Class Note

Course Name : Physics

Course Code : 0533 - 101

Topic : Electric Circuit Analysis

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Created by,

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Batch : 98-D

Roll : 35

Physics

1st Class : 08/06/2024

1. Electric Device - conductor based device
2. Electronic Device - semi-conductor based device
3. DC circuit analysis
   - current flow
   - voltage
   - circuit
   - chemical reaction
   - $I = nAvq = \frac{Q}{t}$
   - volt analysis and current flow analysis

2nd Class : 09/06/2024

4. resistance
   - $R = \frac{\rho L}{A}$ $\left[R \propto \frac{1}{A},\ R \propto L,\ R \propto \frac{1}{A}\right]$ (prove)
5. components of circuit
   - active element
   - passive element
   - exception

3rd Class : 29/06/2024

6. electrical network
   - active network
   - passive network

Next semester

- linear network
- non-linear network

- time variant
- time non-variant

> storage element

- lumped
- distributed

> structure pattern

7. ohm's law ($I \propto V$)

- $R = R_0 (1 + \alpha \Delta\theta)$
- $V = IR$ (prove)
- I-V curve
- V-I curve
- slope

4th class - 30/06/2024

8. network terminology

- node
- junction
- loop
- mesh

5th class - 07/07/2024

- branch (network terminology)

9. equivalent resistance

10. resistors in series

- math problem

6th class - 14/07/2024

11. resistors in parallel

- math problem

7th class - 18/08/2024

- Electric circuit analysis (recap)
- Resistors in series
- Resistors in parallel

8th class - 20/08/24 - online

12. Equivalent Resistance

9th class - 25/08/24

- Circuit analysis

10th class - 01/09/24

- Circuit analysis

11th class - 08/09/24

13. Voltage Divider Rule
14. Current Divider Rule

12th class - 14/09/24

15. Open Circuit
16. Short Circuit

15th class - 17/09/24

* Circuit Analysis

16th class - 22/09/24

* Circuit Analysis

Electrical Circuit Analysis

- Electrical device - conductor based device
- Electronic device - semi-conductor based device - where current flow can be controlled.

Terms of Electricity:

- Voltage : voltage is the electrical pressure, a potential force or difference in the electrical charge between two points.

- current flow : current flow is the electrical flow moving through a wire. current flow in a wire pushed by voltage.

-when free electron in a circuit or loop flows in a specific direction is called current flow.

- The following equation relates charge to current

$$I = \frac{Q}{t}$$

Q = charge , t = time

$$I = nAvq$$

- circuit - A closed path that conduct electricity.

Resistance : Resistance opposes current flow. It is like electrical friction. This resistance slows the current flow. Every electrical component or element has resistance. And this resistance changes electrical energy into another form of energy - heat, light, motion. Resistance is measured in ohms (Ω)

The resistance of an element is determined from the resistivity (ρ), length (L) and cross-sectional area (A)

- $R \propto \frac{1}{A}$
- $R \propto L$
- $R = \frac{\rho L}{A}$

Electrical Circuit Element (components)

Electronic element that make up a circuit are connected together by conductors to form a complete circuit. If these connecting conductors are ideal conductors (i.e. they have no resistance) then all parts of the circuit can be classified into two main catagories depending on whether they deliver or absorb energy from the circuit:

- Active components
- passive components

Active component

An active component is an electronic component which supplies energy to a circuit. Active elemenets have the ability to electrically control electron flow (i.e. the flow of charge). All electronic circuit must contain at least one active component.

∴ Active element - produce power/energy & amplify power/energy

Example of active element:

- Battery
- Motor
- Generator
- Voltage sources
- Current source
- AC
- Solar cell
- Transistor

Passive Component

A passive component is an electronic component which can only receive energy, which it can either dissipate, absorb or store it in an electric field or a magnetic field. Passive element do not need any form of electrical power to operate.

As the name 'passive' suggests - passive device do not provide gain or amplification. Passive components cannot amplify, oscillate, or generate an electrical signal.

Examples of passive element:

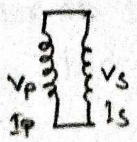
- Resistors
- capacitor (finite time)
- power bank (electrical energy)
- Inductor (magnetic energy)
- Transformer
- Diode, LED

Q. why transistor is an active element?

- Although not as obvious as a current or voltage source - transistors are also an active circuit component. This is because transistors are able to amplify the power of a signal. As this ampification is essentially controlling the flow of charge - transistors are hence classified as an active component.

Q. Why transformer is a passive component?

- A transformer is a passive electronic component. Although this can seem suprising since transformers are often used to raise voltage levels - power is kept constant. When transformers step up (or step down) voltage, power and energy remain the same on the primary and secondary side. As the energy is not actually being amplified - a transformer is classified as a passive element.



$V_p I_p = V_s I_s$

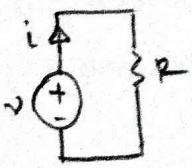
Electrical Network:

Any interconnection of electric circuit elements or components is called electrical networks.

- Electical network
  - active network
  - passive network
  - linear network
  - non-linear network
  - > output
  - time variant
  - time non-variant
  - > storage element
  - lumped
  - distributed
  - > structure pattern.

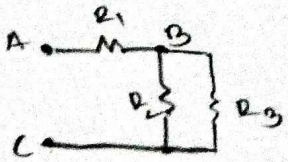
Active Network

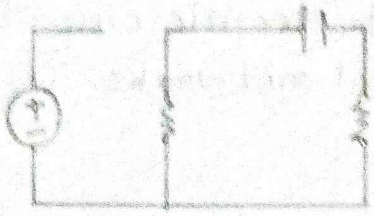
A network consisting of active elements such as op-amps, transistors, along with other elements is called an active network. An active element is an electronic components that supplies energy to a circuit.



Passive Network.

A network consisting of passive elements only such as resistors, capacitors and inductors is known as passive network. A passive element is an electrical component that does not generate power, instead dissipate or stores it





source free circuit

- Source free circuit

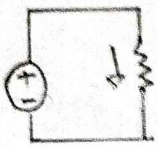
RC

RI

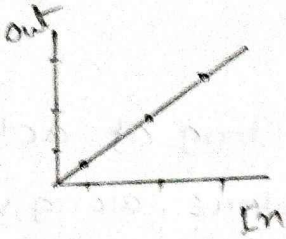
RIC

Linear Network

Input and output are in same ratio/proportion

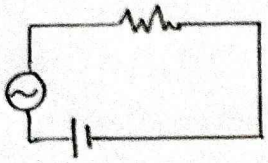


V	I
5V →	1A
10V →	2A
15V →	3A



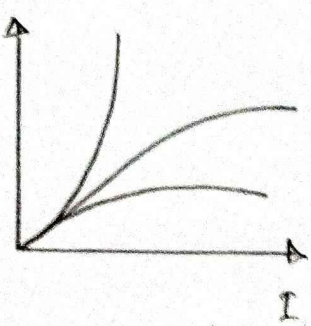
Non - Linear Network.

If there is capacitor, powerbank, inductor



5V → 1A

10V ≠ 2A



Ohm's Law - At constant temperature the current flow through a conductor (or circuit) between two points is directly propotional to the voltage across the two point.

- Mathematically,

$$I \propto V$$

$$\Rightarrow I = GV \qquad \left[G = \frac{1}{R}, \text{ conductance which increase current flow}\right]$$

$$\Rightarrow I = \frac{1}{R} V$$

$$\therefore V = IR$$

- Ohm's law is applicable to both DC and AC

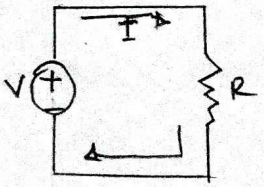
- $R = R_0 (1 + \alpha \Delta\theta)$

$$= R_0 + R_0 \alpha \Delta\theta$$

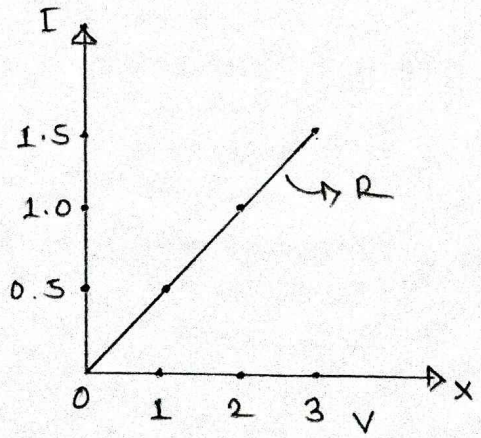
where,

- R = Resistance (Ω)
- I = current flow (A)
- V = voltage (V)

- conductance - is the ability of an element to conduct electric current; it is masured in siemens (S).



V	I
1	.5
2	1
3	1.5



$S = \frac{1}{R}$ (I-V)

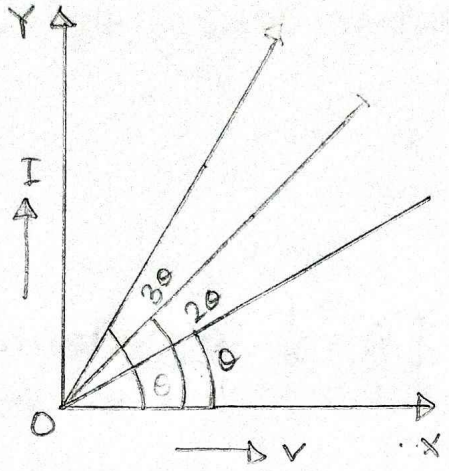


Fig: (I-V) curve

$I \propto V$

$V = IR$

$I = \frac{1}{R} V$

$\therefore y = mx$

$\therefore$ slope $= \frac{1}{R}$

- $R_1 > R_2 > R_3$
- $S_3 > S_2 > S_1$

$S = R$ (V-I)

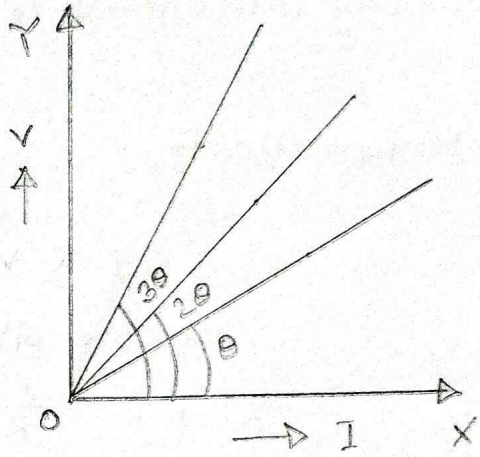


Fig: (V-I) curve

$I \propto V$

$V = IR$

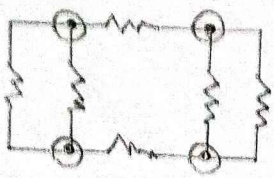
$\therefore y = mx$

$\therefore$ slope $= R$

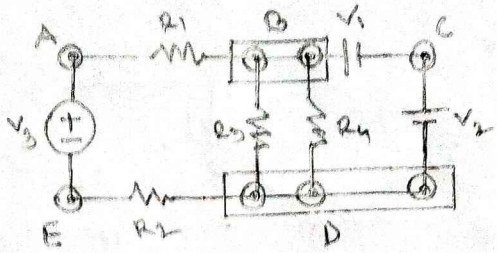
- $R_3 > R_2 > R_1$
- $S_3 > S_2 > S_1$

Network Terminology:

- **Node** - A connecting point of two or more element.



