BEE

Basic Electrical Engineering.

Syllabus

Unit - 1

DC - Circuits.

⇒ Introduction of Basic electrical elements.
⇒ Energy Sources.
⇒ KCL and KVL.
⇒ Super position theorem.
⇒ Thevinen's theorem.
⇒ Norton's theorem.

Unit - 2

Ac - Circuits.

⇒ Single phase Ac - circuits consisting of (R, L, C, RL, RC) Combination of Series connection.
⇒ Single Phase Ac - Circuits consisting of (R, L, C, RL, RC) combination of Parallel Connection
⇒ Star - Delta Connections.

Unit - 3

Transformers.

⇒ Construction and Working Principle of transformer.
⇒ Losses in transformer.
⇒ Regulation and efficiency of transformer.
⇒ Construction of three phase transformer.

Unit - 4

Electrical Machines

→ Construction and working principle of Induction motar.
→ Construction and working principle of synchronous generators.
→ Regulation and Efficiency of electrical machines.
→ Speed Torque characteristics of separately excited DC motar.

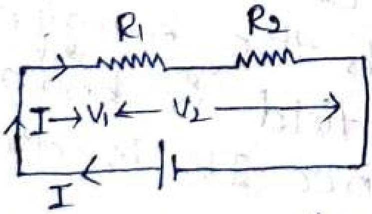
Unit - 5

Electrical Installation.

→ Basic electrical Installation are SFU(switch fuse Unit)
→ MCB'S (Main circuit Brokers)
→ Types of wires and cabels.
→ Types of Batteries.
→ Power factor Improvement.

Resistance in series and Parallel Connection

1. Resistance in series : In this case the series connection of resistance in a circuit the same current flowing through all the elements shown in fig



from the above circuit based on the

$V = V_1 + V_2$ (according to ohm's law $V = IR$)

$IR = IR_1 + IR_2$

$IR = I(R_1 + R_2)$

$R = R_1 + R_2$

lly for 'n' turns in resistance connection in series

$R_{eq} = R_1 + R_2 + R_3 + \cdots\cdots + R_n$

It is denoted by "ρ". The units of the resistivity is "ohm-meter" (Ω-m)

$$\boxed{\rho = \frac{Ra}{l}}$$

→ Conductivity : It is defined as the reciprocal of resisitivity is known as conductance. It is denoted by "σ" The units of the conductivity is "$\Omega^{-1} \cdot m^{-1}$" (or) ℧-m

$$\boxed{\sigma = 1/\rho}$$

→ Conductor : It is defined as the material in which allows the flow of electrons is known as conductor.

The example of the conductor are Aluminium, Copper, Silver.

→ Insulator : The material in which does not allow the flow of electrons is known as the Insulator.

The example of Insulator are Rubber, Wood, Plastic.

→ Semi-Conductor : The material as the electric conducitivity between conductor and Insulator is known as the Semi conductor.

→ Node : It is defined as the terminal of any branch of network (or) Inter connection of two (or) more branches of network is known as node.

→ Power : It is defined as the product of Voltage and current is known as Power. It is denoted by "P". The units of the power are "Watts."

$$\boxed{P = VI}$$

Limitations of Ohm's Law :

* It is applicable to all metallic Conductors such as silver, Copper, Aluminium.
* It is not applicable all electrical Circuit elements, such as Vaccum cleaner and transistors.

→ Conductance : It is defined as the reciprocal of resistance is known as a conductance.
It is denoted by G. The units of conductance is Ω^{-1} (or) ℧ (ohm)

$$\boxed{G = 1/R}$$

→ Resistivity : It is defined as the resistance of the material as the unit length and unit area of cross Section is known as the resisitivity.

'c' The units of capacitance is Microfarad (μF).

*

→ Ohm's Law :
Statement : At Constant temperature the flow of current in a electrical circuit is directly Proportional

to Voltage and inversly proportional to resistance.

$$\boxed{I \propto V/R}$$

$$I = V/R \Rightarrow \boxed{V = IR}$$

$$R = V/I$$

→ Voltage : It is defined as the total amount of workdone to charge is known as a voltage. It is also known as potential difference. It is denoted by 'v'. The units of voltage is "Volts (V)"

→ Current : It is defined as the flow of electrons in a closed path is known as a Current.

(or)

The rate of change of charge with respect to time

$$\boxed{i = \frac{dq}{dt}}$$

It's unit is "Ampere (A)"

Semiconductor:

The examples of Semi conductor are germanium and silicon.

DC - Circuits

Introduction of Basic Electrical Elements.

→ Resistor : It is defined as the which opposes the current. The resistance of the conductor is directly proportional to unit length and inversly proportional to unit area of cross section.

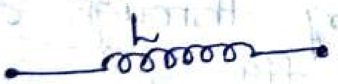
The mathematical expression of resistance are

$$\boxed{R \propto l/a}$$

$$\boxed{R = \rho\, l/a}$$ → ρ = Resisitivity of conductor
l = unit length
a = Unit area of cross section.

The resistance is denoted by 'R' and the units of resistance is ohm's (Ω)

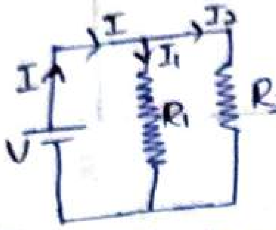
→ Inductance : It is defined as the elements in which the energy stored in Magnetic field is known as the Inductance. It is denoted by "L." The units of Inductance is "Henry (H)"



→ Capacitance : It is defined as the elements in which the energy stored in electric field is known as the capacitance. It is denoted by "c."

2. Resistance in Parallel:

In this case of llel connection in electric circuit the voltage across same elements. The electric circuit shown in fig.



The above circuit based on the eq^n $I = I_1 + I_2$ (according to ohm's law $I = V/R$)

$$I = I_1 + I_2$$

$$\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2}$$

$$V\left(\frac{1}{R}\right) = V\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

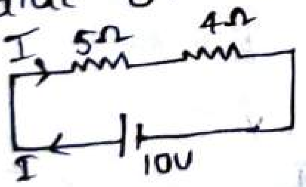
$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow \frac{1}{R} = \frac{R_1+R_2}{R_1R_2}$$

lly the 'n' no. of turns in resistance connected in Parallel. The eq^n are

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}$$

Problems:

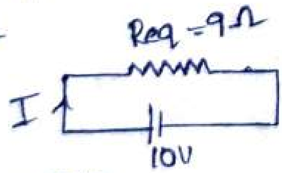
* find the value of current as shown in digram.



Sol: $R = R_1 + R_2$

$R = 5+4$

$R = 9\,\Omega$



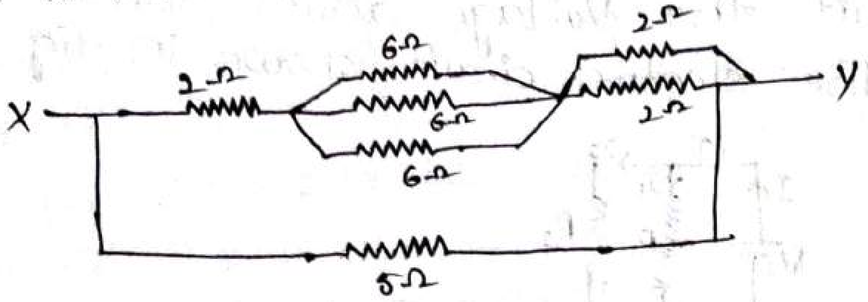
$V = IR$

$I = V/R$

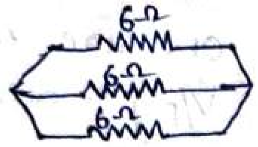
$I = 10/9$

$\boxed{I = 1.1\,A}$

2) find the equivalence resistance the terminal of x & y.



Sol: Given



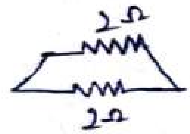
$$\Rightarrow \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R} = \frac{1}{6} + \frac{1}{6} + \frac{1}{6}$$

$$\frac{1}{R} = \frac{3}{6}$$

$$\frac{1}{R} = \frac{1}{2}$$

$$R = 2\Omega$$

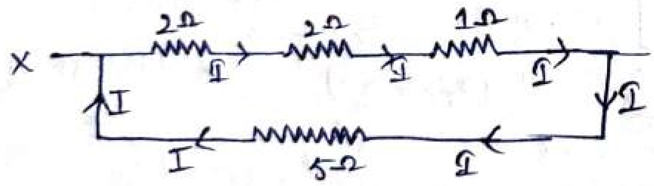


$$\Rightarrow \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R} = \frac{1}{2} + \frac{1}{2}$$

$$\frac{1}{R} = \frac{2}{2}$$

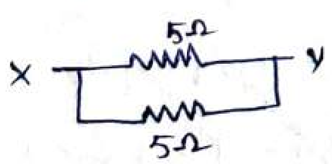
$$R = 1\Omega$$



$$R = R_1 + R_2 + R_3$$

$$= 2 + 2 + 1$$

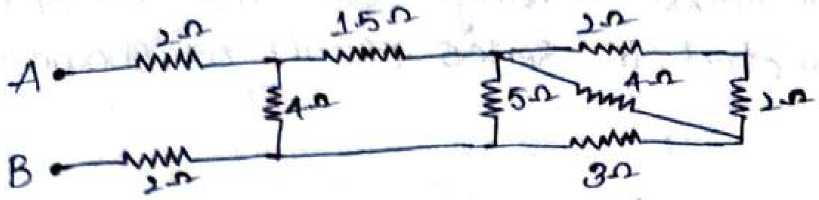
$$R = 5\Omega$$



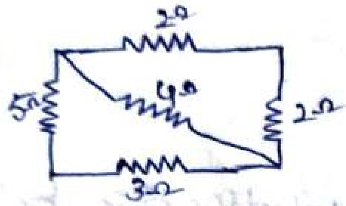
$$R = \frac{R_1 R_2}{R_1 + R_2} \Rightarrow \frac{5 \times 5}{5+5} \Rightarrow \frac{25}{10}$$

$$\boxed{\therefore R_{eq} = 2.5\Omega}$$

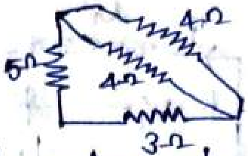
3) find the equivalent resistance between two terminals A & B the circuit shown in below.



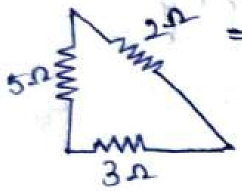
Sol:



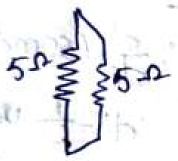
$R = R_1 + R_2$
$= 2+2$
$R = 4\Omega$



$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$
$= \frac{1}{4} + \frac{1}{4}$
$\frac{1}{R} = \frac{2}{4}$
$R = 2\Omega$

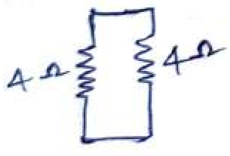


$\Rightarrow R = R_1 + R_2$
$= 2+3$
$R = 5\Omega$



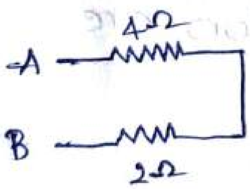
$\Rightarrow \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$
$\frac{1}{R} = \frac{1}{5} + \frac{1}{5}$
$\frac{1}{R} = \frac{2}{5}$
$R = 2.5\Omega$

$\Rightarrow R = R_1 + R_2$
$R = 1.5 + 2.5$
$R = 4\Omega$



$\Rightarrow \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow \frac{1}{R} = \frac{1}{4} + \frac{1}{4}$
$\frac{1}{R} = \frac{2}{4}$
$R = \frac{4}{2} \Rightarrow R = 2\Omega$

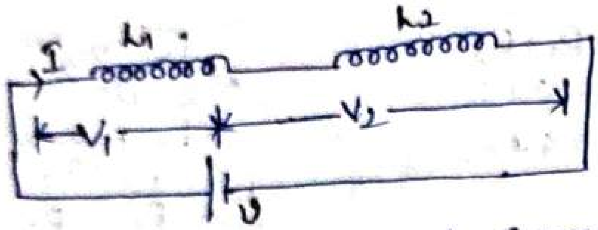
$\Rightarrow R = R_1 + R_2$
$= 2+2$
$R = 4\Omega$



$\Rightarrow R = R_1 + R_2$
$= 4+2$
$R = 6\Omega$

Inductance in Series Connection:

In this case of Series Connection the Same Current will flow through all the elements which are connected in Series circuit as shown in fig.



The voltage and Current relationship between in the Inductance and the rate of change of current with respect to time is directly proportional to voltage

$$v \propto \frac{di}{dt}$$

$$v = L\frac{di}{dt} \quad \text{—} \ (1)$$

$$\left[\therefore \frac{d}{dx}(\text{some}) = \int(\text{some})dx\right]$$

$$di = \frac{1}{L} v dt$$

$$\int di = \frac{1}{L}\int v dt$$

$$i = \frac{1}{L}\int v dt$$

$$i = \frac{1}{L}\int v dt \quad \text{—} \ (2)$$

from the above circuit based on the equation

$$V = V_1 + V_2$$

According to voltage-Current relationship between Inductance $\left(V = L\frac{di}{dt}\right)$

$$V = V_1 + V_2$$

$$L \cdot \frac{di}{dt} = L_1\frac{di}{dt} + L_2\frac{di}{dt}$$

$$L \cdot \frac{\cancel{di}}{\cancel{dt}} = \frac{\cancel{di}}{\cancel{dt}}(L_1 + L_2)$$

$$L = L_1 + L_2$$

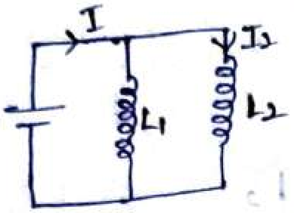
$$\therefore L_{eq} = L_1 + L_2 + L_3 + \dots + L_n$$

$\therefore$ The "n" no. of turns inductance are Connected in Series the equivalent inductance equation are

$$L_{eq} = L_1 + L_2 + \dots + L_n.$$

Inductance in Parallel Connection:

In this case of llel connection the Same Voltage across each branch from the Circuit as shown in fig.



from above circuit based on the equation $I = I_1 + I_2$.

According to voltage - current relationship between Inductance $\left(\because i = \frac{1}{L}\int v\,dt\right)$

$$I = I_1 + I_2$$

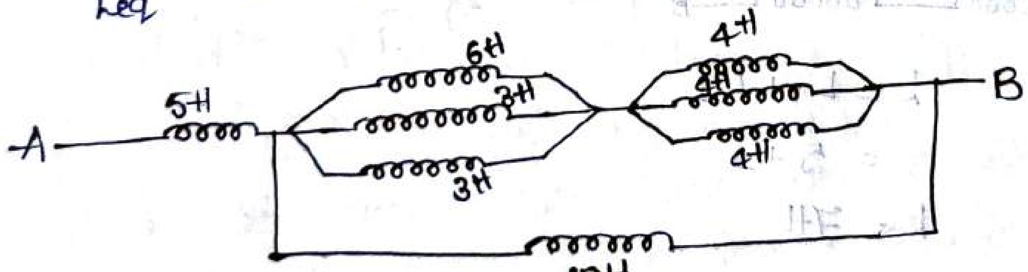
$$\frac{1}{L}\int v\,dt = \frac{1}{L_1}\int v\,dt + \frac{1}{L_2}\int v\,dt$$

$$\frac{1}{L}\int v\,dt = \int v\,dt\left(\frac{1}{L_1} + \frac{1}{L_2}\right)$$

$$\frac{1}{L} = \frac{1}{L_1} + \frac{1}{L_2}$$

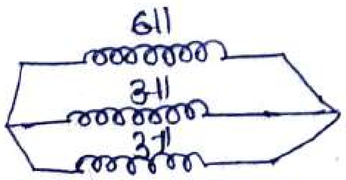
$\therefore$ The no. of turns Connected in llel the equivalent inductance equation is

$$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \dots + \frac{1}{L_n}$$

4) 

find the equivalent inductance between the two terminals A & B as shown in fig.

