Circuit analysis technique

Mesh(loop)current method(Maxwell's method):

This method is derived from (KVL) and can be applied by the following step:

1) Convert all current sources in the circuit to voltage sources.
2) Assign independent loop in the circuit to be analyzed (all the loop have the same direction).
3) Write the loop equations of the circuit as in the following formulas.

$I_1\sum R_{loop1} - I_2\sum R_{between\ loop1\&2} - \ldots\ldots\ldots\ldots - I_n\sum R_{between\ loop1\&n} = \sum V_{loop1} \ldots\ldots (1)$

$-I_1\sum R_{between\ loop1\&2} + I_2\sum R_{loop2} - \ldots\ldots\ldots\ldots - I_n\sum R_{between\ loop2\&n} = \sum V_{loop2} \ldots (2)$

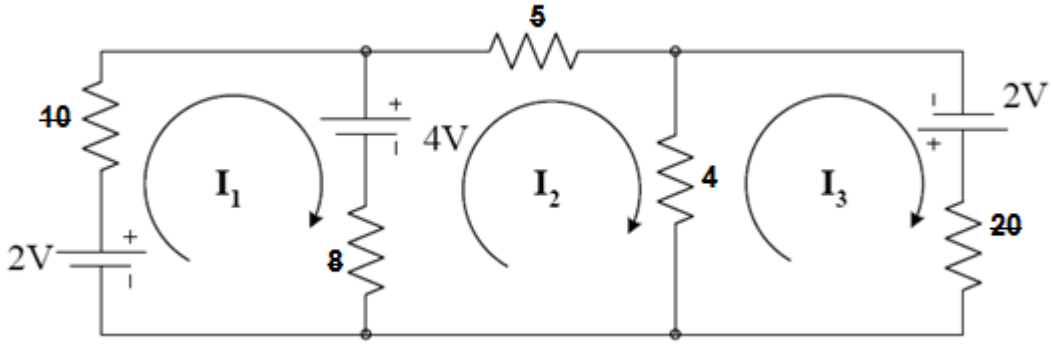
. . . .

. . . .

$-I_1\sum R_{betwwen\ loop1\&n} - I_2\sum R_{between\ loopn\&2} - \ldots\ldots\ldots + I_n\sum R_{loopn} = \sum V_{loopn} \ldots\ldots (n)$

4) Solve the above equation to find out the current value($I_1, I_2 \ldots\ldots I_n$)

Example: write the mesh equation for the network shown below.(all resistors value are in ohm)



$I_1(10+8) - I_2(8) - I_3 0 = 2-4 \ldots\ldots\ldots\ldots\ldots 1$

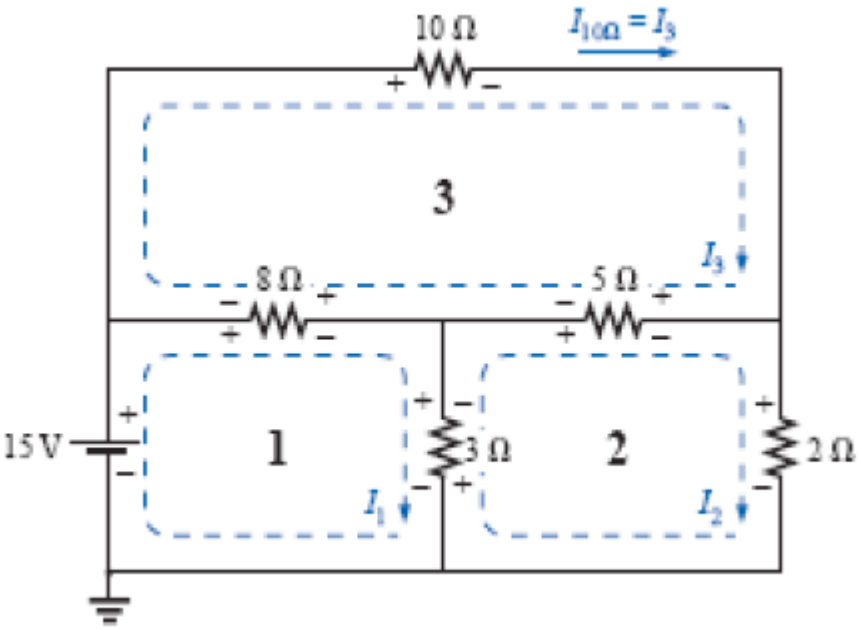
$-I_1(8) + I_2(8+5+4) - I_3(4) = 4 \ldots\ldots\ldots\ldots 2$

$I_1(0) - I_2(4) + I_3(4+20) = 2 \ldots\ldots\ldots\ldots\ldots 3$

Solve the aboe equation we obtain:

I_1=-0.54A ,I_2=0.92 A ,I_3=0.678 A

Example:find the current through the 10 ohm resistor.



