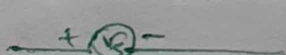
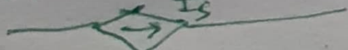
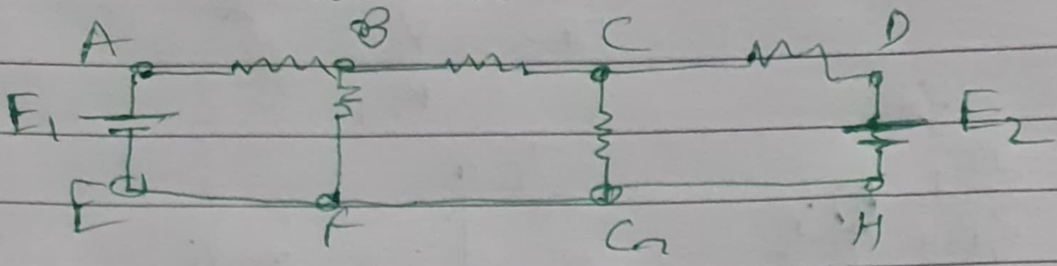
Dependent	Independent
i) Depends on some other circuit quantity which may either be voltage or current	i) ~~indepe~~ does not depend on any other quantity in circuit
ii) Parts of models used to represent Electrical properties of electronic devices such as operational amplifiers, transistors etc	ii) Actually exist as physical entities like DC generator, alternator, accumulator etc.
iii) required 4 terminals a pair for control other pair shows properties of source	iii) only two terminals
iv) 4 types vol dep vol so vol dep cur so cur dep vol so cur dep cur so	2 types indep vol so indep cur so
v) Dep vol so produces vol as func of vol elsewhere in given cir 	v) Ideal Indep vol so maintains specified vol acr ter irresp of cur drawn thru it 
vi) Dep cur ---- func of cur ---- 	Ideal indep cur so ---- specified cur ---- regardless of vol acr term 

Page No ______
Date ______

<u>Node</u> → A pt where two or more ~~branches~~ elements ~~meet~~ join tgt called node



A, B, C, D are nodes

<u>Jn</u> → Pt where three or more branches mett
→ Every jn is a node but not every node is jn
→ B, C are jn
→ current is divided.

<u>Active element</u>
→ element which supplies energy to circuit is active ele
→ E_1, E_2 are ac' ele
→ imp in circuit cuz provide necessary energy to other circuit components to work.

<u>Passive element</u>
→ receives energy is passive which it either absorbs or dissipates
→ resistor, inductor capacitor
→ R_1 R_2 R_3 R_4 R_5 are passive
→ also called parameters of network
→

KCL

→ states total current flowing towards a jn pt is equal to tot cur flowing out of jn pt.

or

Algebraic sum of all the cur meeting at a jn pt is always zero.

→ App → Nodal analysis

→ Math exp $\Sigma I = 0$

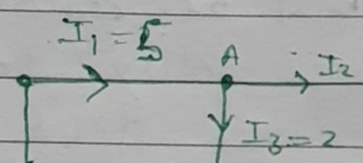
Open circuit

→ Sign conv

i) current flowing towards = +ve

ii) " " away from jn pt = −ve

Eg



KCL at node A

$$I_1 = I_2 + I_3$$

$$5 = I_2 + 2$$

$$\boxed{I_2 = 3\ A}$$

KVL

In any network, the alg sum of voltage drop across circuit elements in closed loop is equal to alg sum of emf across closed loop.

or

The alg sum of all branch voltages across a closed loop is always zero.

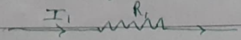
Math $\Sigma V + IR = 0$

$\Sigma V = 0$

App Mesh / Loop analysis

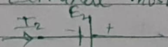
Sign

→ When cur flows thro resis, the voltage drop occurs across ~~b/w~~ resis; the polarity of voltage drop always depends on direction of cur. Cur flows from higher pot to lower pot.



