \end{bmatrix}$$

The determinant is $D = 11$, $I_1 = -2$, $I_2 = -1$. The voltage V can be calculated two ways: $V = 4 + 3 \times I_2 = 1$, or $V = 3 + 2(I_1 - I_2) = 1$.

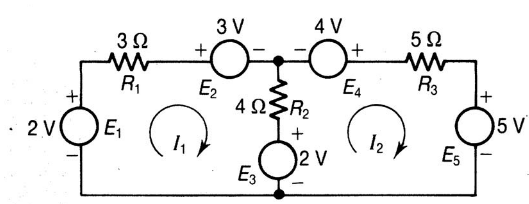
P.2.21. Calculate the currents and the voltage V.



$$\begin{bmatrix} 15 & -5 \\ -5 & 20 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 1 \\ -3 \end{bmatrix}$$

The determinant is $D = 275$, $I_1 = 5/275$, $I_2 = -40/275$. $V = 15 \times I_2 = -60/275$.

P.2.22. Calculate the currernts, the voltages and the powers either deliverred or consumed in all elements.



$$\begin{bmatrix} 7 & -4 \\ -4 & 9 \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} -3 \\ 11 \end{bmatrix}$$

The determinant is $D = 47$, $I_1 = -23/47$, $I_2 = -5/47$,
$V_{R1} = 3I_1 = -69/47$;
$P_{R1} = 3I_1^2 = 1587/2209$.
$V_{R2} = 4(I_2 - I_1) = 72/47$;
$P_{R2} = 4(I_2 - I_1)^2 = 1296/2209$;
$V_{R3} = 5I_2 = -25/47$,
$P_{R3} = 5I_2^2 = 125/2209$
$P_{E1} = 2I_1 = -46/47$, consumed
$P_{E2} = -3 \times I_1 = 69/47$, delivered.
$P_{E3} = 2(I_2 - I_1) = 36/47$, delivered.
$P_{E4} = 4I_2 = -20/47$, consumed,
$P_{E5} = -5 \times I_2 = 25/47$, delivered.
The sum of powers delivered by the sources, 64/47, is equal to the sum of powers consumed by the resistors.