SUBJECT- ELECTRICAL CIRCUIT THEORY

SUBJECT CODE-4030320

CONTENT

1. NOTES OF LESSON INDEX PAGE
2. NOTES OF LESSON (VIDEO LINK,PPT LINK ATTACHED IN THE INDEX PAGE)

PREPARED BY

N SRIRAM,

LECTURER/EEE.

764 - Sri Ranganathar Institute of Polytechnic College
1/104 A, Athipalayam, Thudiyalur to Kovilpalayam Road,
Coimbatore - 641110
Tamil Nadu
Phone No: (0422) [illegible]
E-mail: [illegible]

NOTES OF LESSON –INDEX PAGE

YEAR	SECOND YEAR	SEMESTER	IV SEMESTER
·CT/SUBJECT CODE	ELECTRICAL CIRCUIT THEORY 4030320	SCHEME	N-SCHEME

UNIT-I- DC CIRCUITS

TOPIC	REFER TEXT BOOK NAME	VIDEO PRESENTATION	PPT	ANY OTHER
Basic Concepts of Current,	**"Circuits and Networks Analysis and Synthesis"** **AUTHORS** A Sudhakar Shyammohan S Palli **PUBLISHER** Tata McGraw Hill Education Private **"Electric Circuits"** **AUTHORS** Mahamood Nahvi Joseph A Edminister **PUBLISHER** Schaum Publishing Company, Newyork	https://www.youtube.com/watch?v=W6WAfcYKrdA	NIL	
EMF,				
Potential Difference,				
Resistance and Resistivity		https://www.youtube.com/watch?v=HsLLq6Rm5tU		
Ohm"s Law –				
Work, Power, Energy		https://www.youtube.com/watch?v=u3cfW5RmKuw		
Resistance in Series, Parallel and Series				
Parallel Circuits		https://www.youtube.com/watch?v=u3cfW5RmKuw		
Kirchhoff's Laws		https://www.youtube.com/watch?v=lP2R52diLqg		
Concept of Capacitance		https://www.youtube.com/watch?v=Q79ztk0o5Jk		
Capacitors in Series and in Parallel		https://www.youtube.com/watch?v=yNa4oray8_8		
Problems in the above Topics.				E-BOOK

UNIT-II- CIRCUIT THEOREMS

).	TOPIC	REFER TEXT BOOK NAME	VIDEO PRESENTATION	PPT	ANY OTHER
	Definitions of Node	**"Circuits and Networks Analysis and Synthesis"** **AUTHORS** A Sudhakar Shyammohan S Palli **PUBLISHER** Tata McGraw Hill Education Private **"Electric Circuits"** **AUTHORS** Mahamood Nahvi Joseph A Edminister **PUBLISHER** Schaum Publishing Company, Newyork	**https://www.youtube.com/watch?v=JpNQ-9_VEKA** **https://www.youtube.com/watch?v=S0GsrzjVkd4** **https://www.youtube.com/watch?v=8udwPc5pCoA** **https://www.youtube.com/watch?v=DdLA8rntWEY** **https://www.youtube.com/watch?v=RbII8o49Hvs**	**NIL**	**E-BOOK**
	Branch and Network				
	Mesh Equations				
	Nodal Equations				
	Star / Delta Transformations				
	Superposition Theorem				
	Thevenin"s Theorem				
	Norton"s Theorem				
	Maximum Power Transfer Theorem				
	Problems in DC Circuits only				

UNIT-III- SINGLE PHASE CIRCUITS

<table>
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AUTHORS
A Sudhakar
Shyammohan S Palli

PUBLISHER
Tata McGraw Hill Education Private

"Electric Circuits"

AUTHORS
Mahamood Nahvi Joseph A Edminister

PUBLISHER
Schaum Publishing Company, Newyork</td><td rowspan="15">NIL</td><td rowspan="15">PPT

PPT</td><td rowspan="15">E-BOOK</td></tr>
<tr><td>Instantaneous, Peak, Average and Effective Values</td></tr>
<tr><td>Form Factor and Peak Factor (Derivation for Sine Wave)</td></tr>
<tr><td>Pure Resistive, Inductive and Capacitive Circuits</td></tr>
<tr><td>RL, RC, RLC Series Circuits – Impedance – Phase Angle</td></tr>
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UNIT-IV- THREE PHASE AC CIRCUITS

TOPIC	REFER TEXT BOOK NAME	VIDEO PRESENTATION	PPT	ANY OTHER
Three Phase AC Systems-Phase Sequence	**"Circuits and Networks Analysis and Synthesis"** **AUTHORS** A Sudhakar Shyammohan S Palli **PUBLISHER** Tata McGraw Hill Education Private **"Electric Circuits"** **AUTHORS** Mahamood Nahvi Joseph A Edminister **PUBLISHER** Schaum Publishing Company, Newyork	NIL	PPT	E-BOOK
Necessity of Three Phase System				
Concept of Balanced and Unbalanced Load				
Balanced Star & Delta Connected Loads				
Relation between Line and Phase Voltages and Currents Phasor Diagram Three Phase Power				
Power Factor				
Three Phase Power and Power Factor Measurement by Single Wattmeter and Two Wattmeter Methods				
Problems in all Topics				

UNIT-V- STORAGE BATTERIES

TOPIC	REFER TEXT BOOK NAME	VIDEO PRESENTATION	PPT	ANY OTHER
Classification of cells	**"Circuits and Networks Analysis and Synthesis"** **AUTHORS** A Sudhakar Shyammohan S Palli **PUBLISHER** Tata McGraw Hill Education Private **"Electric Circuits"** **AUTHORS** Mahamood Nahvi Joseph A Edminister **PUBLISHER** Schaum Publishing Company, Newyork	**https://www.youtube.com/watch?v=Q0VSVy- 1IM** **https://www.youtube.com/watch?v=HhxtfUL1O7c**	NIL	OHP Lead Acid BATTERY **E-BOOK** NICKEL IRON BATTERY
Construction, Chemical action and physical changes during charging and discharging of Lead Acid, Nickel Iron and Nickel Cadmium Cells				
Advantages and Disadvantages of Nickel Ion and Nickel Cadmium Cells over Lead Acid Cell		**https://www.youtube.com/watch?v=w7gmrejRABY** **https://www.youtube.com/watch?v=kz9fErCL6Bk**		
indication of fully charged and discharged battery		**https://www.youtube.com/watch?v=YFd0kb9Nwt0**		
defects and their remedies				
capacity				
AH efficiency and WH efficiency (no problems)		**https://www.youtube.com/watch?v=B9XLbuvq9As**		
methods of charging				
care and maintenance		**https://www.youtube.com/watch?v=Ie3Vmf1Gevk**		
applications – maintenance free batteries				
Lithium Cells, Lithium -Ion Cells and Mercury Cells		**https://www.youtube.com/watch?v=Sh7DPjNiu9U**		
Concept of Recharged Cell		**https://www.youtube.com/watch?v=3KX_KuS6FPI**		

Law of resistance

The resistance of a conductor (r)

1. Is directly proportional to its length (l)
2. Is inversely proportional to its area of cross section (A)
3. Depends upon the nature of material.
4. Depends on its temperature.

I. conductor ன் resistance (R) ஆனது

1. Length (l) நேர் விகிதத்தில் இருக்கும்
2. Area of cross section (A) இற்கு எதிர் விகிதத்தில் இருக்கும்.
3. Material ன் nature (தன்மை) யை பொறுத்து இருக்கும்
4. Temperature யை பொறுத்து இருக்கும்.

$$R \propto l$$

$$R \propto \frac{1}{a}$$

$$R \propto \frac{l}{a}$$

$$\boxed{R = \frac{\rho l}{a}}$$

$$\boxed{R = \rho \frac{l}{a}}$$

where ρ - (Rho) constant

l - length of conductor

a - area of cross section

Specific resistance (or) resistivity

1. It is defined as the resistance between the opposite face of a cube material.

The unit is ohm - m.

ஒரு meter cube material லின் opposite பக்கங்களை Resistance ஆக அளவிடுவது.

$$\boxed{R = \rho \frac{l}{a}}$$

Power

$$P = VI \text{ watts}$$

$$P = I^2 R \text{ watts}$$

$$P = \frac{V^2}{R^2} \text{ watts}$$

05.08.2022

Friday (2)

Energy Sources

1. Ideal Voltage source
2. Ideal current source

1. Ideal voltage source

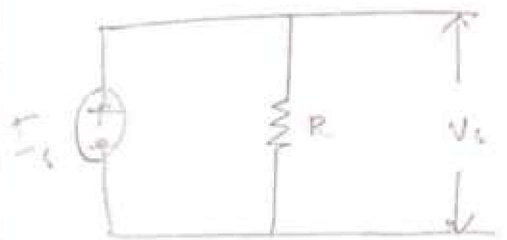
Where

V_s → Voltage source

I_s → current source

R → Resistance

2. Ideal current source



V_s – Voltage source

I_s – current source

R – Resistance

(1) If an electric bulb has a Voltage of 230 V with current of 5 Amp. The resistance of bulb is 18 Ω. Draw the Ideal voltage source and Ideal current source.

Given:

$V = 230$ Volts

$I = 5A$

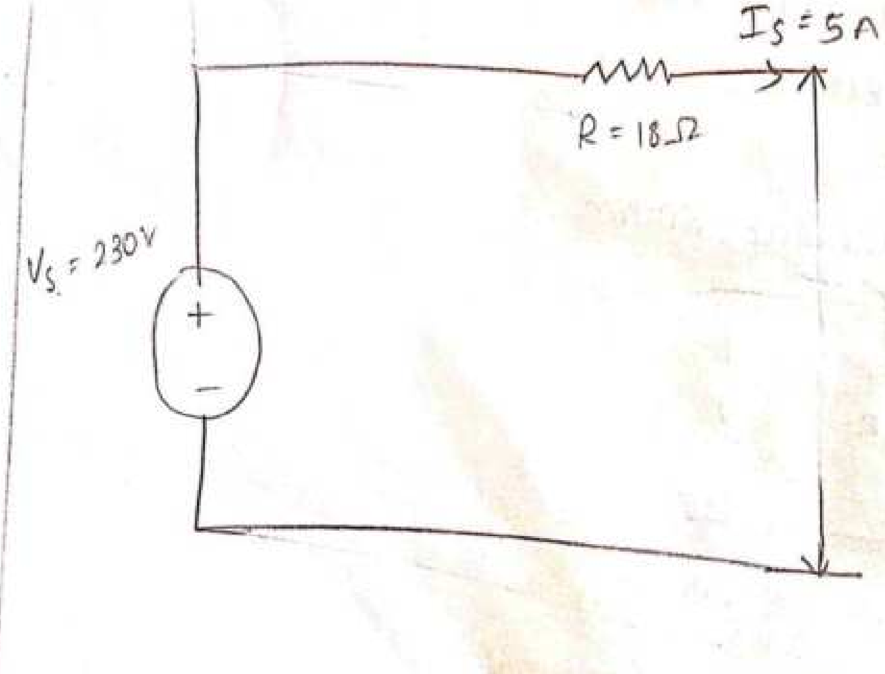
$R = 18\ \Omega$

To find:

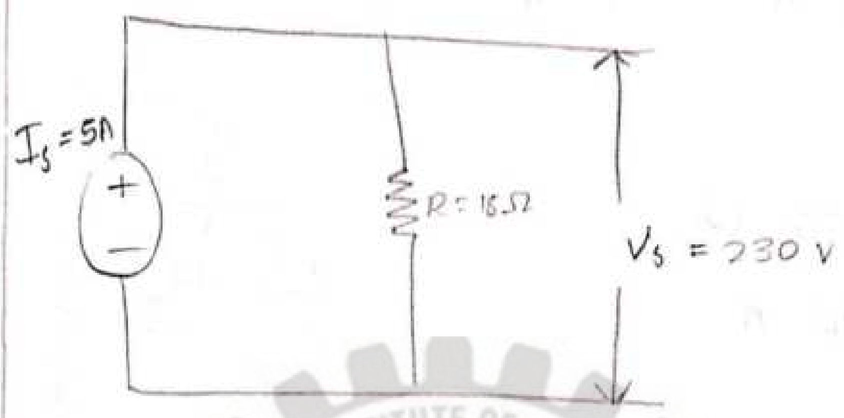
1. Ideal voltage source
2. Ideal current source

Solution

1. Ideal voltage source



2. Ideal current source



1. Calculate the Voltage of a circuit. If the Value of current is 10 A and Resistance is 25 Ω

Given data

(current) $I = 10\ A$

(Resistance) $R = 25\ \Omega$

(voltage) $V = ?$

To find the voltage

$$V = IR$$

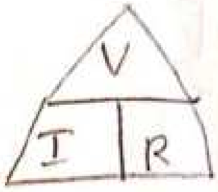
$$V = 10 \times 25$$

$$V = 250$$

$$V = 250\ V$$

(2) Calculate the voltage of a circuit if the value of current is 40 A and $R = 250\Omega$

Given data:



(Resistance) $R = 250\ \Omega$

(current) $I = 40\ A$

To find Voltage $V = ?$

Solution:

$V = IR$

$V = 40 \times 250$

$V = 10{,}000\ V$

3. Calculate the resistance of a circuit if value of current is 10 A and voltage is 230 V

Given data:

current $(I) = 10\ A$

Voltage $(V) = 230\ V$

To find

Resistance $(R) = ?$

Solution

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

$$R = \frac{230}{10}$$

$$\boxed{R = 23\,\Omega}$$

4. Calculate the resistance of a circuit if the value of current is 15 A and voltage 240 v

Given data

Current $(I) = 15\,A$

Voltage $(V) = 240\,V$

To find

Resistance $(R) = ?$

Solution

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

$$R = \frac{240}{15}$$

$$\boxed{R = 16\,\Omega}$$

(5) Calculate the current of a circuit if the value of voltage is 230 v and Resistance is 10 Ω

Given data

~~curr~~ Voltage $(V) = 230\,v$

Resistance $= 10\,\Omega$

To find

I (current) = ?