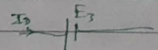
$V = -I_1 R_1$

→ Pot rise - travelling from negative to positively marked terminal must be considered +ve

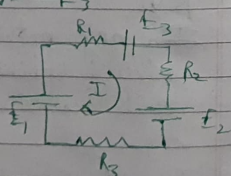


$V = +E_2$

→ Pot drop - travelling from +ve to -vely marked terminal must be considered -ve



$V = -E_3$



eg →

$\Sigma V = +E_1 - IR_1 - E_3 - IR_2 - E_2 - IR_3 = 0$

Mesh analysis

* When no. of branches in a network ↑es, then using conventional methods for the analysis of network can lead to complications.

, To simplify the soln of such networks, the method of mesh / loop analysis is used.

* It is an app of KVL which states that alg sum of all branch voltages in closed loop is 0 i.e $\Sigma V = 0$

, explanation ~~steps~~ for mesh analysis :-

→ Find no. of meshes, convert all current source to equivalent voltage source.

→ Assign mesh current to each mesh assuming flow of cur to be clockwise.

→ Apply KVL in each mesh and write eqn.

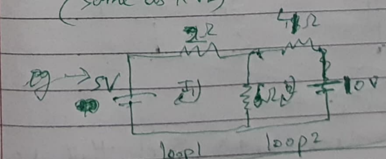
→ no. of eqn will be no. of unknown mesh currents.

→ Solve eqn to find unknown mesh cur.

* Sign conven

→ - (Same as KVL) -

* eg →



loop1, $90 - 9i_1 - 6(i_1 - i_2) = 0$

$90 - 9i_1 - 6i_1 + 6i_2 = 0$

$15i_1 - 6i_2 = 90$

$\boxed{5i_1 - 2i_2 = 30}$ (1)

loop2, $-6(i_2 - i_1) - 8i_2 - 40 = 0$

$-6i_2 + 6i_1 - 8i_2 - 40 = 0$

$3i_1 - 7i_2 = 20$ (2)

$i_1 =$

Nodal Analysis

* App of KCL which states tot cur flo towards a jn pt / into node is equal to tot cur flo out of jn pt.

* In this method, one of the nodes is taken as reference node or zero pot node or datum node whose pot is 0 & assign and the pot diff b/w each of the other & reference node is expressed in terms of unknown voltage (V_A, V_B, ---)

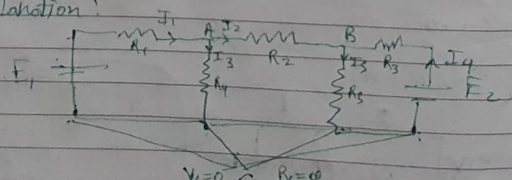
* Then KCL is applied at each node assuming the possible direction of branch current.

* Node vol theo reduces no. of eq^n to be solved to find unknown quantities.

* If there are (n) no. of nodes then there will be $(n-1)$ no. of nodal eq^n in terms of $(n-1)$ no. of unknown ~~gue~~ nodal voltages.

<sign conv>

Explanation:



Consider circuit of three nodes such that node C is taken as reference node & V_A, V_B be voltages of node A & B w.r.t ref node C

Apply KCL at node A, $I_1 = I_2 + I_3$

$$\frac{E_1 - V_A}{R_1} = \frac{V_A - V_B}{R_2} + \frac{V_A}{R_4} \quad \text{—} (1)$$

at node B, $\therefore I_5 = I_2 + I_4$

$$\frac{V_B}{R_5} = \frac{V_A - V_B}{R_2} + \frac{E_2 - V_B}{R_3} \quad \text{—} (2)$$

In this way we can find values of V_A & V_B by the help of above two eq^{n}s.

