LORDS INSTITUTE OF ENGINEERING AND TECHNOLOGY
(UGC Autonomous)

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B.E–I YEAR II SEMESTER CSE C & CSE D

BEE ASSIGNMENT 1

Date of Submission	***04-04-2024***

Short Answer Questions:

1. Define

Voltage: It is the difference in the electric potential between two points.
It is the work done in moving a charge from one pole to another through a wire.
The standard unit of measurement used is volt.
It is represented by the symbol **'V'.**
Interms of energy per unit charge

v= dw / dq

dw: workdone
dq: rate of charge of electron

Current: Electric Current is the rate of flow of electrons in a conductor.
The SI Unit of electric current is the Ampere**.**
It is represented by the symbol '**I'**
The flow of electrons inside the conducting material or conductor generates an electric current.
Interms of charge

i= dq / dt

dq: rate of charge of electron
dt: rate of time

Energy: Energy is the ability to perform work. Energy can neither be created nor destroyed, and it can only be transformed from one form to another.
The unit of Energy is the same as of Work, i.e. Joules.
It is represented by the symbol **'E'**

Power: The rate of doing work, and it is the amount of energy consumed per unit of time.
The SI unit of power is Joules per Second (J/s), which is termed as Watt.
It is represented by the symbol **'P'**

$$P = \frac{W}{t}$$

W = Work done | t = Time taken | P = Power

$$p = \frac{w}{t}$$
$$= \frac{w}{q} \times \frac{q}{t}$$
$$p = v\,i$$

Node: Node is a point where, terminal of two or more circuit elements are connected together. Node is a junction point in the circuit.
If there is no element between two or more connected adjacent nodes, these nodes can be recombined as a single node.

Branch: Any of the circuit elements, when connected to the circuit, it is definitely connected between two nodes of the circuit. When an element exists between two nodes, the path from one node to another through this element is called branch of the circuit.

Loop: An electric circuit has numbers of nodes. If one starts from one node and after going through a set of nodes returns to same starting node without crossing any of the intermediate node twice, he has travels through one loop of the circuit.
Loop is any closed path in the circuit formed by branches.

Mesh: A 'mesh' (also called a loop) is simply a path through a circuit that starts and ends at the same place. For the purpose of mesh analysis, a mesh is a loop that does not enclose other loops.

2. Define:

a) Active and Passive Elements

Active Elements :

The active elements are one which supplies energy or having capable of generating energy. Active elements are also known as energy sources. Energy sources (voltage sources or current sources), battery, alternator or dc generator, transistor, diode (with negative differential resistance), LED, photodiode, and SCR are some examples of active elements.

Passive Elements

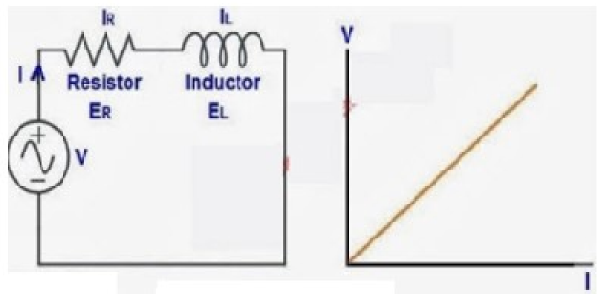
The elements which can either store or dissipates energy are called Passive Elements. Unlike active element, passive elements do not generate energy or provide amplification rather they consume energy and stores it in the form of electrostatic or electromagnetic fields or dissipates it in the form of heat.

Some examples of passive elements are resistors, inductors, capacitors, transformers, diodes, etc.

b) Linear & Non Linear elements

Linear elements:

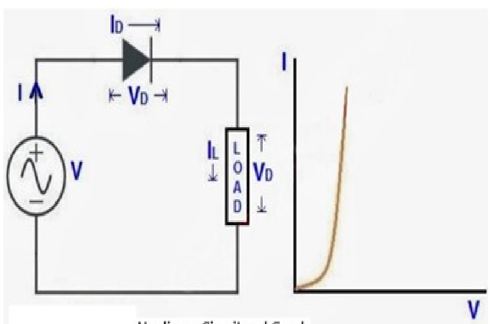
Linear elements are those whose value doesn't change with current or voltage. The V-I characteristics of linear elements will be a straight line and always passes through the origin. Linear elements obey the law of superposition and homogeneity. They obey the properties of Ohm's law. Some examples of linear elements are resistance, inductor, and capacitor.



Non Linear Elements:

The circuit elements whose value varies with respect to current and voltage (i.e., circuit parameters doesn't remain constant) is called Non-Linear Element. The current flowing and voltage across these elements have a non-linear relationship.

Non-linear elements do not satisfy homogeneity and superposition laws. The plot between the voltage and current of non-linear elements will not be a straight line like linear elements. Some examples of non-linear elements are diodes, transistors, saturated iron core inductors and transformers, modulators, etc.