Solution

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

$$I = \frac{230}{10}$$

$$I = 23\ A$$

(6) Calculate the current of a circuit if the value of voltage 245V and Resistance 8.6 Ω

Given data

Voltage (V) = 245 V

Resistance (R) = 8.6 Ω

To find

current (I) = ?

Solution

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

$$I = \frac{245}{8.6}$$

$$I = 28.48A$$

(8) calculate the current and resistance of a 100 W, 200 V electric bulb.

Given data

power (P) = 100 W

voltage (V) = 200 V

To find

current (I) = ?

Resistance (R) = ?

Solution

To find current :

$$P = VI$$

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

$$I = \frac{100}{200}$$

$$I = 0.50\ A$$

To find resistance :

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

$$R = \frac{200}{0.50}$$

$$R = 400\ \Omega$$

8. Calculate the current and resistance of a 150 W 230 V Electric bulb.

Given data

Voltage (V) = 230 V

Power (P) = 150 W

To find

(I) current = ?

Resistance R = ?

Solution

To find current:

$\cancel{R} = \cancel{\frac{V}{R}}$ $P = VI$

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

$I = \frac{150}{230}$

$\boxed{I = 0.65\ A}$

To find resistance:

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

$R = \frac{230}{0.65}$

$\boxed{R = 353.84\ \Omega}$

9. Calculate the power rating of a heater coil used on 220V taking a supply of 5 Amps.

Given data,

Voltage = 220 V

Current (I) = 5 A

To find

(P) Power = ?

Solution

$P = VI$

$P = 220 \times 5$

$P = 1100$ watts

10. The resistance of an incandecent lamp when cold is 25Ω. It hot value after operating voltage of 125V is 250Ω

i) Movement of switching ON

ii) Normal working current

Given data

Resistance (R_1) = 25 Ω

Resistance (R_2) = 250 Ω

Voltage (V) = 125 V

To find

~~Resistan~~. current (I) = ?

Solution

i) To find movement of switching on

$$I = \frac{V}{R_1}$$

$$I = \frac{125}{25}$$

$$I = 5\,A$$

ii) Normal working current

$$I = V/R_2$$

$$I = \frac{125}{250}$$

$$I = 0.50\,A$$

2

06.08.22
Saturday

conversion

1. To convert KM into M ⇒ $\boxed{\text{Value} \times 10^{3}\,m}$
2. To convert cm^2 into m^2 ⇒ $\boxed{\text{Value} \times 10^{-4}\,m^2}$

(1) find the resistance of copper wire of 0.75 km long, having cross sectional area of $0.01 \, cm^2$. Take $\rho = 1.72 \times 10^{-8}$

$$R = \frac{\rho l}{a}$$

Given data

ρ (Rho) $= 1.72 \times 10^{-8}$

l (length) $= 0.75$ km

a (area) $= 0.01 \, cm^2$

To find

resistance (R) = ?

Solution

$$R = \frac{\rho l}{a}$$

length $(l) = 0.75 \times 10^{3}$ m

cross section $(a) = 0.01 \times 10^{-4} \, m^2$

(Rho) $\rho = 1.72 \times 10^{-8}$

R =

$$R = \frac{(1.72 \times 10^{-8}) \times (0.75 \times 10^{3})}{(0.01 \times 10^{-4})}$$

$$R = \frac{(1.29 \times 10^{-5})}{(0.01 \times 10^{-4})}$$

$$R = 12.9\ \Omega$$

② find the resistance of a copper wire of 0.95 km long, having cross section area of $0.04\ cm^2$. Take $\rho = 1.54 \times 10^{-6}$

Given data:

length $(l) = 0.95\ km$

$0.95 \times 10^3\ m$

area $(a) = 0.04\ cm^2$

$0.04 \times 10^{-4}\ m^2$

$\rho = 1.54 \times 10^{-6}$

To find

Resistance $(R) = ?$

Solution

$$R = \frac{\rho l}{a}$$

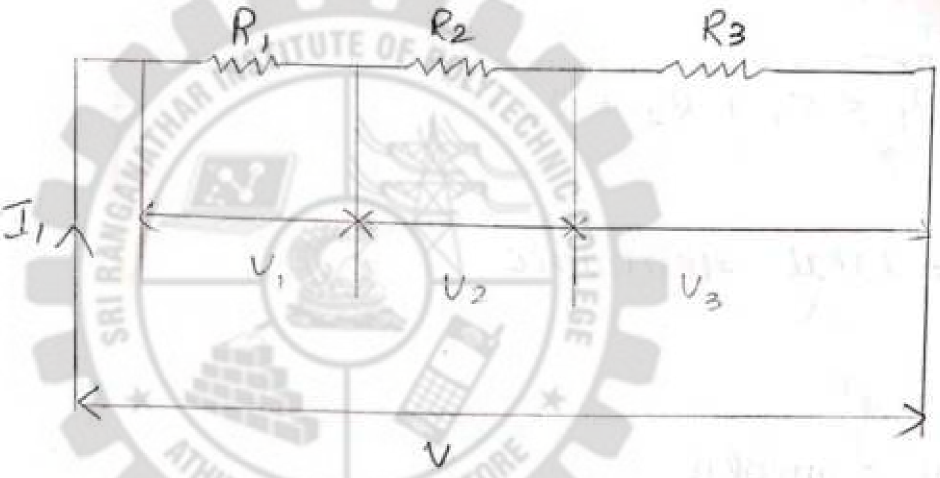
$$R = \frac{(1.54 \times 10^{-6}) \times (0.95 \times 10^3)}{(0.04 \times 10^{-4})}$$

08.08.2
Monday :)

Connections of resistance

1. Series connection
2. parallel connection
3. Series - parallel connection

1. Series connection



Where,

V = Voltage

I = current

R_1, R_2 R_3 = Resistance

V_1 = voltage drop accross R_1

V_2 = voltage drop across R_2

V_3 = voltage drop across R_3

$\therefore$ Total Voltage $V = V_1 + V_2 + V_3 \rightarrow (1)$

We know that $V_1 = IR_1$, $V_2 = IR_2$, $V_3 = IR_3$

Substitute equ (2) in (1) we get

$$V = V_1 + V_2 + V_3 \longrightarrow (1)$$

$$V = (IR_1) + (IR_2) + (IR_3)$$

$$V = I\,[R_1 + R_2 + R_3]$$

$$V/I = R_1 + R_2 + R_3$$

$$R = R_1 + R_2 + R_3 \quad [\text{since } R = V/I]$$

$$\boxed{R_T = R_1 + R_2 + R_3}$$

R_T = Total resistance

Parallel connection

V - voltage

I - current

I_1 - current through Resistance R_1

I_2 - current through resistance R_2

I_3 - current through resistance R_3

$\therefore$ Total current $I = I_1 + I_2 + I_3 \rightarrow (1)$

By ohm's law $I = V/R$

SO, $I_1 = V/R_1$, $I_2 = V/R_2$, $I_3 = V/R_3 \rightarrow (2)$

Sub equ (2) in (1) we get

$$I = I_1 + I_2 + I_3 \rightarrow (1)$$

$$I = \left(V/R_1\right) + \left(V/R_2\right) + \left(V/R_3\right)$$

$$I = V\left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right]$$

$$I/V = \left[1/R_1 + 1/R_2 + 1/R_3\right]$$

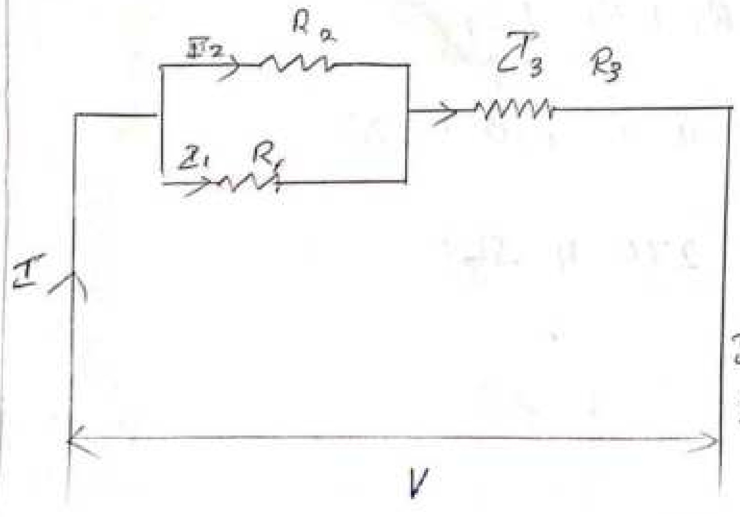
$$1/R = 1/R_1 + 1/R_2 + 1/R_3$$ [Since $R = V/I$

SO $1/R = I/V$]

$$1/R_T = 1/R_1 + 1/R_2 + 1/R_3$$

$1/R_T$ = Total resistance

Series - parallel connection



I - current

V - voltage

I_1 - current through R_1

I_2 - current through R_2

I_3 - current through R_3

$\therefore$ Total current $I = I_1 + I_2 + I_3 \rightarrow (1)$

By ohm's law $I = V/R$

So, $I_1 = V/R_1$, $I_2 = V/R_2$, $I_3 = V/R_3 \rightarrow (2)$

Sub equ (2) in (1) we get

$$I = I_1 + I_2 + I_3 \rightarrow (1)$$

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

$$I = V\left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right]$$

$$I/V = \left[1/R_1 + 1/R_2 + 1/R_3\right]$$

$$1/R = 1/R_1 + 1/R_2 + 1/R_3$$

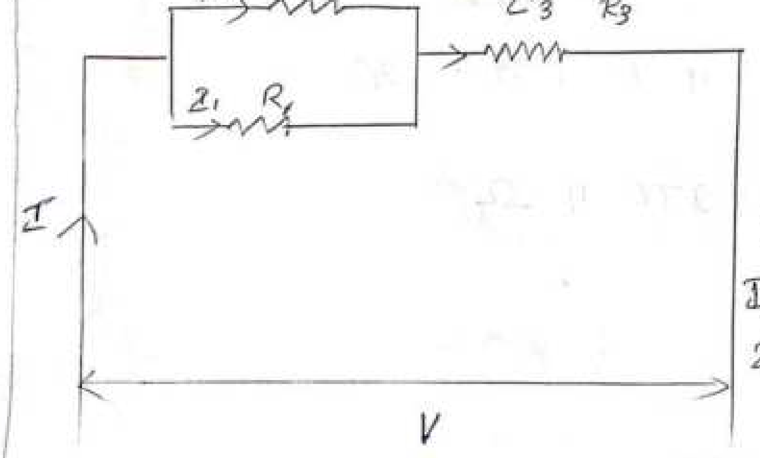
$$\boxed{1/R_T = 1/R_1 + 1/R_2 + 1/R_3}$$

[Since $R = V/I$

so $1/R = I/V$]

$1/R_T$ = Total resistance

Series - parallel connection



I - current

V - voltage

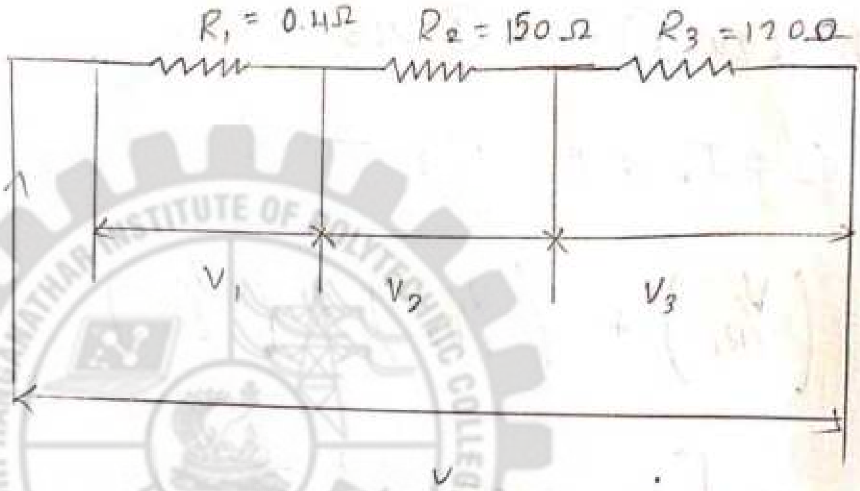
I_1 - current through R_1

I_2 - current through R_2

I_3 - current through R_3

① A circuit is made of $0.4\,\Omega$ wire, a $150\,\Omega$ bulb and $120\,\Omega$ Rheostat which are connected in series. Detetermine total resistance.

Series



Given data

$R_1 = 0.4\,\Omega$

$R_2 = 150\,\Omega$

$R_3 = 120\,\Omega$

To find

Total resistance = ?

Solution

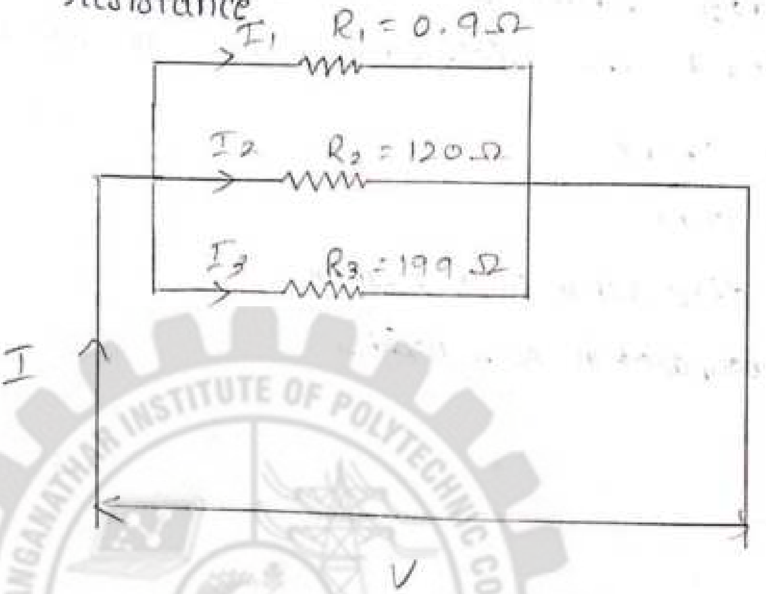
$$\boxed{R_T = R_1 + R_2 + R_3}$$

$$R_T = 0.4 + 150 + 120$$

$$R_T = 270.4\,\Omega$$

② A circuit is made of 0.9 Ω wire, a 120 Ω bulb and 199 Ω Rheostat which are connected in parallel connection. Determine the total resistance

Parallel



Given data//..