Energy Sources

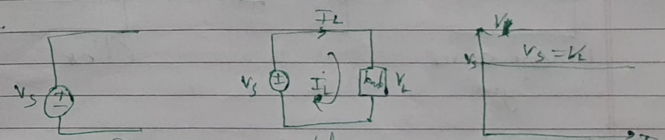
Two types further 2 types

Vol Ideal

Cur Prac

Ideal Vol So

defined as which gives const voltage across its terminal irrespective of the current drawn thru terminal



Symbol of Vol So

Ideal $V_s = V_L$

characteristic

Internal resistance = 0

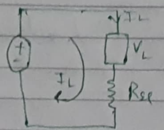
$\boxed{R_{se} = 0}$

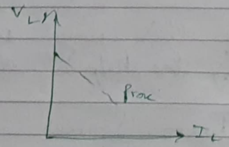
-) Prac Vol So

Every vol so has smol int res in series with vol so & rep as R_{se}

Due to R_{se}, vol across terminals decrease slightly with inc in cur & is given by exp

$$\boxed{V_L = V_S - I_L R_{se}}$$

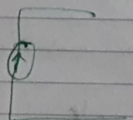




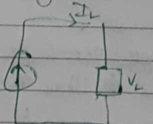
Vol drop

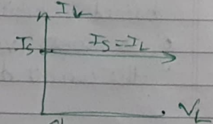
-> Ideal cur source

as which gives const current thru its terminal irres of voltage appearing across its terminal.



DC cor source Sym





Char

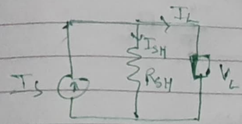
Int Resis $= R_{SH} = \infty$

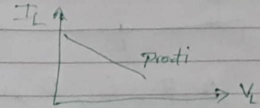
Pract Cor So

Every cur so has int Resis connected parallel to cor so given by R_{SH}

· Due to R_{SH} current thru terminal decreases slightly as voltage increases

i.e. $I_L = I_S - \frac{V_L}{R_{SH}}$





Characteristics

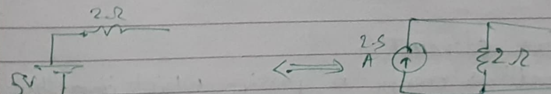
Source transformation / Conversion

-> Technique to convert on kind of source into other

-> Voltage so with resis in series can be conv into equivalent cur so with resis in parallel

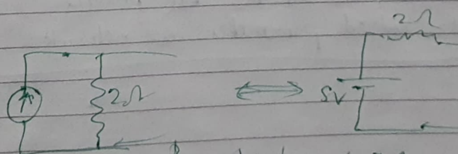
-> Cur so -- resis parallel -- Vol so -- resis series

Vol in Cur



By ohm's $I = \frac{V}{R} = \frac{5}{2} = 2.5\,A$

Cur to Vol



By ohm's $V = IR$

$V = 2.5(2) = 5V$

2.09 $i_1 = 0$ 3.63   -4.82
-1.86 $i_2 = 10$ -5.45
-4.18 $i_3 = -10$

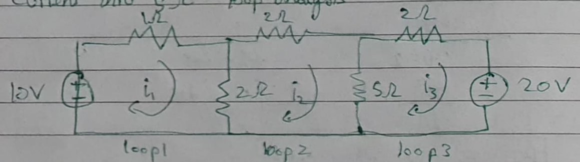
$$PI = \frac{1}{2}\left[\frac{1}{4} - \frac{x}{2D}\cos 2x\right]$$