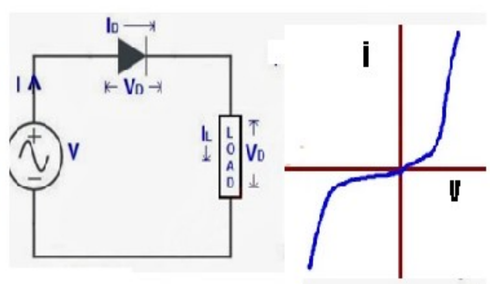


Nonlinear Circuit and Graph

c) Unilateral & Bilateral elements

Unilateral Elements :

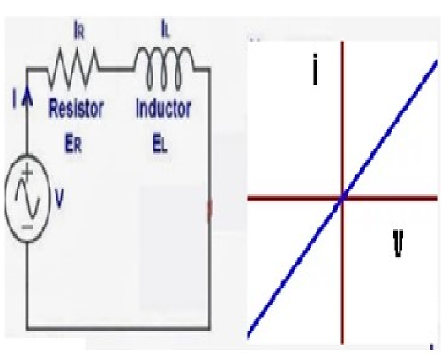
The circuit elements whose characteristics change with a change in direction of current flowing through it are called Unilateral Elements. A unilateral element allows current only in one direction. If the direction of the current changes, either it opposes the current flow or there will be a change in its behavior. A diode and transistor are examples of unilateral elements. We know that a diode conducts only in forward-bias condition i.e. when P-side is at a higher potential than the N-side. During the reverse bias state, a diode acts as an open circuit.



Bilateral Elements

A bilateral element is one whose characteristics or behavior remain same in both directions of current flow i.e., even if the direction of current changes V-I characteristics of the element remain same. A bilateral element allows current through it in both directions. The resistance/impedance of bilateral elements remains same in both directions of current flow. Some examples of bilateral elements are resistors, inductors, capacitors, TRAIC, etc.

A resistor is a bilateral element because it allows current in both directions. The value of current and voltage across the resistor remains same even if the direction of the current changes.



3. Define ohm's Law: Limitations of Ohms law?

Ohm's law states that the voltage across a conductor is directly proportional to the current flowing through it, provided all physical conditions and temperatures remain constant.

Mathematically, this current-voltage relationship is written as V = I * R

In the equation, the constant of proportionality, R, is called Resistance and has units of ohms, with the symbol Ω.

The same formula can be rewritten in order to calculate the current and resistance respectively as follows:

I = V / R **R = V / I**

Limitations of Ohm's Law

Following are the limitations of Ohm's law:

- Ohm's law is not applicable for unilateral electrical elements like diodes and transistors as they allow the current to flow through in one direction only.
- For non-linear electrical elements with parameters like capacitance, resistance etc the ratio of voltage and current won't be constant with respect to time making it difficult to use Ohm's law.

4. What is source Transformation? Types of Transformation techniques used?

The technique/method of transforming one form's source into the other is known as the Source Transformation technique.

The basic analysis methods for any electrical network / electric circuit are Nodal analysis & Mesh analysis.

There are 2 types of practical sources: practical voltage and current.

There are two Source Transformation techniques used:

Practical voltage source into a practical current source

Practical current source into practical voltage source

5. Mention the types of voltage and current Sources?

The Voltage and Current sources are classified as

Independent Sources:

- Independent Voltage Source
  - ➢ Ideal Voltage source.
  - ➢ Practical Voltage source.
- Independent Current Source
  - ➢ Ideal current source.
  - ➢ Practical current source.

Dependent Sources

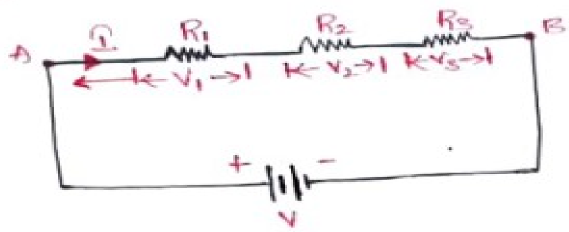
- Voltage Dependent Voltage Source
- Voltage Dependent Current Source
- Current Dependent Voltage Source
- Current Dependent Current Source

Long Answer Questions

1. Derive the expressions for resistors connected in series with example?

Resistors Connected in Series

Equivalent Resistance in Series Circuit :



When two or more number of resistors are connected end-to-end, as shown in fig (a), then the resistances are said to be connected in series.

Let R_1, R_2 and R_3 are three Resistances connected in series across a voltage source of V. I be the current flowing through all the resistors.

– According to Ohm's law.

Voltage drop across the resistance R_1,

$$V_1 = I R_1.$$

Voltage drop across the resistance R_2,

$$V_2 = I R_2.$$

Voltage drop across the resistance R_3,

$$V_3 = I R_3.$$

– The applied voltage equal to the sum of those individual voltage drops.

$$V = V_1 + V_2 + V_3.$$

$$V = IR_1 + IR_2 + IR_3$$

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

$$\frac{V}{I} = R_1 + R_2 + R_3.$$

– Equivalent Resistance, $\boxed{R_{eq} = R_1 + R_2 + R_3}$

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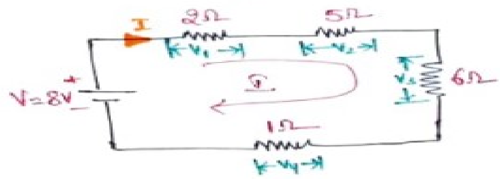
* – Find the Current and R_{eq} of the given Circuit ? and find voltage d



Given Data.