$R_1 = 0.9\,\Omega$

$R_2 = 120\,\Omega$

$R_3 = 199\,\Omega$

To find

Total resistance = ?

soln..

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

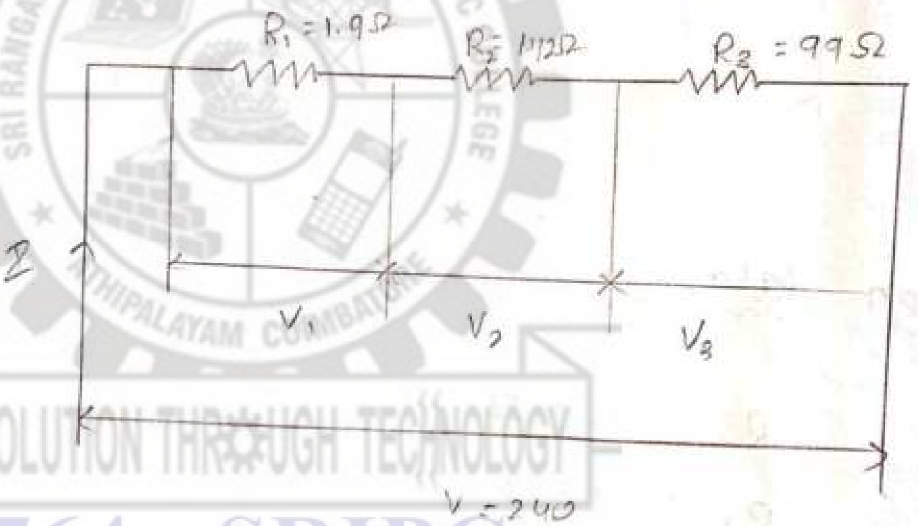
$$\frac{1}{R_T} = \left[\frac{1}{0.9}\right] + \left[\frac{1}{120}\right] + \left[\frac{1}{199}\right]$$

$$\frac{1}{R_T} = 1.12\,\Omega \qquad R_T = \frac{1}{1.12} = 0.89\,\Omega$$

10. 08. 2022
Wednesday

1. A circuit is made of 1.9 Ω wire, a 142 Ω bulb and 99 Ω Rheostat which are connected in series. Determine the following with voltage 240 volts

i) Total resistance
ii) Total current
iii) voltage drop across each resistor.
iv) power dissipated in each resistor.



Given data:

Resistance $(R_1) = 1.9\ \Omega$
Resistance $(R_2) = 142\ \Omega$
Resistance $(R_3) = 99\ \Omega$
Voltage $(V) = 240$

To find:

Total resistance = ?
Total current = ?
Voltage drop across each resistor = ?
Power dissipated in each other = ?

Solution:

i) Total resistance

$$R_T = R_1 + R_2 + R_3$$

$$R_T = 1.9 + 142 + 99$$

$$\boxed{R_T = 242.9\,\Omega}$$

ii) Total current

$$I = V / R_T$$

$$I = 240 / 242.9$$

$$\boxed{I = 0.98 \text{ amps}}$$

iii) voltage drop accross each resistor

$$V_1 = I R_1$$

$$V_1 = 0.98 \times 1.9$$

$$V_1 = 1.86 \text{ volts}$$

$$V_2 = I R_2$$

$$V_2 = 0.98 \times 142$$

$$\cancel{V_2 = 1.38}$$

$$V_2 = 139.16 \text{ volts}$$

$$V_3 = 0.98 \times 99$$

$$V_3 = 97.02 \text{ volts}$$

iv) power dissipated in each resistor

$$P_1 = I^2 R_1$$

$$P_1 = 0.98^2 \times 1.9$$

$$P_1 = 1.82 \text{ watts}$$

$$P_2 = I^2 R_2$$

$$P_2 = 0.98^2 \times 142$$

$$P_2 = \cancel{1366}$$

$$P_2 = 136.37 \text{ watts}$$

$$P_3 = I^2 R_3$$

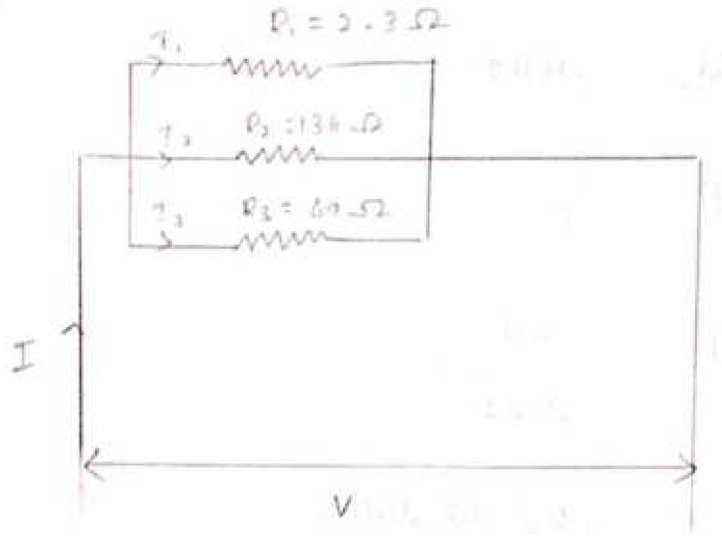
$$P_3 = 0.98 \times 99$$

$$P_3 = 95.07 \text{ watts}$$

2) A circuit is made of 2.3 Ω wire, a 136 Ω bulb and 69 Ω Rheostat which are connected in parallel. Determine the following with voltage 240V

1. Total resistance
2. Total current
3. Voltage drop across each resistor
4. Power dissipated in each resistor.

Parallel



Given data :-

R_1 (Resistance) = 2.3 Ω

R_2 (Resistance) = 136 Ω

R_3 (Resistance) = 69 Ω

Voltage (V) = 240

To find

Total resistance = ?

Total current = ?

Voltage drop across each other ?

power dissipated in each resistor = ?

Soln:-

1. Total resistance

$$1/R_T = 1/R_1 + 1/R_2 + 1/R_3$$

$$1/R_T = \left[1/2.3\right] + \left[1/136\right] + \left[1/69\right]$$

$$1/R_T = 0.45\ \Omega$$

$$R_T = 1/0.45$$

$$\boxed{R_T = 2.22\ \Omega}$$

ii) Total current

$$I = V/R_T$$

$$I = \frac{240}{2.22}$$

$$I = 108.10 \text{ amps}$$

iii) Voltage drop across each resistor

$$V_1 = I R_1$$

$$V_1 = 108.10 \times 2.3$$

$$V_1 = 248.63 \text{ volts}$$

$$V_2 = I R_2$$

$$V_2 = 108.10 \times 136$$

$$V_2 = 1470.16 \text{ volts}$$

$$V_3 = I R_3$$

$$V_3 = 108.10 \times 69$$

$$V_3 = 7458.9 \text{ volts}$$

iv) Power dissipated in each resistor :

$$P_1 = I^2 R_1$$

$$P_1 = (108.10)^2 \times 2.3$$

$$P_1 = 26876.90 \text{ watts}$$

$P_2 = I^2 R_2$

$P_2 = (108.10)^2 \times 136$

$P_2 = 1589242.96$ watts

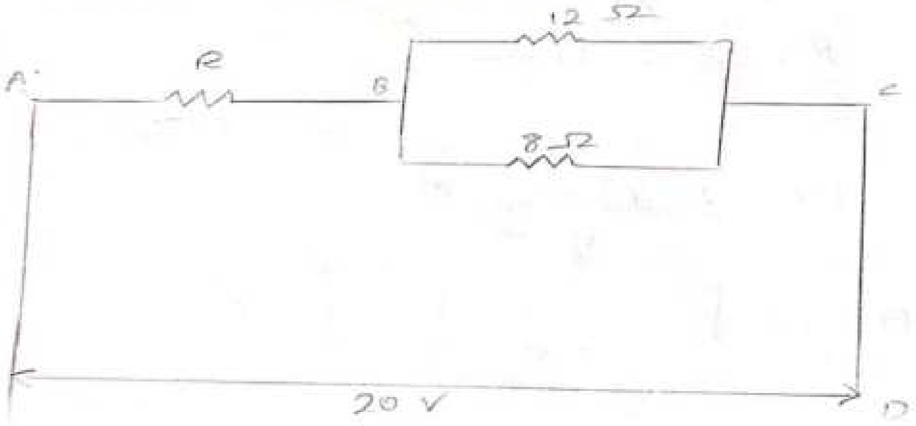
$P_3 = I^2 R_3$

$P_3 = (108.10)^2 \times \cancel{13}\,69$

$P_3 = 806307.09$ watts

11.08.2022
Thursday

A Resistance of R ohm is connected in series with a parallel circuit comprising of two resistance 12 ohms and 8 ohms respectively. The total power dissipated in the circuit is 70 watts. when the applied voltage is 20 V. calculate the value R.



Given data..

Resistance R_1 = R

Resistance R_2 = $12\,\Omega$

Resistance R_3 = $8\,\Omega$

Total power (P) = $70\,W$

Voltage (V) = $20\,V$

To find

Unknown resistance $R = ?$

Solution

To find unknown resistance

$$R_T = R_{AB} + R_{BC}$$

$$R_{AB} = R_T - R_{BC} \longrightarrow (1)$$

S-1

To find R_T ?

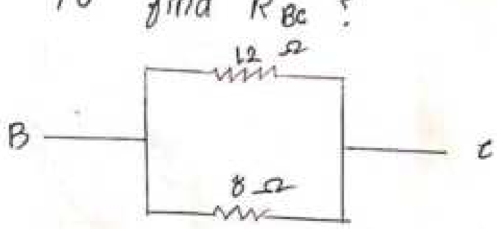
Total resistance $R_T = \dfrac{V^2}{P}$

$$R_1 = \frac{20^2}{70}$$

$$R_T = 5.71\,\Omega$$

S-2

To find R_{BC} ?



Resistance in parallel

$$1/R_{BC} = 1/R_2 + 1/R_3$$

$$1/R_{BC} = (1/12) + (1/8)$$

$$1/R_{BC} = 0.20$$

$$R_{BC} = 1/0.20$$

$$R_{BC} = 4.8\ \Omega$$

S - 3

Sub R_T and R_{BC} value in equ①. so we get

$$R_{AB} = R_T - R_{BC} \quad \text{——} ①$$

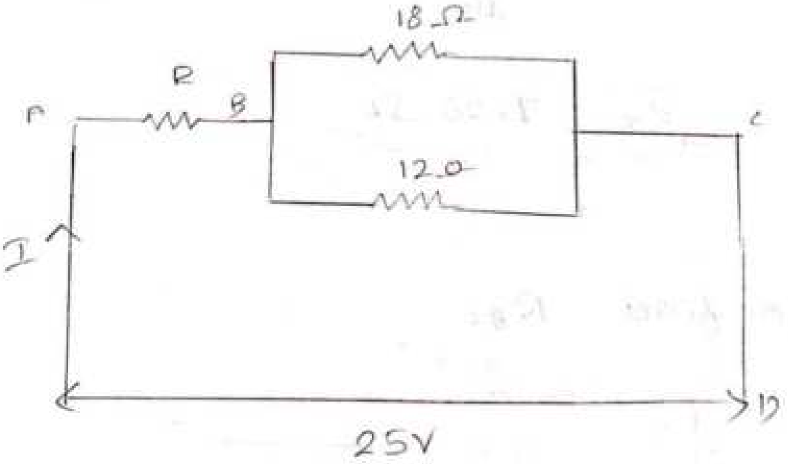
$$R_{AB} = 5.71 - 4.8$$

$$R_{AB} = 0.914\ \Omega$$

unknown resistance $R_{AB} = 0.914\ \Omega = R$

(Ex) 6

A resistance of R ohm is connected in series with a parallel circuit comparising of two Resistances 18 ohm and 12 ohm respectively. The total power dissipated in the circuit is 86 watts. when the applied voltage is 25V. Calculate the value of 'R'.



Given data

$$\text{Resistance } (R_1) = R$$

$$\text{Resistance } (R_2) = 18\ \Omega$$

$$\text{Resistance } (R_3) = 12\ \Omega$$

$$\text{Total power } (P) = 86 \text{ watts}$$

$$\text{voltage } (V) = 25\ V$$

To find ?

Unknown resistance $R = ?$

Solution

To find unknown resistance

$$R_T = R_{AB} + R_{BC}$$

$$R_{AB} = R_T - R_{BC} \longrightarrow (1)$$

Step-1

To find R_T

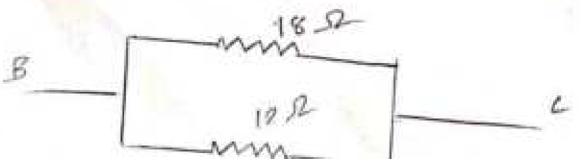
$$\text{Total resistance } R_T = \frac{V^2}{P}$$

$$R_T = \frac{25^2}{86}$$

$$R_T = 7.26\ \Omega$$

Step 2

To find R_{BC}



Total resistance in parallel

$$\frac{1}{R_{BC}} = \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{BC}} = \left(\frac{1}{18}\right) + \left(\frac{1}{12}\right)$$

$$\frac{1}{R_{BC}} = 0.138$$

$$R_{BC} = \frac{1}{0.138}$$

$$\boxed{R_{BC} = 7.24\,\Omega}$$

Step 3

Sub R_T and R_{BC} in eqv (1)

$$R_{AB} = R_T - R_{BC} \longrightarrow (2)$$

$$R_{AB} = 7.26 - \cancel{4}\, 7.24$$

$$\boxed{R_{AB} = 0.02\,\Omega}$$

~~Total resistance~~

Unknown resistance $R_{AB} = \cancel{0.91}\ 0.02\,\Omega = \cancel{1R}$

Conditions for Kirchoff's law

for battery

நாம் எடுக்கும் மின்சுற்றில் உள்ள battery ன் மதிப்பு ஆனது positive terminal ல் இருந்து Negative terminal லை செல்வதாக இருந்தால் அதன் EMF யை negative sign ஆல் குறிக்க வேண்டும்

1. In a circuit, the value of the battery goes from positive terminal to negative terminal means, that EMF should be mentioned in "negative sign."