4 nodes



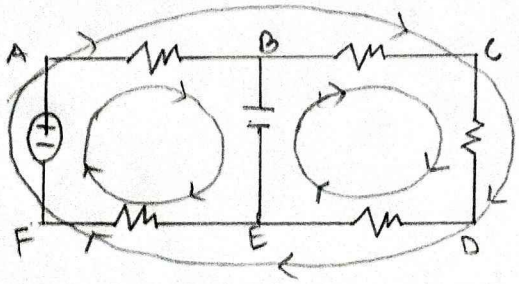
Node - A, B, C, D, E

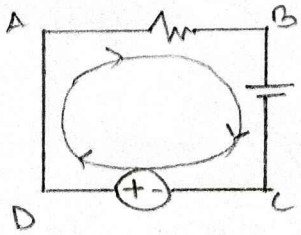
Junction - B, D

- **Junction** - A connecting point of three or more element

⊛ Every junction must be node, every node may not be junction.

- **Loop** - A closed path of circuit.





mesh - ABCD

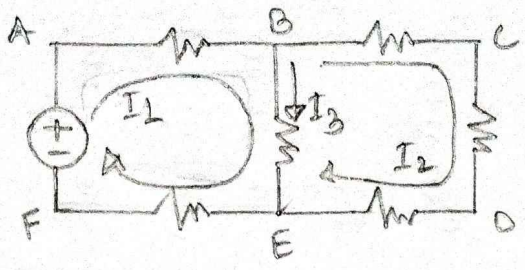
Loops - ABEFA, BCDBE, ABCDEFA

Mesh - ABEFA, BCDBE

- **Mesh** - Mesh is the loop that does not contain another loop within it.

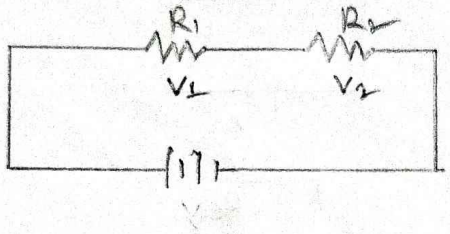
⊛ Every mesh must be loop, every loop may not be mesh.

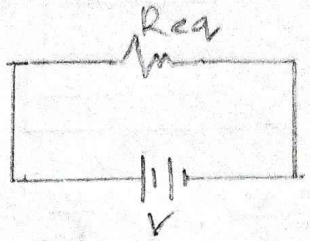
• Branch - A path of circuit that carries same current flow is known as branch.



Branch - EFAB, BCDE, BE

Resistors in Series –





$\Sigma V_{supply} = \Sigma V_{drop}$

$V_1 = IR_1$

$V_2 = IR_2$

$V = IR_{eq}$

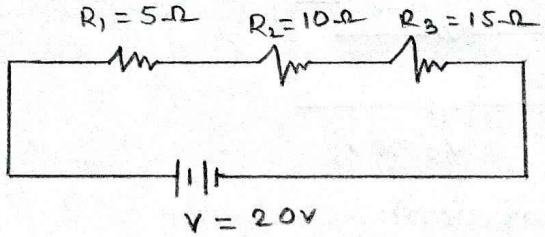
$V = V_1 + V_2$

$IR_{eq} = IR_1 + IR_2$

$\therefore R_{eq} = R_1 + R_2$

- current is the same through series element.

Q.



i) Find the equivalent resistance.

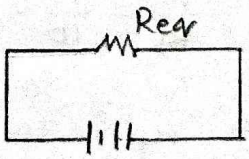
ii) Determine the supply current by the 20v battery.

iii) Calculate the current flow through each resistance.

iv) Find the voltage drop across each resistors.

Sol.

I)



$R_{eq} = R_1 + R_2 + R_3 = (5+10+15)\Omega$

$= 30\Omega$

II) $V = IR$

$I = \frac{V}{R} = \frac{20}{30} = 0.67A$

III) current flow 0.67A is same in R_1, R_2, R_3 as they are in series

IV) $V_1 = 0.67 \times 5 = 3.35v\ (IR_1)$

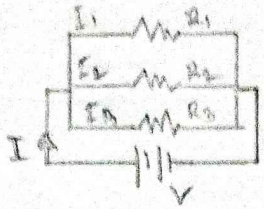
$V_2 = IR_2 = 0.67 \times 10$

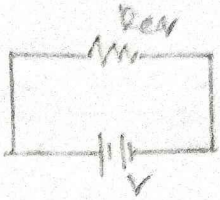
$= 6.70\ v$

$V_3 = IR_3 = 0.67 \times 15$

$= 10.05\ v$

Resistors in parallel-





$$I_1 = \frac{V}{R_1}, \quad I_2 = \frac{V}{R_2}, \quad I_3 = \frac{V}{R_3}$$

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

$$\Sigma I_{supply} = \Sigma I_{divided}$$

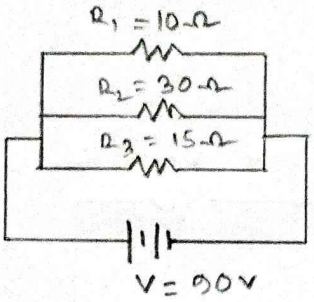
$$\Rightarrow I = I_1 + I_2 + I_3$$

$$\Rightarrow \frac{V}{R_{eq}} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\Rightarrow R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$$

- Voltage is same across parallel connection

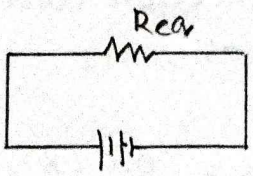
Q.



i) Find the equivalent resistance
ii) determine the voltage drop across each resistors.
iii) calculate the supply current
iv) Find the current flow through each resistors.

Sol.

i)



$$R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$$

$$= \left(\frac{1}{10} + \frac{1}{30} + \frac{1}{15}\right)^{-1} \Omega$$

$$= 5\Omega$$

iii) $I = \frac{V}{R} = \frac{90}{5} = 18\ A$

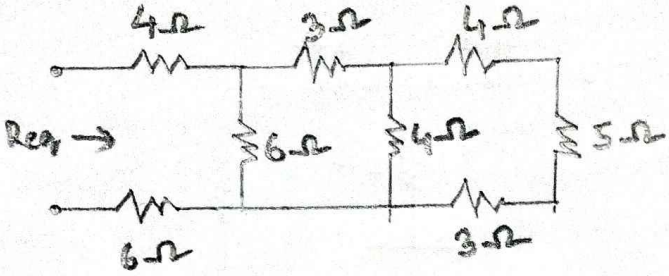
iv) $I_1 = \frac{V}{R_1} = \frac{90}{10} = 9A$

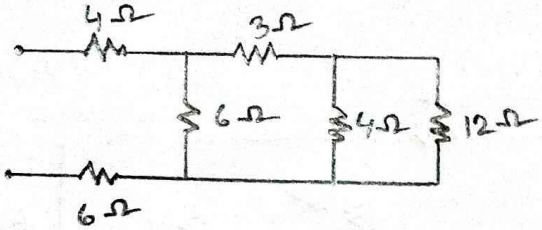
$I_2 = \frac{V}{R_2} = \frac{90}{30} = 3A$

$I_3 = \frac{V}{R_3} = \frac{90}{15} = 6A$

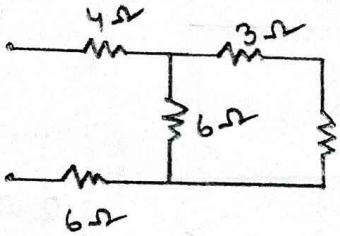
ii) Voltage is same (90v) across each resistors.

Problem: 10 - Find the total equivalent resistance...

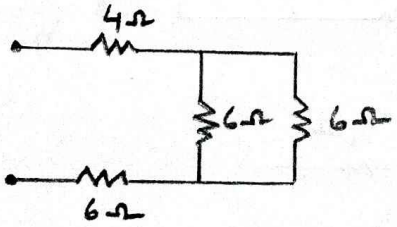




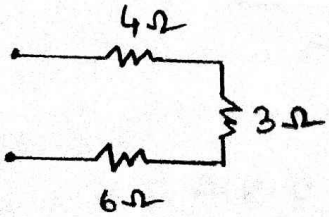
$[4\Omega + 5\Omega + 3\Omega = 12\Omega]$



$[12\Omega \parallel 4\Omega = 3\Omega]$



$[3\Omega + 3\Omega = 6\Omega]$

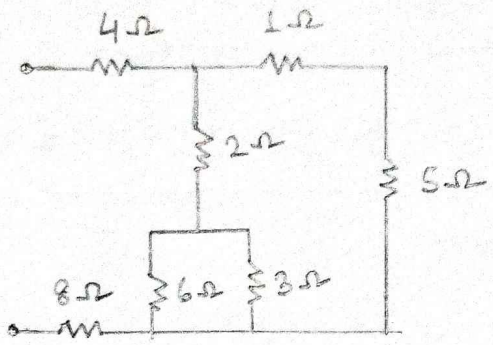


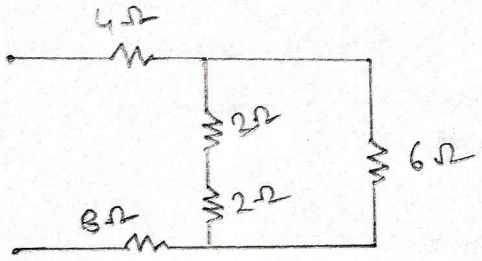
$[6\Omega \parallel 6\Omega = 3\Omega]$

$\therefore R_{eq} = 4\Omega + 3\Omega + 6\Omega$

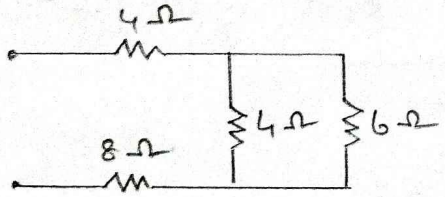
$= 13\Omega$

Problem: 11 - Find Req

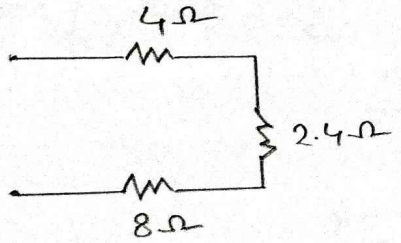




$$\left[\begin{array}{l} 1\Omega + 5\Omega = 6\Omega \\ 6\Omega \| 3\Omega = 2\Omega \end{array}\right]$$