Sol:

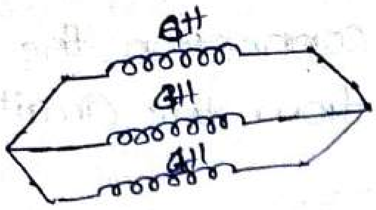


$\Rightarrow$ $\frac{1}{L} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}$

$$= \frac{1}{6} + \frac{1}{3} + \frac{1}{3}$$

$$= \frac{1+2+2}{6} \Rightarrow \frac{5}{6}$$

$$L = 1.2H$$

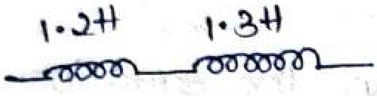


$$\Rightarrow \frac{1}{L} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}$$

$$\frac{1}{L} = \frac{1}{4} + \frac{1}{4} + \frac{1}{4}$$

$$\frac{1}{L} = \frac{3}{4}$$

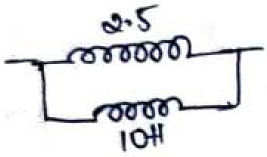
$$L = 1.3H$$



$$\Rightarrow L = L_1 + L_2$$

$$= 1.2 + 1.3$$

$$L = 2.5H$$



$$\Rightarrow \frac{1}{L} = \frac{1}{L_1} + \frac{1}{L_2}$$

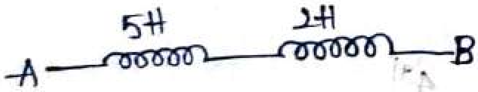
$$= \frac{1}{2.5} + \frac{1}{10}$$

$$\frac{1}{L} = \frac{10}{25} + \frac{1}{10}$$

$$\frac{1}{L} = \frac{100+25}{250}$$

$$\frac{1}{L} = \frac{125}{250}$$

$$L = \frac{250}{125} \Rightarrow L = 2H$$



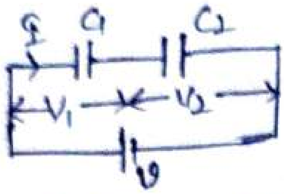
$$L = L_1 + L_2$$

$$= 5 + 2$$

$$L = 7H$$

Capacitance in Series:

In this case of Series Connection Same Current will flow through all the elements which are connected in Series as shown in fig



the Voltage and current relationship between capacitance. The current is directly proportional to rate of change of voltage with respect to time

$$i \propto \frac{dv}{dt}$$

$$i = c\frac{dv}{dt}$$

$$v = \frac{1}{c}\int i\,dt$$

from above circuit based on the eq^n $v = v_1 + v_2$

According to voltage and current relationship b/w capacitance.

$$v = \frac{1}{c}\int i\,dt$$

$$v = v_1 + v_2$$

$$\frac{1}{c}\int i\,dt = \frac{1}{c_1}\int i\,dt + \frac{1}{c_2}\int i\,dt$$

$$\frac{1}{c}\int i\,dt = \int i\,dt\left(\frac{1}{c_1} + \frac{1}{c_2}\right)$$

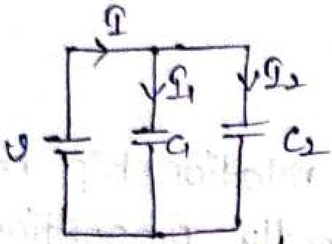
$$\frac{1}{c} = \frac{1}{c_1} + \frac{1}{c_2}$$

∴ for 'n' no. of turns capacitance are connected in Series the equivalent capacitance eq^n. is

$$\frac{1}{C_{eq}} = \frac{1}{c_1} + \frac{1}{c_2} + \dots + \frac{1}{C_n}$$

Capacitance in Parallel:

In this case of parallel connection the same voltage across each branch from circuit which are connected in ||el as shown in fig



from the circuit based on the eq^n, $I = I_1 + I_2$

According to voltage and current relationship b/w capacitance $\left(i = C\frac{dv}{dt}\right)$

$$I = I_1 + I_2$$

$$C\frac{dv}{dt} = C_1\frac{dv}{dt} + C_2\frac{dv}{dt}$$

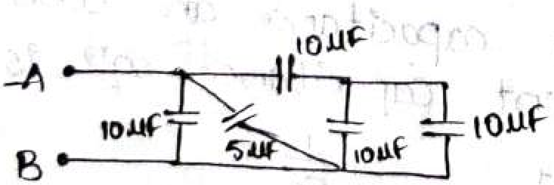
$$C\cancel{\frac{dv}{dt}} = \cancel{\frac{dv}{dt}}(C_1 + C_2)$$

$$C = C_1 + C_2$$

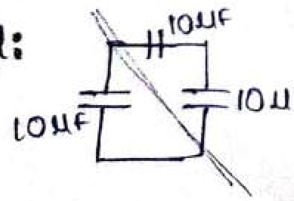
$\therefore$ for 'n' no. of turns capacitance are connected in ||el the equivalent capacitance is

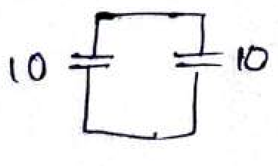
$$C_{eq} = C_1 + C_2 + \cdots\cdots + C_n$$

5) find the equivalent capacitance between the terminal A & B as shown in fig.



Sol:

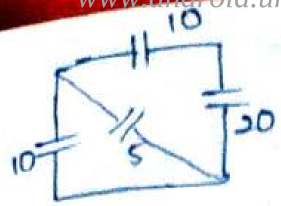




$$C = C_1 + C_2$$

$$= 10 + 10$$

$$C = 20\ \mu F$$



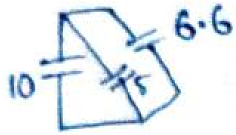
$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\frac{1}{C} = \frac{1}{10} + \frac{1}{20}$$

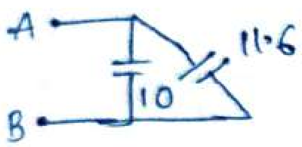
$$\frac{1}{C} = \frac{2+1}{20} \Rightarrow \frac{3}{20}$$

$$C = \frac{20}{3}$$

$$C = 6.6$$



$$C = C_1 + C_2$$
$$= 5 + 6.6$$
$$C = 11.6\,\mu F$$

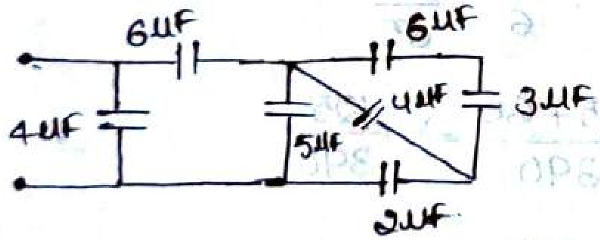


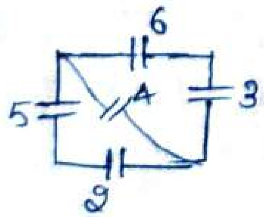
$$C = C_1 + C_2$$
$$C = 10 + 11.6$$
$$C = 21.6\,\mu F$$

$$\boxed{\therefore C_{eq} = 21.6\,\mu F}$$

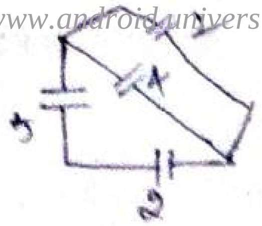
6) find the equivalent capacitance b/w the terminals A & B.

Sol:





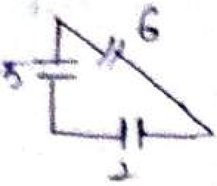
$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$
$$= \frac{1}{6} + \frac{1}{3}$$
$$\frac{1}{C} = \frac{1+2}{6}$$
$$\frac{1}{C} = \frac{3}{6} = \frac{1}{2}$$
$$\frac{1}{C} = \frac{1}{2}$$
$$\boxed{C = 2\,\mu f}$$



$C = C_1 + C_2$

$= 4 + 2$

$C = 6 \mu F$



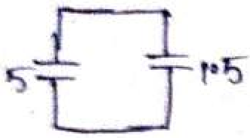
$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$

$\frac{1}{C} = \frac{1}{6} + \frac{1}{2}$

$\frac{1}{C} = \frac{1+3}{6} = \frac{4}{6}$

$\frac{1}{C} = \frac{2}{3}$

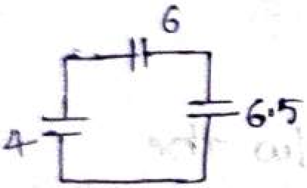
$C = 1.5 \mu F$



$C = C_1 + C_2$

$C = 1.5 + 5$

$C = 6.5 \mu f$



$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$

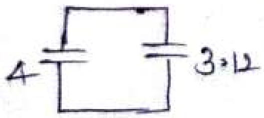
$\frac{1}{C} = \frac{1}{6} + \frac{1}{6.5}$

$\frac{1}{C} = \frac{1}{6} + \frac{10}{65}$

$\frac{1}{C} = \frac{65+60}{390} \Rightarrow \frac{125}{390}$

$C = \frac{390}{125}$

$C = 3.12 \mu f$



$C = C_1 + C_2$

$C = 4 + 3.12$

$C = 7.12 \mu f$

$\boxed{\therefore C_{eq} = 7.12 \mu f}$

Power and Energy relationship between (R, L & C)

Resistance : The power observed by the resistance are given by $P = VI$

According to ohm's law resistance are two conditions $[V = IR,\ I = V/R]$

$$P = VI$$
$$P = IR(I)$$
$$\boxed{P = I^2R}$$

$$P = VI$$
$$P = V\left(\frac{V}{R}\right) \Rightarrow \boxed{P = \frac{V^2}{R}}$$

→ The energy observed by the resistance are given by
$\omega = \int P\,dt$

According to the ohm's law resistance are two conditions $[V = IR,\ I = V/R]$

$$\omega = \int P\,dt$$
$$\omega = P\int dt$$
$$\omega = Pt$$
$$\omega = VIt$$
$$\omega = IR(It)$$
$$\boxed{\omega = I^2Rt}$$

$$\omega = Pt$$
$$\omega = VIt$$
$$\omega = V\left(\frac{V}{R}\right)t$$
$$\boxed{\omega = \frac{V^2t}{R}}$$

Inductance : The Power observed by the Inductance are given by $P = VI$

According to voltage is directly proportional to the rate of change of current with respect to time.

$$V \propto \frac{di}{dt}$$

where
$$V = L\frac{di}{dt}$$

$$P = VI$$

$$P = L \frac{di}{dt}(i)$$

$$\boxed{P = Li\frac{di}{dt}}$$

→ The energy observed by the inductance are given by

$$\omega = \int P dt$$

$$\omega = \int VI dt$$

According to voltage is directly proportional to the rate of change of current w.r.t time

$$V \propto \frac{di}{dt}$$

$$V = L\frac{di}{dt}$$

$$\omega = \int P dt$$

$$\omega = \int VI dt$$

$$\omega = \int L \cdot \frac{di}{dt} i dt$$

$$\omega = L \int i di$$

$$\boxed{\omega = \frac{Li^2}{2}}$$

Capacitance : The power observed by the capictance are given by $P = VI$

According to current is directly proportional to the rate of change of voltage w.r.to time

$$i \propto \frac{dv}{dt}$$

$$i = c\frac{dv}{dt}$$

$$P = VI$$

$$\boxed{P = cv\frac{dv}{dt}}$$

→ The energy observed by the capacitance are given by $\omega = \int p\,dt$

$$\omega = \int vI\,dt$$

According to current is directly proportional to the rate of change voltage w.r.t time.

$$\omega = \int vc \frac{dv}{dt} \cdot dt$$

$$\omega = c\int v\,dv$$

$$\boxed{\omega = c\frac{V^2}{2}}$$

	V	I	P	E
R	$V = IR$	$I = V/R$	$P = i^2R$ (or) $P = \frac{V^2}{R}$	$\omega = i^2Rt$ (or) $\omega = \frac{V^2t}{R}$
L	$V = L \cdot \frac{di}{dt}$	$i = \frac{1}{L}\int v\,dt$	$P = Li\frac{di}{dt}$	$\omega = \frac{Li^2}{2}$
C	$V = \frac{1}{C}\int i\,dt$	$i = c\frac{dv}{dt}$	$P = cv\frac{dv}{dt}$	$\omega = \frac{cV^2}{2}$

* Network Elements:

The network elements are classified into five types They are.

i) Active and Passive element
ii) Unilateral and Bilateral element
iii) Linear and Non-Linear element
iv) Lumped and distributed element
v) Time Varient and Time in-Varient element.

i) Active and Passive element :

The element which can deliver energy is known as a Active element

Ex: Energy Sources (current & voltage)

The element which consume the energy either receiving (or) stories the energy is known as Passive element

Ex: Resistance (R), Inductance (L), capacitance (c)

ii) Unilateral and Bilateral :

[Unilateral elements offers low resistance for the flow of current in one direction and high resistance for the flow of current in opposite direction is known as unilateral element.] They have different voltage and current relationship for the two possible direction of current.

Ex: Semiconductor devices and diodes.

→ Bilateral elements offers same resistance for the flow of current either direction is known as bilateral element. They have same voltage and current relationship for the two possible direction of current.

Ex: Resistance, Inductance, Capacitance.

iii) Linear and Non-linear element :

A circuit elements said to be linear if it is satisfy the relationship b/w voltage and current (ohm's law)

$V \propto I$, $i \propto \frac{dv}{dt}$

$V = IR$

$V \propto \frac{di}{dt}$ $\quad i = c\frac{dv}{dt}$

$V = L\frac{di}{dt}$

Ex: Resistance, Inductance and Capacitance.

→ A circuit elements said to be non-linear if it doesn't satisfy the relationship b/w voltage and current is known as non-linear elements

Ex: Diodes and Thermometer.

* Lumped and Distributed elements:

The elements which are physically seperable elements is known as a lumped elements.

Ex: Resistance, Inductance and capacitance.

→ The elements which are physically un-separable elements is known as a distributed elements.

Ex: A transmition line has distributed resistance Inductance and capacitance along it's length.

Time Varient and Time Invarient Elements:

If the parametric of the network element do not vary with time is known as time Invarient elements.

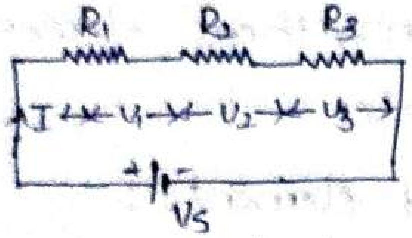
→ If the parametric of the network elements do vary with time is known as time varient elements

→ Normally, we consider network elements are linear, Time invarient and lumped elements.

Voltage division Rule:

A series circuit resistors acts as a voltage division since, the same current flowing in each resistance value. The voltage drops are directly proportional to the each value of the resistance.

The resistance are connected in Series as shown in figure using principle different Voltage are obtained from Single source.



from the circuit based on the eqn $I = \frac{V_S}{R_T}$

Where $R_T = R_1 + R_2 + R_3 \cdots$ total resistance connected in Series.

$$V = IR$$

$$V_1 = IR_1$$

$$V_1 = \frac{V_S}{R_T} R_1$$

$$\boxed{V_1 = V_S \frac{R_1}{R_T}}$$

lly $V_2 = V_S \frac{R_2}{R_T}$

$V_3 = V_S \frac{R_3}{R_T}$

$$\boxed{V_N = V_S \frac{R_N}{R_T}}$$

The General eqn for voltage division rule.

Where V_N = Voltage across N resister

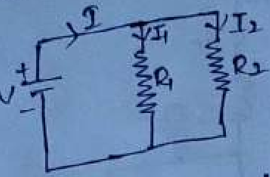
R_N = Resistance across voltage value is determined

R_T = The total resistance are connected in Series.

Current division Rule :

In Parallel circuit the current is divided into all branches the llel circuit acts as a current divider. The total amount of current is divided into branch current according to each value of resistance.

Let. Consider the llel circuit as shown in fig



from the circuit the value of current I_1 & I_2 are given by $I_1 = V/R_1$, $I_2 = V/R_2$

Total resistance $R_T = \frac{R_1R_2}{R_1+R_2}$

Total current $I = V/R_T \Rightarrow I = \frac{I_1R_1}{R_T}$

$$I = \frac{I_1R_1}{R_1R_2} \times R_1+R_2$$

$$I = I_1 \times \frac{R_1+R_2}{R_2}$$

$$\boxed{I_1 = I \times \frac{R_2}{R_1+R_2}}$$

lly $I_2 = I \times \frac{R_1}{R_1+R_2}$

General eq^n of current division rule $\boxed{I_N = I \times \frac{R_T}{R_T+R_N}}$

Where,

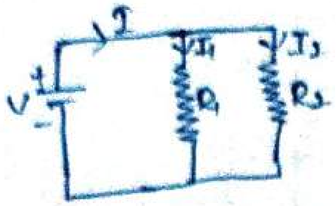
I_N = Current in n^{th} resistor

R_N = Resistance of n^{th} term.

R_T = Resistance are llel branches of n^{th} term.

according to each value of resistance.

let. Consider the llel circuit as shown in fig



from the circuit the value of current I_1 & I_2 are given by $I_1 = V/R_1$, $I_2 = V/R_2$

Total resistance $R_T = \frac{R_1 R_2}{R_1+R_2}$

Total Current $I = V/R_T \Rightarrow I = \frac{I_1 R_1}{R_T}$

$$I = \frac{I_1 R_1}{R_1 R_2} \times R_1+R_2$$

$$I = I_1 \times \frac{R_1+R_2}{R_2}$$

$$\boxed{I_1 = I \times \frac{R_2}{R_1+R_2}}$$

lly $I_2 = I \times \frac{R_1}{R_1+R_2}$

General eqn of current division rule $\boxed{I_N = I \times \frac{R_T}{R_T+R_N}}$

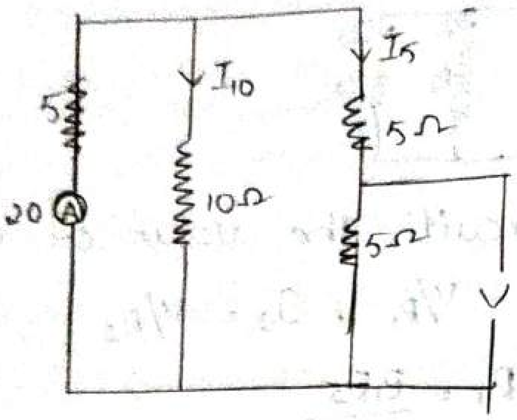
where,

I_N = Current in n^{th} resistor

R_N = Resistance of n^{th} term.

R_T = Resistance are llel branches of n^{th} term.

Q) Determine the Current in 10Ω resistor and find the value of voltage in the circuit as shown in fig



Sol: $I_1 = I \times \frac{R_2}{R_1+R_2}$

$R_T = 5+5 = 10\Omega$

$I_{10} = 20 \times \frac{10}{10+10}$

$I_{10} = 20 \times \frac{10}{20}$

$\boxed{I_{10} = 10A}$

$I_5 = I \times \frac{R_1}{R_1+R_2}$

$= 20 \times \frac{10}{10+10}$

$= 20 \times \frac{10}{20}$

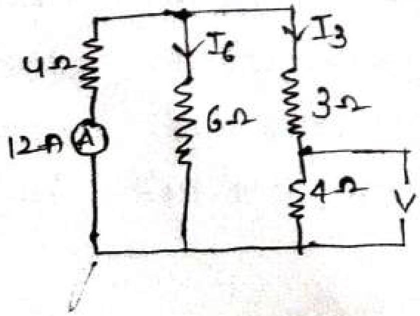
$\boxed{I_5 = 10A}$

$V = I_5 R$

$= 10 \times 5$

$= 50V$

Q) Determine the current in 6Ω resistor and find the value of voltage in the circuit as shown.



