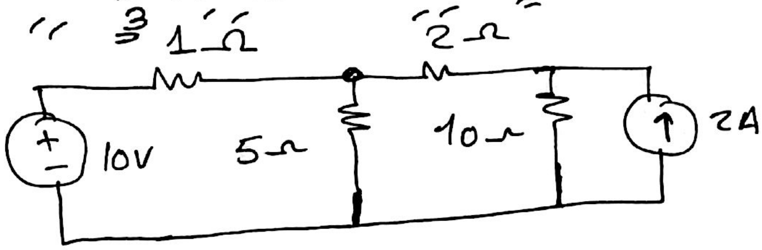
Lec (4)

Node Voltage

Node :- any joint tie 2 branches or more

. essential Node :- " " " 3 " "

ex

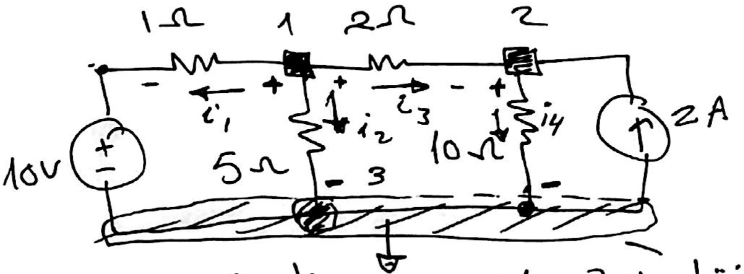


1) ∵ This ckt has 3 essential Nodes

∴ need (3-1) equations

أول مهمة تحديد nodes (تربط 3 branches أو أكثر)

2) Select reference node (أقل) (V=0 النقطة اللي تحت نعتبرها reference)



تعتبر نقطة واحدة (لأنهم ليهم نفس الجهد)

3) KCL نبدأ وضع معادلة عند كل node وذلك بافتراض اتجاه للتيار في كل branch و polarity للمقاومات مع اعتبار (- = ref) والطرف المقابل الأعلى (+)

أسهل طريقة عند كل node اعتبر التيارات كلها خارجة من node ما عدا الـ current source لازم باتجاهها المرسوم

∴ $0 = i_1 + i_2 + i_3$

∴ $\Sigma I_{1in} = \Sigma I_{1out}$

$\frac{V_1 - 10}{1\Omega} + \frac{V_1 - 0}{5} + \frac{(V_1 - V_2)}{2} = 0 \rightarrow$ [1]

(فرق الجهد بين طرفي المقاومة ÷ المقاومة)

at node 2 $\Sigma I_{2in} = \Sigma I_{2out}$

∴ $i_3 + 2A = i_4$

$\left(\frac{V_2 - V_1}{2}\right) - 2 + \frac{V_2 - 0}{10} = 0 \rightarrow$ [2]

أو نعتبر عند كل node التيارات خارجة ما عدا لو عندي current source داخل لازم أكتبه داخل

∴ at node 2

$\frac{V_2 - V_1}{2} + \frac{V_2}{10} = 2$

solve (1) & (2)

from (2) $V_2 = 20 + 5V_1 - 5V_2$

∴ $6V_2 = 20 + 5V_1$ ∴ $V_2 = \frac{20 + 5V_1}{6}$

at (1) $V_1 - 10 + \frac{V_1}{5} + \frac{V_1}{2} - \frac{V_2}{2} = 0$

$\frac{10V_1 + 2V_1 + 5V_1}{10} - 10 - \frac{20 + 5V_1}{12} = 0$

$1.7V_1 - 10 - \frac{20}{12} - \frac{5}{12}V_1 = 0$

$1.283V_1 = 11.667 \rightarrow V_1 = 9.09\,V$, $V_2 = 9.1\,V$

Sistemde

$$-3.4V_1 + V_2 + 20 = 0$$

$$0.5V_1 - 0.6V_2 + 2 = 0$$

$$= \begin{bmatrix} -3.4 & 1 \\ 0.5 & -0.6 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} -20 \\ -2 \end{bmatrix}$$

$$\Delta = \begin{vmatrix} -3.4 & 1 \\ 0.5 & -0.6 \end{vmatrix} = -3.4 \times -0.6 - 1 \times 0.5 = +1.54$$