2. If the battery goes from negative terminal to positive terminal means that EMF should be mention in positive sign for current

for current

1. In a circuit the direction of current and direction of current in resistance are in same direction means that voltage drop must be metioned in negative sign.

2. If the both curents are in opposite direction means the voltage drop must be mention in positive sign.

Conditions for kirchoff's law

for battery

நாம் எடுக்கும் மின்சுற்றில் உள்ள battery ன் மதிப்பு ஆனது positive terminal ல் இருந்து negative terminal லை செல்வதாக இருந்தால் அதன் EMF யை negative sign ஆல் குறிக்க வேண்டும்

1. In a circuit, the value of the battery goes from positive terminal to negative terminal means, that emf should be mentioned in "negative sign."

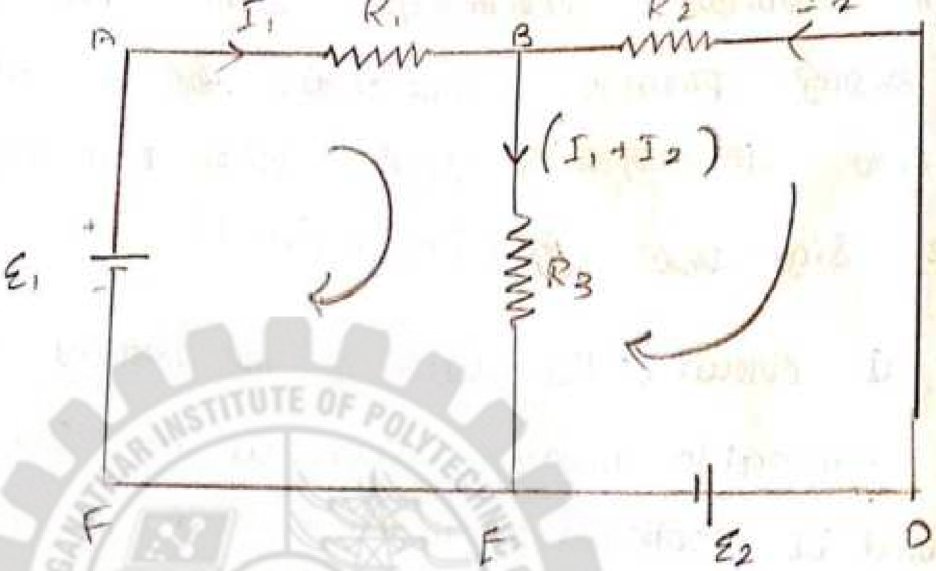
2. If the battery goes from negative terminal to positive terminal means that EMF should be mention in positive sign for current

for current

1. In a circuit the direction of current and direction of current in resistance are in same direction means that voltage drop must be metioned in negative sign.

2. If the both curents are in opposite direction means the voltage drop must be mention in positive sign.

Illustration of Kirchoff's law :



In closed loop ABCEA

$$-I_1R_1-(I_1+I_2)R_3+\varepsilon_1=0$$

$$-I_1R_1-(I_1+I_2)R_3=-E_1$$

In closed loop BCDEB

$$I_2R_2-\varepsilon_2+(I_1+I_2)R_3=0$$

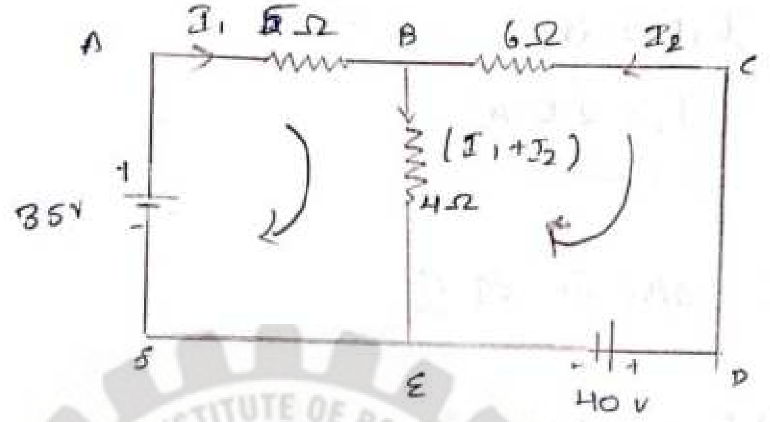
$$I_2R_2+(I_1+I_2)R_3=\varepsilon_2$$

In closed loop ABCDEFA

$$-I_1R_1+I_2R_2-E_2+\varepsilon_1=0$$

$$-I_1R_1+I_2R_2=\varepsilon_2-\varepsilon_1$$

(1) find the current in 4Ω Resistor



In closed loop ABEFA

$$-5I_1 - 4(I_1+I_2) + 35 = 0$$

$$-9I_1 - (4I_1+I_2) + 35 = 0$$

$$-9I_1 - 4I_2 = -35 \rightarrow (1)$$

In closed loop ABCDEF

$$-5I_1 + 6I_2 - 40 + 35 = 0$$

$$-5I_1 + 6I_2 - 5 = 0 \rightarrow (2)$$

Eq are

$$-9I_1 - 4I_2 = -35 \rightarrow (1)$$

$$-5I_1 + 6I_2 = 5 \rightarrow (2)$$

To find I_1 and I_2

Multiply eq 1 × 3 ⟹ $-27I_1 + 12I_2 = -105$

Multiply eq 2 × 2 $\quad -10I_1 + 12I_2 = 10$

$$-37I_1 = -95$$

$+I_1 = -95 / -37$

$I_1 = 2.6$

$I_1 = 2.6\ A$

Sub I_1 value in eq (1)

$-9I_1 - 4I_2 = -35 \rightarrow (1)$

$-9(2.6) - 4I_2 = -35$

$-23.4 - 4I = -35$

$4I_2 = -35 + 23.4$

$-4I_2 = 11.6$

$I_2 = \frac{-11.6}{-4}$

$I_2 = 2.9\ A$

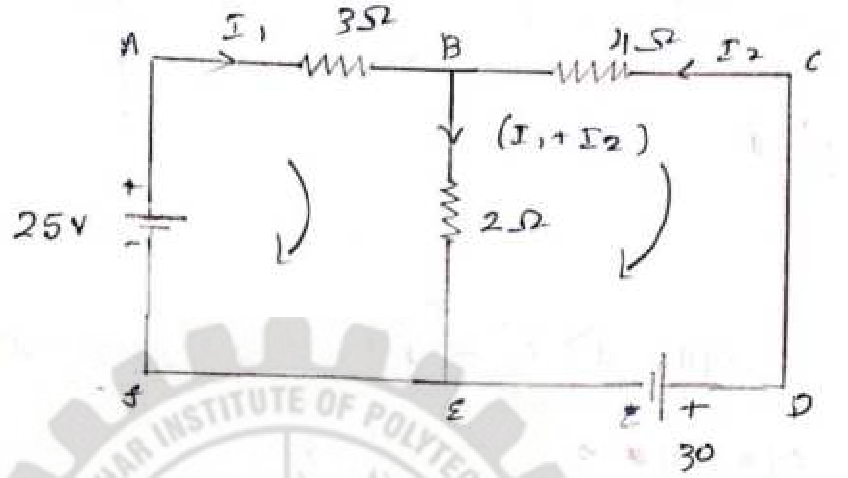
current through 4Ω resistance

$I = I_1 + I_2$

$I = 2.6 + 2.9$

$I = 5.5$ Amps

find the current in 2 Ω resistor



The closed loop ABEFA

$$-3I_1 - 2(I_1 + I_2) + 25 = 0$$

$$\cancel{-3I_1 - 2(I_1 + I_2) = -25} \rightarrow (1)$$

$$\cancel{-5I_1 - 2I_2 = -25}$$

~~The closed loop ABCDEF~~

~~$3I$~~

$$-3I_1 - 2I_1 - 2I_2 + 25 = 0$$

$$-5I_1 - 2I_2 = -25 \rightarrow (1)$$

$-4(5+2)$

The closed loop ABCDEF

$-20 - 8$

$$-3I_1 + 4I_2 - 30 + 25 = 0$$

$$-3I_1 + 4I_2 - 5 = 0$$

$$-3I_1 + 4I_2 = 5 \rightarrow (2)$$

Equations

1. $-5I_1 - 2I_2 = -25 \rightarrow (1)$

2. $-3I_1 + 4I_2 = 5 \rightarrow (2)$

To find

~~equ (1) × 2~~ $\cancel{-10 I_1 - 2I_2 = -25}$

equ (2) $-10 I_1 +$

equ (1) × 2 $\quad -10 I_1 - 4 I_2 = -50$

equ (2) $\quad -3 I_1 + 4 I_2 = 5$

$$-13 I_1 = -45$$

$-13 I_1 = -45$

$$I_1 = \frac{-45}{-13}$$

$I_1 = 3.46$ A

Sub I_1 in the 2nd equ

$$-3(3.46) + 4I_2 = 5$$

$$-10.38 + 4I_2 = 5$$

$$+4I_2 = 5 + 10.38$$

$$+4I_2 = 15.38$$

$$I_2 = \frac{15.38}{4}$$

$$\boxed{I_2 = 3.84\ A}$$

Current through

$$I = I_1 + I_2$$

$$I = 3.4 + 3.8$$

$$\boxed{I = 7.2\ \text{Amps}}$$

17. 08. 2022

Capacitan

1. any two conducting surface separated by an insulating medium exhibit the property of the capacitor.

2. A capacitor stores energy in the form of an electric field that is established by the opposite charges on the two electrodes

Capacitance

The ability of a capacitor to store electricity is known as its capacitance.

$Q \propto V$ $\quad Q$ = charge

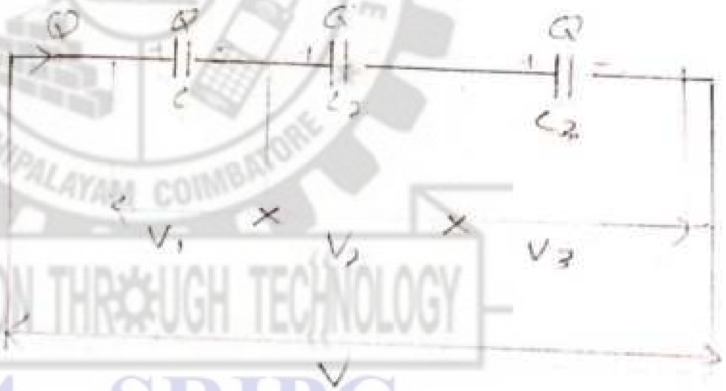
(or) $\quad V$ = Voltage

$\quad C$ = capacitance

$C = Q/V$

The unit is "faraday" (F)

Capacitor in Series



Total voltage $V = V_1 + V_2 + V_3$

[we know that $C = Q/V$, so $V = Q/C$]

Sub V in equ ①,

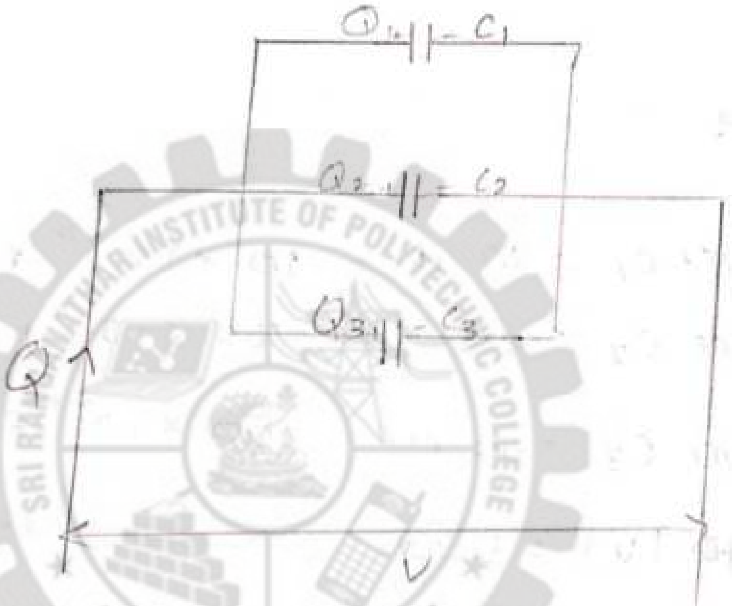
$$V = V_1 + V_2 + V_3 \longrightarrow ①$$

$$Q/C = Q/C_1 + Q/C_2 + Q/C_3$$

$$Q/C = Q\left[1/C_1 + 1/C_2 + 1/C_3\right]$$

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$\left[C = Q/V,\ \frac{1}{C} = \frac{V}{Q},\ \frac{1}{C} \times Q = V,\ Q/C = V \right]$



Total charge $Q = Q_1 + Q_2 + Q_3 \rightarrow$ (1)

[we know that $C = Q/V$, so $Q = CV$]

sub Q in equ (1)

$CV = C_1 V + C_2 V + C_3 V$

$CV = V\left[C_1 + C_2 + C_3\right]$

$$C = C_1 + C_2 + C_3$$

18.08.2022
Thursday

11.A (1). Three capacitors 10MF, 25MF and 50MF are connected in a) Series b) parallel find the equivalent capacitance in each of the cases (a) and (b) when they connected across 500V supply.