Sol: $I_6 = I \times \frac{R_2}{R_1+R_2}$

$R_T = 4+3$
$= 7$

$I_6 = 12 \times \frac{7}{6+7}$

$= 12 \times \frac{7}{13}$

$I_6 = \frac{84}{13}$

$\boxed{I_6 = 6.4\,A}$

$I_3 = I \times \frac{R_1}{R_1+R_2}$

$= 12 \times \frac{6}{6+7}$

$= 12 \times \frac{6}{13}$

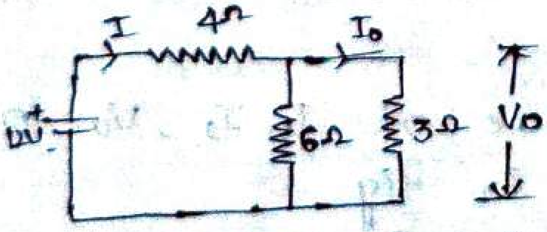
$I_3 = \frac{72}{13}$

$\boxed{I_3 = 5.5A}$

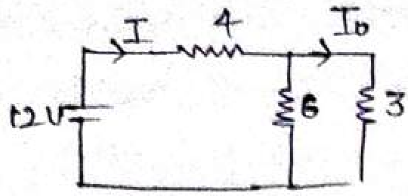
$V = I_3 R$
$= 5.5 \times 4$

$\boxed{V = 22\,V}$

Q) Using voltage and current division rule find the values of V_o, I_o in the circuit as shown in fig



Sol:



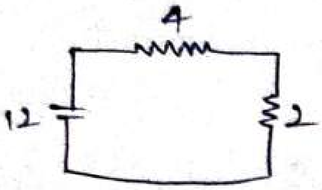
$$\frac{1}{Req} = \frac{1}{6} + \frac{1}{3}$$

$$= \frac{1+2}{6}$$

$$= \frac{3}{6}$$

$$\frac{1}{Req} = \frac{1}{2}$$

$$\boxed{Req = 2\Omega}$$



$$Req = R_1 + R_2$$
$$= 4 + 2$$
$$Req = 6\Omega$$

$$I = \frac{V}{R}$$

$$I = \frac{12}{6}$$

$$\boxed{I = 2A}$$

$$I_0 = I \times \frac{R_T}{R_T + R_N}$$

$$= 2 \times \frac{6}{6+3}$$

$$= 2 \times \frac{\cancel{6}\,2}{\cancel{9}\,3}$$

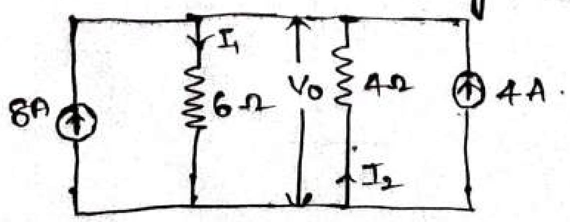
$$= \frac{4}{3}$$

$$\boxed{I_0 = 1.3A}$$

$$V_0 = I_0 R$$
$$= 1.3 \times 3$$

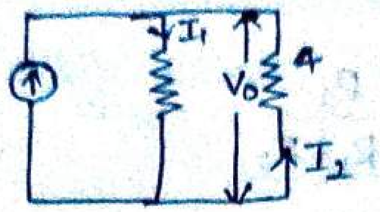
$$\boxed{V_0 = 3.9V}$$

8) Determine the value of I_1, I_2, V_0 in the circuit as shown in fig.



Sol: $I = 8+4 = 12A$

$$I_1 = I \times \frac{R_2}{R_1+R_2}$$



$$I = 12 \times \frac{4}{4+6}$$

$$I = 12 \times \frac{4}{10}$$

$$I = \frac{48}{10}$$

$$\boxed{I_1 = 4.8A}$$

$$I_2 = I \times \frac{R_1}{R_1+R_2}$$

$$I_2 = 12 \times \frac{6}{6+4}$$

$$= 12 \times \frac{6}{10}$$

$$\boxed{I_2 = 7.2A}$$

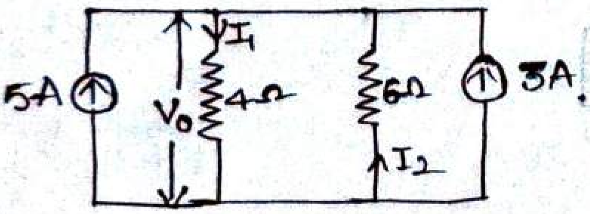
As the current I_2 is in Opposite direction then I_2 becomes "negative sign"

$$\boxed{I_2 = -7.2A}$$

$$V_0 = I_1 \times R_1$$
$$= 4.8 \times 6$$

$$\boxed{V_0 = 28.8\ V}$$

3) Determine the Value of I_1, I_2, V_0 in the Circuit as shown in fig.



Sol: $I = 5+3$

$I = 8A$

$$I_1 = I \times \frac{R_2}{R_1+R_2}$$

$$= 8 \times \frac{6}{4+6}$$

$$= 8 \times \frac{6}{10}$$

$$= \frac{24}{5}$$

$$\boxed{I_1 = 4.8A}$$

$$I_2 = I \times \frac{R_1}{R_1+R_2}$$

$$= 8 \times \frac{4}{4+6}$$

$$= 8 \times \frac{4}{10}$$

$$= \frac{32}{10}$$

$$\boxed{I_2 = 3.2A}$$

As the current I_2 in Opposite direction then I_2 becomes "negative sign."

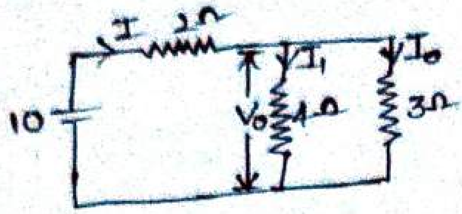
$$\boxed{I_2 = -3.2A}$$

$$v_0 = I_1 \times R_1$$

$$= 4.8 \times 6$$

$$\boxed{v_0 = 28.8V}$$

Q) Using Voltage and Current division rule find the values of V_0, I_0 in the circuit as shown in fig.



Sol: $\frac{1}{Req} = \frac{1}{4} + \frac{1}{3}$

$\frac{1}{Req} = \frac{3+4}{12} = \frac{8}{12}$

$\frac{1}{Req} = \frac{2}{3}$

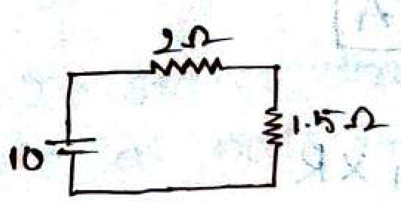
$Req = \frac{3}{2}$

$\boxed{\therefore Req = 1.5\,\Omega}$

$Req = R_1 + R_2$

$= 2 + 1.5$

$Req = 3.5\,\Omega$



$I = \frac{V}{R}$

$= \frac{10}{3.5}$

$\boxed{I = 2.8\,A}$

$I_0 = I \times \frac{R_T}{R_T \times R_N}$

$= 2.8 \times \frac{4}{4+3}$

$= 2.8 \times \frac{4}{7}$

$= \frac{11.2}{7}$

~~$\boxed{I_0 = 1.6A}$~~

~~$V_0 = I_0 \times R$~~
~~$= 1.6 \times 4$~~

~~$\boxed{V_0 = 6.4V}$~~

$\boxed{I_0 = 1.6A}$

$I_1 = I \times \frac{R_T}{R_T + R_N}$

$= 2.8 \times \frac{3}{3+4}$

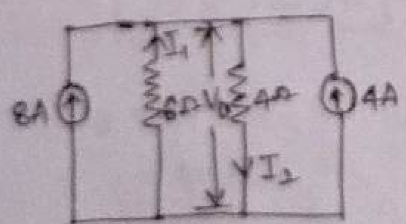
$= 2.8 \times \frac{3}{7}$

$\boxed{I_1 = 1.2A}$

$V_0 = I_1 \times R$
$= 1.2 \times 4$

$\boxed{V_0 = 4.8V}$

6)



Sol: $I = 8 - 4$
$I = 4\Omega$

$I_1 = I \times \frac{R_2}{R_1 + R_2}$

$= 4 \times \frac{4}{6+4}$

$I_1 = 4 \times \frac{4}{10}$

$= \frac{16}{10}$

$\boxed{I_1 = 1.6A}$

V_0
V_0

*Kirchoff's law:
Kirchoff's

1. Kirchoff's C
2. Kirchoff's V

1.* Kirchoff's C
algebraic Su
'zero' is K

The Sum o
equal to Su
is Known a

Ex: Applicat
shown

$$\boxed{I_0 = 1.6A}$$

$$V_0 = I_0 \times R$$
$$= 1.6 \times 4$$
$$\boxed{V_0 = 6.4V}$$

$$\boxed{I_0 = 1.6A}$$

$$I_1 = I \times \frac{R_T}{R_T + R_N}$$

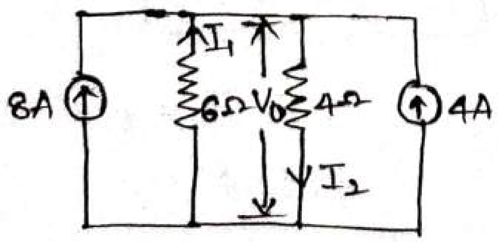
$$= 2.8 \times \frac{3}{3+4}$$

$$= 2.8 \times \frac{3}{7}$$

$$\boxed{I_1 = 1.2A}$$

$$V_0 = I_1 \times R$$
$$= 1.2 \times 4$$
$$\boxed{V_0 = 4.8V}$$

Q)



Sol: $I = 8 - 4$

$I = 4\Omega$

$$I_1 = I \times \frac{R_2}{R_1+R_2}$$

$$= 4 \times \frac{4}{6+4}$$

$$I_1 = 4 \times \frac{4}{10}$$

$$= \frac{16}{10}$$

$$\boxed{I_1 = 1.6A}$$

$$I_2 = I \times \frac{R_1}{R_1+R_2}$$

$$= 4 \times \frac{6}{6+4}$$

$$= 4 \times \frac{6}{10}$$

$$= \frac{24}{10}$$

$$\boxed{I_2 = 2.4A}$$

$$v_0 = I_1 R_1$$

$$v_0 = -1.6 \times 6$$

$$\boxed{v_0 = -9.6V}$$

Kirchoff's law:

Kirchoff's law is classified into two types:

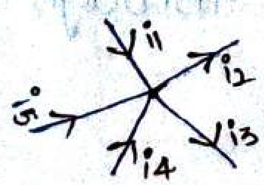
1. Kirchoff's current law [KCL]
2. Kirchoff's voltage law [KVL]

1. Kirchoff's current law: It states that the algebraic sum of currents at node is equal to 'zero' is known as KCL.

(or)

The sum of the current entering at node is equal to sum of the current leaving at node is known as KCL.

Ex: Application of KCL at node is given as shown in fig.



$$i_1 - i_2 - i_3 + i_4 + i_5 = 0$$

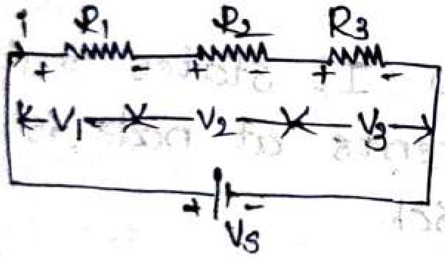
: The Sum of the current entering at node is equal to sum of the current leaving at node.

$$\boxed{i_1 + i_4 + i_5 = i_2 + i_3}$$

2) Kirchoff's Voltage Law:

It states that the algebraic sum of the potential difference (or) voltage around the closed circuit is equal to 'Zero' is known as KVL.

The example of electric circuit resistance are connected in series as shown in fig. The voltage source are having two ends (neg, pos). The voltage source passing through +ve end the voltage drops are '-ve' and the voltage source are passing through -ve end the voltage drops are '+ve'.



from the circuit based on the eqn's in voltage source passing through +ve end is given as

$$V_S - V_1 - V_2 - V_3 = 0$$

$$\boxed{V_S = V_1 + V_2 + V_3}$$

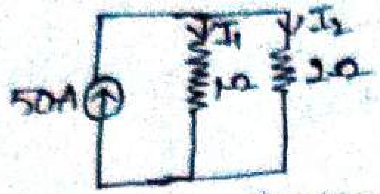
: The voltage source passing through -ve end is given as

$$-V_S + V_3 + V_2 + V_1 = 0$$

$$\boxed{V_S = V_1 + V_2 + V_3.}$$

Prblm:

Q) By using KCL determine the values of I_1, I_2, V the circuit shown in fig.



Sol: Sum of the current entering at node = Sum of the current leaving at node.

$I = I_1 + I_2$ $\qquad I_1 = \frac{V}{1}$, $I = \frac{V}{2}$

$50 = \frac{V}{1} + \frac{V}{2}$

$50 = \frac{2V + V}{2}$

$100 = 3V$

$V = \frac{100}{3}$

$\boxed{V = 33.33}$

$I_1 = \frac{V}{1} \Rightarrow \frac{33.33}{1}$ $\qquad I_2 = \frac{V}{2} \Rightarrow \frac{33.33}{2}$

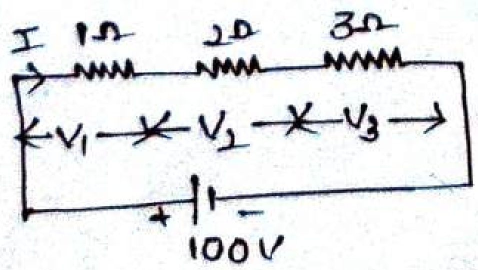
$\boxed{I_1 = 33.33}$ $\qquad \boxed{I_2 = 16.66\,A}$

$I = I_1 + I_2$

$50 = 33.33 + 16.66$

$50 \simeq 49.99.$

Q) By using KVL determine the values of V_1, V_2, V_3 and I in the circuit shown in fig.



Sol: $V = IR$

$V = V_1 + V_2 + V_3$

$V = IR_1 + IR_2 + IR_3$

$100 = I(R_1 + R_2 + R_3)$

$100 = I(1+2+3)$

$100 = I(6)$

$I = \frac{100}{6}$

$\boxed{I = 16.66A}$

$V_1 = IR_1$

$V_1 = 16.66(1)$

$\boxed{V_1 = 16.66V}$

$V_2 = IR_2$

$V_2 = 16.66(2)$

$\boxed{V_2 = 33.32V}$

$V_3 = IR_3$

$V_3 = 16.66(3)$

$\boxed{V_3 = 49.98V}$

$V = V_1 + V_2 + V_3$

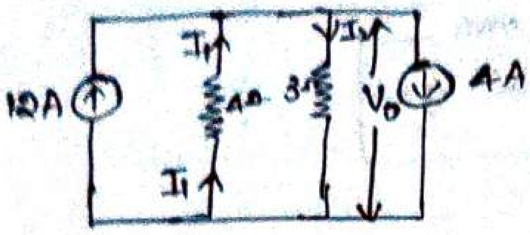
$V = 16.66 + 33.32 + 49.98$

$V = 99.96$

$100 \simeq 99.96$

Homework Prblms

→ Determine the value of I_1, I_2, V_0 in the circuit as shown in fig.



Sol: $I = 12 - 4$

$I = 8\Omega$

$I_1 = I \times \frac{R_2}{R_1+R_2}$

$= 8 \times \frac{3}{4+3}$

$= 8 \times \frac{3}{7}$

$= \frac{24}{7}$

$\boxed{I_1 = 3.4}$

As the current I_1 is in opposite direction then I_1 becomes "negative sign."

$\boxed{I_1 = -3.4}$

$I_2 = I \times \frac{R_1}{R_1+R_2}$

$= 8 \times \frac{4}{4+3}$

$= 8 \times \frac{4}{7}$

$= \frac{32}{7}$

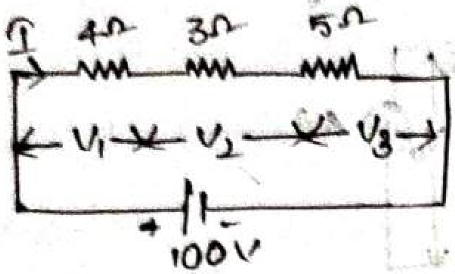
$\boxed{I_2 = 4.5}$

$V_0 = I_1 \times R_1$

$= -3.4 \times 3$

$\boxed{V_0 = -10.2}$

Q) By using KVL determine the values of V_1, V_2, V_3 and I in the circuit as shown in fig.