Solution:

Loop1 $(8+3)I_1-(3)I_2-(8)I_3=15$

Loop2 $-(3)I_1+(3+5+2)I_2-(5)I_3=0$

Loop3 $-(8)I_3-(5)I_2+(8+5+10)I_3=0$

Rewrite the above equation

$11I_1-3I_2-8I_3=15$

$-3I_1+10I_2-5I_3=0$

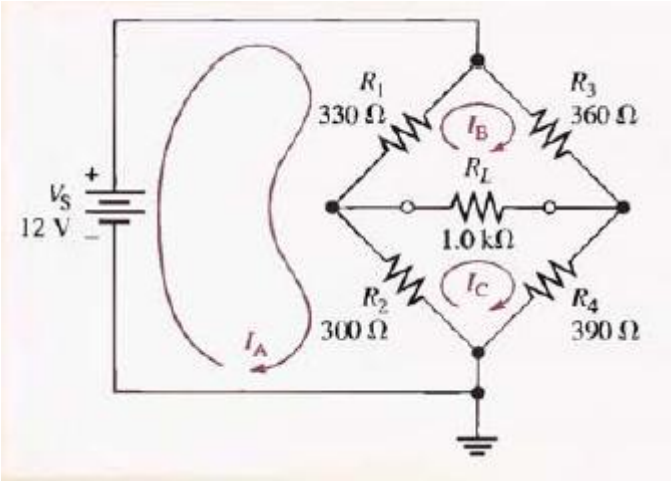
$-8I_3-5I_2+2I_3=0$

The current through 10 ohm resistor is I_3 and can be determined using the detreminates

$$I_3 = I_{10\Omega} = \frac{\begin{vmatrix} 11 & -3 & 15 \\ -3 & 10 & 0 \\ -8 & -5 & 0 \end{vmatrix}}{\begin{vmatrix} 11 & -3 & -8 \\ -3 & 10 & -5 \\ -8 & -5 & 23 \end{vmatrix}}$$

I_3=1.220 A

Example for the circuit shown below write down the loope equation the determine the currents value(Thomas .L.Floyd)



$(330+300)I_A-330I_B-300I_C=12$……loop1

$-330I_A+(330+360+1000)I_B-1000I_C=0$……loop2

$-300I_A-1000I_B+(1000+300+390)I_C=0$……loop3

Rewrit the above equations

$630I_A-330I_B-300I_C=12$

$-330I_A+1690I_B-1000I_C=0$

$-300I_A-1000I_B+169I_C=0$

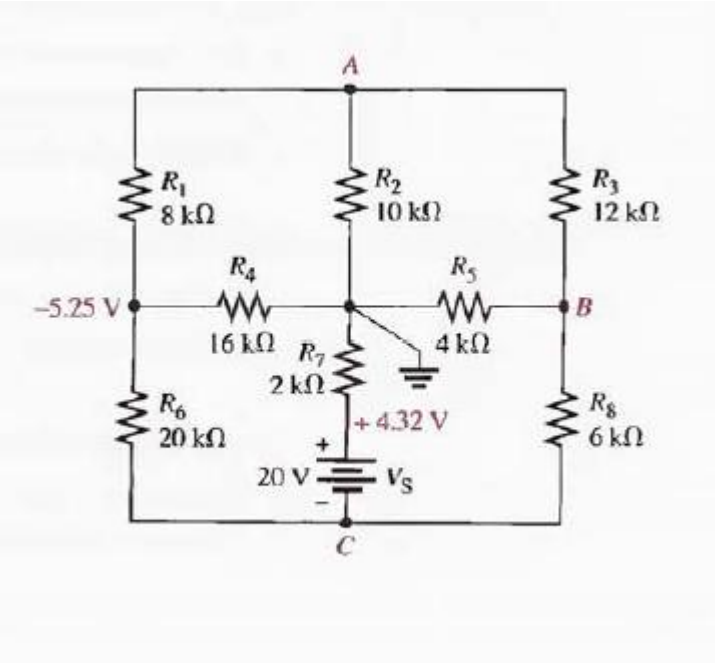
(SOLVE THE ABOVE EQUATIONS USING DETERMENATES(HW))