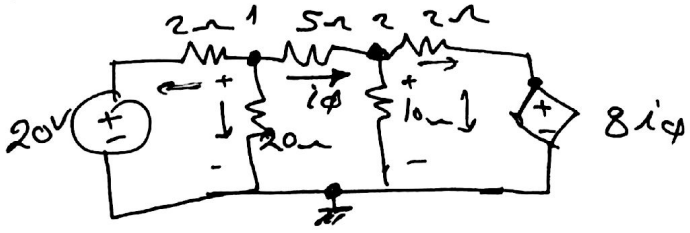
$$\Delta_1 = \begin{vmatrix} -20 & 1 \\ -2 & -0.6 \end{vmatrix} = -20 \times -0.6 + 2 \times 1 = +14$$

$$\Delta_2 = \begin{vmatrix} -3.4 & -20 \\ 0.5 & -2 \end{vmatrix} = -3.4 \times -2 + 20 \times 0.5 = +16.8$$

$$V_1 = \frac{\Delta_1}{\Delta} = \frac{+14}{+1.54} = 9.09V \qquad V_2 = \frac{\Delta_2}{\Delta} = \frac{+16.8}{+1.54} = 10.91V$$

Case [2] Dependent Sources

ex Find Power dissipated in 5Ω Resistor



sol

Node ①

$$\frac{V_1-20}{2}+\frac{V_1}{20}+\frac{V_1-V_2}{5}=0 \longrightarrow ①$$

note $i\phi = \frac{V_1-V_2}{5}$

Node ②

$$\frac{V_2-V_1}{5}+\frac{V_2}{10}+\frac{V_2-8i\phi}{2}=0 \longrightarrow ②$$

∴

$$\frac{8V_2}{10}-\frac{V_1}{5}-4i\phi=0$$

$$\Rightarrow \frac{4}{5}V_2-\frac{V_1}{5}-4\left(\frac{V_1-V_2}{5}\right)=0$$

$$\frac{8}{5}V_2-V_1=0 \longrightarrow ②$$

$$V_2=\frac{5}{8}(V_1) \longrightarrow ③$$

in ①

$$\frac{V_1}{2}+\frac{V_1}{20}+\frac{V_1}{5}-10-\frac{V_2}{5}=0$$

$$\frac{10V_1+V_1+4V_1}{20}-10-\frac{1}{8}(V_1)=0$$

$$\frac{15V_1}{20}-\frac{1}{8}V_1-10=0$$

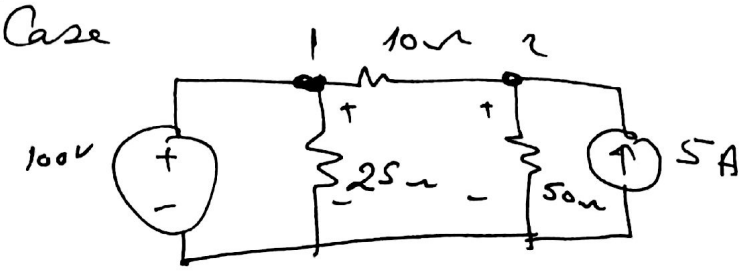
$$10=\frac{6V_1-V_1}{8}=\frac{5V_1}{8} \qquad \therefore V_1=\frac{8\times 10}{5}=16V$$

$$V_2=\frac{5}{8}\times 16=10V$$

$$i\phi=\frac{V_1-V_2}{5}=\frac{16-10}{5}=1.2A$$

$$\text{Power}=i\phi^2\times 5=1.44\times 5=7.2W$$

Case 3:- Special Case



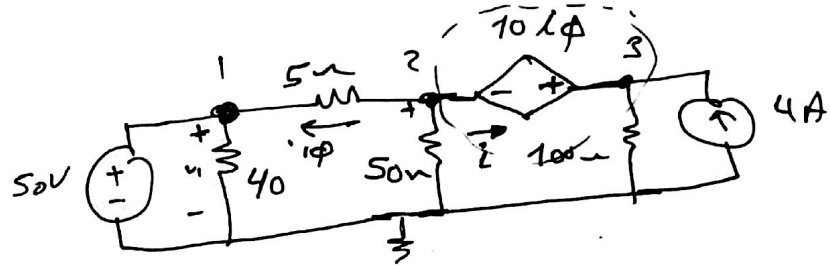
Node ①

at Node 1 $V_1 = 100V$

Node 2 $\frac{V_2 - V_1}{10} + \frac{V_2}{50} = 5$

Sub 1 in 2 $\therefore \frac{V_2}{10} - 10 + \frac{V_2}{50} = 5 \quad \therefore V_2 = 125V$