Sol: $V = IR$

$V = V_1 + V_2 + V_3$

$V = IR_1 + IR_2 + IR_3$

$V = I(R_1 + R_2 + R_3)$

$V = I(4+3+5)$

$100 = I(12)$

$I = \frac{100}{12}$

$\boxed{I = 8.3A}$

$V_1 = IR_1$
$= 8.3(4)$
$\boxed{V_1 = 33.2V}$

$V_2 = IR_2$
$= 8.3(3)$
$\boxed{V_2 = 24.9V}$

$V_3 = IR_3$
$= 8.3(5)$
$\boxed{V_3 = 41.5V}$

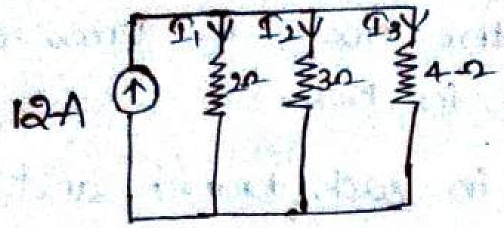
$V = V_1 + V_2 + V_3$

$= 33.2 + 24.9 + 41.5$

$100 = 99.6$

$100 \simeq 99.6$

8) By using KCl determine the values of I_1, I_2, V the circuit shown in fig



Sol: $I = I_1 + I_2 + I_3$

$$12 = \frac{V}{2} + \frac{V}{3} + \frac{V}{4}$$

$$12 = \frac{6V + 4V + 3V}{12}$$

$$12 = \frac{13V}{12}$$

$$144 = 13V$$

$$V = \frac{144}{13}$$

$$\boxed{V = 11.07}$$

$$I_1 = \frac{V}{2} = \frac{11.07}{2}$$

$$\boxed{I_1 = 5.5A}$$

$$I_2 = \frac{V}{3} = \frac{11.07}{3}$$

$$\boxed{I_2 = 3.6A}$$

$$I_3 = \frac{V}{4} = \frac{11.07}{4}$$

$$\boxed{I_3 = 2.7A}$$

$$I = I_1 + I_2 + I_3$$

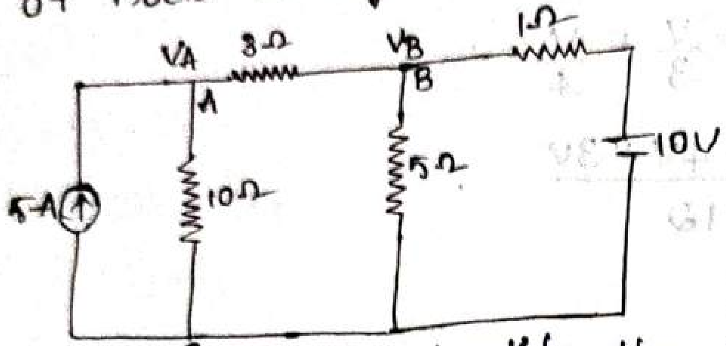
$$12 = 5.5 + 3.6 + 2.7$$

$$12 \simeq 11.8$$

Nodel Analysis :

Nodel analysis is also known as node voltage analysis (or) Branch current method. It is used to determine voltage b/w the node in terms of branch current. This method used in KCL.

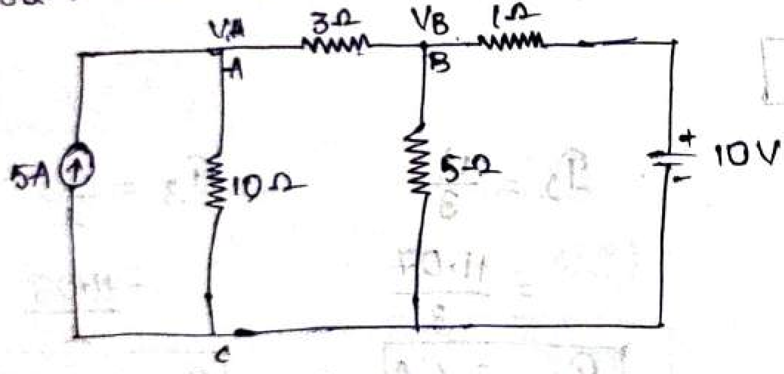
Q) Determine the current in each branch and write the eq^n of node voltage in the circuit shown in fig



Sol: In the given circuit identify the nodes A, B & C

Select 'c' node as Reference node.

Assain the variables voltage V_A, V_B



By using KCL node - I

$$5 = \frac{V_A}{10} + \frac{V_A - V_B}{3}$$

$$5 = \frac{3V_A + 10V_A - 10V_B}{30}$$

$$150 = 13V_A - 10V_B \quad \text{——— (1)}$$

By using KCL node - II

$$\frac{V_B - V_A}{3} + \frac{V_B}{5} + \frac{V_B - 10}{1} = 0$$

$$\frac{5V_B - 5V_A + 3V_B + 15V_B - 150}{15} = 0$$

$$-5V_A + 23V_B = 150 \quad \text{——— (2)}$$

Solving ① & ② eqn's and calculate the value of V_A, V_B.

$⑤ \times 1 = 13V_A - 10V_B = 150$

$⑬ \times 2 = -5V_A + 23V_B = 150$

$65V_A - 50V_B = 750$

$-65V_A + 299V_B = 1950$

$249V_B = 2700$

$V_B = \frac{2700}{249}$

$\boxed{V_B = 10.84V}$

Substitute $V_B = 10.84$ in eq ①

$13V_A - 10(10.84) = 150$

$13V_A - 108.4 = 150$

$13V_A = 150 + 108.4$

$13V_A = 258.4$

$V_A = \frac{258.4}{13}$

$\boxed{V_A = 19.87V}$

Current in $10\Omega = I = \frac{V}{R} = \frac{V_A}{R} = \frac{19.87}{10}$

$= 1.987V.$

Current in $3\Omega = \frac{V_A - V_B}{R} = \frac{19.87 - 10.84}{3} = \frac{9.03}{3}$

$= 3.01A$

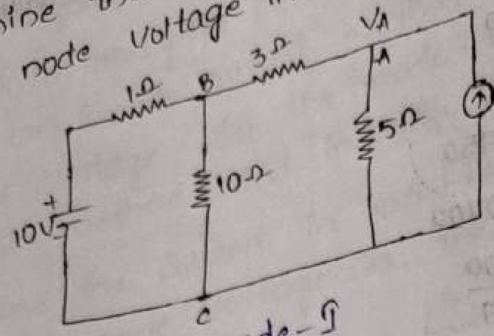
Current in $5\Omega = \frac{V_B}{R} = \frac{V_B}{5} = \frac{10.84}{5}$

$= 2.168A$

Current in $1\Omega = \frac{V_B - 10}{1} = \frac{10.84 - 10}{1}$

$= 0.84A.$

Q) Determine the current in each branch and write the eq^n node voltage in circuit shown in fig.



Sol: By using KCL node-I

$$10 = \frac{V_A}{5} + \frac{V_A - V_B}{3}$$

$$10 = \frac{3V_A + 5V_A - 5V_B}{15}$$

$$150 = 8V_A - 5V_B \quad \text{——— ①}$$

By using KCL node-II

$$\frac{V_B - V_A}{3} + \frac{V_B}{10} + \frac{V_B - 10}{1} = 0$$

$$\frac{10V_B - 10V_A + 3V_B + 30V_B - 300}{300} = 0$$

$$-10V_A + 43V_B - 300 = 0$$

$$-10V_A + 43V_B = 300 \quad \text{——— ②}$$

solving eq^n ① & ② and calculate of values V_A, V_B

$10 \times ①$ $150 = 8V_A - 5V_B$

$8 \times ②$ $300 = -10V_A + 43V_B$

$$1500 = 80V_A - 50V_B$$
$$2400 = -80V_A + 344V_B$$
$$3900 = 294V_B$$

$$V_B = \frac{3900}{294}$$

$$\boxed{V_B = 13.26V}$$

Sub...

$8V_A - 66.3 = 150$

$8V_A = 150 + 66.$

$8V_A = 216.3$

$V_A = \frac{216.3}{8}$

$\boxed{V_A = 27.0}$

Current in $5\Omega = \frac{V_A}{5\Omega}$

Current in $3\Omega = \frac{V_A - }{3}$

Current in $10\Omega = \frac{V_B}{10}$

Current in $1\Omega =$

Energy Sources :

Energy Sources

→ Independent S

→ Dependent Sou

Independent Sou

1) Ideal and Pr

2) Ideal and P

Ideal Voltage

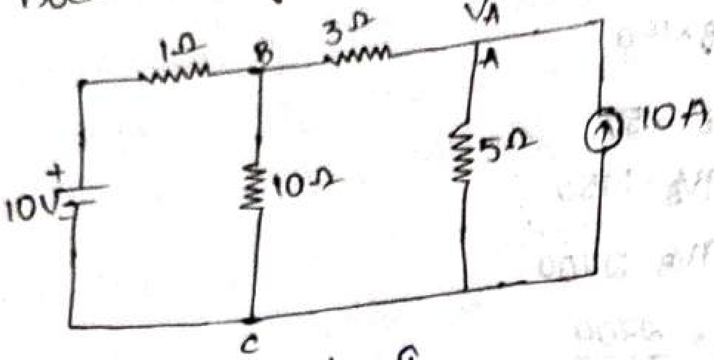
independent

→ The ideal

voltage d

→ When a

Q) Determine the Current in each branch and write the eq^n node voltage in circuit shown in fig.



Sol: By using KCL node-I

$$10 = \frac{V_A}{5} + \frac{V_A - V_B}{3}$$

$$10 = \frac{3V_A + 5V_A - 5V_B}{15}$$

$$150 = 8V_A - 5V_B \quad \text{——— (1)}$$

By using KCL node-II

$$\frac{V_B - V_A}{3} + \frac{V_B}{10} + \frac{V_B - 10}{1} = 0$$

$$\frac{10V_B - 10V_A + 3V_B + 30V_B - 300}{300} = 0$$

$$-10V_A + 43V_B - 300 = 0$$

$$-10V_A + 43V_B = 300 \quad \text{——— (2)}$$

solving eq^n (1) & (2) and calculate of values V_A, V_B

$$10 \times (1) \quad 150 = 8V_A - 5V_B$$
$$8 \times (2) \quad 300 = -10V_A + 43V_B$$

$$1500 = 80V_A - 50V_B$$
$$2400 = -80V_A + 344V_B$$

$$3900 = 294V_B$$

$$V_B = \frac{3900}{294}$$

$$\boxed{V_B = 13.26V}$$

Write 7.

Substitute $V_B = 13.26$ in eq ①

$$8V_A - 5(13.26) = 150$$
$$8V_A - 66.3 = 150$$
$$8V_A = 150 + 66.3$$
$$8V_A = 216.3$$
$$V_A = \frac{216.3}{8}$$
$$\boxed{V_A = 27.03V}$$

Current in $5\Omega = \frac{V_A}{R} = \frac{V_A}{5} = \frac{27.03}{5} = 5.406\ A$.

Current in $3\Omega = \frac{V_A - V_B}{3} = \frac{27.03 - 13.26}{3} = \frac{13.77}{3} = 4.59A$

Current in $10\Omega = \frac{V_B}{10} = \frac{13.26}{10} = 1.326\ A$.

Current in $1\Omega = \frac{V_B - 10}{1} = \frac{13.26 - 10}{1} = 3.26\ A$.

Energy Sources :

Energy Sources are classified into two types.

→ Independent Source.

→ Dependent Source

Independent Sources : Independent Sources are Sub-divided into two types.

1) Ideal and Practical Voltage Source.

2) Ideal and Practical Current Source.

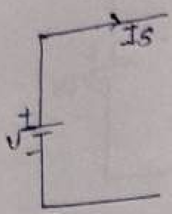
Ideal Voltage Source : Ideal Voltage Source, the voltage independent of current Source.

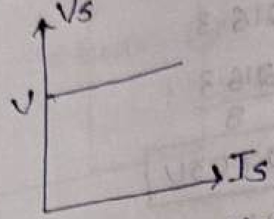
→ The ideal voltage Source maintain the constant voltage doesn't change.

→ When a changes takes place in electric networks.

→ Ideal voltage Source we have zero internal resistance.

→ The ideal voltage Source are doesn't exist

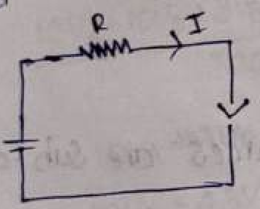


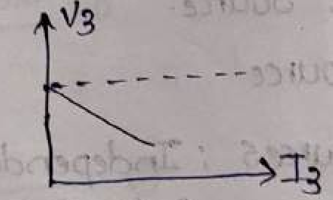


ii) Practical voltage Source : In practical voltage Source can be consider as Series combination of ideal voltage Source and Some internal resistance is Known as practical voltage Source.

→ In practical voltage source depend upon Current source.

→ In practical voltage Source having Some internal resistance due to with decreases the voltage and increases the current.



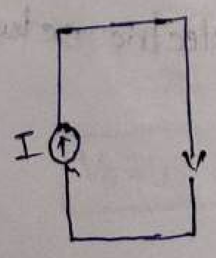


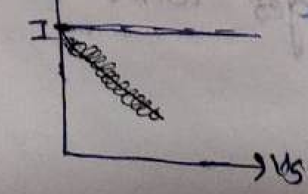
Ideal Current Source : Ideal Current Source, the Current Source independent of Voltage Source.

→ Ideal current Source maintain the constant Current and does not change.

→ When the changes take place in electric networks

→ Ideal current Source doesn't exist

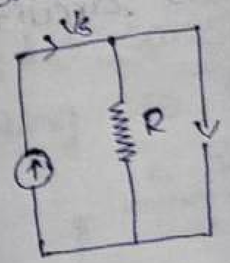




iii) *Practical cu...
consider as parallel
and Some internal
current Source.

→ Practical current
upon voltage So...

→ practical current
resistance, due
increases in



Dependent Sou...

Dependen...

1) Voltage depe...

2) voltage dep...

3) Current de...

4) Current dep...

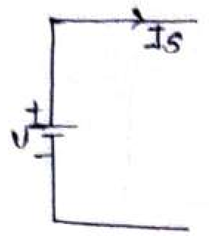
Super positio...

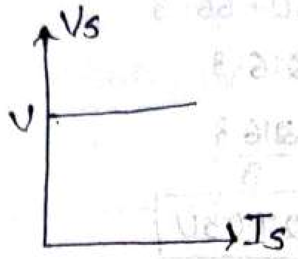
Statement :
any linear
the respon...
algebraic S...
acting indi...

Note : Remo...
Circuit . Ren...

→ Ideal voltage source we have zero internal resistance.

→ The ideal voltage source are doesn't exist.

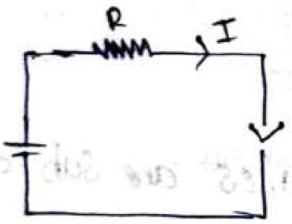


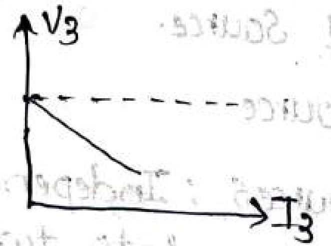


ii) Practical voltage source : In practical voltage source can be consider as series combination of ideal voltage source and some internal resistance is known as practical voltage source.

→ In practical voltage source depend upon current source.

→ In practical voltage source having some internal resistance due to with decreases the voltage and increases the current.



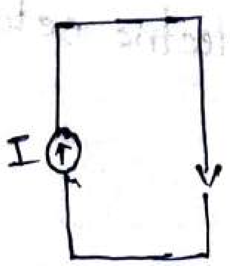


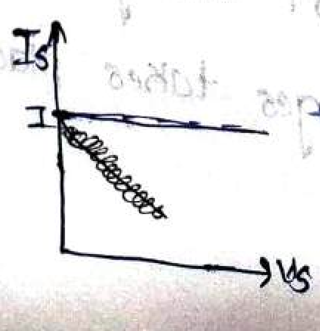
Ideal current source : Ideal current source, the current source independent of voltage source.

→ Ideal current source maintain the constant current and does not change.

→ when the changes take place in electric networks.

→ Ideal current source doesn't exist.

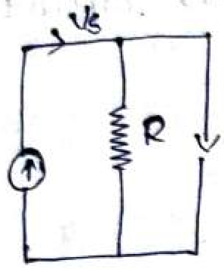


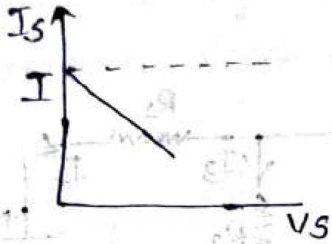


iii) *Practical Current Source: Practical Current Source can be consider as parallel combination of ideal current source and same internal resistance is known as practical current source.

→ practical current source the current source depend upon voltage source.

→ practical current source having the same internal resistance, due to which decreases the current and increases in voltage.





Dependent Source:

Dependent sources classified into four types.

1) Voltage dependent voltage source.
2) voltage dependent current source.
3) Current dependent voltage source.
4) Current dependent current source.

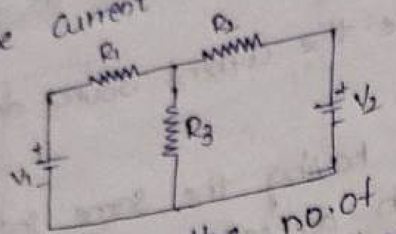
Super position theorem:

Statement: Super position theorem it states that in any linear elements containing two (or) more sources, the response of any element is equal to the algebraic sum of the response caused by source are acting individually.

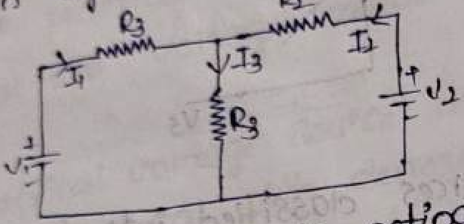
Note: Removeal of voltage source means short circuit. Removal of current means open circuit.

Explanation / verification of Super position theorem:

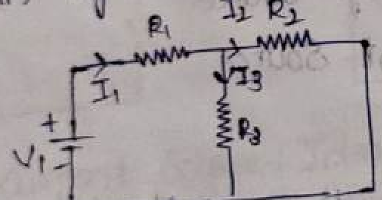
In the given circuit shown in figure find the current flowing through various branches.