$I_{A=35.1}\ mA$

$I_{B=16.2}$ mA

$I_C=15.8\ mA$

Example Write the loop equation for the circuit shown below



$(8+10+16)I_1-10I_2-16I_3=0$

$-10I_1+(10+12+4)I_2-4I_4=0$

$-16I_1+(20+16+20)I_3-2I_4=-20$

$-4I_2-2I_3+(2+4+6)I_4=20$

H.W solve the above equation to find out $I_1,I_2,I_3\&I_4$

Nodal circuit analysis; this method is derived from(K.C.L) and can be used to analyze **electric** circuit by following the step below

1) Convert all voltage sources to current sources.
2) assign circuit nodes and assign one of this nodes ass a references node.
3) write the nodal equation as below:

$V_1\sum G_{node1} - V_2\sum G_{between\ node1\&2} - .. - V_n\sum G_{between\ node1\&n} = \sum I_{node1} .....(1)$

$-V_1\sum G_{between\ node1\&2} + V_2\sum G_{node2} - ..... - V_n\sum G_{between\ node2\&n} = \sum I_{node2} ...(2)$

. . . .

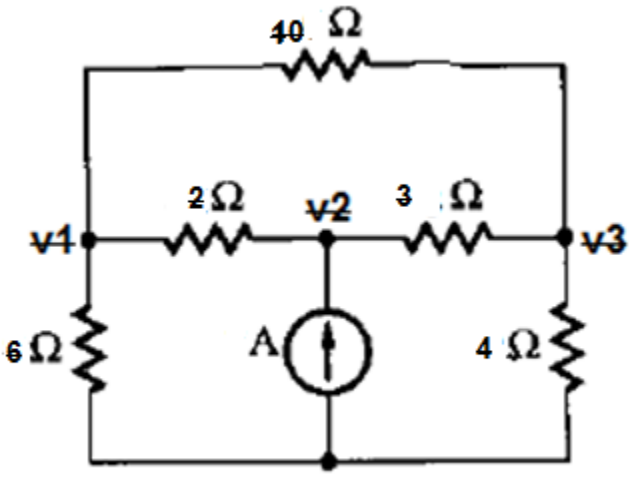
. . . .

$-V_1\sum G_{betwwen\ node1\&n} - V_2\sum G_{between\ noden\&2} - .... + V_n\sum G_{noden} = \sum I_{noden} ....(n)$

Were G=1/R

4) Solve the above equation to find out the current value ($v_1, v_2 ..... v_n$)

Example: use nodal analysis determine the current through 4 ohm resistor for circuit shown below



(1/2+1/10+1/6)v1-(1/2)v2-(1/10)v3=0……node1

-(1/2)v1+(1/2+1/3)v2-(1/3)v3=3……node2

-(1/10)v1-(1/3)v2+(1/3+1/10+1/4)v3=0……node3

Rewrite the above equation

0.766v1-0.5v2-0.1v3=0

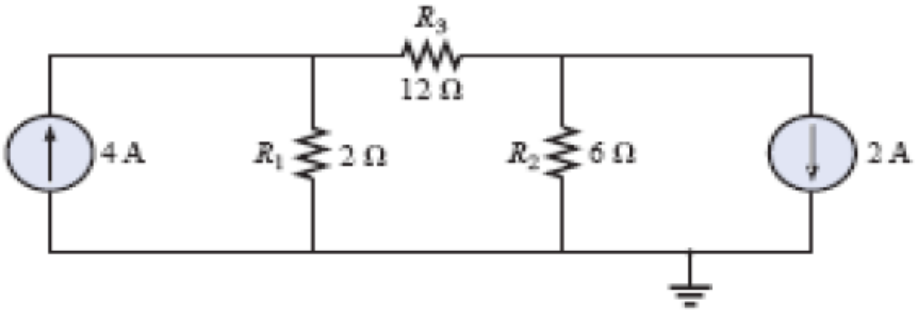
-0.5v1+0.8333v2-0.333v3=0.333

-0.1v1-0.333v2+0.683v3=0

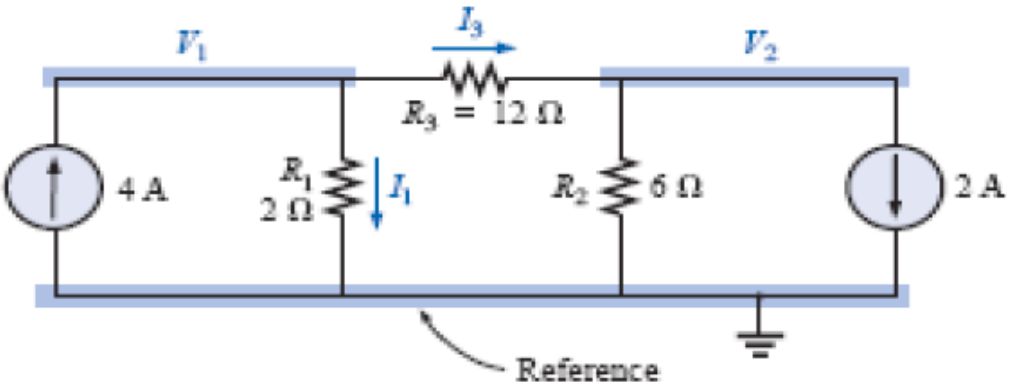
Solve the aove equation to find v1,v2 and v3