$V = 8V$

$R_{eq} = ?$ $(R_1+R_2+R_3+R_4)$

$I = ?$ (V/R_{eq})

Voltage drops = ? $(V_1, V_2, V_3$ & $V_4)$

$$R_{eq} = R_1 + R_2 + R_3 + R_4$$

$$= 2 + 5 + 6 + 1$$

$$\boxed{R_{eq} = 14\Omega}$$

Current $I = V/R_{eq}$

$$I = 8/14$$

$$\boxed{I = 0.57A}$$

Voltage drop at R_1, $V_1 = I R_1$

$$= 0.57 \times 2 \Rightarrow V_1 = 1.143V.$$

Voltage drop at R_2, $V_2 = I R_2$

$$= 0.57 \times 5 \Rightarrow V_2 = 2.85V$$

Voltage drop at R_3, $V_3 = I R_3$

$$= 0.57 \times 6 \Rightarrow V_3 = 3.42V$$

Voltage drop at R_4, $V_4 = I R_4$

$$= 0.57 \times 1 \Rightarrow V_4 = 0.57V.$$

$R_{eq} = 14$ V

$I = 0.57A$

$V_1 = 1.14V$

$V_2 = 2.85V$

$V_3 = 3.42V$

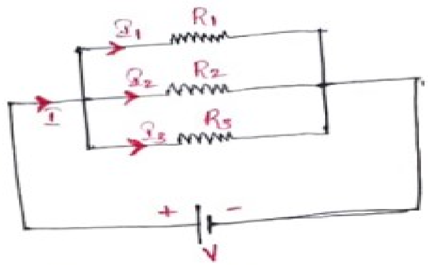
$V_4 = 0.57V.$

2. Derive the expressions for resistors connected in parallel with example?

Resistor's Connected in Parallel

Equivalent Resistance in parallel circuit :

Three resistances are joined as shown in figure are said to be connected in parallel across a voltage source of 'V'.



Let R_1, R_2 & R_3 are three resistances connected in parallel across a voltage source of V.

I – total current.

I_1, I_2 & I_3 are the current flowing through the three resistors R_1, R_2 & R_3 ~~are~~ respectively.

Current flowing through the Resistor R_1, $I_1 = V/R_1$

Current flowing through the Resistor R_2, $I_2 = V/R_2$

Current flowing through the Resistor R_3, $I_3 = V/R_3$

Total Current, $I = I_1 + I_2 + I_3$

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

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

$$\frac{I}{V} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}.$$

$$\boxed{\frac{V}{I} = R_{eq}} \qquad \boxed{\frac{I}{V} = \frac{1}{R_{eq}}.}$$

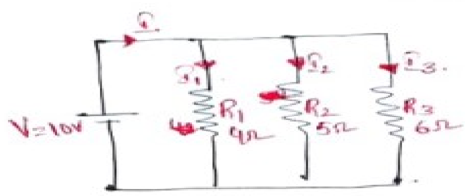
$$\boxed{\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

Find the ~~tot~~ Currents I_1, I_2, I_3 and I, R_{eq} of the given Circuit ?

Given data :-

$V = 10V$

find I, I_1, I_2, I_3 & R_{eq}.



$R_{eq} = R_1 \parallel R_2 \parallel R_3$.

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{eq}} = \frac{1}{4} + \frac{1}{5} + \frac{1}{6}$$

$$\frac{1}{R_{eq}} = 0.25 + 0.2 + 0.166$$

$$\frac{1}{R_{eq}} = 0.616\,\Omega$$

$$R_{eq} = \frac{1}{0.616} \Rightarrow \boxed{R_{eq} = 1.62\,\Omega}$$

$I = V/R_{eq}$

$= 10/1.62$

$\boxed{I = 6.16\,A}$

Current at R_1, $I_1 = V/R_1$

$= 10/4 = \boxed{2.5A = I_1}$

Current at R_2, $I_2 = V/R_2$

$= 10/5 = \boxed{2A = I_2}$

Current at R_3, $I_3 = V/R_3$

$= \frac{10}{6} = \boxed{1.66\,A = I_3}$

$R_{eq} = 1.62\,\Omega$
$I = 6.16\,A$
$I_1 = 2.5\,A$
$I_2 = 2A$
$I_3 = 1.66A$

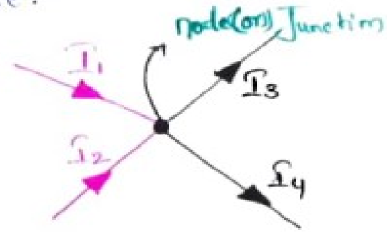
3. Explain KCL with an example?

Kirchhoff's Current Law :- KCL

The Currents flowing into a node (or a junction) must be equal to the current flowing out of it.

$$I_1 + I_2 = I_3 + I_4$$

(or).

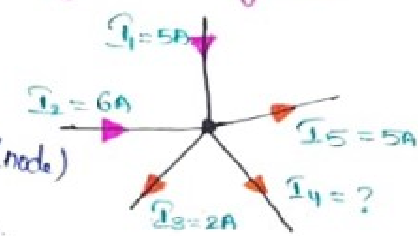


The Algebraic Sum of all currents in a node is equal to zero.

$$\Sigma i = 0$$

$$I_1 + I_2 - I_3 - I_4 = 0$$

(1) — Find the current I_4 in the given diagram?