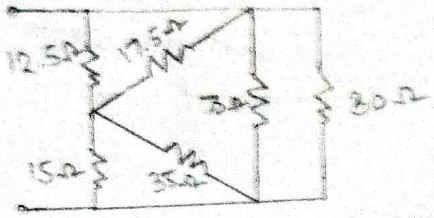
$$\left[2\Omega + 2\Omega = 4\Omega\right]$$

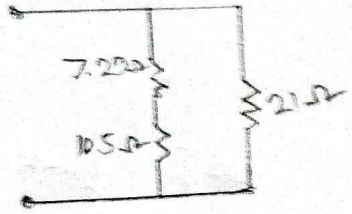


$$\therefore R_{eq} = 4\Omega + 8\Omega + 2.4\Omega$$

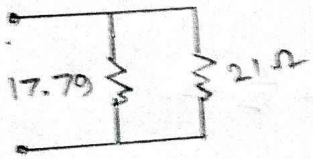
$$= 14.4\Omega$$

Problem : 12 – Find Req





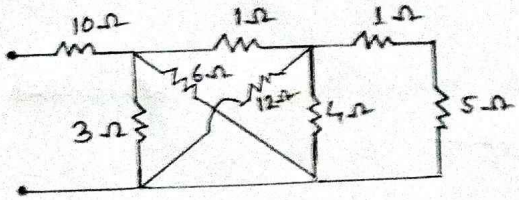
$$\left[\begin{array}{l} 70\,\Omega \parallel 30\,\Omega = 21\,\Omega \\ 12.5\,\Omega \parallel 17.5\,\Omega = 7.29\,\Omega \\ 15\,\Omega \parallel 35\,\Omega = 10.5\,\Omega \end{array}\right]$$

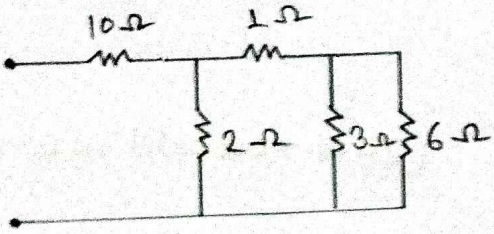


$$R_{eq} = \left(\frac{1}{17.79} + \frac{1}{21}\right)^{-1}$$

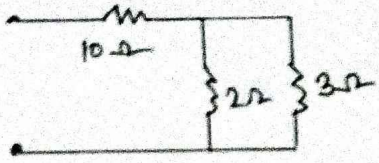
$$= 9.64$$

Problem : 13 – Find Req





$$\left[\begin{array}{l} 5\,\Omega + 1\,\Omega = 6\,\Omega \\ 12\,\Omega \parallel 4\,\Omega = 3\,\Omega \\ 6\,\Omega \parallel 3\,\Omega = 2\,\Omega \end{array}\right]$$

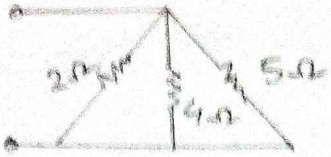


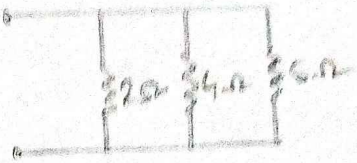
$$\left[(3\,\Omega \parallel 6\,\Omega) + 1\,\Omega = 3\,\Omega\right]$$

$$\therefore R_{eq} = \left(\frac{1}{2} + \frac{1}{3}\right)^{-1} + 10 = 1.2 + 10 = 11.2\,\Omega$$

Problem: 14 - Find Req.

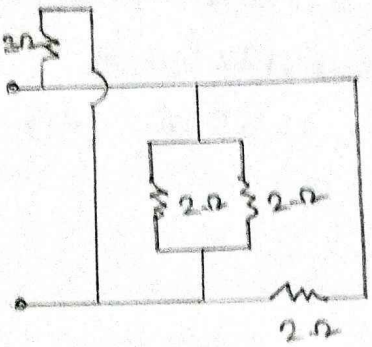
a)

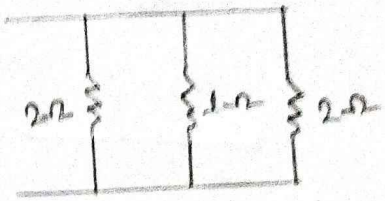




$$R_{eq} = \left(\frac{1}{2} + \frac{1}{4} + \frac{1}{5}\right)^{-1} =$$

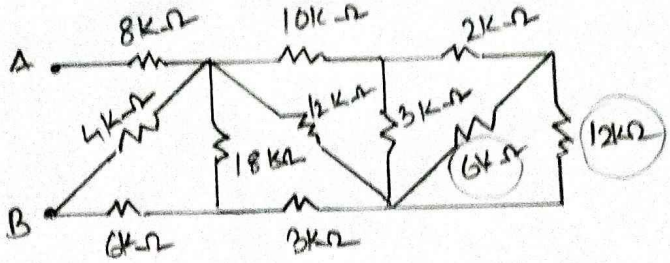
b)

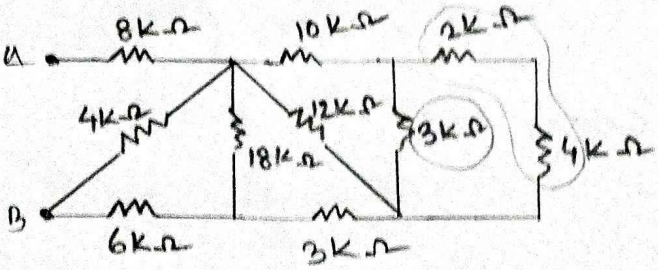




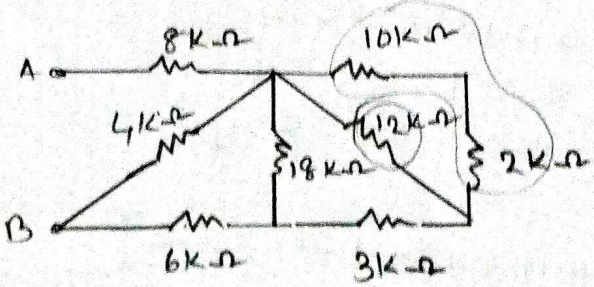
$$R_{eq} = \left(\frac{1}{2} + \frac{1}{2} + 1\right)^{-1} = \frac{1}{2}\,\Omega$$

c)

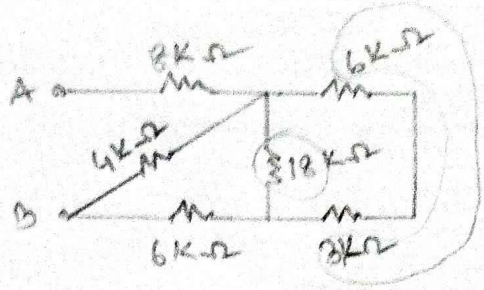




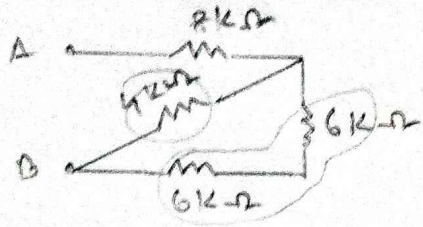
$6K\Omega \,||\, 12K\Omega = 4K\Omega$



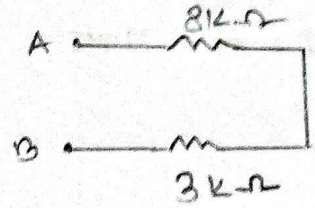
$(2K\Omega + 4K\Omega) \,||\, 3K\Omega = 2K\Omega$



$[(10K\Omega + 2K\Omega) \parallel 12K\Omega = 6K\Omega]$



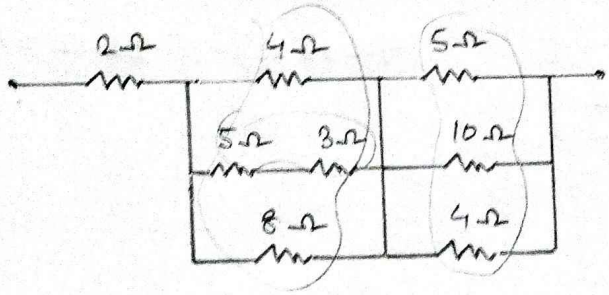
$[(6K\Omega + 3K\Omega) \parallel 18K\Omega = 6K\Omega]$

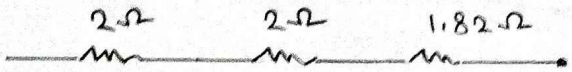


$[(6K\Omega + 6K\Omega) \parallel 4K\Omega = 3K\Omega]$

$\therefore R_{eq} = 8K\Omega + 3K\Omega = 11K\Omega$

b)





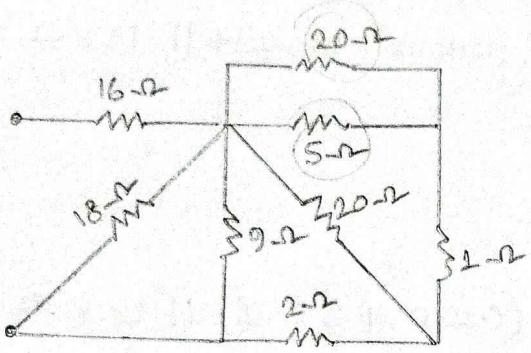
$5\Omega \parallel 10\Omega \parallel 4\Omega = 1.82\Omega$

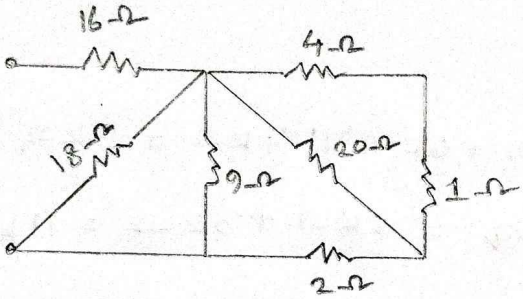
$4\Omega \parallel (5\Omega + 3\Omega) \parallel 8\Omega = 2\Omega$