Given data:

capacitance $C_1 = 10 \mu F = 10 \times 10^{-6} F$

capacitance $C_2 = 25 \mu F = 25 \times 10^{-6} F$

capacitance $C_3 = 50 \mu F = 50 \times 10^{-6} F$

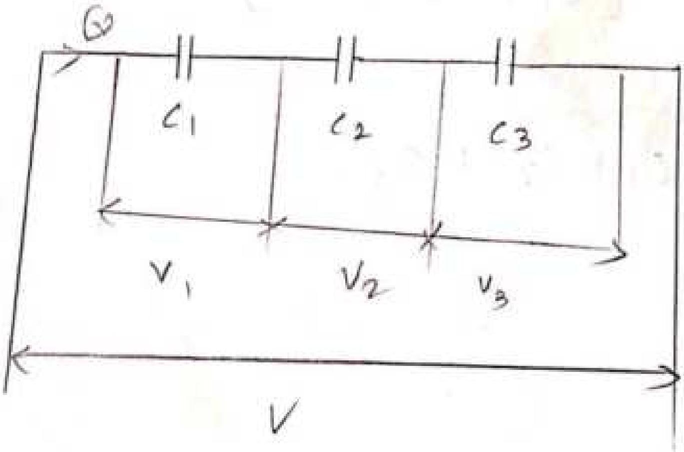
Voltage $(V) = 500V$

To find

Total capacitance in series $1/C_T = ?$

Total capacitance in parallel $C_T = ?$

i) Series



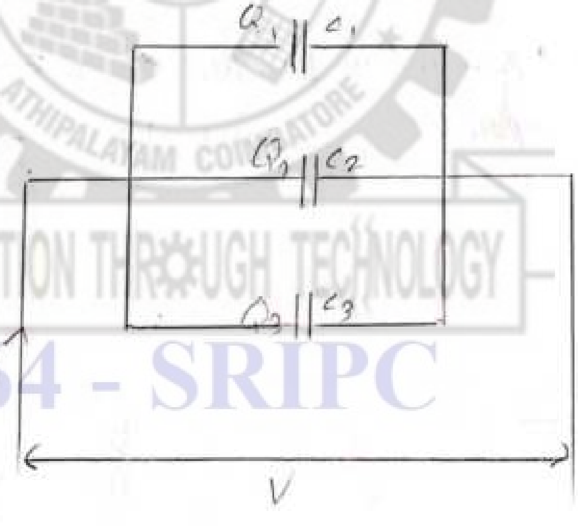
$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$\frac{1}{C_T} = \frac{1}{(10\times10^{-6})} + \frac{1}{(25\times10^{-6})} + \frac{1}{(50\times10^{-6})}$$

$$\frac{1}{C_T} = 160{,}000$$

$$C_T = 6.25\times10^{-06}\ F$$

ii) Parallel



$$C = C_1 + C_2 + C_3$$

$$C = (10\times10^{-6}) + (25\times10^{-6}) + (50\times10^{-6})$$

$$C = 8.5\times10^{-5}\ F$$

(2) Three capacitors 23μF, 31 μF, and 49μF are connected in a) series b) in parallel. find the equivalent capacitance in each of the cases (a) and (b) across 410V supply.

Given data.

$$\text{capacitance } (C_1) = 23 \times 10^{-6}\ F$$

$$\text{Capacitance } (C_2) = 31 \times 10^{-6}\ F$$

$$\text{capacitance } (C_3) = 49 \times 10^{-6}\ F$$

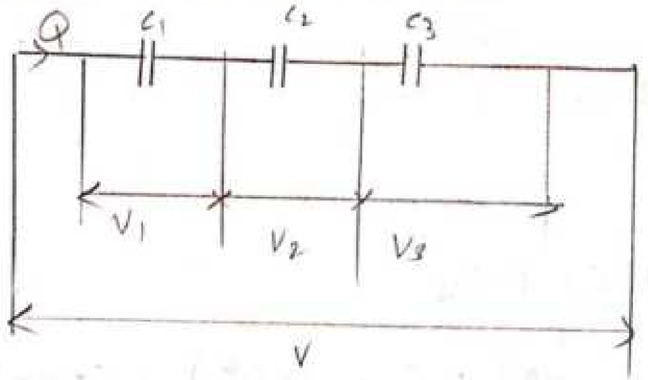
$$\text{Voltage } (V) = 410V$$

To find

Total capacitance in parallel C_T = ?

Total capacitance in series $1/C_T$ = ?

Series



$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$\frac{1}{C_T} = \frac{1}{(23\times10^{-6})} + \frac{1}{(31\times10^{-6})} + \frac{1}{(49\times10^{-6})}$$

$$\frac{1}{C_T} = 96,144.48$$

$$C_T = \frac{1}{96144.48}$$

$$C_T = 1.04 \, F$$

2) Parallel

$$C = C_1 + C_2 + C_3$$

$$C = (23\times10^{-6}) + (31\times10^{-6}) + (49\times10^{-6})$$

$$C = 1.03\times10^{-04} \, F$$

Unit - II

22.08.22
Monday

Circuit Theorem

Super position theorem

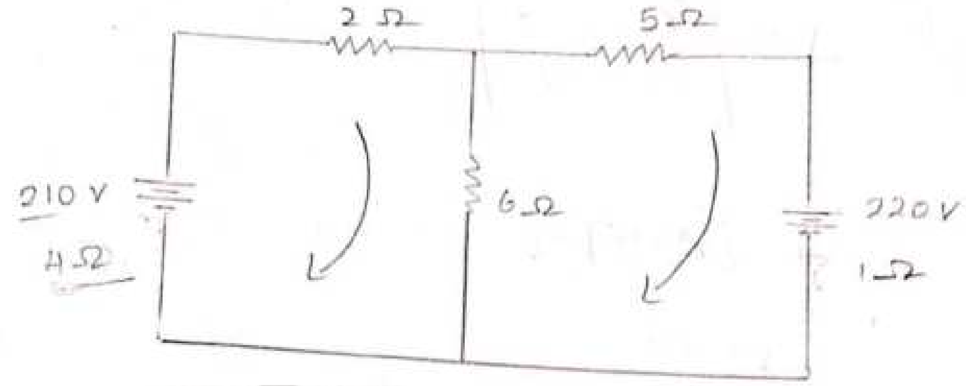
ஒரு மின்சுற்றில் இரண்டு அல்லது அதற்கு
மேற்பட்ட Sources கள் செயல்படும் போது ஏதாவது மின்தடையில்
செல்லும் மின்னோட்டமானது ஒவ்வொரு Sources um
தனித்தனியாக செயல்படும் போது அந்த மின்தடையின் வழியாக
செல்லும் மின்னோட்டங்களின் கூட்டுத்தொகைக்கு
சமமாகும்.

In a linear bilateral electrical circuit that is energised by two or more sources the current in any resistor is equal to the algebraic sum of the separate current in the resistor when each source acts seperately.

Conditions for super position theorem:

1. while one source is applied the other sources are replaced by their respective internal resistance.
2. To replace the voltage sources its has to be short circuited by the internal resistance.

(1) find the current through 6 Ω resistor by using super position theorem



Step - 1

Soln:

210 V battery is acting alone, another 220V battery is replaced by its interval resistance.

$$\begin{bmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

$$\begin{bmatrix} 4+2+6 & -6 \\ -6 & 6+5+1 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 210 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 12 & -6 \\ -6 & 12 \end{bmatrix} \cdot \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 210 \\ 0 \end{bmatrix}$$

To find Δ

$$\Delta = \begin{bmatrix} 12 & -6 \\ -6 & 12 \end{bmatrix}$$

$$\Delta = [12 \times 12] - [-6 \times -6]$$

$$\Delta = 108$$

To find Δ_1

$$\Delta_1 = \begin{bmatrix} 210 & -6 \\ 0 & 12 \end{bmatrix}$$

$$\Delta = (210 \times 12) - (0 \times -6)$$

$$\cancel{\Delta = 14440.00}$$

$$\Delta_1 = 2520.00$$

To find Δ_2

$$\Delta_2 = \begin{bmatrix} 12 & 210 \\ -6 & 0 \end{bmatrix}$$

$$\Delta_2 = [12 \times 0] - (-6 \times 210)$$

$$\Delta_2 = 1260.00$$

To find Δ

$$\Delta = \begin{bmatrix} 12 & -6 \\ -6 & 12 \end{bmatrix}$$

$$\Delta = [12 \times 12] - [-6 \times -6]$$

$$\Delta = 108$$

To find Δ_1

$$\Delta_1 = \begin{bmatrix} 210 & -6 \\ 0 & 12 \end{bmatrix}$$

$$\Delta = (210 \times 12) - (0 \times -6)$$

$$\cancel{\Delta = 14110.00}$$

$$\Delta_1 = 2520.00$$

To find Δ_2

$$\Delta_2 = \begin{bmatrix} 12 & 210 \\ -6 & 0 \end{bmatrix}$$

$$\Delta_2 = [12 \times 0] - (-6 \times 210)$$

$$\Delta_2 = 1260.00$$

To find current I_1 and I_2

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{2520}{108}$$

$$= 23.33\ A$$

$$I_2 \quad \frac{\Delta_2}{\Delta} = \frac{1260}{108}$$

$$= 11.66\ A$$

Therefore current through 6Ω Resistor by single surface acting is

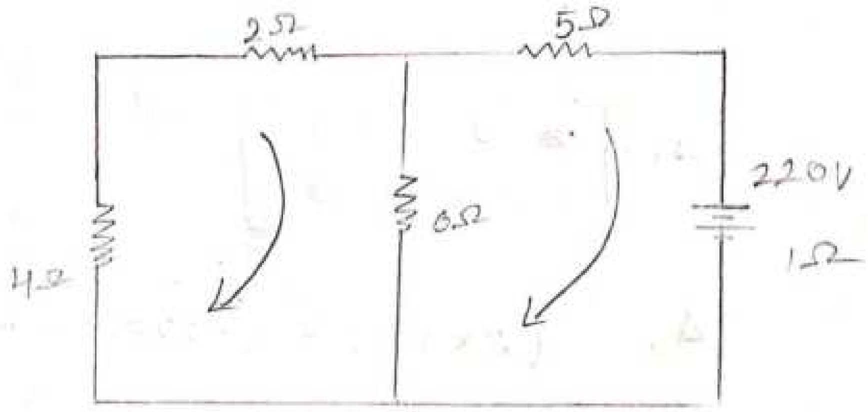
$$I^1 = I_1 - I_2$$

$$I^1 = 23.33 - 11.66$$

$$\boxed{I^1 = 11.67\ A}$$

Step 2 :

220 V battery is acting alone, another 210v battery is replaced by its internal resistance



$$\begin{bmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

$$\begin{bmatrix} 2+4+6 & -6 \\ -6 & 6+5+1 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 0 \\ -220 \end{bmatrix}$$

$$\begin{bmatrix} 12 & -6 \\ -6 & 12 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 0 \\ -220 \end{bmatrix}$$

To find Δ

$$\Delta = \begin{bmatrix} 12 & -6 \\ -6 & 12 \end{bmatrix}$$

$$\Delta = (12 \times 12) - (-6 \times -6)$$

$$\Delta = 108$$

To find Δ_1

$$\Delta_1 = \begin{bmatrix} \cancel{30}\ 0 & -6 \\ -220 & 12 \end{bmatrix}$$

$$\Delta_1 = (0 \times 12) - (-220 \times -6)$$

$$\Delta_1 = -1320$$

To find Δ_2

$$\Delta_2 = \begin{bmatrix} 12 & 0 \\ -6 & -220 \end{bmatrix}$$

$$\Delta_2 = (12 \times -220) - (-6 \times 0)$$

$$\Delta_2 = -2640$$

To find current I_1 and I_2

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{-1320}{108}$$

$$I_1 = -12.22 \text{ A}$$

$$I_2 = \frac{\Delta_2}{\Delta} = \frac{-2640}{108}$$

$$I_2 = -24.44 \text{ A}$$

$$I'' = I_1 - I_2$$

$$I'' = (-12.22) - (-24.44)$$

$$I'' = 12.22 \text{ A}$$

Step 3

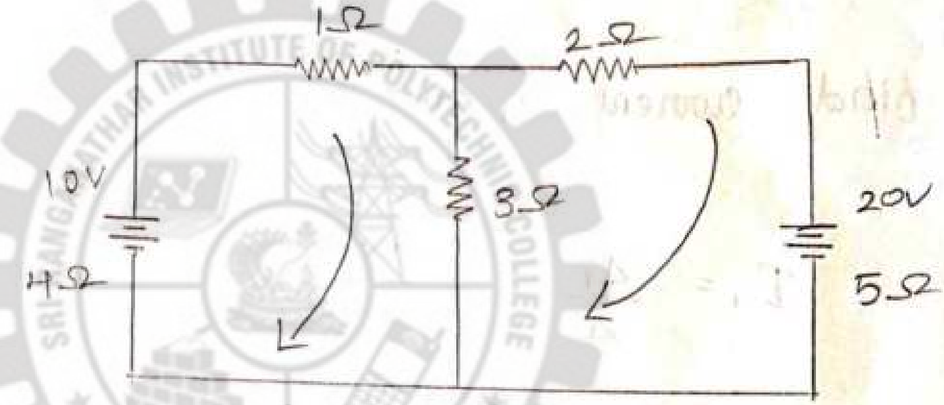
Total current in 6Ω resistor which two source acting together

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

$$I_T = [11.67] + [12.22]$$

$$\boxed{I_T = 23.89\ A}$$

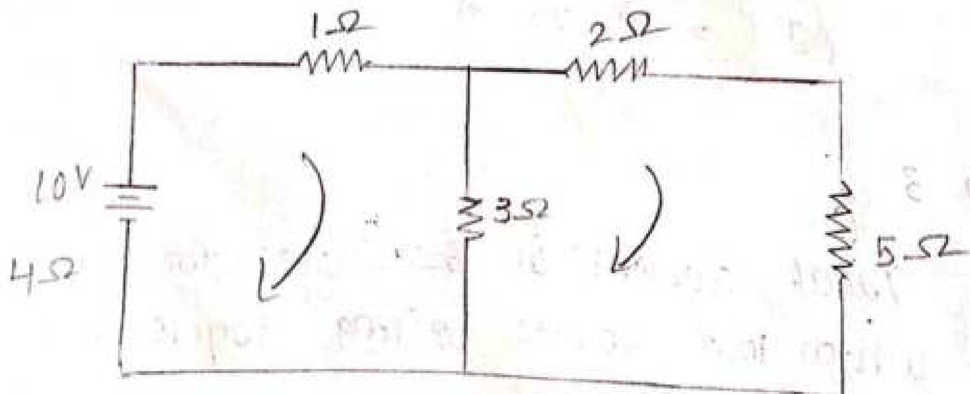
(2) find the current through 3Ω resistor by using super position theorem.