Sum of Current entering = Sum of Currents leaving (node)

$I_1 + I_2 = I_3 + I_4 + I_5$.

$5A + 6A = 2A + I_4 + 5A$.

$11A = 7A + I_4$.

$I_4 = 11A - 7A$

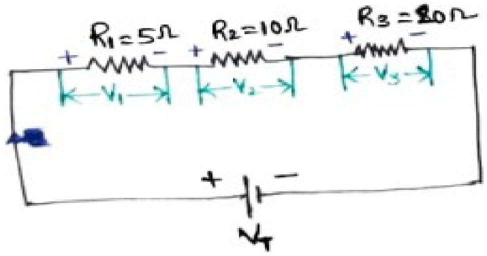
$\boxed{I_4 = 4A}$

4. Explain KVL with an example?

Kirchoff's Voltage Law :-

The voltage around a loop equals the sum of every voltage drop in the same loop for any closed network and equals zero.

$\Sigma V = 0$ (closed loop)



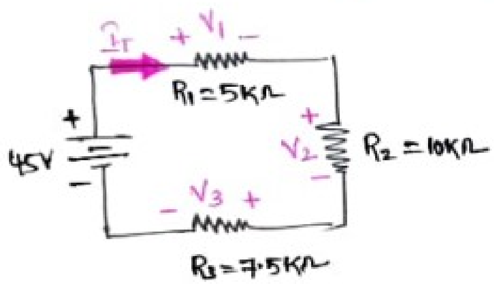
The sum of the voltages Produced = Sum of the voltages Consumed

$$\underbrace{V_T}_{\text{Produced}} = \underbrace{V_1 + V_2 + V_3}_{\text{Consumed}}.$$

The sum of all voltages in a circuit is equal to zero.

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

(2). To find the voltage drop and total current in the circuit?



$\Sigma V = 0$

$-V_T + V_1 + V_2 + V_3.$

$-V_T + (I \times R_1) + (I \times R_2) + (I \times R_3)$

$-V_T + I(R_1 + R_2 + R_3).$

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

$I = V_T / R_1 + R_2 + R_3$

$= 45V / (5 + 10 + 7.5) K\Omega$

$= 45 / 22.5 K\Omega$

$I = 0.002A$

$\boxed{I = 2mA}$

Voltage drop at R_1 is.

$V_1 = I \times R_1$

$= 2 \times \cancel{10^{-3}} \times 5 \times \cancel{10^3}$

$\boxed{V_1 = 10V}$

$V_2 = I \times R_2$

$= 2 \times \cancel{10^{-3}} \times 10 \times \cancel{10^3}$

$\boxed{V_2 = 20V}$

$V_3 = I \times R_3$

$= 2 \times \cancel{10^{-3}} \times 7.5 \times \cancel{10^3}$

$\boxed{V_3 = 15V}$

$\therefore V_T = V_1 + V_2 + V_3$

$= 10 + 20 + 15$

$45V = 45V$

5. State and Explain Mesh Analysis with an example?

Mesh Analysis (or) Loop Analysis :-

The method in which the current flowing through a planar circuit is calculated.

A planar circuit is defined as the circuits that are drawn on the plane surface in which there are no wires crossing each other. Therefore, a mesh analysis can be also known as Loop Analysis or Mess-Current Method.

Procedure of Mesh Analysis:

Step 1:
To identify the meshes and label these mesh currents in either clockwise or Anticlockwise direction.

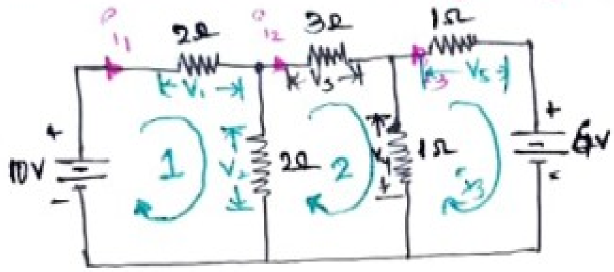
Step 2:-
To observe the amount of current that flows through each element interms of mesh currents.

Step 3:-
Writing the mesh equations to all meshes using Kirchoff's voltage law and then Ohm's Law.

Step 4:-
The mesh currents are obtained by following step 3 in which mesh equations are solved.

For a given electrical circuit the current flowing through any element and the voltage across any element can be determined using the node voltages.

Find the current and power consumed in 3Ω resistance for the circuit shown below by using Mesh analysis?



By using KVL method to find loop equations.

No. of loops = 3.

Loop equations = 3

Apply KVL in loop 1

$V = V_1 + V_2$

$10 = I_1R_1 + R_2(I_1 - I_2)$

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

$\boxed{4I_1 - 2I_2 = 10}$ — (1)

Apply KVL in loop 2.

$0 = V_3 + V_4 + V_2$

$3i_2 + 1(i_2 - i_3) + 2(i_2 - i_1) = 0$

$3i_2 + i_2 - i_3 + 2i_2 - 2i_1 = 0$

$\boxed{-2i_1 + 6i_2 - i_3 = 0}$ — (2)

Apply KVL in loop 3.