$\therefore R_{eq} = 2\Omega + 2\Omega + 1.82\Omega$

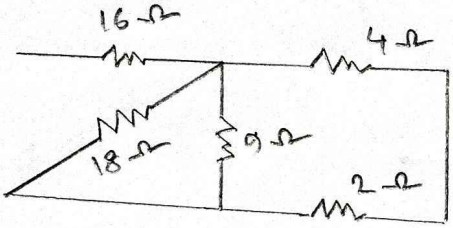
$= 5.82\Omega$

Problem: 15 - Find R_{eq}

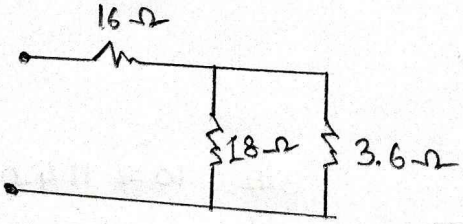




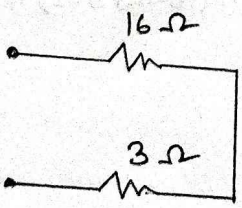
$20\Omega \parallel 5\Omega = 4\Omega$



$(4\Omega + 1\Omega) \parallel 20\Omega = 4\Omega$



$(4\Omega + 2\Omega) \parallel 9\Omega = 3.6\Omega$

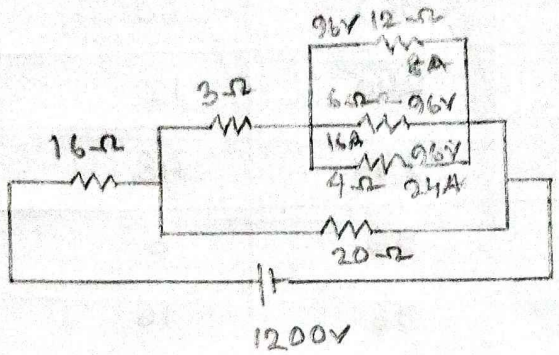


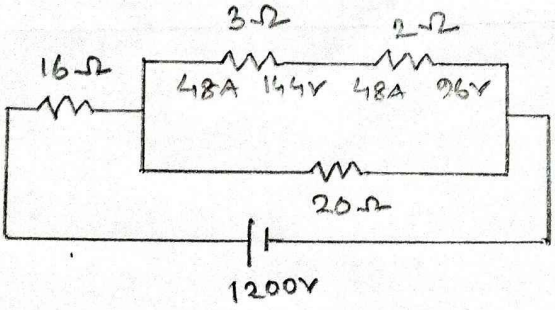
$\therefore R_{eq} = 16\Omega + 3\Omega = 19\Omega$

Problem : 27 - Find the Req. Calculate the voltage drop and current through each resistors.

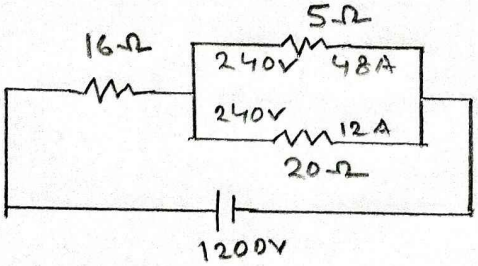
• I same in series

• V same in parallel

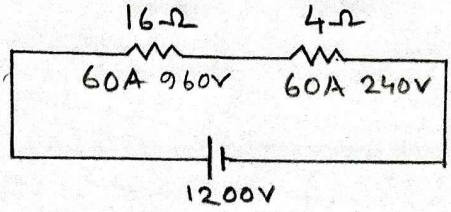




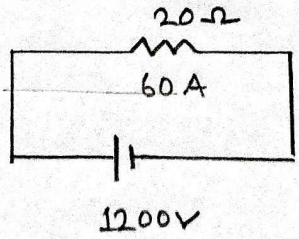
$12\Omega \parallel 6\Omega \parallel 4\Omega = 2\Omega$



$3\Omega + 2\Omega = 5\Omega$



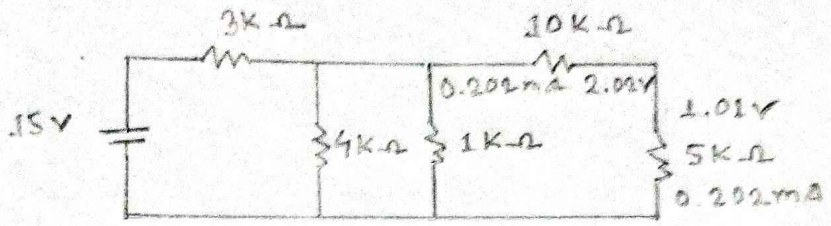
$5\Omega \parallel 20\Omega = 4\Omega$

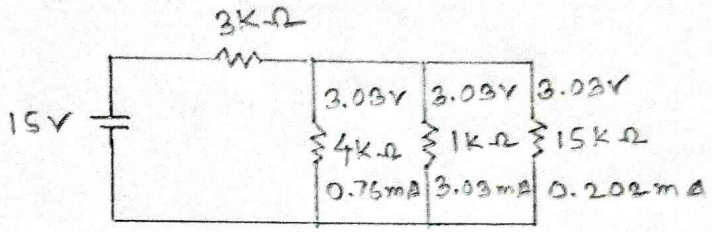


$16\Omega + 4\Omega = 20\Omega$

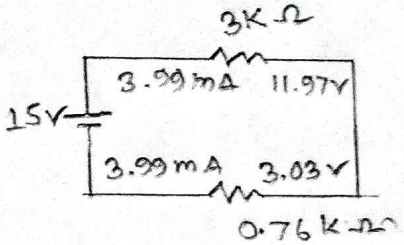
resistors, R (Ω)	Voltage, V (V)	Current, I (A)
16	960	60
20	240	12
3	144	48
12	96	8
6	96	16
4	96	24

Problem: 28 - Find Req, current flow. and voltage drop through each resistors.

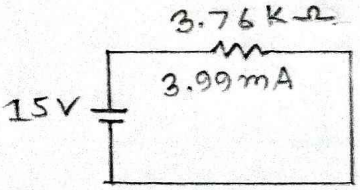




10K Ω + 5 K Ω = 15K Ω



4K Ω || 1K Ω || 15K Ω = 0.76K Ω

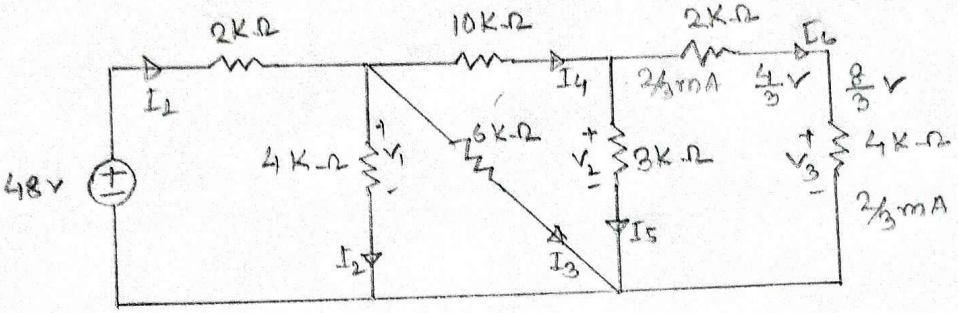


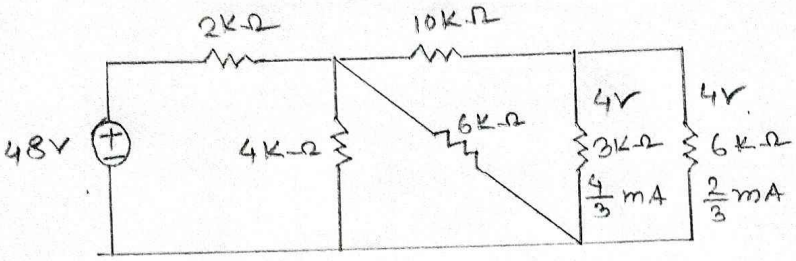
3K Ω + 0.76K Ω = 3.76 K Ω

R (KΩ)	V (V)	I (mA)
3	15	3.99
4	3.03	0.76
1	3.03	3.03
10	2.02	0.202
5	1.01	0.202

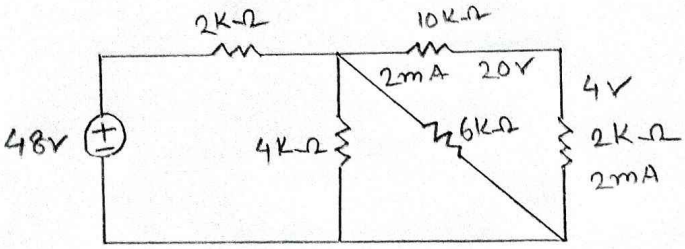
- Req = 3.76 K Ω
- I = 3.99 mA

Problem : 29 - Find all current & voltage...

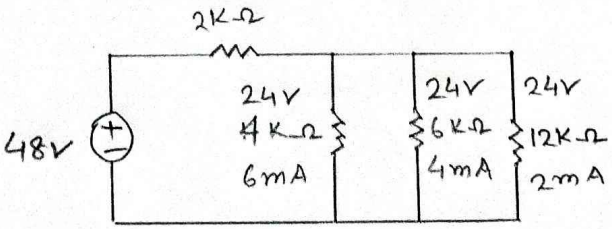




$2K\Omega + 4K\Omega = 6K\Omega$



$6K\Omega \| 3K\Omega = 2K\Omega$



$2K\Omega + 10K\Omega = 12K\Omega$

$I_1 = 12mA$

$I_2 = 6mA$

$I_3 = 4mA$

$I_4 = 2mA$

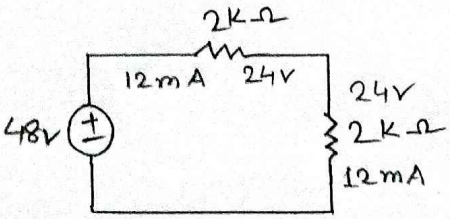
$I_5 = \frac{4}{3} mA$

$I_6 = \frac{2}{3} mA$

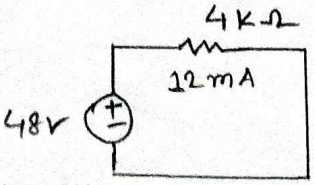
$V_1 = 24V$

$V_2 = 4V$

$V_3 = \frac{8}{3} V$

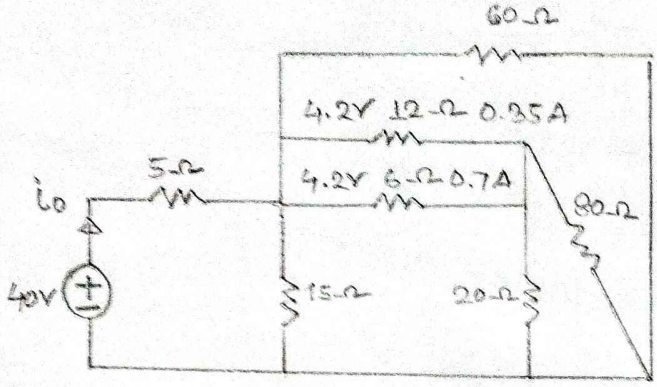


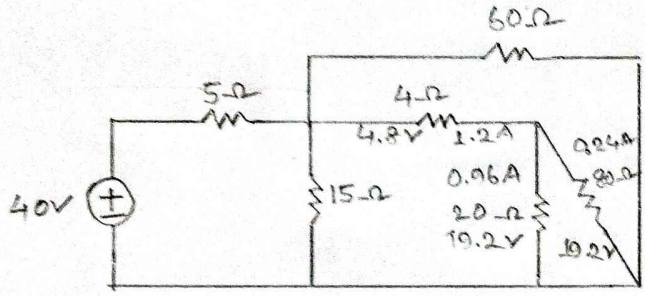
$4K\Omega \| 6K\Omega \| 12K\Omega = 2K\Omega$