~~Current through 6Ω resistor.~~ While ~~Single source is~~ acting.

Step - 1

10 V battery is acting alone, another 20V battery is replaced by its internal resistance.



$$\begin{bmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

$$\begin{bmatrix} 4+1+3 & -3 \\ -3 & 3+2+5 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 10 \\ 10 \end{bmatrix}$$

$$\begin{bmatrix} 8 & -3 \\ -3 & 10 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 10 \\ 10 \end{bmatrix}$$

To find Δ

$$\Delta = \begin{bmatrix} 8 & -3 \\ -3 & 10 \end{bmatrix}$$

$$\Delta = (8 \times 10) - (-3 \times -3)$$

$$\Delta = 71$$

To find Δ_1

$$\Delta_1 = \begin{bmatrix} 10 & -3 \\ 0 & 10 \end{bmatrix}$$

$$\Delta_1 = (10 \times 10) - (0 \times -3)$$

$$\Delta_1 = 100$$

To find Δ_2

$$\Delta_2 = \begin{bmatrix} 8 & 10 \\ -3 & 0 \end{bmatrix}$$

$$\Delta_2 = (8 \times 0) - (-3 \times 10)$$

$$\Delta_2 = 30$$

To find current I_1 and I_2

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{100}{71}$$

$$I_1 = 1.40\,A$$

$$I_2 = \frac{\Delta_2}{\Delta} = \frac{30}{71}$$

$$I_2 = 0.42\,A$$

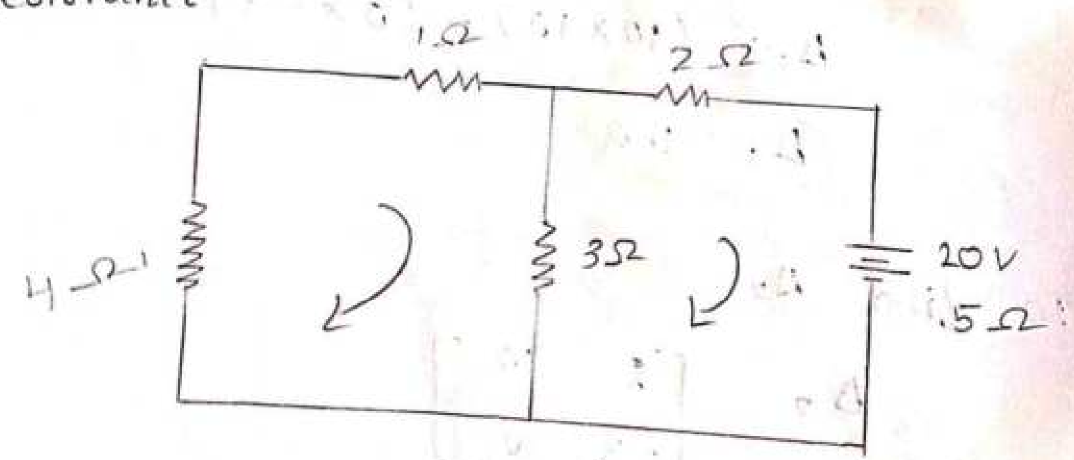
$$I' = I_1 - I_2$$

$$I' = 1.40 - 0.42$$

$$I' = 0.98\,A$$

Step 2

20 V battery is acting alone, another 10 V battery is replaced by its internal resistance



$$\begin{bmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

$$\begin{bmatrix} 4+1+3 & -3 \\ -3 & 3+2+5 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

$$\begin{bmatrix} 8 & -3 \\ -3 & 10 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

$$\begin{bmatrix} 8 & -3 \\ -3 & 10 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 0 \\ -20 \end{bmatrix}$$

To find Δ

$$\Delta = \begin{bmatrix} 8 & -3 \\ -3 & 10 \end{bmatrix}$$

$$\Delta = (8 \times 10) - (-3 \times -3)$$

$$\Delta = 71$$

To find Δ_1

$$\Delta_1 = \begin{pmatrix} 0 & -3 \\ -20 & 10 \end{pmatrix}$$

$$\Delta_1 = (0 \times 10) - (20 \times -3)$$

$$\Delta_1 = -60$$

To find Δ_2

$$\Delta_2 = \begin{pmatrix} 8 & 0 \\ -3 & -20 \end{pmatrix}$$

$$\Delta_2 = (8 \times -20) - (0 \times -3)$$

$\Delta_2 = 160$

To find current I_1 and I_2.

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{-60}{71}$$

$$I_1 = -0.84 \text{ A}$$

$$I_2 = \frac{\Delta_2}{\Delta} = \frac{-160}{71}$$

$$I_2 = -2.25$$

$$I'' = I_1 - I_2$$

$$I'' = (-0.84) - (2.25)$$

$$I'' = 1.41 \text{ A}$$

Step 3

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

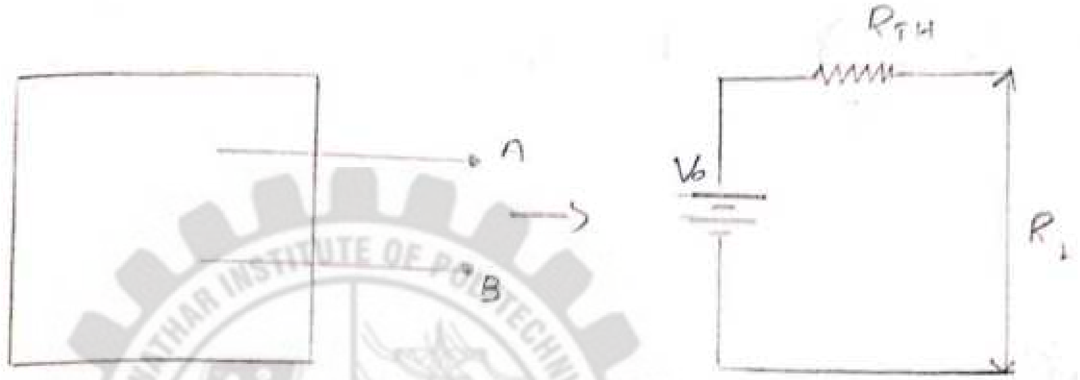
$$I_T = (0.98) + (1.41)$$

$$I_T = 2.39 \text{ A}$$

24.08.22
wednesday

Thevanin's theorem

A linear two terminal network can be replaced by a voltage source in series with the resistance.



load current $I_L = \dfrac{V_0}{R_{th} + R_L}$

Where

R_{th} - Thevanin's resistance

I_L - load current

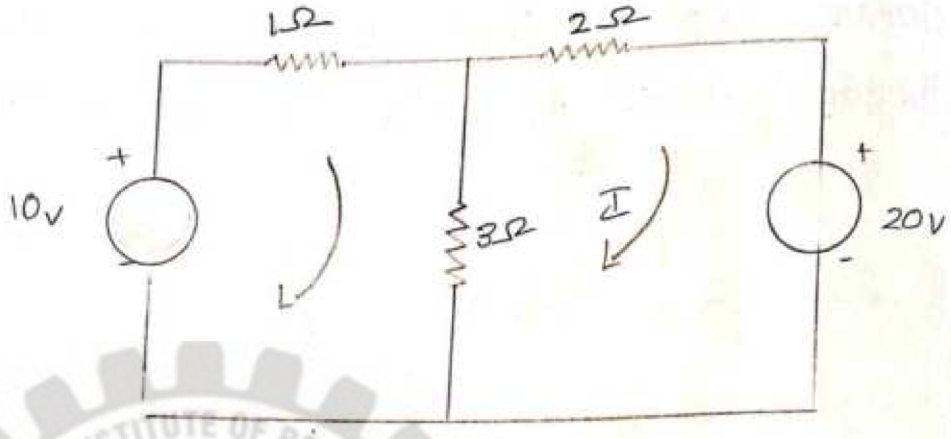
V_0 - open source voltage

R_L - load resistance

conditions for thevanin's theorem

1. Remove the load whose the current is required.
2. find the open circuit voltage which across the two terminals where the load is removed.
3. Determine the thevanin's resistance.
4. find the current flowing through load resistance.

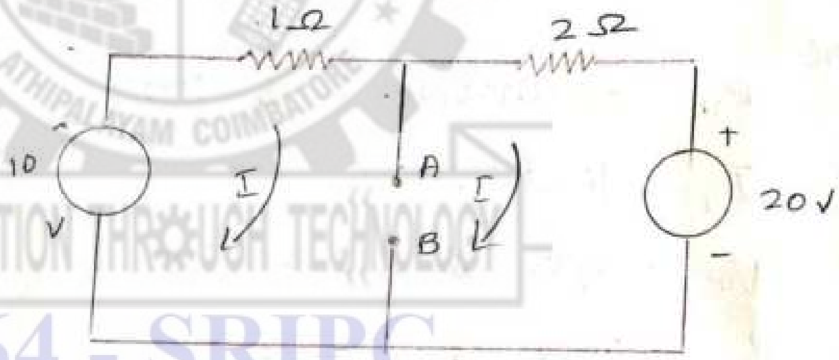
By using thevanin's theorem. find the current through 3 Ω resistor.



Soln.

Step-1

To find V_0



$$V_0 = V_{AB}$$

V_0 = 10v + voltage drop 1 Ω resistor

$$V_0 = 10 + [I \times 1] \longrightarrow (1)$$

To find 'I' By using KVL

$$-1I - 2I - 20 + 10 = 0$$

$$-3I - 10 = 0$$

$$-3I = 10$$

$$I = \frac{10}{-3}$$

$I = -3.33\ A$

[Where to take current in positive value due to open circuit voltage]

$I = 3.33\ A$

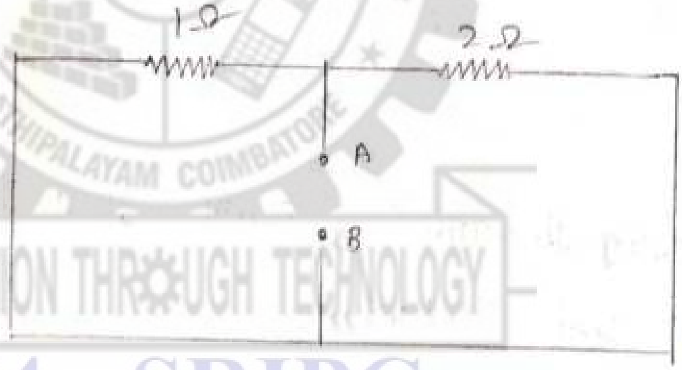
Sub 'I' in equ (1) we get

$$V_0 = 10 + [I \times 1] \longrightarrow (1)$$

$$V_0 = 10 + [3.33 \times 1]$$

$$V_0 = 13.33\ V$$

Step 2 To find R_{Th}



from point A and B, Two resistance in parallel

$$\frac{1}{R_{TH}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_{TH}} = \frac{1}{1} + \frac{1}{2}$$

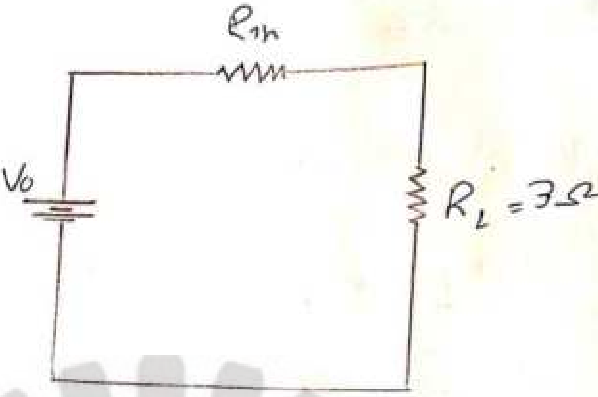
$$\frac{1}{R_T} = 1.5$$

$$R_{Th} = \frac{1}{1.5}$$

$$R_{th} = 0.66\ \Omega$$

Step - 3

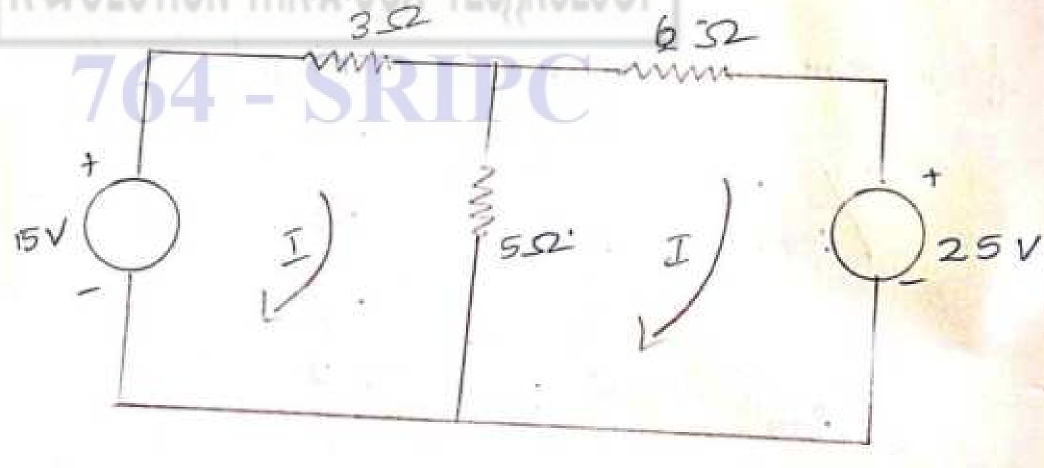
Thevanin's equivalent circuit



$$I_L = \frac{V_0}{R_{TH} + R_L} = \frac{13.33}{(0.66 + 3)}$$

$$I_L = 3.64\ A$$

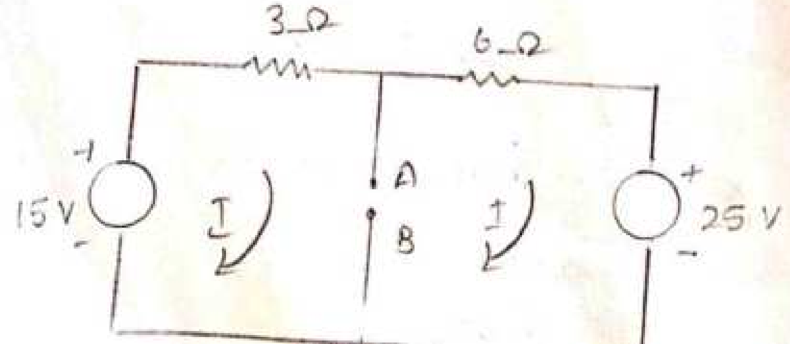
By using thevanin's theorem. find the current through 5Ω resistor