$-V_2 = V_5 + V_4$

$-6 = 1I_3 + 1(I_3 - I_2)$

$-6 = I_3 + I_3 - I_2$

$\boxed{-I_2 + 2I_3 = -6}$ — (3)

$I_1 = \frac{\Delta_1}{\Delta} = 2.72A$

$I_2 = \frac{\Delta_2}{\Delta} = 0.44A$

$I_3 = \frac{\Delta_3}{\Delta} = -2.77A$

Matrix form

$$\begin{bmatrix} 4 & -2 & 0 \\ -2 & 6 & -1 \\ 0 & -1 & 2 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \\ -6 \end{bmatrix}$$

By Cramer's Method :-

Current at 3Ω Resistance

$I_{3\Omega} = I_2 = 0.44A.$

Power Consumed at 3Ω Resistance is

$P_{3\Omega} = V \times I_2$

$= 10 \times 0.44$

$\boxed{P_{3\Omega} = 4.4W}$

6. State and Explain Nodal Analysis with an example?

Nodal Analysis :

Nodal analysis is used for solving any electrical Network, and it is defined as.

The Mathematical method for calculating the voltage distribution between the Circuit nodes.

This method is also known as node-voltage method, Since the node voltages are w.r.to the ground.

Features of Nodal Analysis :

- Nodal analysis is an application of Kirchoff's Current Law.
- When there are 'n' nodes in a given electrical Circuit, there will be 'n-1' Simultaneous equations to be Solved.
- To obtain all the node voltages, 'n-1' should be Solved.
- The number of non-reference nodes and the number of nodal equations obtained are Equal.

Procedure of Nodal Analysis :

Step 1: To identify the principal nodes and select one of them as reference node. This reference node will be treated as the Ground.

Step 2: All the node Voltages w.r.to the ground from all the Principal nodes should be labelled expect the reference node.

Step 3: The nodal equations at all the Principal nodes except the reference node should have a nodal equation. The nodal equation is obtained from Kirchoff's Current Law and then from Ohm's Law.

Step 4: To obtain the node voltages, the nodal equations can be determined by following Step 3.

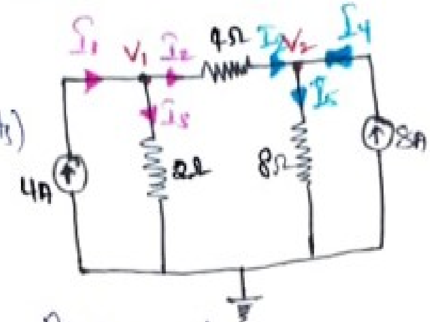
Hence, for a given electrical Circuit, the Current flowing through any element and the voltage across any element can be determined using the node voltages.

Problem on Nodal Analysis:

Write the node equilibrium equation for the network shown below. Also find the node voltage V_1 and V_2?

Soln:- Node is nothing but junction point

V_1 and V_2 are two node (junction points)



At Node V_1: Nodal equations are.

Step 1 Apply KCL at node 1. (V_1).

As per KCL.

Entry currents +ve

Leaving current −ve

$$I_1 - I_2 - I_3 = 0$$

$$+4 - \frac{(V_1 - V_2)}{4} - \left(\frac{V_1 - 0}{2}\right) = 0$$

$$4 - \frac{V_1}{4} + \frac{V_2}{4} - \frac{V_1}{2} = 0$$

$$4 = V_1\left(\frac{1}{4} + \frac{1}{2}\right) - V_2(1/4)$$

$$4 = V_1(0.25 + 0.5) - V_2(0.25)$$

$$4 = 0.75V_1 - 0.25V_2 \quad \text{— (1)}$$

Step 2

Apply KCL at node 2 (V_2)

I_2 and I_4 are entry currents

I_5 are leaving current

$$I_4 - I_5 + I_2 = 0$$

$$8 - \frac{V_2 - 0}{8} + \frac{V_1 - V_2}{4} = 0$$

$$8 - \frac{V_2}{8} - \frac{V_2}{4} + \frac{V_1}{4} = 0$$

$$8 = -V_1(1/4) + V_2\left(\frac{1}{8} + \frac{1}{4}\right)$$

$$8 = -0.25V_1 + V_2(0.125 + 0.25)$$

$$8 = -0.25V_1 + 0.375V_2 \quad \text{— (2)}$$

Step 3:- Solve eqn (1) and (2) in Matrix form.

$$\begin{bmatrix} 0.75 & -0.25 \\ -0.25 & 0.375 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 4 \\ 8 \end{bmatrix}$$

Step 4:- By Cramer's rule

$$V_1 = \frac{\Delta_1}{\Delta} = \frac{3.5}{0.218} =$$

$$\boxed{V_1 = 16.05V}$$

$$V_2 = \frac{\Delta_2}{\Delta} = \frac{7}{0.218}$$

$$\boxed{V_2 = 32.11V}$$

$$\Delta = \begin{bmatrix} 0.75 & -0.25 \\ -0.25 & 0.375 \end{bmatrix} = 0.218$$

$$\Delta_1 = \begin{bmatrix} 4 & -0.25 \\ 8 & 0.375 \end{bmatrix} = 3.5$$

$$\Delta_2 = \begin{bmatrix} 0.75 & 4 \\ -0.25 & 8 \end{bmatrix} = 7$$

7. State and explain super position theorem with an Example

Statement : The Superposition theorem states that in any linear network, containing two or more sources the response in any element is equal to the algebraic sum of responses caused by individual sources acting alone while the other sources are eliminated.