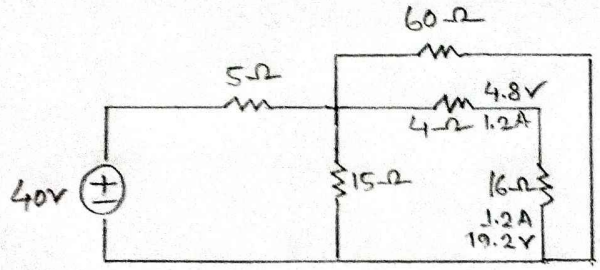
$2K\Omega + 2K\Omega = 4K\Omega$

Problem: 30 – Find R_{eq} and i_o

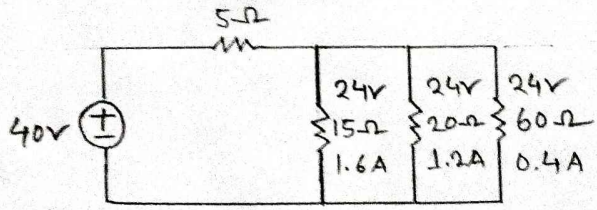




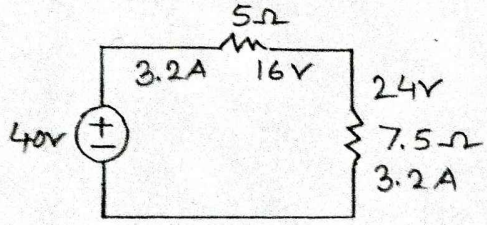
$12\,\Omega \parallel 6\,\Omega = 4\,\Omega$



$20\,\Omega \parallel 80\,\Omega = 16\,\Omega$



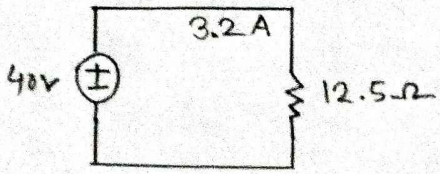
$4\,\Omega + 16\,\Omega = 20\,\Omega$



$15\,\Omega \parallel 20\,\Omega \parallel 60\,\Omega = 7.5\,\Omega$

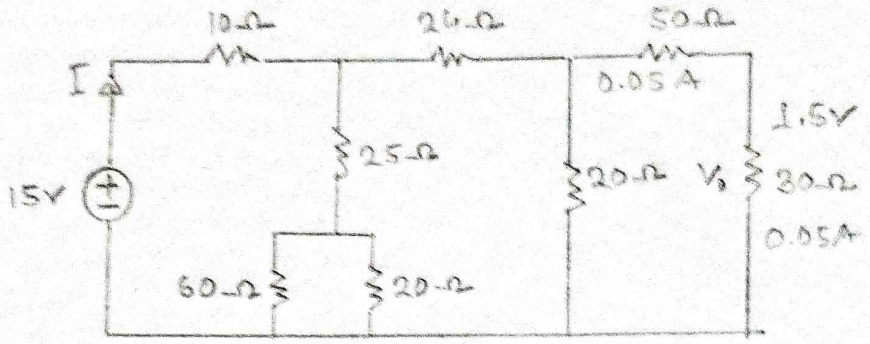
$R_{eq} = 12.5\,\Omega$

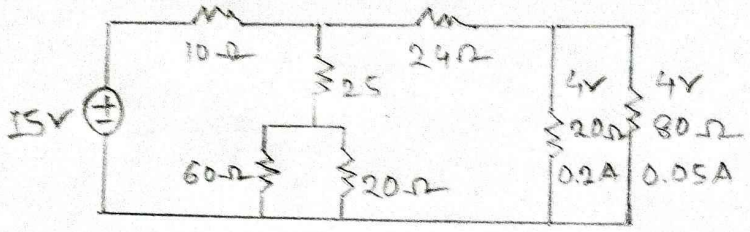
$i_o = 3.2A$



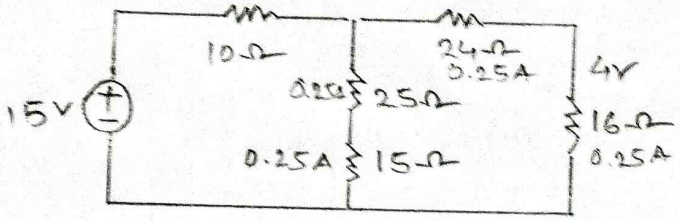
$5\,\Omega + 7.5\,\Omega = 12.5\,\Omega$

Problem : 31 - Find i and V_o



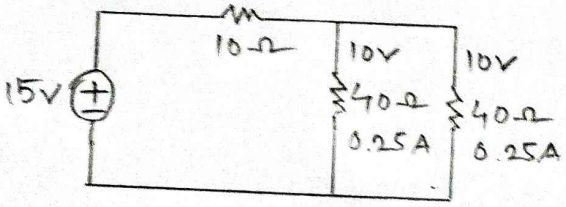


$50\Omega + 30\Omega = 80\Omega$



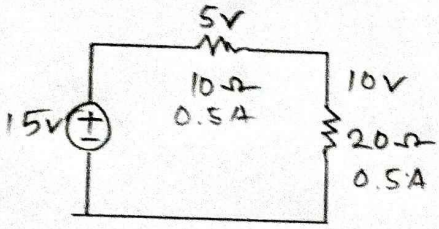
$20\Omega \parallel 80\Omega = 16\Omega$

$60\Omega \parallel 20\Omega = 15\Omega$

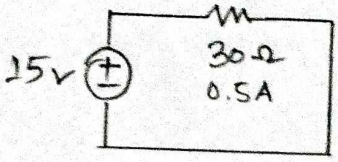


$24\Omega + 16\Omega = 40\Omega$

$25\Omega + 15\Omega = 40\Omega$



$40\Omega \parallel 40\Omega = 20\Omega$

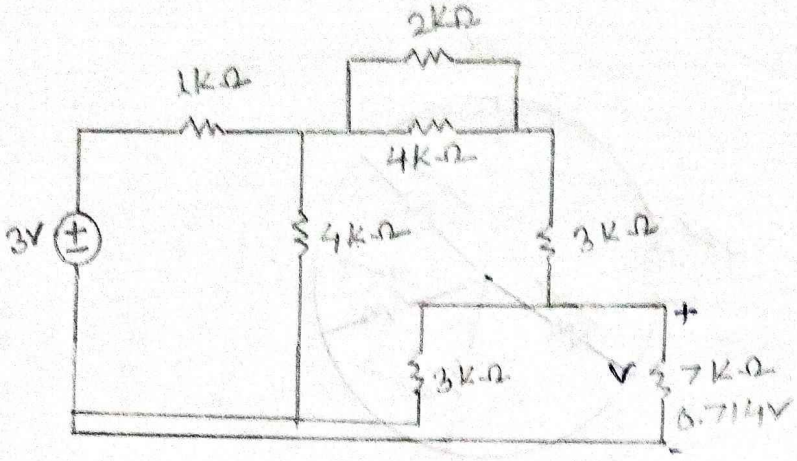


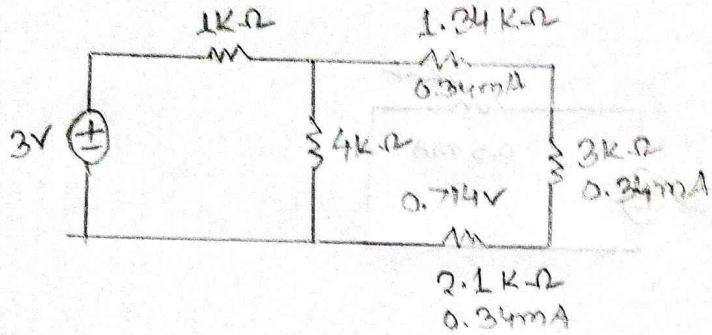
$20\Omega + 10\Omega = 30\Omega$

$I = 0.5A$

$V_o = 1.5V$

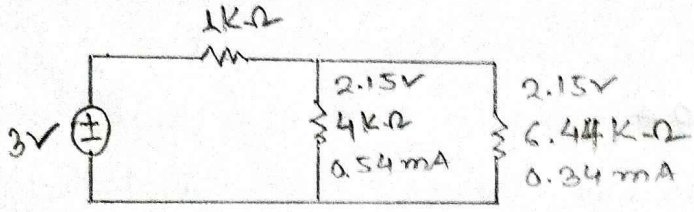
Q. Find V



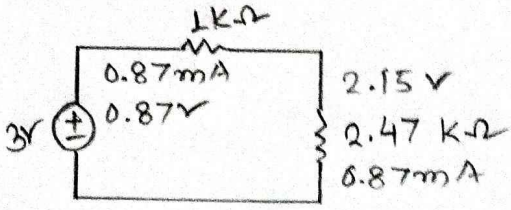


$2K\Omega \parallel 4K\Omega = 1.34K\Omega$

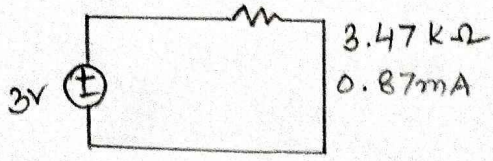
$3K\Omega \parallel 7K\Omega = 2.1K\Omega$



$1.34K\Omega + 3K\Omega + 2.1K\Omega$
$= 6.44K\Omega$



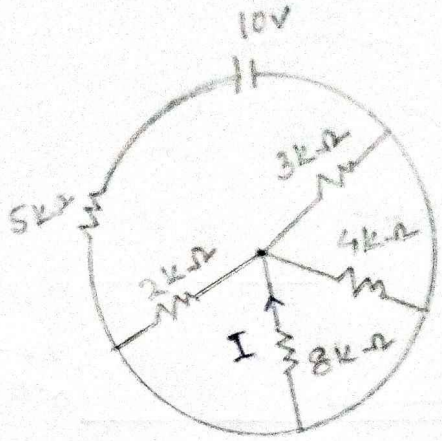
$4K\Omega \parallel 6.44K\Omega = 2.47K\Omega$

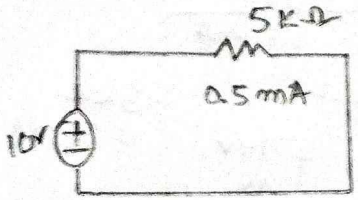


$1K\Omega + 2.47K\Omega = 3.47K\Omega$

$\therefore$ V in $7K\Omega$ = 0.714V

Q. Find I in 8KΩ

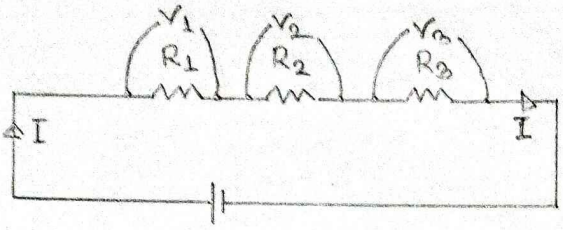


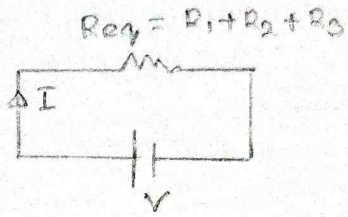


I in 8KΩ = 0A

Voltage Divider Rule :

In a series circuit, the voltage across the resistive elements will divide as the magnitude of the resistance level.