Step 1: Identify the no. of branches in the circuit and mark the current direction in each branch. Let consider I_1, I_2 & I_3 in the direction circuit is shown in fig.



Step 2: Let consider V_1 is acting and V_2 is short circuit according to super position theorem as shown in fig.



In the above circuit the total resistance R_T is given

$$RT_1 = \frac{R_2 \times R_3}{R_2 + R_3} + R_1$$

Total current flowing through the circuit is given

$$\boxed{I_1 = \frac{V_1}{RT_1}}$$

The current flowing through R_2 According to current division Rule.

Total curre...

$$I_2' = I_1' \times \frac{R_3}{R_3 + R_2}$$

The current flowing ...

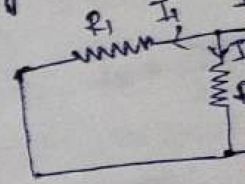
$$I_3' = I_1' \times \frac{R_2}{R_2 + R_3}$$

By using KCL $I_1' =$ ...

I_3' ...

Step 3: Let consider ...

According to Sup...



In the above ...

given by $RT_2 = \frac{R}{R}$ ...

Total current ...

by $\boxed{I_2'' = \frac{V_2}{R}}$ ...

The current ...

$I_1'' =$ ...

The curren...

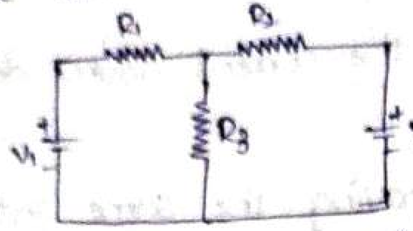
$I_3'' =$ ...

By using ...

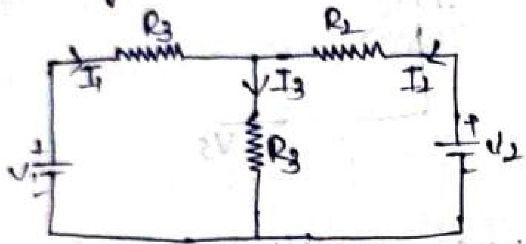
super position theorem:

Explanation / verification of super position theorem:

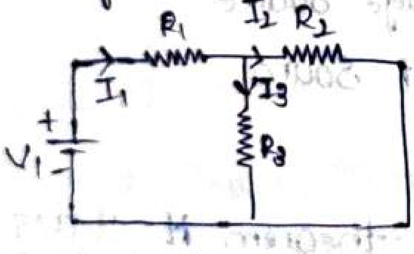
In the given circuit shown in figure find the current flowing through various branches.



Step 1: Identify the no. of branches in the circuit and mark the current direction in each branch. Let consider I_1, I_2 & I_3 in the direction circuit is shown in fig.



Step 2: Let consider V_1 is acting and V_2 is short-circuit according to super position theorem as shown in fig.



In the above circuit the total resistance R_T is given

$$R_{T_1} = \frac{R_2 \times R_3}{R_2 + R_3} + R_1$$

Total current flowing through the circuit is given

$$\boxed{I_1 = \frac{V_1}{R_{T_1}}}$$

The current flowing through R_2 According to current division Rule.

Total Current $\times$ $\frac{\text{opposite Resistance}}{\text{opp resi + Sum of the resis}}$

$$I_2' = I_1' \times \frac{R_3}{R_3+R_2}$$

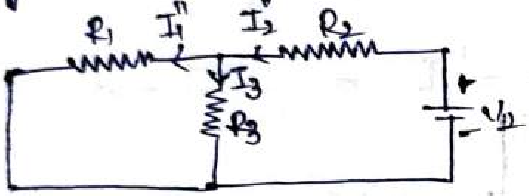
the current flowing through R_3

$$I_3' = I_1' \times \frac{R_2}{R_2+R_3}$$

By using KCL $I_1' = I_2' + I_3'$

$$I_3' = I_1' - I_2'$$

step 3: Let consider V_2 is acting and V_1 is shot circuit According to Super position theorem as shown in fig



In the above circuit the total resistance RT_2 is given by

$$RT_2 = \frac{R_1 \times R_3}{R_1+R_3} + R_2$$

Total Current flowing through the circuit is given by

$$\boxed{I_2'' = \frac{V_2}{RT_2}}$$

The current flowing through R_1

$$I_1'' = I_2'' \times \frac{R_3}{R_3+R}$$

the current flowing through R_3

$$I_3'' = I_2'' \times \frac{R_1}{R_1+R_3}$$

By using KCL $I_2'' = I_1'' + I_3''$

$$I_3'' = I_2'' - I_1''$$

Step 4:

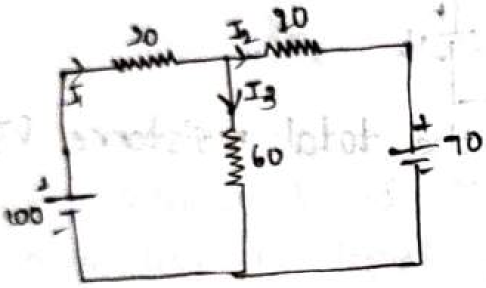
The resultant direction of current in various branches is given as the resultant direction of current

$I_1 = I_1'' - I_1'$ (or) $I_1' - I_1''$ [opposite direction in both cases]

the resultant direction of current $I_2 = I_2'' - I_2'$ (or) $I_2' - I_2''$
[opposite direction in both causes]

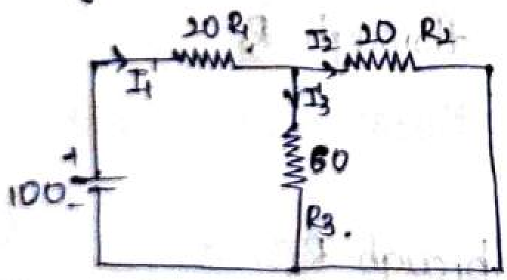
The resultant direction of current $I_3 = I_3' + I_3''$
[same direction in both causes].

Q) In the circuit shown in fig find the current flow through various branches



Sol: Let us consider 100V is acting and 70V is in shot circuit.

According to Super position theorem.



In the above circuit total resistance RT_1 is

20 & 60 are in llel

$$RTeq = \frac{20 \times 60}{20+60} \Rightarrow \frac{1200}{80}$$

$$RT = 15\Omega$$

15Ω & 20Ω are in Series

$$RT_1 = 15 + 20$$

$$\boxed{RT_1 = 35\Omega}$$

Total current flowing through the circuit

$I_1' = \frac{V_1}{RT_1} \Rightarrow I_1' = \frac{100}{35}$

$= 2.85$

$I_1' = 2.85A$

According to current division rule current flowing through $R_2 = 20\Omega$

$I_2' = I_1' \times \frac{R_2}{R_3+R_2}$

$I_2' = 2.85 \times \frac{60}{60+20}$

$I_2' = \frac{285}{100} \times \frac{60}{80}$

$I_2' = \frac{855}{4\times100} \rightarrow I_2' = \frac{213.75}{100}$

$I_2' = 2.1375A$

$\boxed{I_2' = 2.13A}$

Current flowing through $R_3 = 60\Omega$

$I_3' = I_1' \times \frac{R_2}{R_2+R_3}$

$I_3' = 2.85 \times \frac{20}{20+60}$

$I_3' = \frac{285}{100} \times \frac{20}{80} \Rightarrow I_3' = \frac{285}{4\times100}$

$I_3' = \frac{71.25}{100} \Rightarrow I_3' = 0.7125$

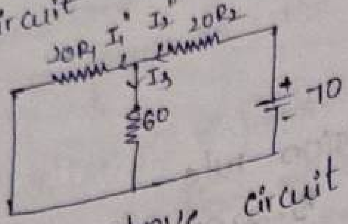
$\boxed{I_3' = 0.71A}$

By using KCL $I_1' = I_2' + I_3'$

$2.85 = 2.13 + 0.71$

$2.85 \simeq 2.84$

→ Let consider 70V is acting and 100V is in shot circuit



In the above circuit total resistance RT_2 is

20 & 60 are in ||el

$$R_{eq} = \frac{20\times60}{20+60} = \frac{1200}{80} = 15\,\Omega$$

15Ω & 20Ω are in series.

$RT_2 = 15+20 = 35\,\Omega$

Total current flowing through the circuit is

$$I_2'' = \frac{V_2}{RT_2} \Rightarrow I_2' = \frac{70}{35}$$

$$\boxed{I_2'' = 2A}$$

According to current division rule

Current flowing through $R_1 = 20\,\Omega$

$$I_1'' = I_2'' \times \frac{R_3}{R_3+R_1}$$

$$I_1'' = 2\times\frac{60}{60+20} \Rightarrow I_1'' = 2\times\frac{60}{80} \Rightarrow I_1'' = 3/2$$

$$\boxed{I_1'' = 1.5A}$$

Current flowing through $R_3 = 60\,\Omega$

$$I_3'' = I_2'' \times \frac{R_1}{R_1+R_3}$$

$$I_3'' = 2\times\frac{20}{20+60} \Rightarrow I_3'' = 2\times\frac{20}{80} \Rightarrow I_3'' = 1/2$$

$$\boxed{I_3'' = 0.5A}$$

By using KCL $I_2'' = I_1'' + I_3''$

$2 = 1.5 + 0.5$

$2 = 2$

The ... branches is given in $I_1 = I_1' - I_1''$

$\Rightarrow I_1 = 2.85 -$

$\Rightarrow \boxed{I_1 = 1.35}$

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Sol: Let us Shot-circu According

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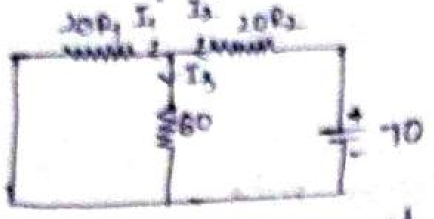
20 & 160

Req =

→ Let consider 70V is acting and 100V is in shot circuit



In the above circuit total resistance R_{T_2} is

20 & 60 are in ||el

$$R_{eq} = \frac{20 \times 60}{20+60} = \frac{1200}{80} = 15\Omega$$

15Ω & 20Ω are in series.

$$R_{T_2} = 15+20 = 35\Omega$$

Total current flowing through the circuit is

$$I_2'' = \frac{V_2}{R_{T_2}} \Rightarrow I_2' = \frac{70}{35}$$

$$\boxed{I_2'' = 2A}$$

According to current division rule current flowing through $R_1 = 20\Omega$

$$I_1'' = I_2'' \times \frac{R_3}{R_3+R_1}$$

$$I_1' = 2 \times \frac{60}{60+20} \Rightarrow I_1'' = 2 \times \frac{60}{80} \Rightarrow I_1'' = 3/2$$

$$\boxed{I_1'' = 1.5A}$$

current flowing through $R_3 = 60\Omega$

$$I_3'' = I_2'' \times \frac{R_1}{R_1+R_3}$$

$$I_3' = 2 \times \frac{20}{20+60} \Rightarrow I_3'' = 2 \times \frac{20}{80} \Rightarrow I_3'' = 1/2$$

$$\boxed{I_3'' = 0.5A}$$

By using KCL $I_2' = I_1'' + I_3''$

$$2 = 1.5 + 0.5$$

$$2 = 2$$

the resultant direction of current in various branches is given the resultant direction of current in $I_1 = I_1' - I_1''$

$\Rightarrow I_1 = 2.85 - 1.5$

$\Rightarrow \boxed{I_1 = 1.35A}$

resultant direction of current in $I_2 = I_2' - I_2''$

$\Rightarrow I_2 = 2.13 - 2.0$

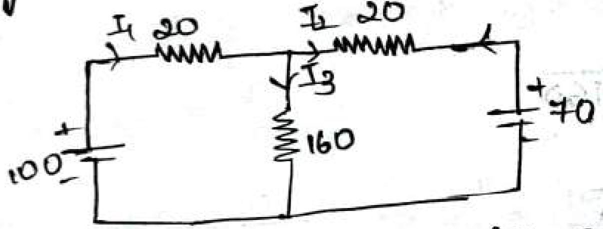
$\Rightarrow \boxed{I_2 = 0.13A}$

resultant direction of current $I_3 = I_3' + I_3''$

$I_3 = 0.71 + 0.5$

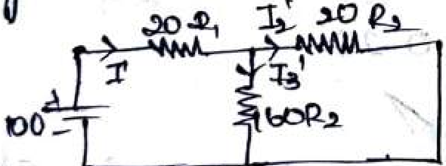
$\boxed{I_3 = 1.21A}$

Q) In the circuit shown in fig. find the current flowing through various branches.



Sol: Let us consider 100V is acting and 70V is in short-circuit

According to Super position theorem



In the above circuit total resistance RT_1 is 20 & 160 are in ||el.

$$Req = \frac{20 \times 160}{20+160} = \frac{3200}{180}$$

$= 17.77$

$Req = 17.77\Omega$

17.77 & 20Ω are in Series.

$RT_1 = 17.77 + 20$

$\boxed{RT_1 = 37.77\Omega}$

Total current flowing through the circuit

$$I_1' = \frac{V_1}{RT_1} \Rightarrow I_1' = \frac{100}{37.77} \Rightarrow \boxed{I_1' = 2.64A}$$

According to current division rule

Current flowing through $R_2 = 20\Omega$

$$\Rightarrow I_2' = I_1' \times \frac{R_3}{R_3+R_2}$$

$$\Rightarrow I_2' = 2.64 \times \frac{160}{160+20}$$

$$\Rightarrow I_2' = \frac{264}{100} \times \frac{160}{180}$$

$$\boxed{I_2' = 2.34A}$$

Current flowing through $R_3 = 160\Omega$

$$\Rightarrow I_3' = I_1' \times \frac{R_2}{R_2+R_3}$$

$$\Rightarrow I_3'' = 2.64 \times \frac{20}{20+160}$$

$$\Rightarrow I_3' = \frac{264}{100} \times \frac{20}{180}$$

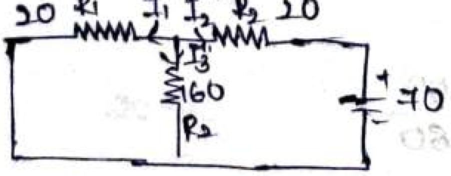
$$\boxed{I_3' = 0.29A}$$

By using KCL $= I_1' = I_2' + I_3'$

$$2.64 = 2.34 + 0.29$$

$$2.64 = 2.63$$

→ Let consider 70V is acting and 100V is short circuit



In the above circuit total resistance RT_2 is

20 & 160 are in $\parallel$el

$$R_{eq} = \frac{20 \times 160}{20+160} = \frac{3200}{180} = 17.77$$

17.77 & 20 are in series

$RT_2 = 17.77 + 20$

$\boxed{RT_2 = 37.77}$

Total Current flowing through the Circuit is

$I_2'' = \frac{V_2}{RT_2} = \frac{70}{37.77}$

$\boxed{I_2'' = 1.85 A}$

According to current division rule current flowing through $R_1 = 20\Omega$

$\Rightarrow I_1'' = I_2'' \times \frac{R_3}{R_3 + R_1}$

$\Rightarrow I_1'' = 185 \times \frac{160}{160+20} \Rightarrow I_1'' = \frac{185}{100} \times \frac{160}{180}$

$\Rightarrow \boxed{I_1'' = 1.64 A}$

Current flowing through $R_3 = 160\Omega$

$\Rightarrow I_3'' = I_2'' \times \frac{R_1}{R_1 + R_3}$

$\Rightarrow I_3'' = 1.85 \times \frac{20}{20+160} \Rightarrow I_3'' = \frac{185}{100} \times \frac{20}{180}$

$\boxed{I_3'' = 0.205 A}$

By using KCL $\Rightarrow I_2'' = I_1' + I_3''$

$\Rightarrow 1.85 = 1.64 + 0.20$

$\Rightarrow 1.85 = 1.84$

The resultant direction of Current in $I_1 = I_1' - I_1''$

$\Rightarrow I_1 = 2.64 - 1.64$

$\Rightarrow \boxed{I_1 = 1 A}$

The resultant direction of Current in $I_2 = I_2' - I_2''$

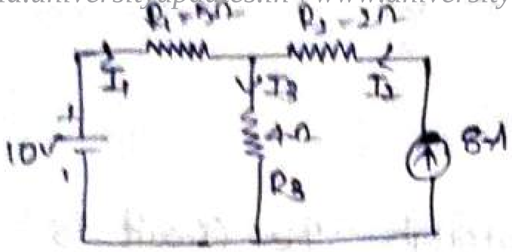
$\Rightarrow I_2 = 2.34 - 1.85$

$\boxed{I_2 = 0.49 A}$

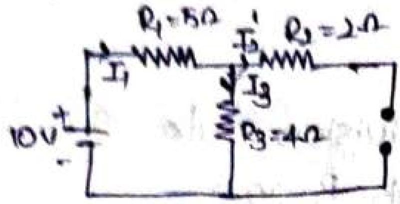
The resultant direction of Current in $I_3 = I_3' + I_3''$

$\Rightarrow I_3 = 0.29 + 0.205 \Rightarrow 0.495$

$\boxed{I_3 = 0.495 A}$



Step 2: Let consider V is acting and current source is open.