In reducing the sources, independent voltage sources are SHORT circuited and independent current sources are OPEN circuited.

Steps to Solve:-

Step 1: Select a single source acting alone, short/open the other sources. (voltage / current)

Step 2: Find the current through or voltage across the required element due to the source under consideration, using suitable network simplification techniques (or) Mesh equations.

Step 3: Repeat the above two steps for all the sources.

Step 4: Add all the individual effects produced by individual sources to obtain the total current in or total voltage across the element.

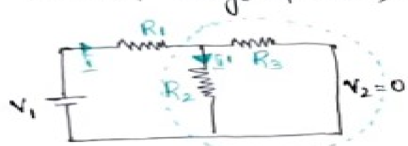
Example of S.P.T

Consider the circuit shown below and find current through resistor R_2

Step 1:

Consider one source at a time.

Consider voltage source, V_1 alone and short circuiting the source V_2.



Step 2:- Find the current I' by using network simplification techniques.

Current Division Rule $= \frac{R_{opp.}}{R_{Total}} \times I_{Total}$.

Consider the short circuited part loop.

Opposite Resistance of $R_2 = R_3$.

$\therefore$ C.D Rule. $I' = \frac{R_3}{R_3+R_2} \times I_T$

$\therefore \quad I_T = \frac{V}{R_{eq}} \quad \Rightarrow R_{eq} = [R_3 \| R_2] + R_1$.

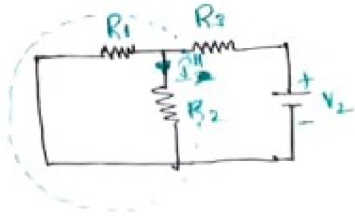
$R_{eq} = \frac{R_3 R_2}{R_3+R_2} + R_1$.

$$\boxed{\therefore I' = \frac{R_3}{R_3+R_2} \times \frac{V}{\frac{R_3 R_2}{R_3+R_2} + R_1}}$$ → R_{eq}.

Step 3:- Repeat the Step ① and ② for all the sources.

$$I'' = \frac{R_1}{R_1+R_2} \times \frac{V}{R_{eq}}$$

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

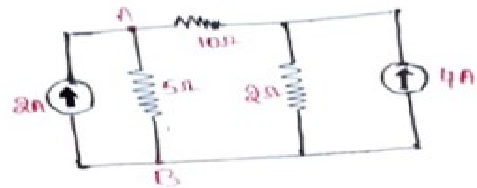


$$\boxed{I'' = \frac{R_1}{R_1+R_2} \times \frac{V}{\underbrace{\frac{R_1R_2}{R_1+R_2} + R_3}_{R_{eq}}}}$$

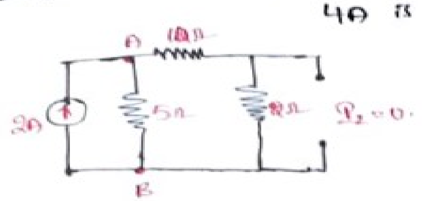
Step 4:- Add all the individual sources to obtain the total current.

Current flowing through R_2 is $\boxed{I' + I'' = I_T}$

8. Find the Voltage across terminals A and B using Superposition theorem?



Step 1:- Current source 2A is Active.
4A is open circuited.



Step 2:- Find the Current at 5Ω Resistance using Current division Rule.

$$\text{Current division Rule} = \frac{R_{opp}}{R_{total}} \times I_{total}.$$

$$I' = \frac{10+2}{10+2+5} \times 2A$$

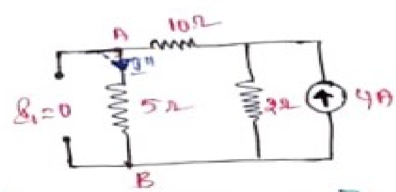
$$I' = 2 \times \frac{12}{17} = \frac{24}{17}$$

$$\boxed{I' = 1.41\,A}$$

[10Ω and 2Ω are in Series.
∴ R_{opp} = 12Ω]

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

Step 3:- Repeat Step ① and ② for all sources.
Current Source 2A is open circuited.
4A is Active.



Apply current Division Rule.

$$I'' = \frac{2}{10+5+7} \times I_T$$

$$= \frac{2}{17} \times 4$$

$$\boxed{I'' = 0.47\,A}$$

[2Ω Resistance is parallel to 5Ω]

$$\boxed{I_T = 4A}$$

Step 4:- Sum of individual Responses obtains the total current

$$I' + I'' = I_T$$

$$I_T = 0.47 + 1.41$$

$$\boxed{I_T = 1.88\,A.}$$

Find voltage across terminals A and B.

$$V_{AB} = I_{3\Omega} \times R_{3\Omega}$$

$$= 1.88 \times 5$$

$$\boxed{V_{AB} = 9.4\,V}$$

9. State and explain Thevinins theorem with an Example

Statement : "A two terminal linear bilateral network consisting of independent and/or dependent voltage or current sources and resistances can be replaced with an equivalent circuit consisting of a voltage source V_{th} in series with resistance R_{th}."