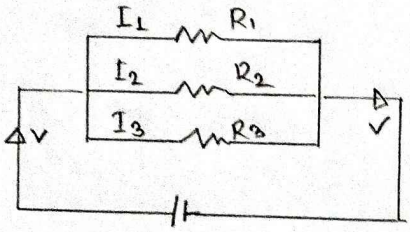


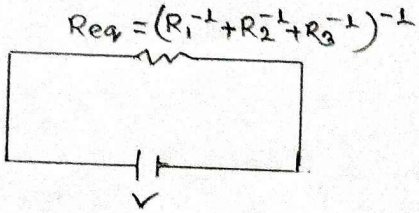
- $V = I R_{eq}$
- $V_1 = IR_1 = \frac{V}{R_{eq}} \cdot R_1$
- $V_2 = IR_2 = \frac{V}{R_{eq}} \cdot R_2$
- $V_3 = IR_3 = \frac{V}{R_{eq}} \cdot R_3$

$$\boxed{\therefore V_x = \frac{R_x}{R_T} \cdot V}$$

Current Divider Rule :

The current divider rule is used to divide current in parallel circuit. It states that, the current through a branch is inversely propotional to the resistance of that branch.





$V = I R_{eq}$

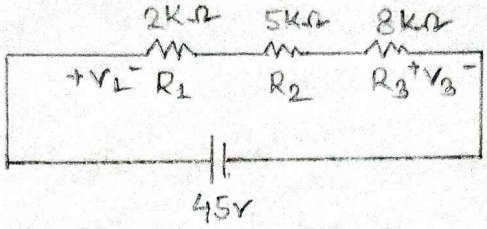
$I_1 = \frac{V}{R_1} = \frac{I R_{eq}}{R_1}$

$I_2 = \frac{V}{R_2} = \frac{I R_{eq}}{R_2}$

$I_3 = \frac{V}{R_3} = \frac{I R_{eq}}{R_3}$

$$\boxed{I_x = \frac{R_T}{R_x} \cdot I}$$

Problem : 16 – Determine the voltages V_1 and V_3 using VDR.



Sol.

As . VDR,

$$V_x = \frac{R_x}{R_T} V$$

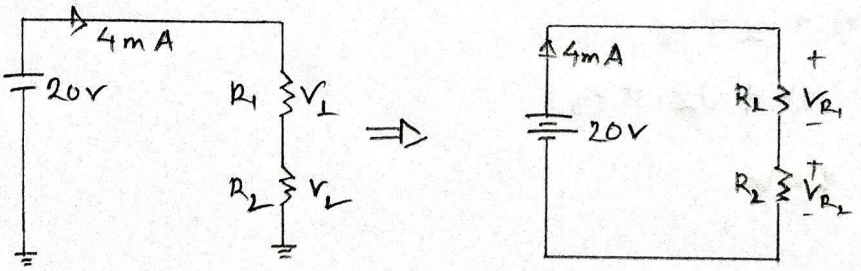
$$\therefore V_3 = \frac{R_3}{R_T} \cdot V$$

$$= \frac{8}{15} \cdot 45 = V$$

$$\therefore V_1 = \frac{R_1}{R_T} \cdot V$$

$$= \frac{2}{15} \cdot 45 = 6V$$

Problem : 17 – Design the voltage divider of the fig such that $V_{R_1} = 4V_{R_2}$



Sol.

Given,

$$V_1 = 4V_2$$

$$\Rightarrow IR_1 = 4(IR_2)$$

$$\Rightarrow R_1 = 4R_2$$

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

$$\therefore R_T = \frac{V}{I} = \frac{20}{4} = 5$$

$$R_T = R_1 + R_2$$

$$\Rightarrow 5 = 4R_2 + R_2$$

$$\therefore R_2 = 1K\Omega$$

$$\therefore R_1 = 4K\Omega$$

Problem : 18 - Solve a to e

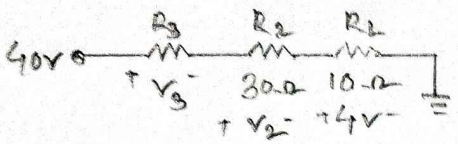
a) Determine V_2 by simply noting that $R_2 = 3R_1$.

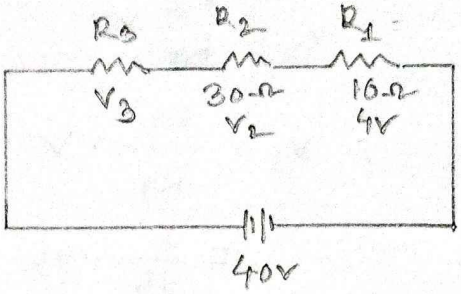
b) Calculate V_3

c) Noting the magnitude of V_3 compared to V_2 or V_1, $R_3 = ?$

d) Calculate the source current I

e) Calculate the resistance R_3 using Ohm's Law and compare it with the result of part c.





Sol. a) Given,

$$R_2 = 3R_1 \qquad V_1 = 4V$$

$$\Rightarrow \frac{V_2}{I} = 3 \cdot \frac{V_1}{I}$$

$$\Rightarrow V_2 = 3V_1$$

$$\therefore V_2 = 3 \cdot 4 = 12V$$

b) $V = V_1 + V_2 + V_3$

$\Rightarrow 40 = 4 + 12 + V_3$

$\therefore V_3 = 24V$

e) $V_3 = 24V$

$V_2 = 12V$

$R_2 = 30\Omega$

$\Rightarrow V_3 = 2V_2$

$\Rightarrow IR_3 = 2IR_2$

$\Rightarrow R_3 = 2R_2$

$\therefore R_3 = 2 \times 30 = 60\Omega$

d) $R_{eq} = R_1 + R_2 + R_3 = 10 + 30 + 60 = 100\,\Omega$

$V = 40\,V$

$\therefore I = \frac{V}{R_{eq}} = \frac{40}{100} = 0.4\,A$

e)

$V_1 = IR_1$

$\Rightarrow I = \frac{V_1}{R_1} = \frac{4}{10} = 0.4\,A$

$V = IR_T$

$R_T = \frac{V}{I} = \frac{40}{0.4} = 100\,\Omega$

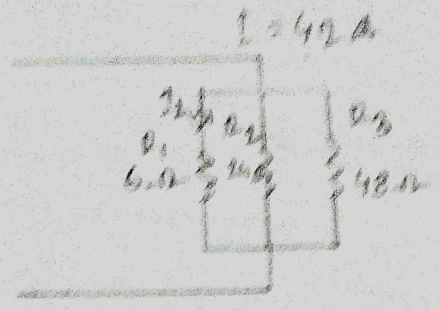
$\therefore \quad V_3 = \frac{R_3}{R_T} \cdot V$

$\Rightarrow R_T V_3 = R_3 V$

$\Rightarrow R_3 = \frac{R_T V_3}{V} = \frac{100 \times 24}{40} = 60\,\Omega$

$\therefore$ Result is same as ques 'c'.

Problem: 19 - Find I_1 using CDR



Sol. $R_T = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$

$= \left(\frac{1}{6} + \frac{1}{24} + \frac{1}{48}\right)^{-1}$

$= 4.363\,\Omega$

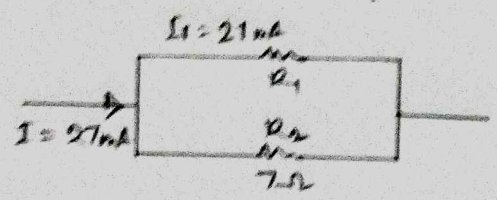
As CDR,

$I_x = \frac{R_T}{R_x} \cdot I$

$\Rightarrow I_1 = \frac{4.363}{6} \cdot 42A$

$= 30.54\ A$

Problem: 20 - Determine R_1



As CDR,

$I_x = \frac{R_T}{R_x} \cdot I$

$I = I_1 + I_2$

$I_2 = 27 - 21 = 6\ A$

$I_2 = \frac{R_T}{R_2} \cdot I$

$\Rightarrow 6 = \frac{R_T}{7} \cdot 27$

$\therefore R_T = 1.56\,\Omega$

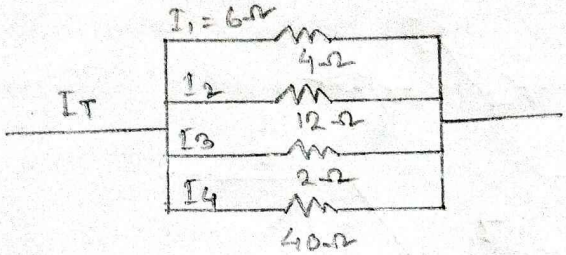
$I_1 = \frac{R_T}{R_1} \cdot I$

$\therefore R_1 = \frac{R_T}{I_1} \cdot I$

$= \frac{1.56}{21} \cdot 27$

$= 2.005\,\Omega$

Problem : 21 – Find I_T, I_2, I_3, I_4



Sol.