Soln

Step - 1

To find V_0



$V_o = V_{AB}$

$V_o = 15V +$ voltage drop across 3Ω resistor

$V_o = 15 + [I \times 3] \longrightarrow (1)$

To find 'I' By using KVL

$-3I - 6I - 25 + 15 = 0$

$-9I - 10 = 0$

$-9I = 10$

$I = 10/-9$

$I = -1.11A$

$I = 1.11A$

(current in (+) value due to open circuit voltage)

sub "I" in equ (1)

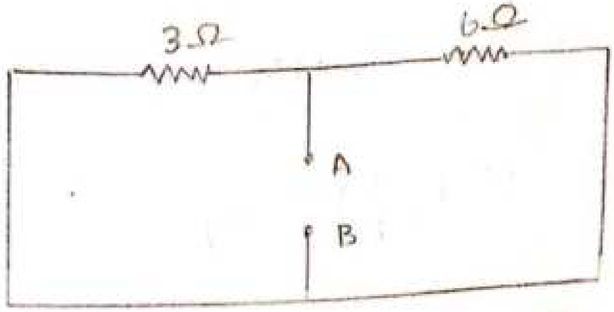
$V_o = 15 + [I \times 3] \longrightarrow (1)$

$V_o = 15 + [1.11 \times 3]$

$V_o = 18.33V$

Step - 2

To find R_{Th}



from point A and B, two resistors are in parallel.

$$\frac{1}{R_{TH}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\cancel{\frac{1}{R_{TH}} = \frac{3}{1}}$$

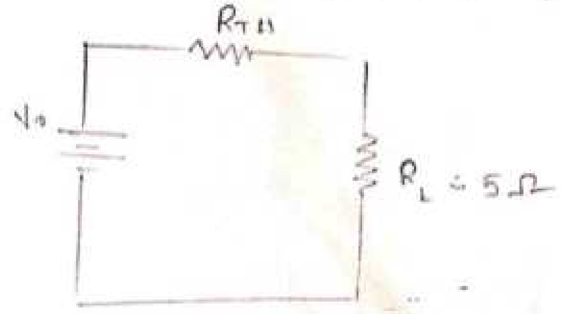
$$\frac{1}{R_{TH}} = \frac{1}{3} + \frac{1}{6}$$

$$\frac{1}{R_{TH}} = 0.5$$

$$R_{TH} = \frac{1}{0.5}$$

$$R_{TH} = 2\Omega$$

Step 3 Thevanin's equivalent circuit

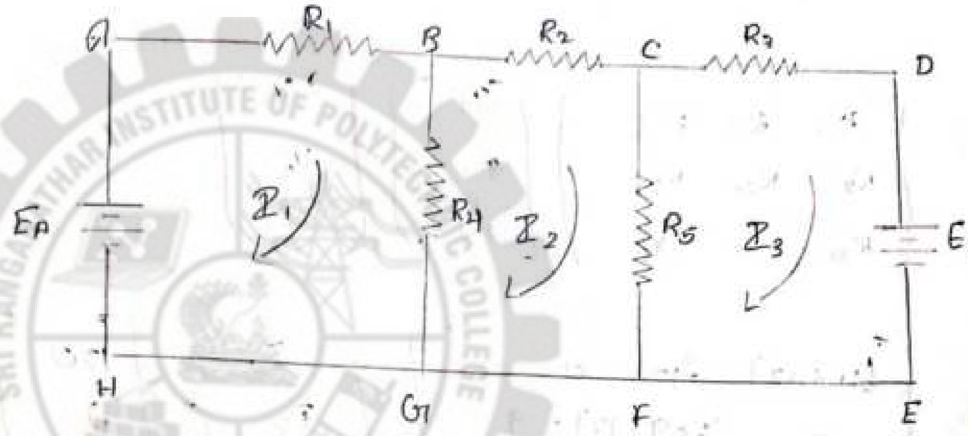


$$I_L = \frac{V_0}{R_{TH} + R_L} = \frac{18.33}{(2+5)}$$

$$\boxed{I_L = 2.61\,A}$$

MESH EQUATIONS

26.08.22
Friday :-



In loop ABGHA

$$-I_1 R_1 - (I_1 - I_2) R_4 + E_A = 0$$

$$-I_1 R_1 - (I_1 - I_2) R_4 = -E_A \longrightarrow (1)$$

In loop BCFGB

$$-I_1 R_2 - (I_2 - I_3) R_5 - (I \quad) R_4 = 0 \longrightarrow (2)$$

In loop CDEFC

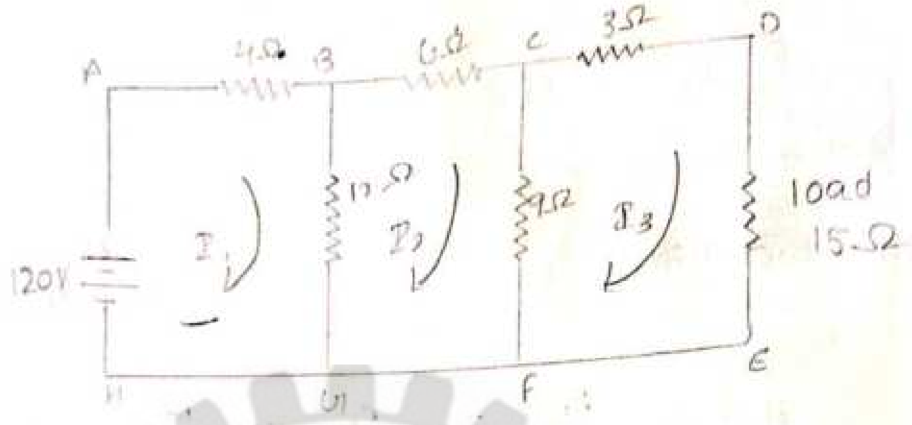
$$-I_3 R_3 - E_B - (I_3 - I_2) R_5 = 0$$

$$-I_3 R_3 - (I_3 - I_2) = E_B \longrightarrow (3)$$

final matrix method is

$$\begin{bmatrix} R_{11} & R_{12} & R_{13} \\ R_{21} & R_{22} & R_{23} \\ R_{31} & R_{32} & R_{33} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}$$

from the circuit obtain the load current and Power deliver to load.



$$\begin{bmatrix} R_{11} & R_{12} & R_{13} \\ R_{21} & R_{22} & R_{23} \\ R_{31} & R_{32} & R_{33} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \\ V_2 \end{bmatrix}$$

$$\begin{bmatrix} (4+12) & -12 & 0 \\ -12 & (6+9+12) & -9 \\ 0 & -9 & (3+15+9 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 120 \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 16 & -12 & 0 \\ -12 & 27 & -9 \\ 0 & -9 & 27 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 120 \\ 0 \\ 0 \end{bmatrix}$$

To find Δ:

$$\Delta = \begin{bmatrix} 16 & -12 & 0 \\ -12 & 27 & -9 \\ 0 & -9 & 27 \end{bmatrix}$$

$$\Delta = 16 \begin{vmatrix} 27 & -9 \\ -9 & 27 \end{vmatrix} - (-12) \begin{vmatrix} -12 & -9 \\ 0 & 27 \end{vmatrix} \; 0 \cdot \begin{vmatrix} -12 & 27 \\ 0 & -9 \end{vmatrix}$$

$$= 16 \left((27 \times 27) - (-9 \times -9) \right) + 12 \left((-12 \times 27) - (-9 \times 0 \right.$$

$$0 \cdot \left((-12 \times -9) - (27 \times 0) \right)$$

$$\Delta = 6480$$

To find Δ_3

$$\Delta_3 = \begin{bmatrix} 16 & -12 & 120 \\ -12 & 27 & 0 \\ 0 & -9 & 0 \end{bmatrix}$$

$$\Delta_3 = 16 \begin{vmatrix} 27 & 0 \\ -9 & 0 \end{vmatrix} - (-12) \begin{vmatrix} -12 & 0 \\ 0 & 0 \end{vmatrix} \; 120 \begin{vmatrix} -12 & 27 \\ 0 & -9 \end{vmatrix}$$

$$\Delta_3 = 16[(27 \times 0) - (-9 \times 0)] + 12[(12 \times 0) - (0 \times 0)]$$

$$+ 120[(-12 \times -9) \times (0 \times 27)]$$

$$\Delta_3 = 12960$$

To find I_3

$$\frac{\Delta_3}{\Delta} = \frac{12960}{6480}$$

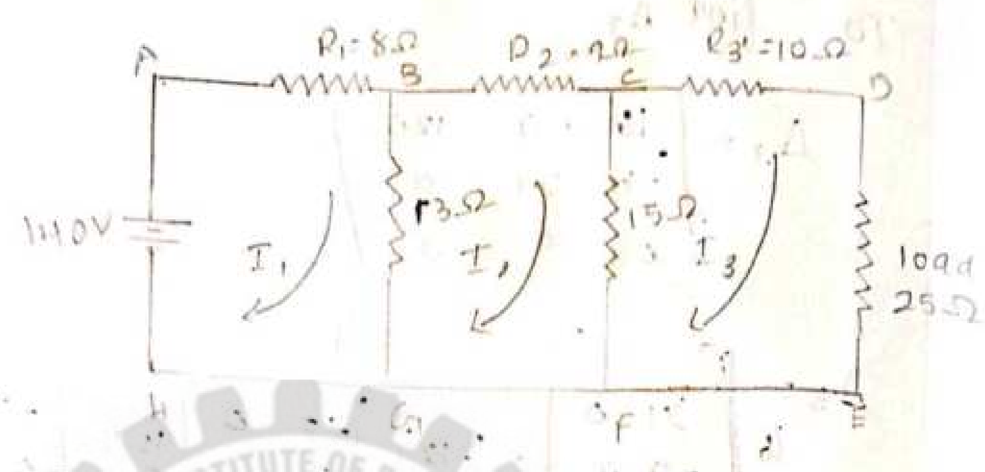
$$I_3 = 2\ A$$

$$P = I^2 R$$

$$P = (2)^2 \times (15)$$

$$P = 60\ W$$

from the circuit obtain the load current and power delivered to load.



$$\begin{bmatrix} R_{11} & R_{12} & R_{13} \\ R_{21} & R_{22} & R_{23} \\ R_{31} & R_{32} & R_{33} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}$$

$$\begin{bmatrix} (8+13) & -13 & 0 \\ -13 & (13+9+15) & -15 \\ 0 & -15 & (15+10+25) \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}$$

$$\begin{bmatrix} 21 & -13 & 0 \\ -13 & 37 & -15 \\ 0 & -15 & 50 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}$$

$$\begin{bmatrix} 21 & -13 & 0 \\ -13 & 37 & -15 \\ 0 & -15 & 50 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 140 \\ 0 \\ 0 \end{bmatrix}$$

To find Δ

$$\Delta = \begin{bmatrix} 21 & -13 & 0 \\ -13 & 37 & -15 \\ 0 & -15 & 50 \end{bmatrix}$$

$$\Delta = 21 \begin{vmatrix} 37 & -15 \\ -15 & 50 \end{vmatrix} - (-13) \begin{vmatrix} -13 & -15 \\ 0 & 50 \end{vmatrix}$$

$$0 \begin{vmatrix} -13 & 37 \\ 0 & -15 \end{vmatrix}$$

$$= 21\left[(37 \times 50) - (-15 \times -15)\right] + 13\left[(-13 \times 50) - (-15 \times 0)\right]$$

$$0\left[(-13 \times -15) - (0 \times 37)\right]$$

$$\Delta = 25,675$$

To find Δ_3

$$\Delta_3 = \begin{bmatrix} \cancel{16} & \cancel{-42} & \\ 21 & -13 & 0 \\ -13 & 37 & -15 \\ 0 & -15 & 50 \end{bmatrix}$$

$$\Delta_3 = \begin{bmatrix} 21 & -13 & 140 \\ -13 & 37 & 0 \\ 0 & -15 & 0 \end{bmatrix}$$

$$\Delta_3 = 21 \begin{vmatrix} 37 & 0 \\ -15 & 0 \end{vmatrix} + 13 \begin{vmatrix} -13 & 0 \\ 0 & 0 \end{vmatrix} 140 \begin{vmatrix} -13 & 37 \\ 0 & -15 \end{vmatrix}$$

$$21\left[(37 \times 0) - (-15 \times 0)\right] + 13\left[(-13 \times 0) - (0 \times 0)\right]$$