R_2 becomes zero

$RT_1 = 5+4$
$= 9\Omega$

Total current $I_1' = \frac{V}{RT_1} = \frac{10}{9} = 1.1A$

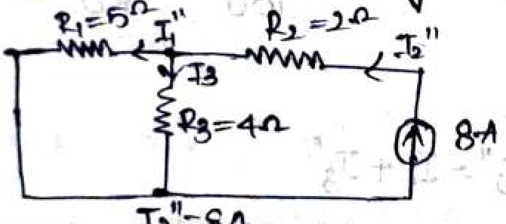
$I_2' = 0$

$\boxed{I_1' = I_3'}$ these are in series

By using KCL $I_1' = I_2' + I_3' \Rightarrow 1.1 = 0 + 1.1$
$1.1 = 1.1$

Step 3:

Current source is acting, voltage source is short



The current flowing through R_1

$$I_1'' = I_2'' \times \frac{R_3}{R_3+R_1} \Rightarrow I_1'' = 8 \times \frac{4}{4+5}$$

$$\Rightarrow I_1'' = \frac{32}{9} \Rightarrow I_1'' = 3.5A$$

$$I_3'' \Rightarrow I_2'' \times \frac{R_1}{R_1+R_3} \Rightarrow I_3'' = 8 \times \frac{5}{4+5} \Rightarrow I_3'' = \frac{40}{9}$$

$$\Rightarrow I_3'' = 4.4A$$

By using $I_2'' = I_3'' + I_1''$

$8 = 4.4 + 3.5$

$8 = 7.9 \simeq 8$

the resultant direction of current $I_1 = I_1'' - I_1'$

$\Rightarrow I_1 = 3.5 - 1.1$

$\Rightarrow I_1 = 2.4 A$

the resultant direction of current $I_2 = I_2'' - I_2'$

$\Rightarrow I_2 = 8 - 0$

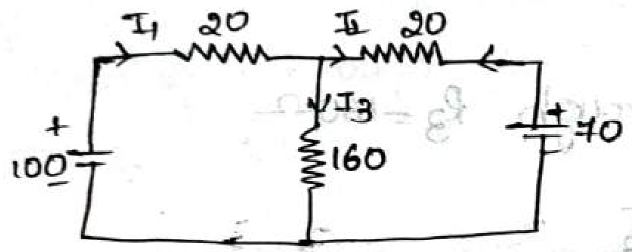
$I_2 = 8A$

The resultant direction of current $I_3 = I_3' + I''$

$\Rightarrow I_3 = 4.4 + 1.1$

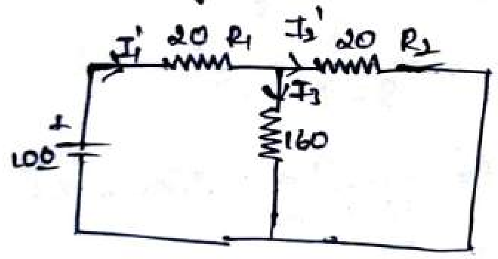
$\Rightarrow I_3 = 5.5 A$

Q) In the circuit shown in fig. find the current flowing through various branches.



Sol: Let us consider 100V is acting and 70V is in short-circuit.

According to Super position theorem



In the above circuit total resistance RT_1 is

20 & 160 are in llel

$$R_{eq} = \frac{20 \times 160}{20 + 160} = \frac{3200}{180} = 17.77$$

$R_{eq} = 17.77\Omega$

17.77 & 20Ω are in Series

$RT_1 = 17.77 + 20$

$\boxed{RT_1 = 37.77\Omega}$

Total current flowing through the circuit

$$I_1' = \frac{V_1}{R_{T_1}} \Rightarrow I_1' = \frac{100}{37.77}$$

$$\boxed{I_1' = 2.64 A}$$

According to current division rule
current flowing through $R_2 = 20\Omega$

$$I_2' = I_1' \times \frac{R_3}{R_3 + R_2}$$

$$\Rightarrow I_2' = 2.64 \times \frac{160}{160+20}$$

$$\Rightarrow I_2' = \frac{264}{100} \times \frac{160}{180}$$

$$\Rightarrow \boxed{I_2' = 2.34 A}$$

Current flowing through $R_3 = 160\Omega$

$$\Rightarrow I_3' = I_1' \times \frac{R_2}{R_2 + R_3}$$

$$\Rightarrow I_3' = 2.64 \times \frac{20}{20+160}$$

$$\Rightarrow I_3' = \frac{264}{100} \times \frac{20}{180}$$

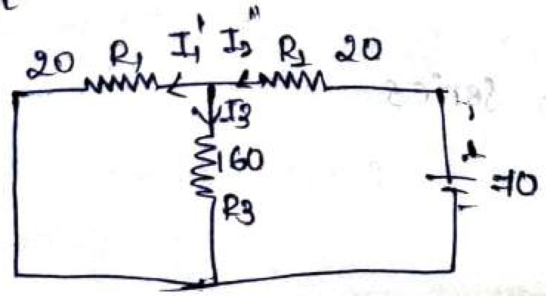
$$\boxed{I_3' = 0.29 A}$$

By using KCL $= I_1' = I_2' + I_3'$

$$2.64 = 2.34 + 0.29$$

$$2.64 = 2.63$$

→ Let consider 70V is acting and 100V is short-circuit



In the above circuit total resistance R_{T_2} is

20 & 160 are in ||el

$$R_{eq} = \frac{20 \times 160}{20+160} = \frac{3200}{180} = 17.77$$

17.77 & 20 are in Series

$$R_{T_2} = 17.77 + 20$$

$$\boxed{R_{T_2} = 37.77}$$

Total current flowing through the circuit is

$$I_2'' = \frac{V_2}{R_{T_2}} = \frac{70}{37.77}$$

$$\boxed{I_2'' = 1.85\,A}$$

According to current division rule

current flowing through $R_1 = 20\Omega$

$$\Rightarrow I_1' = I_2'' \times \frac{R_3}{R_3+R_1}$$

$$\Rightarrow I_1' = 1.85 \times \frac{160}{160+20} \Rightarrow I_1' = \frac{185}{100} \times \frac{160}{180}$$

$$\boxed{I_1' = 1.64\,A}$$

Current flowing through $R_3 = 160\Omega$

$$I_3' = I_2'' \times \frac{R_1}{R_1+R_3}$$

$$I_3'' = 1.85 \times \frac{20}{20+160} \Rightarrow I_3'' = \frac{185}{100} \times \frac{20}{180}$$

$$\boxed{I_3'' = 0.205\,A}$$

By using KCL $\Rightarrow I_2'' = I_1'' + I_3''$

$$1.85 = 1.64 + 0.20$$

$$1.85 = 1.84$$

The resultant direction of current in $I_1 = I_1' - I_1''$

$$\Rightarrow I_1 = 2.64 - 1.64$$

$$\boxed{I_1 = 1A}$$

The resultant direction of current in $I_3 = I_3' - I_3''$

$\Rightarrow I_3' = 2.34 - 1.85$

$\boxed{I_3 = 0.49\,A}$

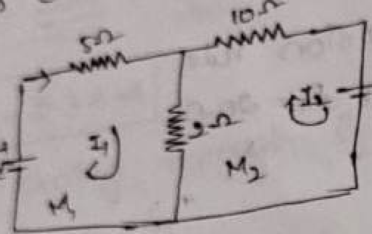
The resultant direction of current in $I_3 = I_3' + I_3''$

$I_3 = 0.29 + 0.205$

$\boxed{I_3 = 0.495\,A}$

Home work prblm

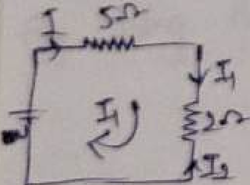
Q) Determine the current and write the equation of mesh current in a circuit as shown in fig



Sol: In the given circuit a closed path so the mesh analysis is applicable

In the given circuit consisiting of two closed loops (M_1 & M_2) and assain a variable of current In the circuit I_1 & I_2

Applying KVL Loop - I

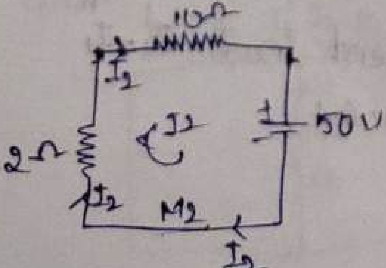


$\Rightarrow 10 = 5I_1 + 2(I_1 - I_2)$

$10 = 5I_1 + 2I_1 - 2I_2$

$10 = 7I_1 - 2I_2$ —— (1)

Applying KVL loop - II



$\Rightarrow -50 = 2(I_2 - I_1) + 10I_2$

$-50 = 2I_2 - 2I_1 + 10I_2$

$-50 = -2I_1 + 12I_2$ —— (2)

By ...

$6 \times 1 \rightarrow 10 = 7I_1 - 2I_2$

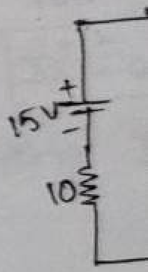
$2 \rightarrow -50 = -2I_1 + 12$...

Substitute $I_1 = 0.2$...

$10 = 7(0.25) -$ ...

$10 - 1.75 =$ ...

Q) Determine th... super position ...



Sol: Step . 1 : I... and mar...

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The tota...

The resultant direction of current in $I_2 = I_2' - I_2''$

$\Rightarrow I_2' = 2.34 - 1.85$

$\boxed{I_2 = 0.49 A}$

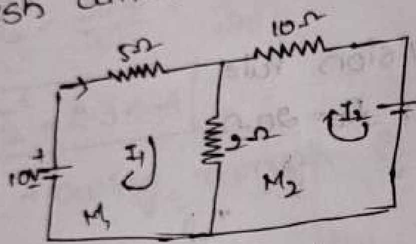
The resultant direction of current in $I_3 = I_3' + I_3''$

$I_3 = 0.29 + 0.205$

$\boxed{I_3 = 0.495 A}$

Home work prblm

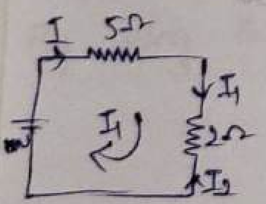
Q) Determine the current and write the equation of mesh current in a circuit as shown in fig



Sol: In the given circuit a closed path so the mesh analysis is applicable

In the given circuit consisting of two closed loops (M_1 & M_2) and assain a variable of current In the circuit I_1 & I_2

Applying KVL Loop - I

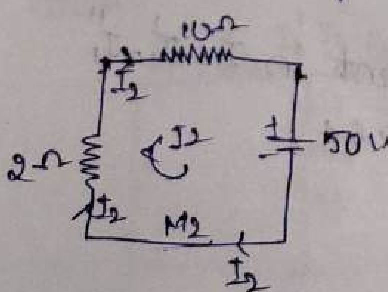


$\Rightarrow 10 = 5I_1 + 2(I_1 - I_2)$

$10 = 5I_1 + 2I_1 - 2I_2$

$10 = 7I_1 - 2I_2$ —— ①

Applying KVL loop - II



$\Rightarrow -50 = 2(I_2 - I_1) + 10I_2$

$-50 = 2I_2 - 2I_1 + 10I_2$

$-50 = -2I_1 + 12I_2$ —— ②

By u

$6 \times 1 \rightarrow 10 = 7I_1 - 2$

$2 \rightarrow -50 = -2I_1$

Substitute $I_1 =$

$10 = 7(0.2$

$10 - 1.75$

Q) Determine

super positio

15V

10

Sol: Step. 1 :

and m

The tot

The resultant direction of current in $I_2 = I_2' - I_2''$

$$\Rightarrow I_2' = 2.34 - 1.85$$

$$\boxed{I_2 = 0.49\,A}$$

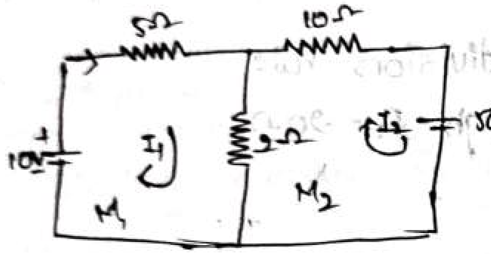
The resultant direction of current in $I_3 = I_3' + I_3''$

$$I_3 = 0.29 + 0.205$$

$$\boxed{I_3 = 0.495\,A}$$

Home work prblm

(Q)* Determine the current and write the equation of mesh current in a circuit as shown in fig

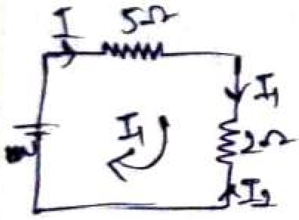


Sol: In the given circuit a closed path so the mesh analysis is applicable

In the given circuit consisiting of two closed loops (M_1 & M_2) and assain a variable of current

In the circuit I_1 & I_2

Applying KVL Loop - I

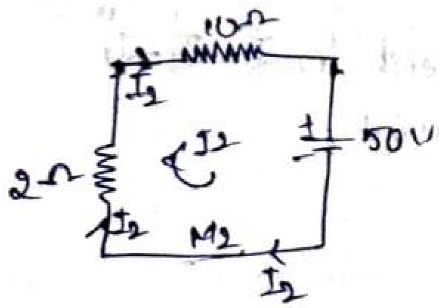


$$\Rightarrow 10 = 5I_1 + 2(I_1 - I_2)$$

$$10 = 5I_1 + 2I_1 - 2I_2$$

$$10 = 7I_1 - 2I_2 \quad \text{——— (1)}$$

Applying KVL loop - II



$$\Rightarrow -50 = 2(I_2 - I_1) + 10I_2$$

$$-50 = 2I_2 - 2I_1 + 10I_2$$

$$-50 = -2I_1 + 12I_2 \quad \text{——— (2)}$$

By using ① & ②

$6 \times 1 \rightarrow 10 = 7I_1 - 2I_2 \Rightarrow 60 = 42I_1 - 12I_2$

$2 \rightarrow -50 = -2I_1 + 12I_2 \rightarrow -50 = -2I_1 + 12I_2$

$10 = 40I_1$

$I_1 = 1/4$

$\boxed{I_1 = 0.25A}$

Substitute $I_1 = 0.25A$ in eq ①

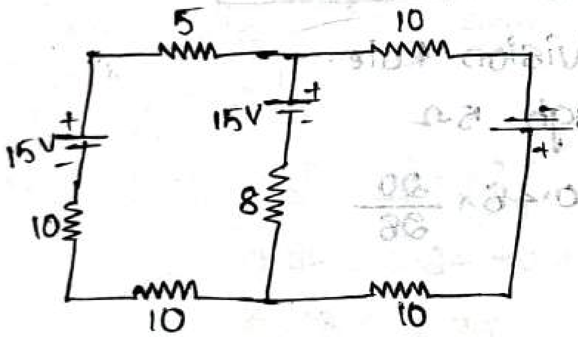
$10 = 7(0.25) - 2I_2 \Rightarrow 10 = 1.75 - 2I_2$

$10 - 1.75 = -2I_2 \Rightarrow -2I_2 = 8.25$

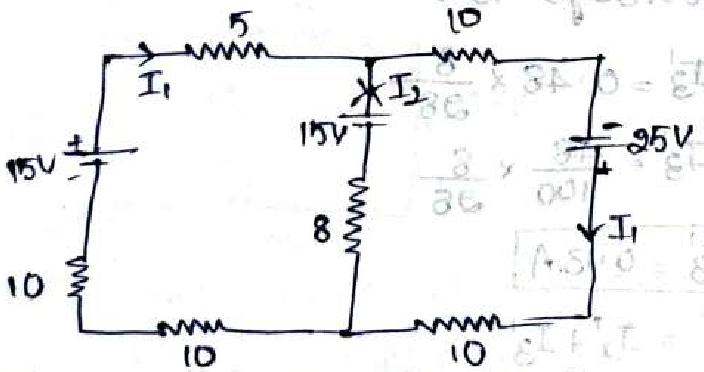
$I_2 = \frac{-8.25}{2}$

$\boxed{I_2 = -4.125A}$

Q) Determine the current in each branch by using super position theorem in the circuit shown in fig.



Sol: Step. 1 : Identify the no. of branches in the circuit and mark the direction of current in the circuit.



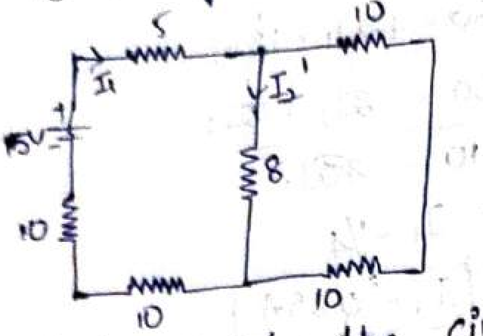
The total resistance $R_T = R_1 + R_2$

$R_T = 20 + 15$

$\boxed{R_T = 35}$

~~Accore~~

Let V_1 is acting V_2 & V_3 are short-circuit



Total resistance of the circuit RT_1

$RT_1 = 10+10$

$= 20$

$= \frac{20 \times 8}{20+8} = \frac{160}{28}$

$= 5.71$

$RT_1 = 5+5.71+10+10 \rightarrow 10.71+10+10$

$RT_1 = 30.71$

Total current flowing through the circuit

$I_1' = \frac{V_1}{RT_1} \Rightarrow I_1' = \frac{15}{30.71} \Rightarrow \boxed{I_1' = 0.48A}$

According to current division Rule.