$$R_T = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}\right)^{-1}$$

$$= \left(\frac{1}{4} + \frac{1}{12} + \frac{1}{2} + \frac{1}{40}\right)^{-1}$$

$$= 1.17\,\Omega$$

As CDR,

$$I_2 = \frac{R_T}{R_2} \cdot I_T$$

$$\therefore I_1 = \frac{R_T}{R_1} \cdot I_T$$

$$\Rightarrow 6 = \frac{1.17}{4} \cdot I_T$$

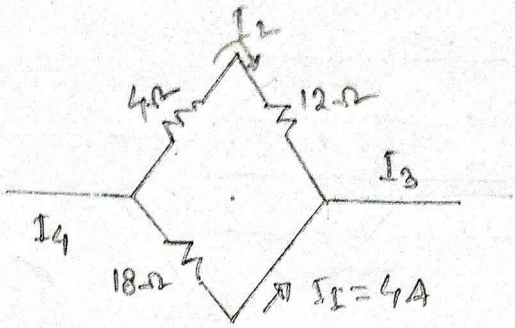
$$\therefore I_T = 20.5\ A$$

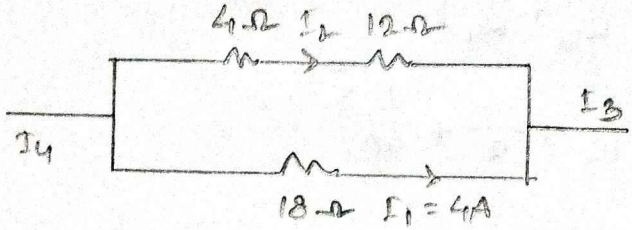
$$I_2 = \frac{1.17}{12} \times 20.5 = 1.998\,A$$

$$I_3 = \frac{1.17}{2} \times 20.5 = 11.993\,A$$

$$I_4 = \frac{1.17}{40} \times 20.5 = 0.599\,A$$

Problem : 22 - Find





$$R_T = \left(\frac{1}{18} + \frac{1}{4+12}\right)^{-1}$$

$$= 8.471\ \Omega$$

From CDR,

$$I_x = \frac{R_T}{R_x} \cdot I$$

$$\therefore \quad I_1 = \frac{8.471}{18} \cdot I_4$$

$$\Rightarrow 4 = 0.471 \times I_4$$

$$\Rightarrow I_4 = 8.49\ A$$

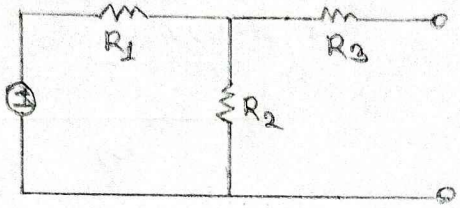
$$\therefore I_3 = I_4 = 8.49A$$

$$\therefore I_2 = I_3 - I_1$$

$$= 4.49$$

Open Circuit:

An open circuit can have a potential difference (voltage) across its terminals, but the current is always zero.



#it doesn't creat a loop

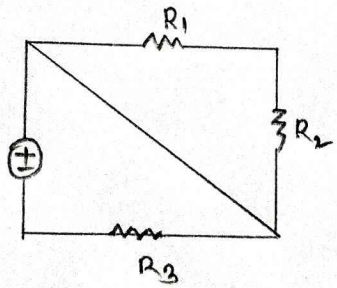
$I_{oc} = 0$

$V = (+ve)$

$\therefore R = \frac{V}{I_{oc}} = \frac{(+ve)}{0} = \infty \quad (R_3)$

Short Circuit:

A short circuit can carry a current level determined by the external circuit, but the potential difference (voltage) across its terminal is always zero volts.

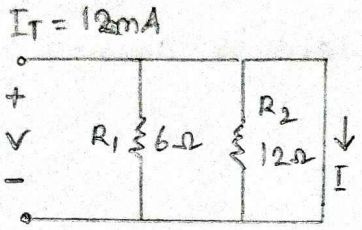


$V = 0$

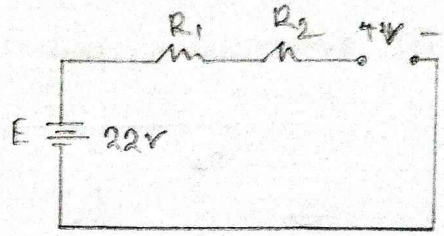
$I_{sc} = (+ve)$

$\therefore R = \frac{V}{I_{sc}} = \frac{0}{(+ve)} = 0 \quad (R_1 + R_2)$

Problem: 23 - Find Vin a, b & I in a, b



a)



b)

Sol. a) Circuit a represents as a circuit

So, the current won't flow through any resistors. Rather go on the path that doesn't contain any resistance.

So, $V = 0$

$I_a = 12mA$

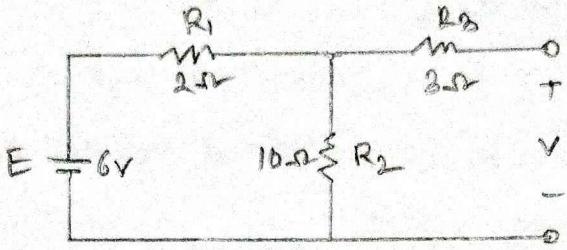
b) circuit b represents as a open circuit.

So the current won't flow because the circuit dosen't contain a loop or the Resistance after R_2 is infinte.

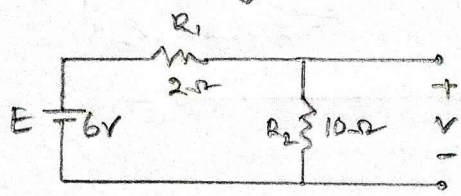
So, $V = 22V$

$I_b = 0mA$

Problem: 24 - Determine V and I,



⇓



As VDR,

$$V_x = \frac{R_x}{R_T} \cdot V$$

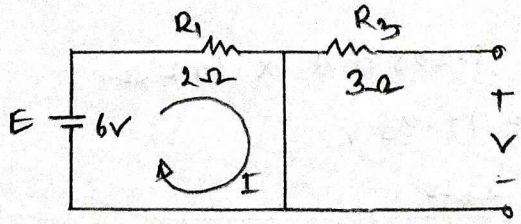
$$\Rightarrow V = \frac{R_2}{R_1+R_2} \cdot E$$

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

$$= 5\ V$$

$$I = \frac{V}{R} = \frac{E}{R_T} = \frac{6}{12} = 0.5\ A$$

If R_2 shorted out what is V and I



The current through R_3 is zero because of the open circuit.

So, $V = IR_3 = 0 \cdot R_3 = 0$

$$I = \frac{E}{R}$$ [as all the current runs through the Jumper]

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

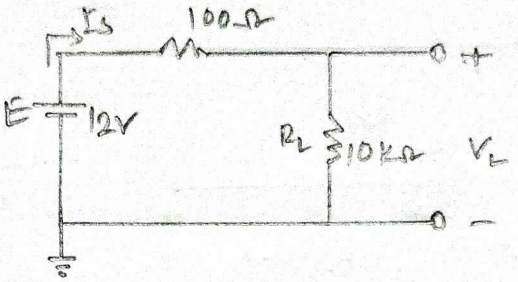
$$= 3\ A$$

Problem 25 :

a) Determine I_s and V_L

b) Determine I_s if R_L is shorted out

c) Determine V_L if R_L is replaced by an open circuit.



Sol. a)

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

$$\Rightarrow I_s = \frac{E}{R_T}$$

$$= \frac{12}{100 + 10\times10^3}$$

$$= 1.198 \text{ mA}$$

$$V_x = \frac{R_x}{R_T} \cdot V$$

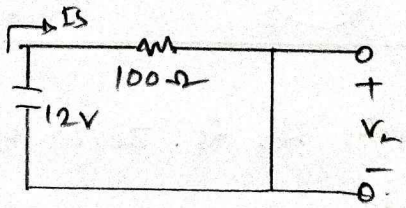
$$\Rightarrow V_L = \frac{10\times10^3}{100 + 10\times10^3} \cdot 12 \qquad \left[V_L = \frac{R_L}{100 + R_L} \cdot E \right]$$

$$= 11.98 \text{ V}$$

Or, $V_L = I R_L = 1.198 \text{ mA} \times 10 \text{ K}\Omega$

$$= 11.98 \text{ V}$$

b)

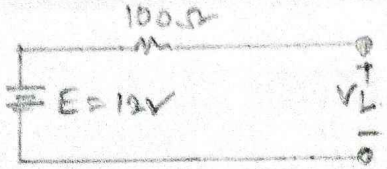


$$I_s = \frac{V}{R}$$

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

$$= 0.12 \text{ A}$$

c)



As it is an open circuit,

$I = 0$

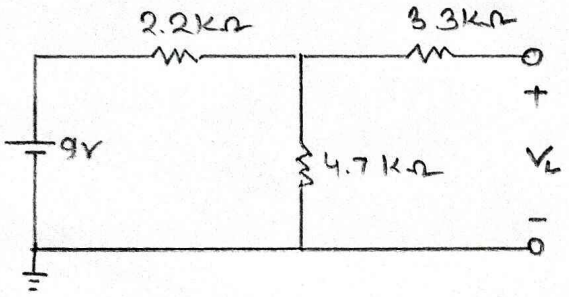
$V_L = 12\,V$

Problem : 26

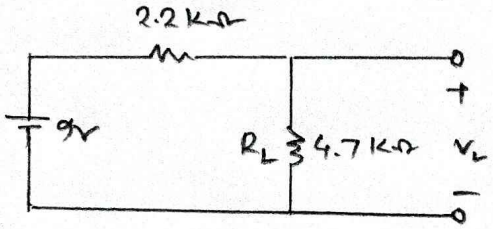
a) Determine the open-circuit voltage, V_L

b) if the 2.2 kΩ resistor is short circuited, what is the value of V_L ?

c) Determine V_L if the 4.7 kΩ resistor is replaced by an open circuit.