V_{th} is the open circuit voltage between the terminals of the network and R_{th} is the resistance measured between the terminals of the network, with all energy sources eliminated.

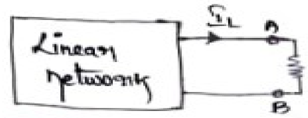


fig (a): Linear network

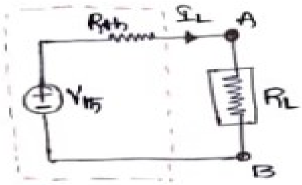


fig (b): Thevinin's equivalent circuit

Steps to solve thevinin's theorem :

Step 1: Disconnect the load resistance R_L

Step 2:- Determine the Thevinin's voltage by using network reduction techniques across the open circuit terminals.

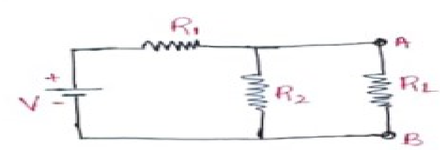
Step 3:- Determine thevenin resistance by reducing independent sources to zero (i.e) independent voltage source is short circuited and independent current source is open circuited.

Step 4:- Draw the voltage source equivalent circuit representation of given network and reconnect the load resistance and calculate the load current.

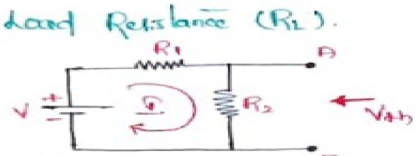
From fig (b) load current, $\boxed{I_L = \dfrac{V_{th}}{R_{th} + R_L}}$

Example of thevinin's theorem :

Consider the circuit. Applying Thevinin's theorem to find load current (I_L) through R_L.



Step 1 : Disconnect the load resistance (R_L).



Step 2 : Calculate voltage thevinin (V_{th}) :

Current, $I = \dfrac{V}{R_1+R_2}$ $[\because R = R_1+R_2]$

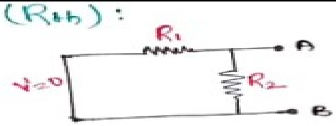
V_{th} is the voltage across the resistor R_2.

$V_{th} = I \times R_2$

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

Step 3 :- Calculate Thevinin Resistance (R_{th}) :

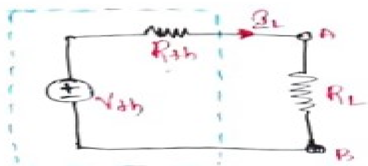
Short Circuiting the independent Voltage Source.



R_1 & R_2 are in Parallel.

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

Step 4 :- Drawing the thevinin's equivalent circuit, reconnecting the load resistance. R_L and Calculating load current.



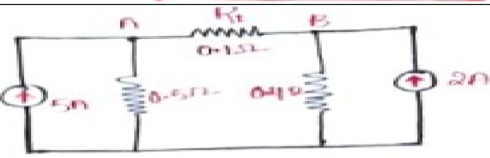
R_{th} and R_L are in Series.

$\therefore R_{eq} = R_{th} + R_L$

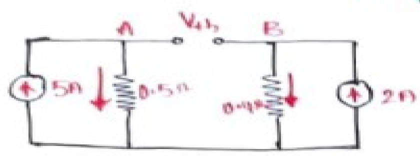
$$I_L = \frac{V_{th}}{R_{eq}}$$

$$\boxed{I_L = \frac{V_{th}}{R_{th} + R_L}}$$

10. Find Current through 0.1ohm resistor in the circuit shown below, using Thevinins Theorem



Step 1 :- Disconnect the load Resistance.



Step 2 :- Calculate V_{th}.

Voltage at A, $V_A = 5 \times 0.5 = 2.5V$

Voltage at B, $V_B = 2 \times 0.4 = 0.8V$.

Thevinin's Voltage $V_{th} = V_{AB}$

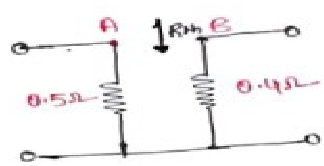
$= V_A - V_B$

$= 2.5 - 0.8$

$$\boxed{V_{th} = 1.7V}$$

Step 3 :- Calculate R_{th}.

0.5Ω and 0.4Ω are in Series between the terminal A and B.

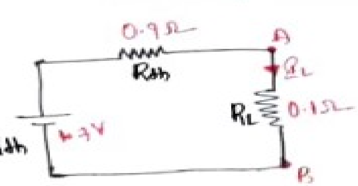


Thevinin's Resistance $R_{th} = R_{AB}$.