Current flowing through 5Ω

$I_2' = I_1' \times \frac{20}{20+8} \Rightarrow I_2' = 0.48 \times \frac{20}{28}$

$I_2' = \frac{48}{100} \times \frac{20}{28}$

$\boxed{I_2' = 0.34A}$

Current flowing through 10Ω

$I_3' = I_1' \times \frac{8}{8+20} \Rightarrow I_3' = 0.48 \times \frac{8}{28}$

$I_3' = \frac{48}{100} \times \frac{8}{28}$

$\boxed{I_3' = 0.13A}$

By using KCL: $I_1' = I_2' + I_3'$

$0.48 = 0.34 + 0.13$

$0.48 \simeq 0.47$

25 & 20 are in parallel

$\frac{1}{25} + \frac{1}{20} \Rightarrow \frac{20+25}{20 \times 25} \Rightarrow \frac{45}{500} \Rightarrow \frac{1}{RT_2} = \frac{45}{500}$

$RT_2 = \frac{500}{45}$

$\boxed{RT_2 = 19.11\Omega}$

Total current flowing through the circuit

$I_2'' = \frac{V_2}{RT_2} \Rightarrow I_2'' = \frac{15}{19.11}$

$\boxed{I_2'' = 0.78A}$

current flowing through the 5Ω

$I_1'' = I_2'' \times \frac{20}{20+25} \Rightarrow I_1'' = I_2'' \times \frac{20}{45}$

$I_1'' = 0.78 \times \frac{20}{45} \Rightarrow \cancel{I_1'' = \frac{78}{100}} \times$

$\boxed{I_1'' = 0.34A}$

current flowing through 10Ω

$I_3'' = I_2'' \times \frac{25}{25+20} \Rightarrow I_3'' = 0.78 \times \frac{25}{45}$

$I_3'' = \frac{78}{100} \times \frac{25^{5}}{45_{9}} \Rightarrow I_3'' = \frac{78 \times 5}{900}$

$\boxed{I_3'' = 0.43A}$

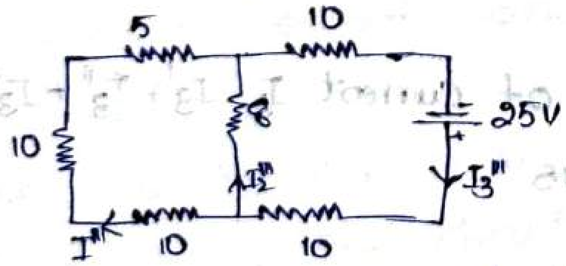
By using KCL : $I_2'' = I_1'' + I_3''$

$0.78 = 0.34 + 0.43$

$0.78 \simeq 0.77$

Step. 4 :

V_3 is acting V_1 & V_2 are short circuit



Total resistance of the circuit RT_3

$10+10+5 = 25$ (Series)

$\frac{25 \times 8}{25+8} = \frac{200}{33} = 6.06$ (parallel)

$6.06 + 20 = 26.06$ (Series)

$\boxed{RT_3 = 26.06}$

Total Current flowing through the circuit

$I_3''' = \frac{V_3}{RT_3}$

$I_3''' = \frac{25}{26.06} \Rightarrow \boxed{I_3''' = 0.95\ A}$

Current flowing through 10Ω

$I_1''' = I_3''' \times \frac{8}{8+25} \Rightarrow I_1''' = 0.95 \times \frac{8}{33}$

$I_1''' = \frac{95}{100} \times \frac{8}{33} \Rightarrow I_1''' = 0.23\ A$

Current flowing through 8Ω

$I_2''' = I_3''' \times \frac{25}{25+8} \Rightarrow I_2''' = 0.95 \times \frac{25}{33}$

$I_2''' = \frac{95}{100} \times \frac{25}{33} \Rightarrow I_2''' = 0.71\ A$

By using KCL: $I_3''' = I_1''' + I_2'''$

$0.95 = 0.23 + 0.71$

$0.95 \simeq 0.94$

Step-5: The resultant direction of current is given by

The resultant direction of current $I_1 = I_1' - I_1'' + I_1'''$

$\Rightarrow I_1 = 0.48 - 0.34 + 0.23$

$\Rightarrow I_1 = 0.37\ A$

The resultant direction of current $I_2 = -I_2' + I_2'' + I_2'''$

$\Rightarrow I_2 = -0.36 + 0.78 + 0.71$

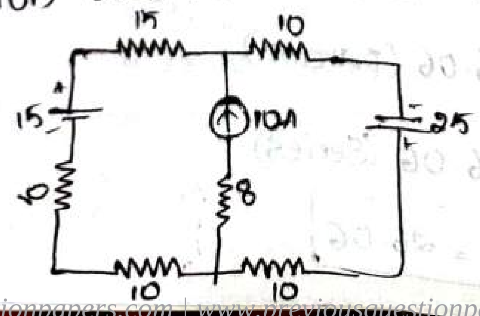
$I_2 = 1.13\ A$

The resultant direction of current $I_3 = I_3' + I_3'' + I_3'''$

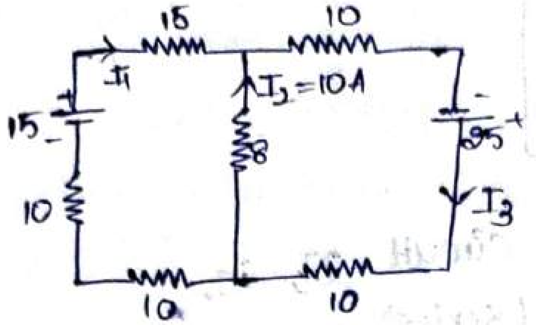
$I_3 = 0.13 + 0.43 + 0.95$

$I_3 = 1.51\ A$

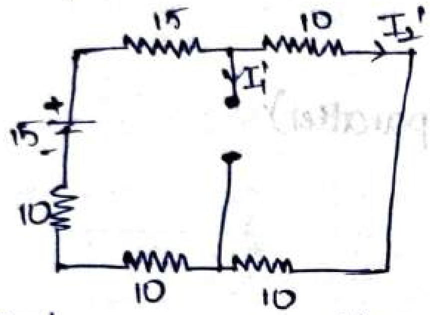
Q) Determine the current in each branch by using Super position theorem in the circuit shown in fig



Sol: Step 1: Identify the no. of branches in the circuit and mark the direction of current in the circuit.



Step 2: Let V_1 is acting & I is open, V_2 is short according to Super position theorem.



Total resistance of the circuit

$$RT_1 = 15+10+10+10+10$$

$$\boxed{RT_1 = 55\Omega}$$

Total current in the Circuit

$$I_1' = \frac{V_1}{RT_1} \Rightarrow I_1' = \frac{15}{55}$$

$$\boxed{I_1' = 0.27\,A}$$

Current flowing through 10Ω

$$I_3' = I_1'$$

[∴ Because flowing through 10Ω
$I_3' = I_1'$] x

∴ Because as the 8Ω resistance Current does not pass. Hence the $\boxed{I_2' = 0A}$. The circuit is in Series connection So the current I_1' flows through as the resistance.

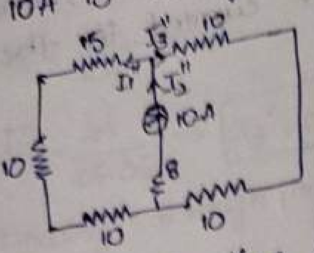
$$\therefore \boxed{I_3' = I_1' = 0.27A}$$

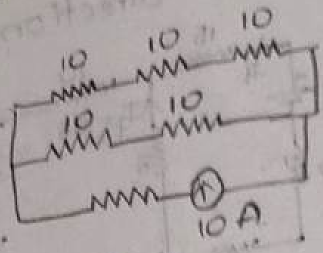
By using KCL: $I_1' = I_2' + I_3'$

$$0.27 = 0 + 0.27$$

$$0.27 = 0.27$$

Step 3: Let 10A is acting & V_1 & V_2 is short circuit





Total resistance of the circuit R_{T_2} is

$R_{T_2} = 10+10 = 20$ (series)

$10+10+15 = 35$ (series)

$R_{T_2} = \frac{20 \times 35}{20+35} \Rightarrow R_{T_2} = \frac{700}{55}$

$\boxed{R_{T_2} = 12.72\,\Omega}$ (parallel)

$R_{T_2} = 12.72+8$

$= 20.72$ (series)

$\therefore \boxed{R_{T_2} = 20.72\,\Omega}$

Total current flowing through the circuit

$\boxed{I_2'' = 10A}$ (Given)

Current flowing through $15\,\Omega$

$I_1'' = I_2'' \times \frac{20}{20+35} \Rightarrow I_1' = 10 \times \frac{20}{55}$

$I_1'' = \frac{200}{55} \Rightarrow \boxed{I_1' = 3.63\,A}$

Current flowing through $10\,\Omega$

$I_3'' = I_2'' \times \frac{35}{35+20} \Rightarrow I_3' = 10 \times \frac{35}{55}$

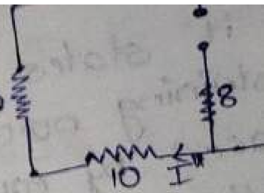
$I_3'' = \frac{350}{55} \Rightarrow \boxed{I_3'' = 6.36\,A}$

By using KCL: $I_2'' = I_1'' + I_3''$

$10 = 3.63 + 6.36$

$10 \simeq 9.9$

Step 4: Let V_2 is acting, V is short circuit & 10A is open.



Total resistance of

$R_{T_3} = 10+10+10+10$

$\boxed{R_{T_3} = 55\,\Omega}$

Total current in

$I_3''' = \frac{V_2}{R_{T_3}}$

$\boxed{I_3''' = 0}$

Current flowi

$\boxed{I_1''' =}$

Current flo

$\boxed{I_2''}$

By using

Step 5:

The re

The resultan

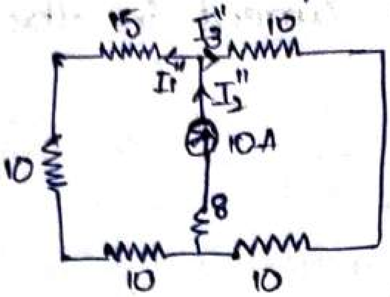
$I_1 = 0.$

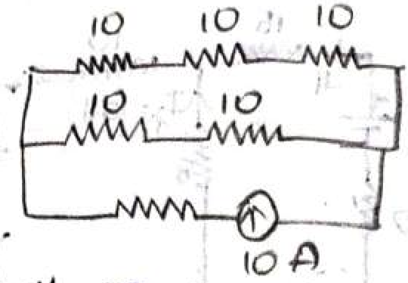
$\boxed{I_1 =}$

The result

The resu

Step. 3 : Let 10A is acting & V_1 & V_2 is short circuit





Total resistance of the circuit RT_2 is

$$RT_2 = 10+10 = 20 \text{ (series)}$$

$$10+10+15 = 35 \text{ (series)}$$

$$RT_2 = \frac{20 \times 35}{20+35} \Rightarrow RT_2 = \frac{700}{55}$$

$$\boxed{RT_2 = 12.72\Omega} \text{ (parallel)}$$

$$RT_2 = 12.72 + 8$$
$$= 20.72 \text{ (series)}$$

$$\therefore \boxed{RT_2 = 20.72\Omega}$$

Total current flowing through the circuit

$$\boxed{I_2'' = 10A} \text{ (given)}$$

current flowing through 15 Ω

$$I_1'' = I_2'' \times \frac{20}{20+35} \Rightarrow I_1' = 10 \times \frac{20}{55}$$

$$I_1'' = \frac{200}{55} \Rightarrow \boxed{I_1'' = 3.63A}$$

current flowing through 10 Ω

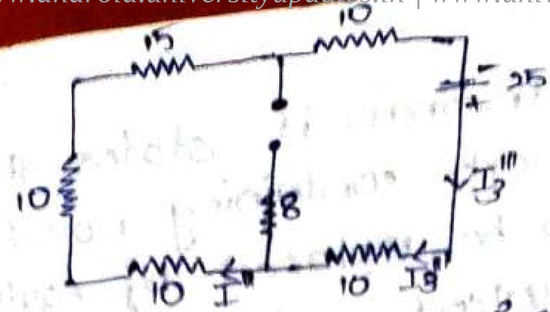
$$I_3'' = I_2'' \times \frac{35}{35+20} \Rightarrow I_3' = 10 \times \frac{35}{55}$$

$$I_3'' = \frac{350}{55} \Rightarrow \boxed{I_3'' = 6.36A}$$

By using KCL : $I_2'' = I_1'' + I_3''$

$$10 = 3.63 + 6.36$$
$$10 \simeq 9.9$$

Step. 4 : Let V_2 is acting, V is short circuit & 10A is open.



Total resistance of the circuit R_{T_3}

$R_{T_3} = 10+10+10+10+15 = 55\Omega$

$\boxed{R_{T_3} = 55\Omega}$

Total current in the circuit

$I_3''' = \frac{V_2}{R_{T_3}} \Rightarrow I_3''' = \frac{25}{55}$

$\boxed{I_3''' = 0.45 A}$

Current flowing through 10Ω

$\boxed{I_1''' = I_3''' = 0.45 A}$

current flowing through 8Ω

$\boxed{I_2''' = 0 A}$

By using KCL: $I_3''' = I_1''' + I_2'''$

$0.45 = 0.45 + 0$

$0.45 = 0.45$

step 5: The resultant direction of current in the circuit

The resultant direction of current $I_1 = I_1' - I_1'' + I_1'''$

$I_1 = 0.27 \cancel{36} - 3.63 + 0.45$

$\boxed{I_1 = -2.91 A}$

The resultant direction of current $I_2 = I_2' + I_2'' + I_2'''$

$I_2 = 0 + 10 + 0$

$\boxed{I_2 = 10 A}$

The resultant direction of current $I_3 = I_3' + I_3'' + I_3'''$

$I_3 = 0.27 + 6.36 + 0.45$

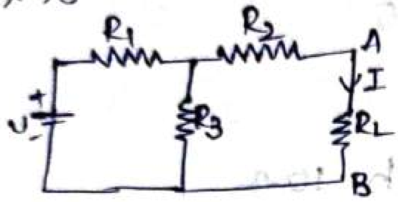
$\boxed{I_3 = 7.08 A}$

Thevenins Theorem:

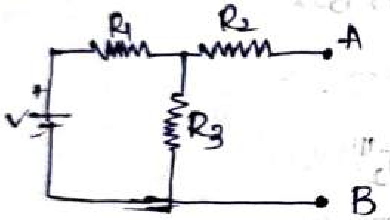
Statement: The thevenins theorem it states that any two terminals linear network containing no. of voltage source and resistance can be replaced by equivalent circuit consisting of equivalent voltage (V_A) is connected with series equivalent resistance [R_{th} element].

Explanation/verification of thevenins Theorems:

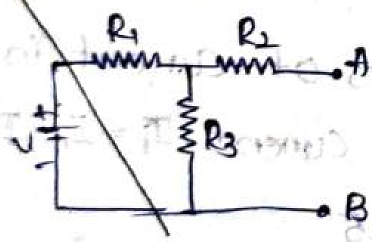
Determine the current through R load (R_L) by using thevenins theorem in the circuit shown in fig



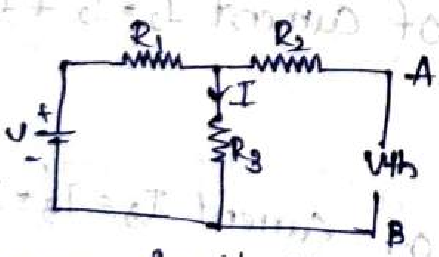
Step 1: Remove the load resistance (R_L) b/w the terminal A and B in the circuit shown in fig



Step 2: Remove the load resistance (R_L) b/w the terminal A and B in the circuit shown in fig.



Step 2: Calculate the thevenins voltage (V_{th}) b/w the terminal A and B in the circuit shown in fig.



The open circuit b/w the terminal A and B the internal resistance of R_2 value will be "zero"

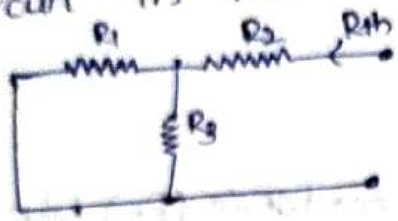
The internal resistance $\boxed{R_T = R_1 + R_2}$

According to ohm's law where $I = \frac{V}{R}$

$$I = \frac{V}{R_T} \Rightarrow I = \frac{V}{(R_1+R_3)}$$

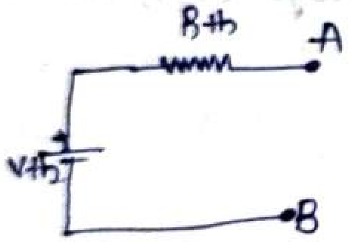
$$V_{Th} = IR_3 \Rightarrow \boxed{V_{Th} = \frac{V}{(R_1+R_3)} \times R_3}$$

Step 3: Calculate the equivalent resistance can be replaced by voltage source are short circuit either current source are open circuit in the circuit shown in fig.

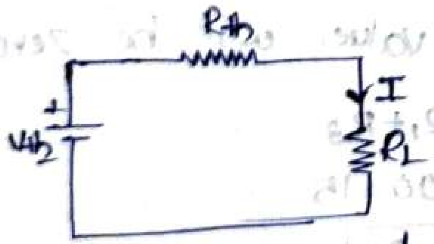


$$\boxed{R_{th} = \frac{R_1 \times R_3}{R_1+R_3} + R_2}$$

Step 4: Draw the equivalent circuit can be replaced by thevenins voltage (V_{th} element) we should connected in series with Thevenins resistance (R_{th}) in the circuit shown in fig.



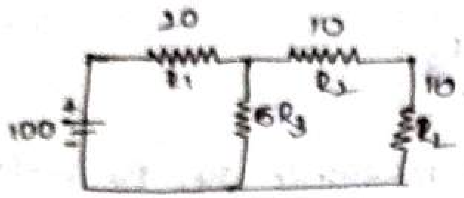
Step 5: Reconnect the load resistance b/w the terminal A and B where it is removed in the circuit shown in fig.