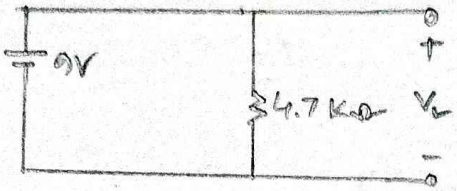
a)



$$I = \frac{V}{R} = \frac{9}{2.2+4.7} = 1.304\,mA$$

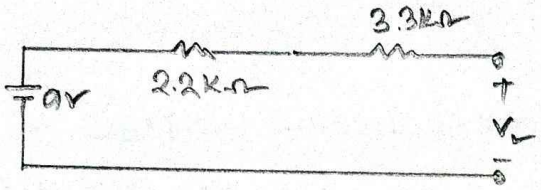
$$\therefore V_L = IR_L = 1.304 \times 4.7 = 6.1288\,V$$

b)



$\therefore V_L = 9V$

c)



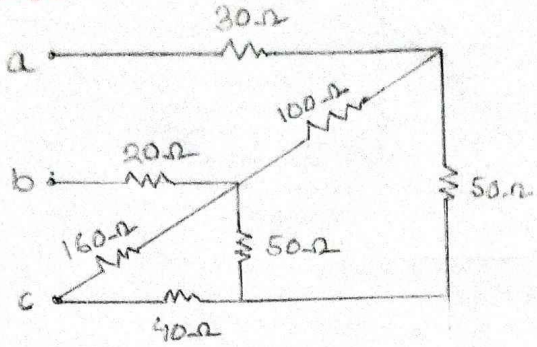
As it is a open circuit,

V_L = Supply voltage

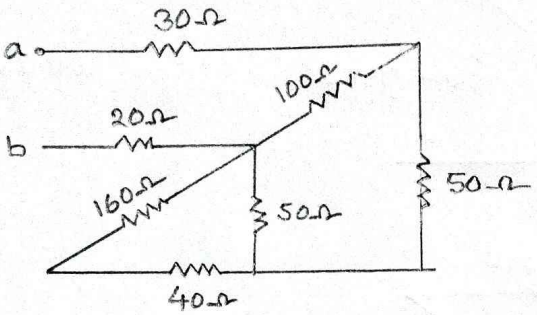
= 9V

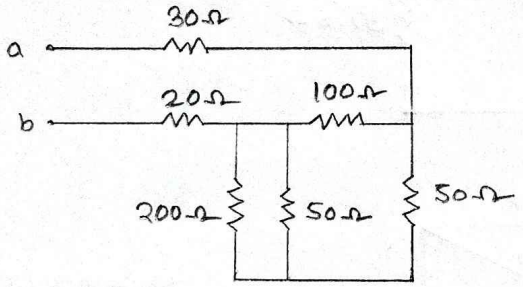
Q. Find Rab, Rbc.

Sol.

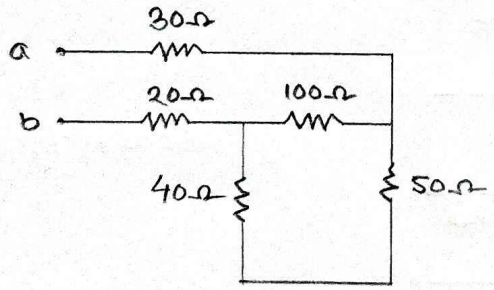


Rab =

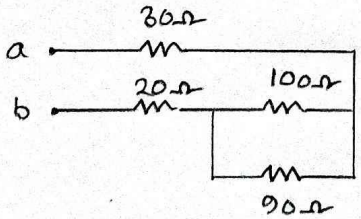




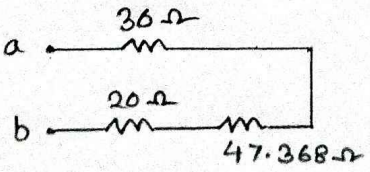
160Ω + 40Ω = 200Ω



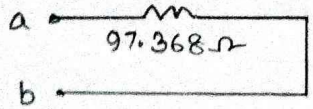
200Ω || 50Ω = 40Ω



40Ω + 50Ω = 90Ω



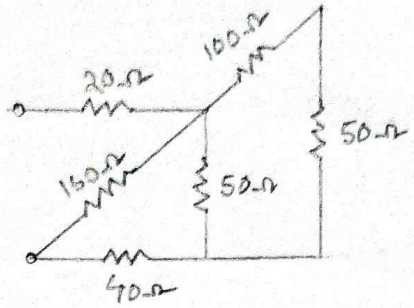
100Ω || 90Ω = 47.368Ω

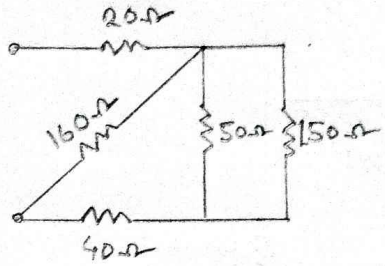


30Ω + 20 + 47.368 Ω = 97.368Ω

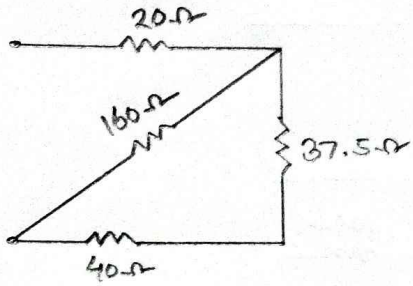
∴ Rab = 97.368Ω

$R_{bc} =$

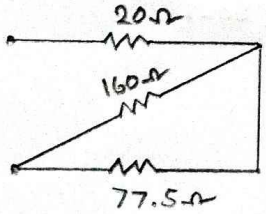




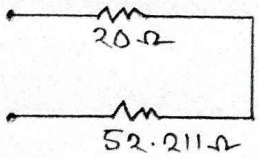
$100\Omega + 50\Omega = 150\Omega$



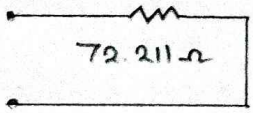
$50\Omega \parallel 150\Omega = 37.5\Omega$



$40\Omega + 37.5\Omega = 77.5\Omega$



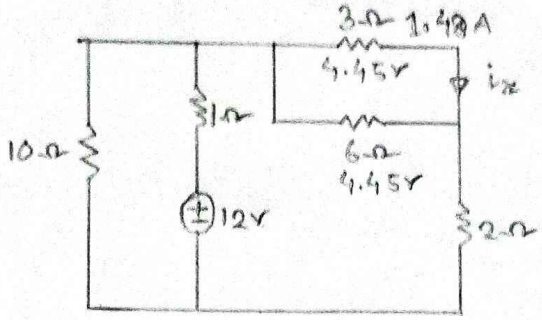
$160\Omega \parallel 77.5\Omega = 52.211\Omega$

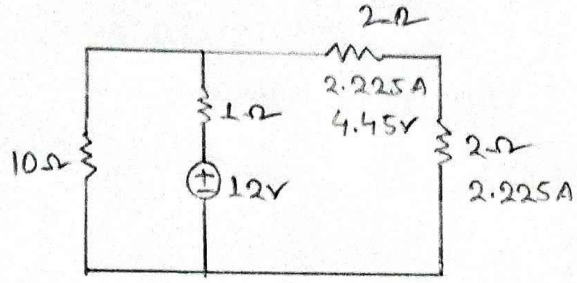


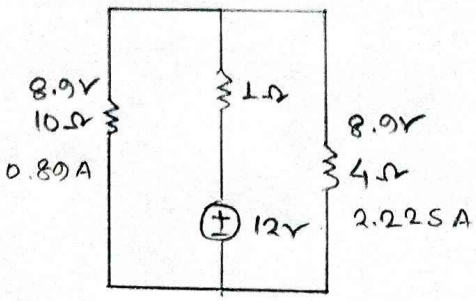
$52.211\Omega + 20\Omega = 72.211\Omega$

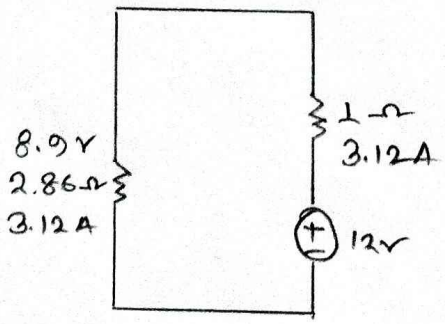
$\therefore R_{bc} = 72.211\Omega$

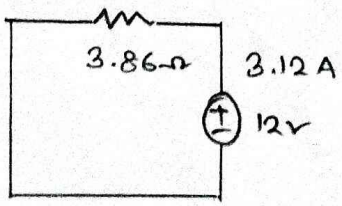
Q. Find i_x





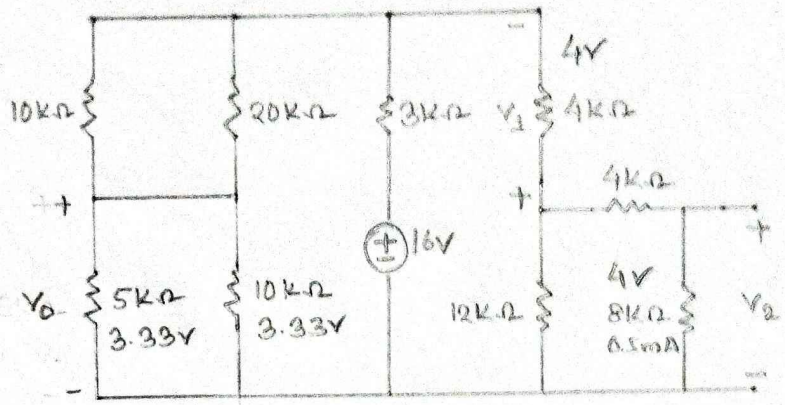


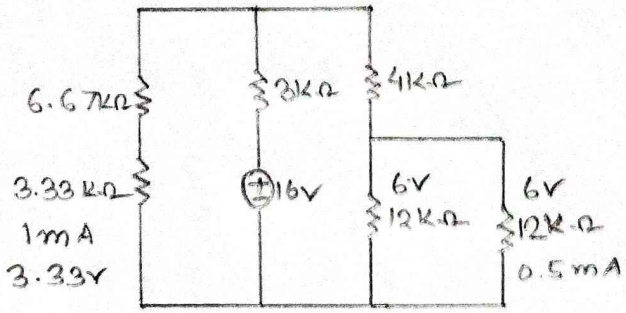


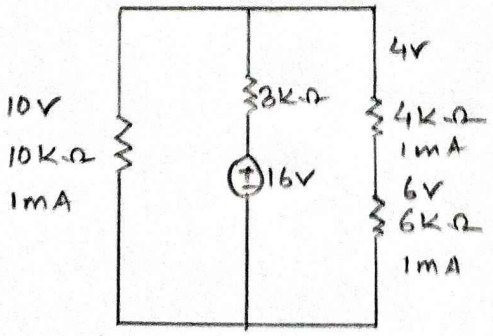


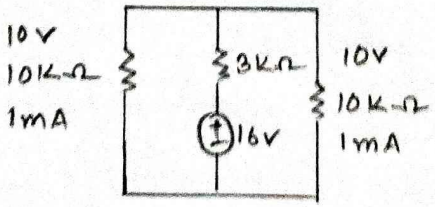
$\therefore i_x = 1.48\,A$

Q. Find, V_0, V_1, V_2

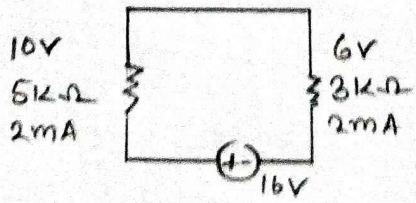
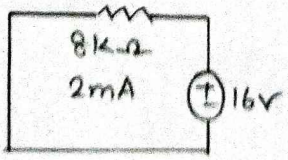








$\therefore V_0 = 3.33V$

$\therefore V_1 = -4V$

$\therefore V_2 = 4V$