$$= \frac{1}{2}\left[\frac{1}{4} - \frac{x}{2}\,\frac{\sin 2x}{2}\right]$$

$$PI = \frac{1}{8} - \frac{x}{8}\sin 2x$$

$$\boxed{y = C_1\cos 2x + C_2 \sin 2x + \frac{1}{8} - \frac{x}{8}\sin 2x}$$

Q9> Current thru 5Ω loop analysis



KVL in loop (1), $10 - 1i_1 - 2(i_1 - i_2) = 0$

$$10 - i_1 - 2i_1 + 2i_2 = 0$$

$$-3i_1 + 2i_2 + 10 = 0$$

$$\boxed{3i_1 - 2i_2 = 10} \text{ — (1)}$$

KVL in loop (2), $-2(i_2 - i_1) - 2i_2 - 5(i_2 - i_3) = 0$

$$-2i_2 + 2i_1 - 2i_2 - 5i_2 + 5i_3 = 0$$

$$\boxed{+2i_1 - 9i_2 + 5i_3 = 0} \text{ — (2)}$$

$$\cancel{\boxed{2i_1 + 5i_2 + 9i_3 = 10}} \text{ — (2)}$$

KVL in loop (3), $-20 - 5(i_3 - i_2) - 2i_3 = 0$

$$-5i_3 + 5i_2 - 2i_3 = 20$$

$$\boxed{+5i_2 - 7i_3 = 20} \text{ — (3)}$$

$$\cancel{15i_1 + 10i_2 = 50}$$

$$\cancel{+10i_2 - 14i_3 = 40}$$

$$\cancel{15i_1 - 14i_3 = 90}$$

$$3i_1 + 3i_2 - 7i_3 = 30$$

eq (1), $i_1 = \dfrac{10 + 2i_2}{3}$

eq (3), $i_3 = \dfrac{5i_2 - 20}{7}$

$$2\left(\frac{10 + 2i_2}{3}\right) - 9i_2 + 5\left(\frac{5i_2 - 20}{7}\right) = 0$$

$$\frac{20 + 4i_2}{3} - 9i_2 + \frac{25i_2 - 100}{7} = 0$$

$$\frac{140 + 28i_2 - 189i_2 + 75i_2 - 300}{21} = 0$$

$$-160 - 86i_2 = 0$$

$$i_2 = \frac{-160}{86}$$

$$\boxed{i_2 = -1.86\text{ A}}$$

So $i_1 = \dfrac{10 + 2(-1.86)}{3} = \dfrac{10 - 3.72}{3} = \dfrac{6.28}{3} = \boxed{2.09\text{ A}}$

$i_3 = \dfrac{5(-1.86) - 20}{7} = \dfrac{-9.3 - 20}{7} = \dfrac{-29.3}{7} = -4.18\text{ A}$

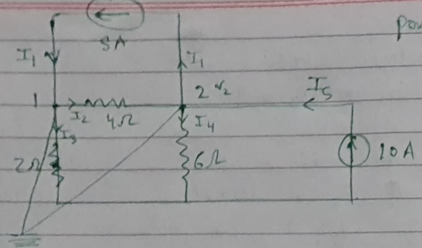
Current thru 5Ω $= \cancel{-5(i_3 - i_2)}$