Case 4:- Supernode



at supernode

$V_3 - V_2 = 10 i\phi \rightarrow I$

$i\phi = \frac{V_2 - V_1}{5}$

* at node 1 $V_1 = 50V \rightarrow II$

* at node 2 $\frac{V_2 - V_1}{5} + \frac{V_2}{50} + i = 0 \rightarrow III$

* at node 3 $i + 4 = \frac{V_3}{100} \rightarrow IV$

∴ I rewritten as $V_3 - V_2 = 10\left[\frac{V_2 - V_1}{5}\right]$

$V_3 - V_2 - 2V_2 = -2V_1 = -100$

$\therefore \boxed{V_3 - 3V_2 = -100} \rightarrow ⓐ$

from node 2 $i = \frac{V_3}{100} - 4$

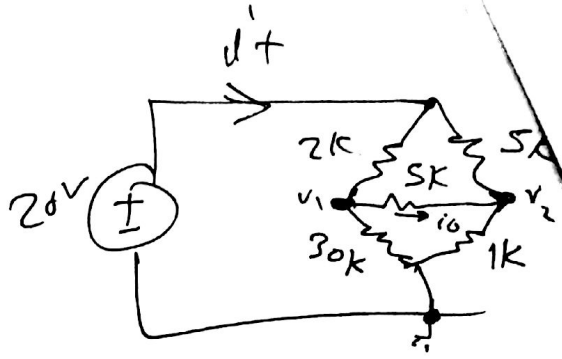
$\therefore \frac{V_2 - 50}{5} + \frac{V_2}{50} + \left(\frac{V_3}{100} - 4\right) = 0$

$\frac{V_2}{5} + \frac{V_2}{50} - 14 + \frac{V_3}{100} = 0$ OR $\boxed{\frac{11V_2}{50} + \frac{V_3}{100} = 14}$ ⓑ

Solve a, b $V_2 = 60V \qquad V_3 = 80V$

5A

Find i_o



Sol/

(1) $\frac{V_1-20}{2k}+\frac{V_1-V_2}{5k}+\frac{V_1-0}{30k}=0$

(2) $\frac{V_2-20}{5k}+\frac{V_2-0}{1k}+\frac{V_2-V_1}{5k}=0$

$\therefore V_1=15 \quad , V_2=5$

$i_o=\frac{V_1-V_2}{5k}=2mA$

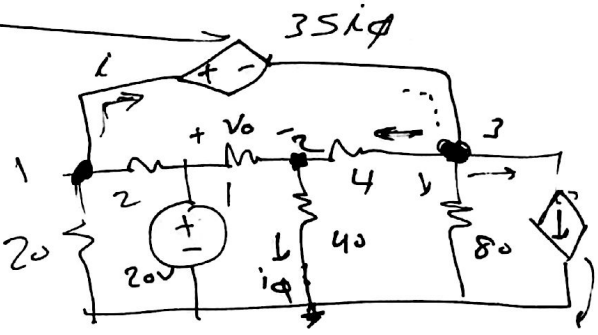
Trick: $i_t=?!$

$i_t=i_1+i_2$

$i_1=\frac{20-V_1}{2k}=2.5mA$

$i_2=\frac{20-V_2}{5k}=3mA$ $\quad i_t=5.5mA$

Report/ Sol



(1) $\frac{V_1-20}{2}+\frac{V_1}{20}+\left[\frac{V_3-V_2}{4}+\frac{V_3}{80}+3.125V_0\right]$

(2) $\frac{V_2-V_3}{4}+\frac{V_2}{40}+\frac{V_2-V_1}{1}$

(3) $\frac{V_3}{80}+3.125V_0+\frac{V_3-V_2}{4}+i=0$

(4) $V_1-V_3=35i_\phi$

(5) $i_\phi=\frac{V_2}{40}$

(6) $V_0=20-V_2$

Find P developed by source 20V

$i_g=30.125$, $V_1=-20.25V$, $V_2=10V$, $V_3=-29V$

$P_g=i_g\times 20=602.5W$