$= 0.5 + 0.4$.

$$\boxed{R_{th} = 0.9\Omega}$$

Step 4 :- Drawing the Thevinin's equivalent Circuit, Connecting the load resistance 0.1Ω



Current through 0.1Ω resistance,

$$I_L = \frac{V_{th}}{R_{th} + R_L}$$

$$= \frac{1.7}{0.9 + 0.1}$$

$$\boxed{I_L = 1.7A}$$

11. State and explain Nortons theorem with an Example

Statement : "Any two-terminal linear network consisting of independent and/or dependent voltage or current sources and resistances can be replaced by an equivalent network consisting of a current source I_n parallel with a resistance R_n".

I_n is the short circuit current through the short placed between the terminals and R_n is the resistance measured between the terminals by reducing the energy sources to zero.

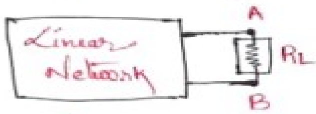


fig (a) Linear Network

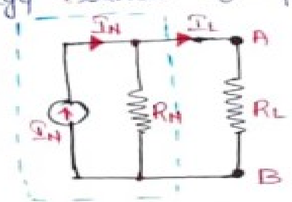


fig (b): Norton's equivalent Circuit

Steps to Solve Norton's theorem :

Step 1 : Disconnect the load resistance and place a short between the terminals.

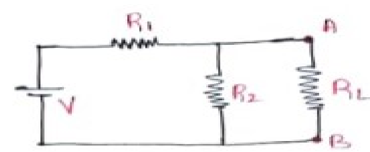
Step 2 : Determine Norton's Current using network analysis techniques.

Step 3 : Determine's Norton's resistance by reducing independent sources to zero ie, short circuiting independent voltage source and open circuiting dependent current source.

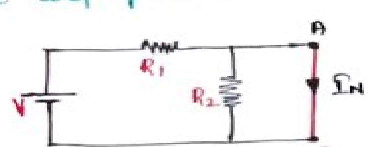
Step 4 : Draw Norton's equivalent circuit and reconnect the load resistance and calculate load current.

Example of ~~Steps to solve~~ Norton's theorem :

Consider the circuit as shown in fig. Applying Norton's theorem to find load current through R_L.



Step 1 : Disconnect the load resistance and place a short between A and B.

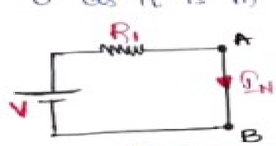


Step 2 :- Calculate Norton's Current I_N :

The value of R_2 becomes '0' as it is in parallel with short.

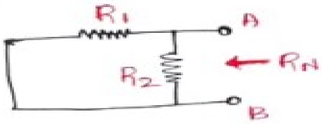
[Any resistance connected parallel to short circuit is zero]

The circuit becomes



Norton's Current, $\boxed{I_N = V/R_1}$

Step 3 :- Calculate R_N.



R_1 and R_2 are in parallel

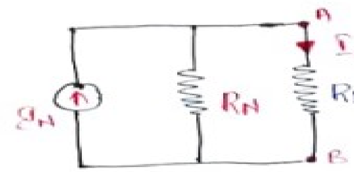
Norton's resistance, $\boxed{R_N = \frac{R_1 R_2}{R_1 + R_2}}$

Step 4 :- Draw Norton's equivalent circuit and reconnect load resistance and calculate I_L.

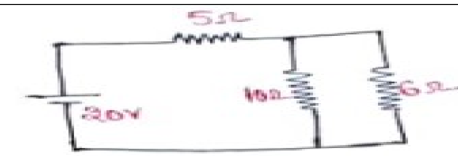
— Apply current division Rule.

Load current

$$\boxed{I_L = \frac{R_N}{R_N + R_L} \cdot I_N}$$



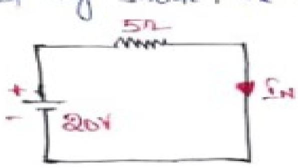
12. Calculate current through 6ohm resistor using Nortons Theorem?



Step 1 : Remove load resistance, 6Ω and place a short across terminals, the circuit becomes.

Step 2 :- Calculate I_N

10Ω is in parallel with a short, then 10Ω replaced by short. the circuit will be.



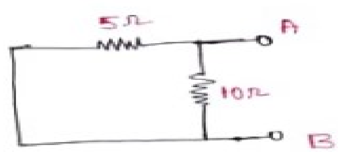
Norton's Current

$$I_N = \frac{20}{5}$$

$$\boxed{I_N = 4A}$$

Step 3 :- Calculate R_N.

5Ω and 10Ω are connected in parallel.

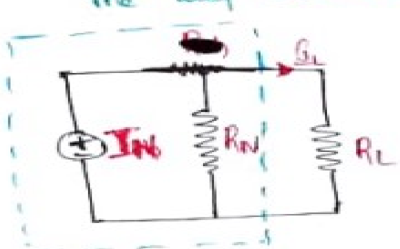


$$R_N = R_{AB} = \frac{5 \times 10}{5 + 10}$$

$$R_N = \frac{50}{15}$$

$$\boxed{R_N = 3.33\Omega}$$

Step 4 :- Drawing the Norton's equivalent circuit, reconnecting the load resistance. R_L and calculate Load current.



$$I_L = I_N \cdot \frac{R_N}{R_N + R_L}$$

$$= 4 \times \frac{3.33}{3.33 + 6}$$

$$\boxed{I_L = 1.43\ A}$$