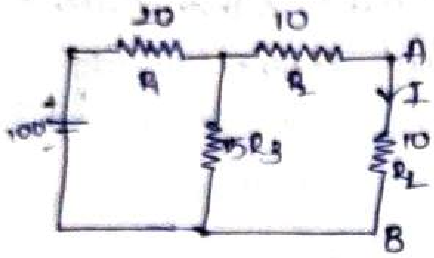
Step 6: Determine the current through R_L above circuit shown in fig. According to ohm's law

$$I = \frac{V}{R} \Rightarrow I = \frac{V_{th}}{R_{th}+R_L} \quad (\because R = R_{th}+R_L)$$

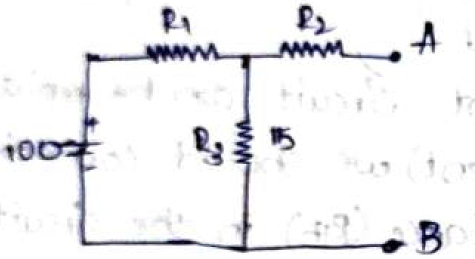
Q) Determine the ~~dc~~ current through R_L resistor by using Thevenin's Theorem in the circuit shown in fig.



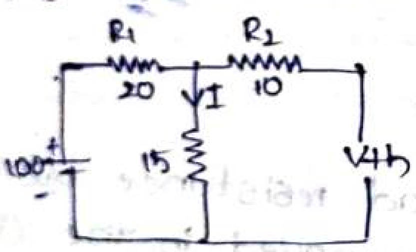
Sol:



Step 1: Remove the load resistance (R_L) b/w the terminal A & B in the circuit.



Step 2: Calculate the thevenin's voltage (V_{th}) b/w the terminal A & B in the circuit.



The open circuit b/w the terminal A & B the internal resistance of R_2 value will be zero.

The total resistance $R_T = R_1 + R_3$

$$R_T = 20 + 15$$

$$\boxed{R_T = 35}$$

According to ohm's law where $I = \frac{V}{R}$

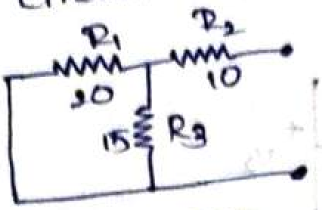
$$I = \frac{V}{R_T} \Rightarrow I = \frac{100}{35}$$

$$\boxed{I = 2.85\,A}$$

$$V_{th} = IR_3 \Rightarrow V_{th} = 2.85 \times 15$$

$$\boxed{V_{th} = 42.75\,V}$$

Step 3: calculate the equivalent resistance can be replaced by voltage source are short-circuit. Either current source are open circuit in the circuit shown in fig.

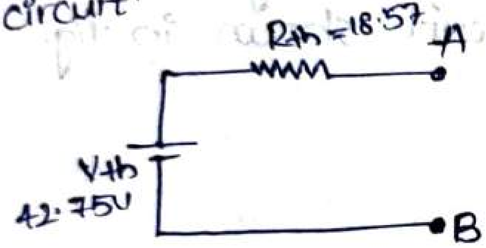


$R_{th} = \frac{20\times15}{20+15} \rightarrow \frac{300}{35} \Rightarrow 8.57\,\Omega$

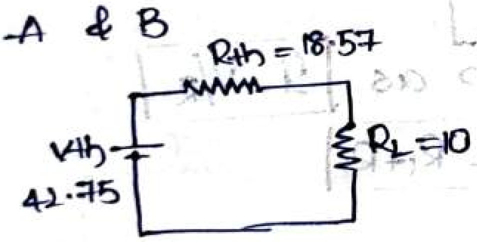
$R_{th} = 8.57 + 10$

$\boxed{R_{th} = 18.57}$

Step 4: Draw the equivalent circuit can be replaced by the thevenins voltage (V_{th} elements) we should connected in series with thevenins resistance (R_{th}) in the circuit.



Step 5: Reconnect the load resistance (R_L) b/w the terminals A & B



$I = \frac{V}{R}$

$R = 18.57 + 10$

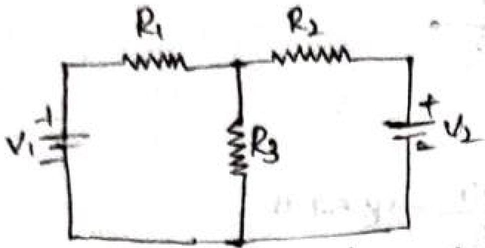
$R = 28.57$

$I = \frac{42.75}{28.57}$

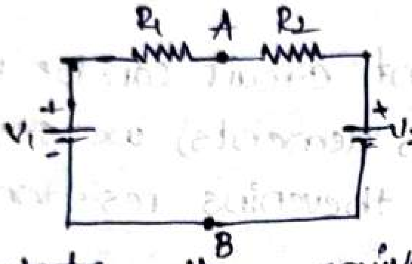
$I = \frac{4275}{2857}$

$\boxed{I = 1.49A}$

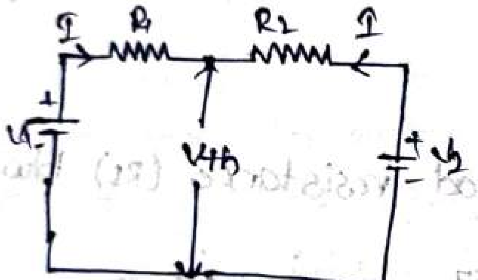
→ Determine the current through R_3 resistance by using thevinion's theorem in the circuit shown in fig



Step 1: Remove the load resistance r_3 b/w the terminal A & B in the circuit shown in fig.



Step 2: calculate the equivalent voltage (with thevinin's with the terminal in the circuit shown in fig.



The total current is given as $\boxed{I = V/R}$

The total resistance $\boxed{R_T = R_1 + R_2}$

$$I = V/R_T \Rightarrow \frac{V_1 - V_2}{R_1 + R_2}$$

$$\frac{V_2 - V_1}{R_1 + R_2}$$

The voltage terminal passing through +ve and the voltage drop is decreased

$$V_{th} = V_1 - IR_1 \quad \text{——} (1)$$

$$V_{th} = V_1 - \frac{(V_1 - V_2)}{R_1 + R_2} \times R_1$$

$$V_{th} = \frac{V_1 R_1 + V_1 R_2 - V_1 R_1 + V_2 R_1}{R_1 + R_2}$$

$$\boxed{V_{th} = \frac{V_1 R_2 + V_2 R_1}{R_1 + R_2}}$$

The voltage passing through -ve and the voltage drop will increases.

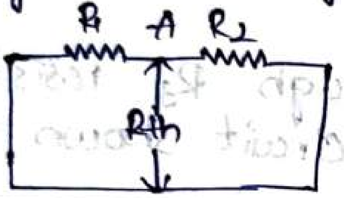
$$V_{th} = V_2 - IR_2 \quad \text{——— } (2)$$

$$V_{th} = V_2 - \left(\frac{V_2 - V_1}{R_1 + R_2}\right) \times R_2$$

$$V_{th} = \frac{V_2 R_1 + V_2 R_2 - V_2 R_2 + V_1 R_2}{R_1 + R_2}$$

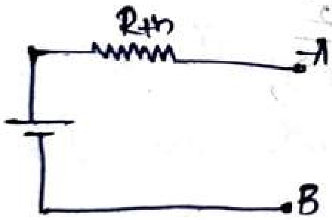
$$\boxed{V_{th} = \frac{V_2 R_1 + V_1 R_2}{R_1 + R_2}}$$

Step.3: Determine the equivalent resistance (R_{th}) can be replaced by the voltage sources (V_1, V_2 short circuit)

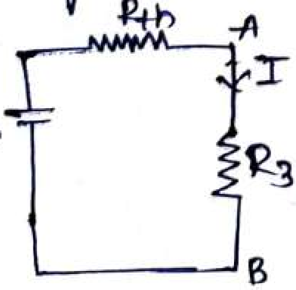


$$\boxed{R_{th} = \frac{R_1 \times R_2}{R_1 + R_2}}$$

Step.4: Draw the equivalent circuit consisting of equivalent voltage (V_{th}) is connected with series, equivalent resistance (R_{th}).



Step.5: Reconnect the load resistance b/w the terminal A & B and determine the current in the circuit shown in figure



$$I = \frac{V}{R_{th}}$$

$$\boxed{I = \frac{V_{th}}{R_{th} + R_3}} \quad \text{——— } (3)$$

According to ohm's law $\boxed{I = \frac{V}{R_T}}$

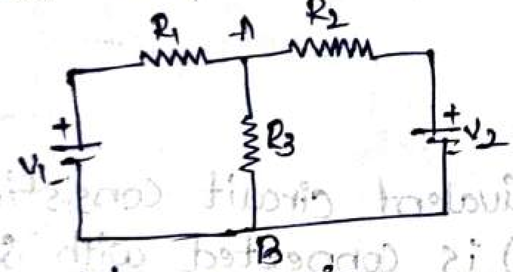
Sub R_{th} & V_{th} in ③

$$I = \frac{\dfrac{V_1 R_2 + V_2 R_1}{R_1+R_2}}{\dfrac{R_1 \times R_2}{R_1+R_2} + R_3}$$

$$I = \frac{\dfrac{V_1 R_2 + V_2 R_1}{R_1+R_2}}{\dfrac{R_1 R_2 + R_1 R_3 + R_2 R_3}{R_1+R_2}}$$

$$\boxed{I = \frac{V_1 R_2 + V_2 R_1}{R_1 R_2 + R_1 R_3 + R_2 R_3}}$$

⇒ Determine the current through R_3 resistance by using nodal analysis in the circuit shown in fig.



By using nodal analysis

$$0 = \frac{V_{th} - V_1}{R_1} + \frac{V_{th}}{R_3} + \frac{V_{th} - V_2}{R_2}$$

$$\boxed{V_{th} = IR_3}$$

$$0 = \frac{IR_3 - V_1}{R_1} + \frac{I\cancel{R_3}}{\cancel{R_3}} + \frac{IR_3 - V_2}{R_2}$$

$$0 = \frac{IR_3}{R_1} - \frac{V_1}{R_1} + I + \frac{IR_3}{R_2} - \frac{V_2}{R_2}$$

$$\frac{IR_3}{R_1} + I + \frac{IR_3}{R_2} = \frac{V_1}{R_1} + \frac{V_2}{R_2}$$

$$I\left(\frac{R_3}{R_1} + 1 + \frac{R_3}{R_2}\right) = \frac{V_1}{R_1} + \frac{V_2}{R_2}$$

$$I\left(\frac{R_2R_3+R_1R_2+R_1R_3}{R_1R_2}\right)=\frac{V_1R_2+V_2R_1}{R_1R_2}$$

$$I(R_2R_3+R_1R_2+R_1R_3)=V_1R_2+V_2R_1$$

$$\boxed{I=\frac{V_1R_2+V_2R_1}{R_1R_2+R_2R_3+R_3R_1}}$$

$$I=\frac{100(20)+70(20)}{(20)(20)+20(160)+(160)(20)}$$

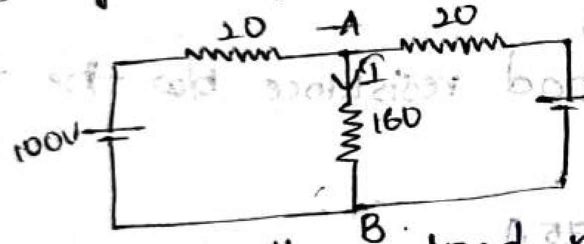
$$I=\frac{100+70}{20+160+160}$$

$$I=\frac{170}{340}$$

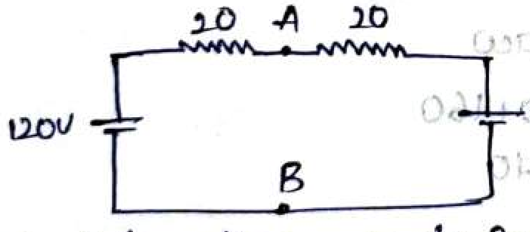
$$=0.5$$

Problem:

Determine the current in 160Ω b/w the terminal A & B by using thenvien's theorem.



Step 1: Remove the load resistance (R_3) b/w the terminals A & B as shown in fig.



Step 2: calculate the equivalent voltage (V_{th}) with the terminal in circuit.

$$I=\frac{V}{R_T}=\frac{V_1-V_2}{R_1+R_2}$$

$$\frac{100-70}{20+20}=\frac{30}{40}$$

$$=0.75A$$

$V_{th} = V_1 - IR_1$

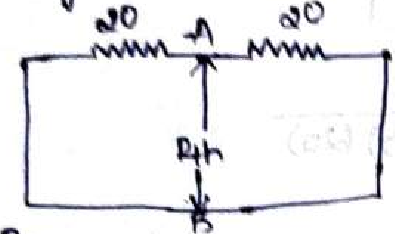
$= 100 - (0.75)(20)$

$= 100 - 15$

$\boxed{V_{th} = 85V}$

[∵ The voltage terminal Passing through +ve and the voltage drop will be decreases]

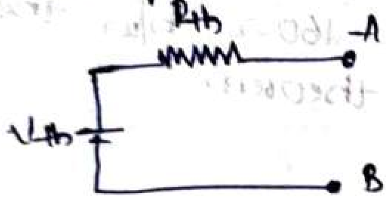
Step 3: Determine the equivalent resistance can be replaced by the voltage sources (V_1, V_2)



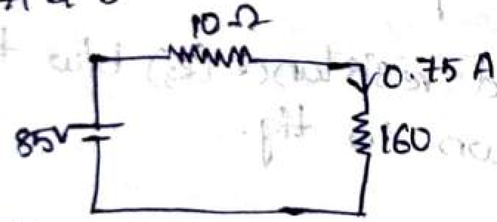
$$R_{th} = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{20 \times 20}{20 + 20} = \frac{400}{40}$$

$\boxed{R_{th} = 10\Omega}$

Step 4: Draw the equivalent circuit consisting of equivalent voltage (V_{th}) is connected in series



Step 5: Reconnect the load resistance b/w the terminal A & B.



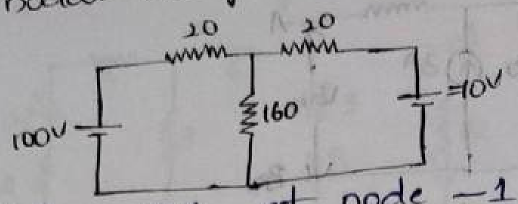
According to ohm's law

$I = \frac{V_{th}}{R_T}$ $\qquad R_T = 10 + 160 = 170$

$I = \frac{85}{170}$

$\boxed{I = 0.5A}$

⇒ Determine the current through R_3 resistance by using nodal analysis.



By applying KVL at node – 1

$$0 = \frac{V_{th}-100}{20} + \frac{V_{th}}{160} + \frac{V_{th}-70}{20}$$

$$0 = \frac{8V_{th} - 800 + V_{th} + 8V_{th} - 560}{160}$$

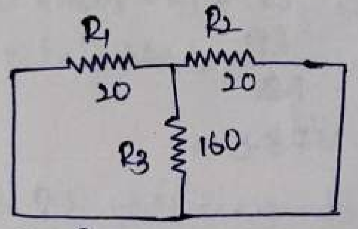
$$0 = \frac{17V_{th} - 1360}{160}$$

$$17V_{th} - 1360 = 0$$

$$V_{th} = \frac{1360}{17}$$

$$\boxed{V_{th} = 80\,V}$$

R_{th}



$$R_{th} = \frac{R_1 \times R_3}{R_1 + R_3} + R_2$$

$$R_{th} = \frac{20 \times 160}{20 + 160} + 20$$

$$= \frac{3200}{180} + 20$$

$$= 17.7 + 20$$

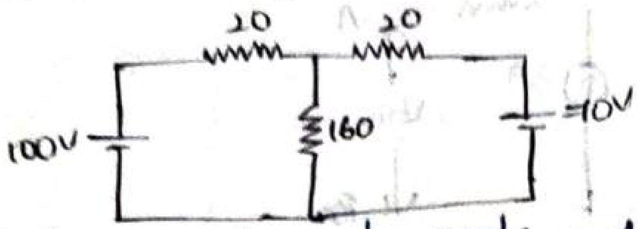
$$\boxed{R_{th} = 37.7\,\Omega}$$

$$V_{th} = IR$$

$$I = \frac{V_{th}}{R_3} = \frac{80}{160}$$

$$= 0.5$$

⇒ Determine the current through R_3 resistance by using nodal analysis



By applying KVL at node -1

$$0 = \frac{V_{th} - 100}{20} + \frac{V_{th}}{160} + \frac{V_{th} - 70}{20}$$

$$0 = \frac{8V_{th} - 800 + V_{th} + 8V_{th} - 560}{160}$$

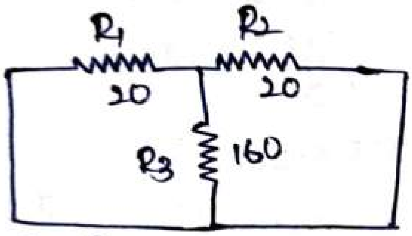
$$0 = \frac{17V_{th} - 1360}{160}$$

$$17V_{th} - 1360 = 0$$

$$V_{th} = \frac{1360}{17}$$

$$\boxed{V_{th} = 80\,V}$$

R_{th}



$$R_{th} = \frac{R_1 \times R_3}{R_1 + R_3} + R_2$$

$$R_{th} = \frac{20 \times 160}{20 + 160} + 20$$

$$= \frac{3200}{180} + 20$$

$$= 17.7 + 20$$

$$\boxed{R_{th} = 37.7\,\Omega}$$

$$V_{th} = IR$$

$$I = \frac{V_{th}}{R_3} = \frac{80}{160}$$

$$= 0.5$$