$= i_2 - i_3$ $\cancel{= -5(-4.18 - 2.09) = -5(-6.29)}$

$= -1.86 + 4.18$ $\cancel{= 31.35\text{ A}}$

$= \boxed{2.32\text{ A}}$

10>



power across 4Ω ?
nodal analysis

KCl at Node 1, $I_1 = I_2 + I_3$

$5 = \frac{V_1 - V_2}{4} + \frac{V_1}{2}$

$5 = \frac{V_1 - V_2 + 2V_1}{4}$

$20 = 3V_1 - V_2$

$\boxed{V_2 = 3V_1 - 20}$ ①

KCl at Node 2, $I_5 + I_2 = I_4 + I_1$

$10 + \frac{V_1 - V_2}{4} = \frac{V_2}{6} + 5$

$5 = \frac{V_2}{6} - \frac{(V_1 - V_2)}{4}$

$5 = \frac{4V_2 - 6V_1 + 6V_2}{24}$

$120 = 10V_2 - 6V_1$

$60 = 5V_2 - 3V_1$

$60 = 5(3V_1 - 20) - 3V_1$

$60 = 15V_1 - 100 - 3V_1$

$160 = 12V_1$

$\boxed{V_1 = 13.33 \text{ volt}}$

$V_2 = 3(13.33) - 20$

$= 39.99 - 20$

$\boxed{V_2 = 19.99 \text{ volt}}$

Current thru 4Ω $= I_2 = \frac{V_1 - V_2}{4} = \frac{13.33 - 19.99}{4}$

$= \frac{-6.66}{4}$

$= -1.665\ A$

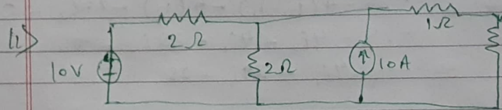
Power thru 4Ω $= I^2 R$

$= (-1.665)^2 \times 4$

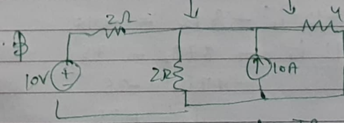
$= 2.772 \times 4$

$= \boxed{11.0889 \text{ watt}}$

11>



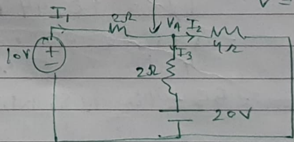
Current I ?
node voltage method



$v = IR$

$v = 10(2)$

$v = 20V$



KCL at A, $I_1 = I_2 + I_3$

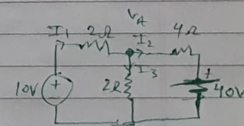
$\frac{10 - V_A}{2} = \frac{V_A}{4} + \frac{V_A - 20}{2}$

$\frac{10 - V_A}{2} = \frac{V_A + 2V_A - 40}{4_2}$

$20 - 2V_A = 3V_A - 40$

$60 = 5V_A$

$V_A = 12\ V$



$I_1 = I_2 + I_3$

$\frac{10 - V_A}{2} = \frac{V_A - 40}{4} + \frac{V_A}{2}$

$\frac{10 - V_A - V_A}{2} = \frac{V_A - 40}{4}$

$5 - V_A = \frac{V_A - 10}{4}$

$15 = \frac{V_A}{4} + V_A$

$60 = 5V_A$

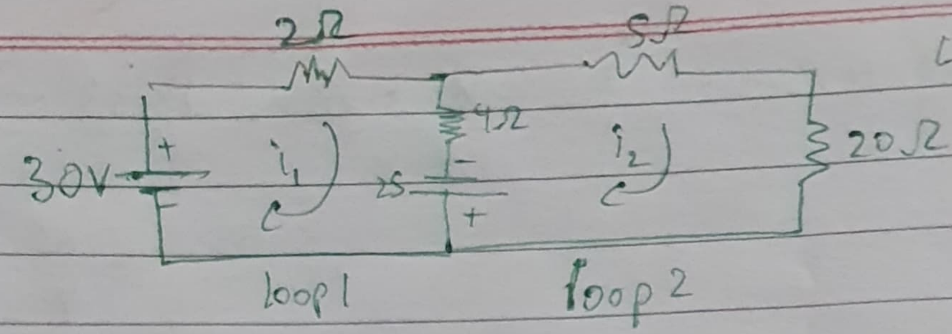
$\boxed{V_A = 12}$

$I = I_2 = \frac{V_A}{4}$

$= \frac{12}{4}$

$\boxed{3\ A}$

9.46 , 0.44

12) 

Current thru 5Ω = ?

mesh analysis

KVL in loop 1, $30 - 2i_1 - 4(i_1 - i_2) + 25 = 0$

$30 - 2i_1 - 4i_1 + 4i_2 + 25 = 0$

$\boxed{-6i_1 + 4i_2 = -55}$ (1)

KVL loop 2, $-25 - 4(i_2 - i_1) - 5(i_2) - 20i_2 = 0$

$-25 - 4i_2 + 4i_1 - 25i_2 = 0$

$4i_1 - 29i_2 = 25$

$\cancel{-12i_1} + 8i_2 = -110$

$\cancel{12i_1} - 87i_2 = 75$

$-79i_2 = -35$

$i_2 = +\frac{35}{79}$

$\boxed{i_2 = +0.44\ A}$

Eq (1), $i_1 \Rightarrow \cancel{\frac{-58+6i_1}{4}} = \cancel{\frac{-58+2.65}{4}} = \cancel{\frac{52.36}{4}}$

$i_1 = \frac{+55 + 4i_2}{6} = \frac{55 + 1.76}{6} = \frac{56.76}{6}$

$\boxed{i_1 = 9.46A}$

$\boxed{\text{Current thru } 5\Omega = i_2 = 0.44\ A}$