V1=8.11 volt,v2=11.11volt and v3=6,61 volt

Example:Determine the nodal voltage for the circuit shown below:



Redraw the circuit assigning the nodal as shown below



Write the node voltage equation:

$V_1(1/2+1/12)-V_2(1/12)=4$ node 1

$-V_1(1/12)+V_2(1/12+1/6)=-2$ node2

……..

$(7/12)V_1(1/12)V_2=4$

$-(1/12)V_1+(3/12)V_2=-2$

……..

$7V_1-V_2=48$

$-V_1+3V_2=-24$

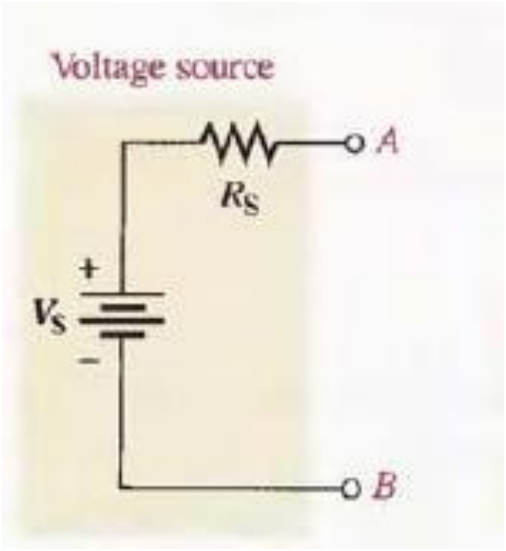
……..

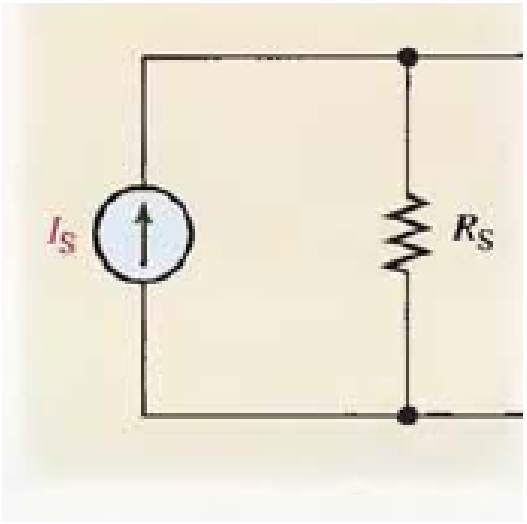
Solve the above equation for V_1 and V_2

$$V_1 = \frac{\begin{vmatrix} 48 & -1 \\ -24 & 3 \end{vmatrix}}{\begin{vmatrix} 7 & -1 \\ -1 & 3 \end{vmatrix}} = \frac{120}{20} = +6\ \mathrm{V}$$

$$V_2 = \frac{\begin{vmatrix} 7 & 48 \\ -1 & -24 \end{vmatrix}}{20} = \frac{-120}{20} = -6\ \mathrm{V}$$

Source conversion: every source ether aattery or generator have internal resistance as shown vellow:



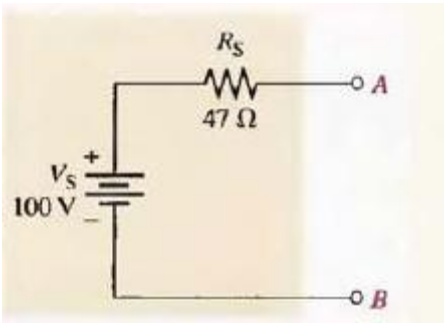


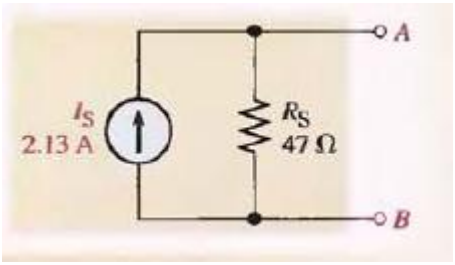
Current source

Any voltage source can be converted(or replaced by)voltage source using ohm's law.

$V_S=I_S\ R_S$

EXAMPLE :converte the shown below voltage source to current source





soulution:

$I_S=V_S/R_S=100/47=2.13Am$