$$140\left[(-13 \times -15) - (37 \times 0)\right]$$

$$\Delta_3 = 27300$$

$$I_3 = \frac{\Delta_3}{\Delta} = \frac{27,300}{25675}$$

$$\boxed{I_3 = 1.06\ A}$$

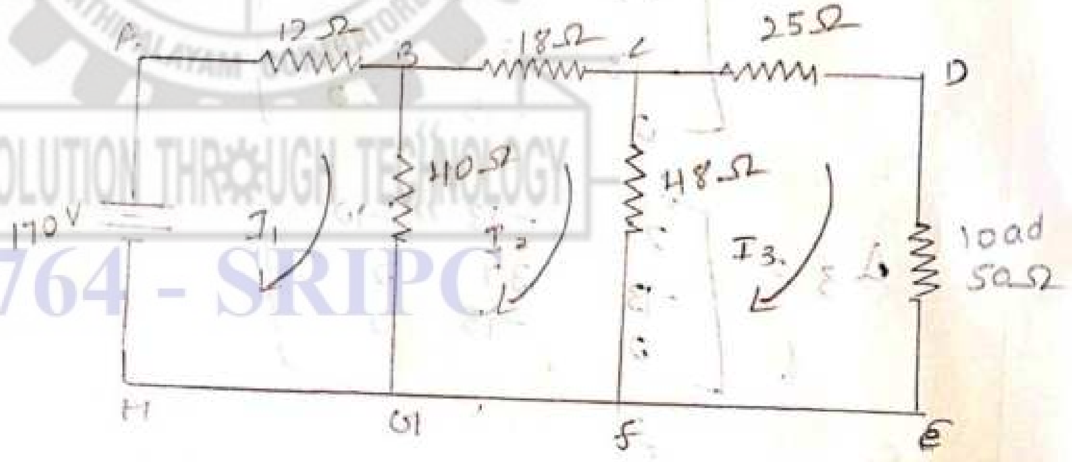
To find power

$$P = I^2 R$$

$$P = (1.06)^2 \times (25)$$

$$\boxed{P = 28.09\ W}$$

③ from the circuit, find I_1 and I_2



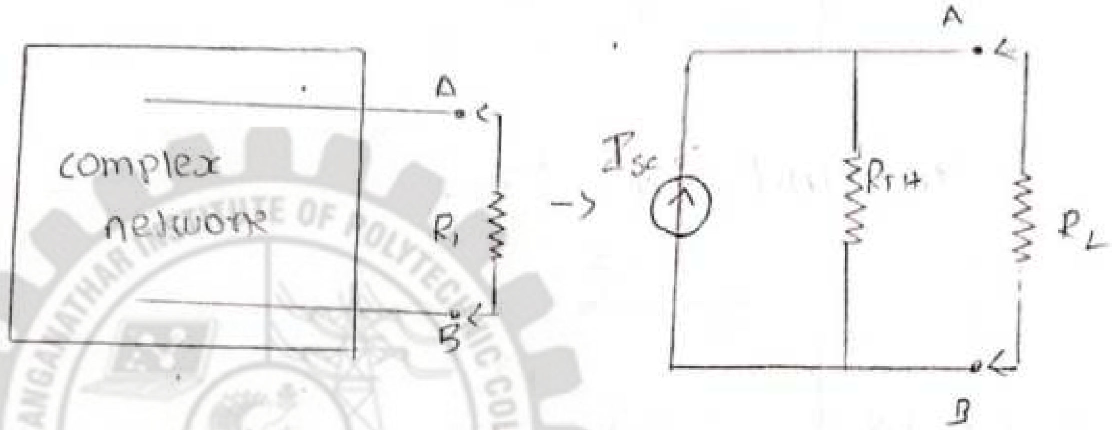
$$\begin{bmatrix} R_{11} & R_{12} & R_{13} \\ R_{21} & R_{22} & R_{23} \\ R_{31} & R_{32} & R_{33} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}$$

$$\begin{bmatrix} (12+40) & -40 & 0 \\ -40 & (40+18+48) & -48 \\ 0 & -48 & (48+25+50) \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix}$$

Monday

Norton's theorem

Norton's theorem state that any two terminal network can be reduced to a current source in parallel with a resistor.



I_{sc} → Short circuit current

R_{TH} → Thevanin's looking back resistance

Load current $I_L = I_{sc} \times \frac{R_{TH}}{R_{Th} + R_L}$

Conditions for norton's theorem

1. Remove the load resistance and put a short circuit

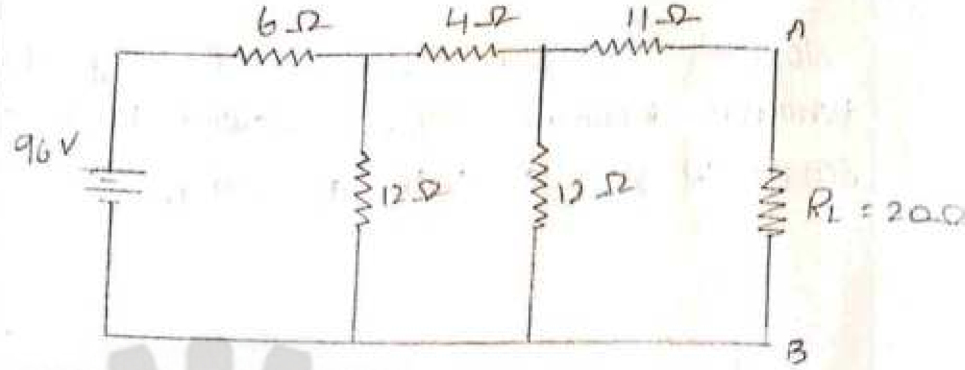
2. ~~Isc~~ find the short circuit current and thevenin's looking back resistance.

3. Replace all voltage's by their internal resistance.

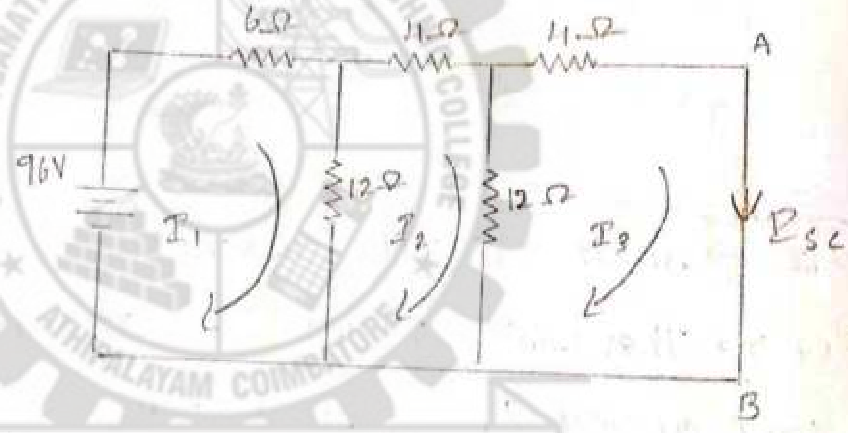
4. To find load current

load current $I_L = I_{sc} \times \frac{R_{TH}}{R_{TH} + R_L}$

① find the current through by R_L. by Using Norton's theorem



To find $I_{sc} = I_3$



By mesh current method

$$\begin{bmatrix} R_{11} & R_{12} & R_{13} \\ R_{21} & R_{22} & R_{23} \\ R_{31} & R_{32} & R_{33} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}$$

$$\begin{bmatrix} 6+12 & -12 & 0 \\ -12 & 12+4+12 & -12 \\ 0 & -12 & 12+11 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 96 \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 18 & -12 & 0 \\ -12 & 28 & -12 \\ 0 & -12 & 16 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} \begin{bmatrix} 96 \\ 0 \\ 0 \end{bmatrix}$$

To find Δ

$$= 18 \begin{vmatrix} 28 & -12 \\ -12 & 16 \end{vmatrix} + 12 \begin{vmatrix} -12 & -12 \\ 0 & 16 \end{vmatrix} 0 \begin{vmatrix} -12 & 28 \\ 0 & -12 \end{vmatrix}$$

$$= 18 \left[(28 \times 16) - (-12 \times -12) \right] + 12 \left[(-12 \times 16) - (-12 \times 0) \right]$$

$$0 \left[(-12 \times -12) - (28 \times 0) \right]$$

$= 3168$

$\Delta = 3168$

To find Δ_3

$$\Delta_3 = \begin{bmatrix} 18 & -12 & 96 \\ -12 & 28 & 0 \\ 0 & -12 & 0 \end{bmatrix}$$

$$\Delta_3 = 18 \begin{vmatrix} 28 & 0 \\ -12 & 0 \end{vmatrix} + 12 \begin{vmatrix} -12 & 0 \\ 0 & 0 \end{vmatrix} 96 \begin{vmatrix} -12 & 28 \\ 0 & -12 \end{vmatrix}$$

$$\Delta_3 = 18 \left[(28 \times 0) - (0 \times -12) \right] + 12 \left[(-12 \times 0) - (0 \times 0) \right]$$

$$+ 96 \left[(-12 \times -12) - (28 \times 0) \right]$$

$$\boxed{\Delta_3 = 13824}$$

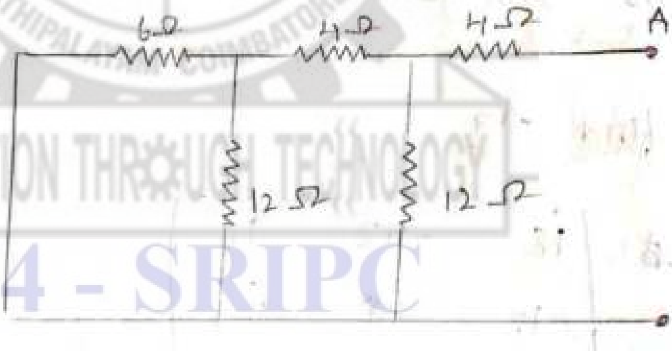
To find I_3

$$I_3 = \frac{\Delta_3}{\Delta}$$

$$I_3 = \frac{13824}{3168}$$

$$\boxed{I_3 = 4.36\ A = I_{sc}}$$

Step 2: find R_{TH}



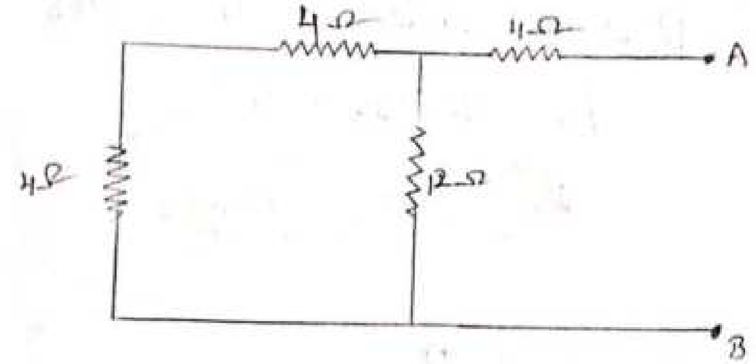
The above circuit is simpli as 6 Ω and 12 Ω resistances are in parallel

$$\therefore \frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_t} = \frac{1}{6} + \frac{1}{12}$$

$$\frac{1}{R_t} = 0.25$$

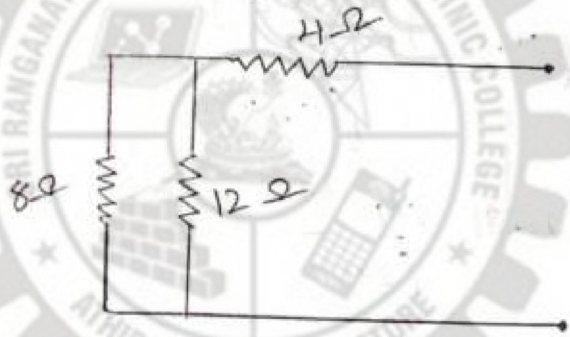
$$R_t = \frac{1}{0.25} \quad \boxed{R_t = 4\ \Omega}$$



4Ω and 4Ω are in series $R_T = R_1 + R_2$

$= 4 + 4 = 8\Omega$

$R_t = 8\Omega$



8Ω and 12Ω are in parallel

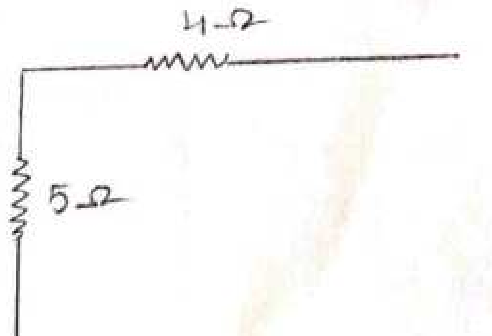
$1/R_t = 1/R_1 + 1/R_2$

$1/R_t = 1/8 + 1/12$

$1/R_t = 0.20$

$R_t = 1/0.20$

$R_t = 5\Omega$



R.

$R\,\Omega$ and $4\,\Omega$ are in series

$$R_T = R_1 + R_2 = 4 + 5$$

$$\boxed{R_T = 9\,\Omega = R_{TH}}$$

Step 3: To find I_L

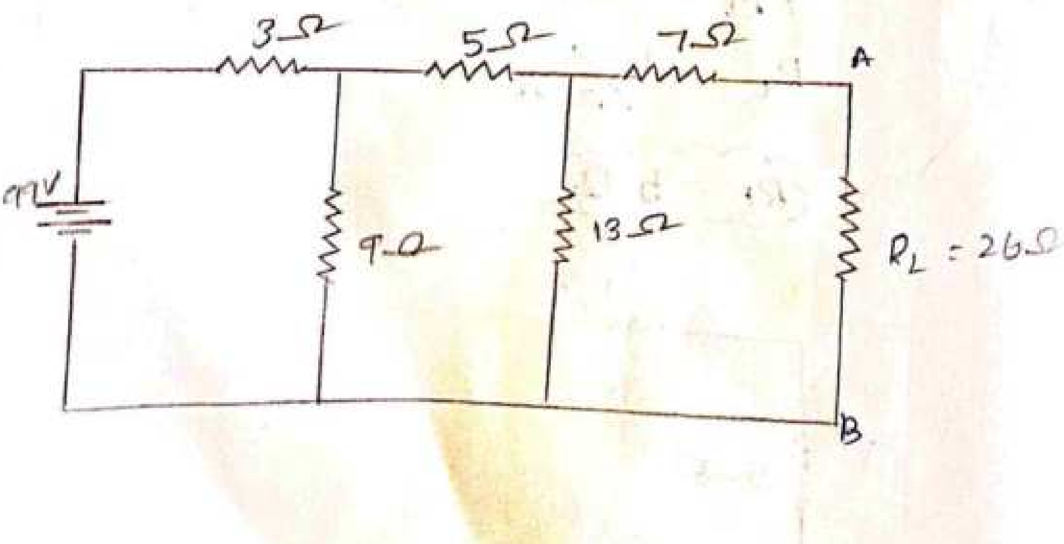
$$I_L = I_{SC} \times \frac{R_{TH}}{(R_{Th} + R_L)}$$

$$I_L = (4.36) \times \frac{(9)}{(9+20)}$$

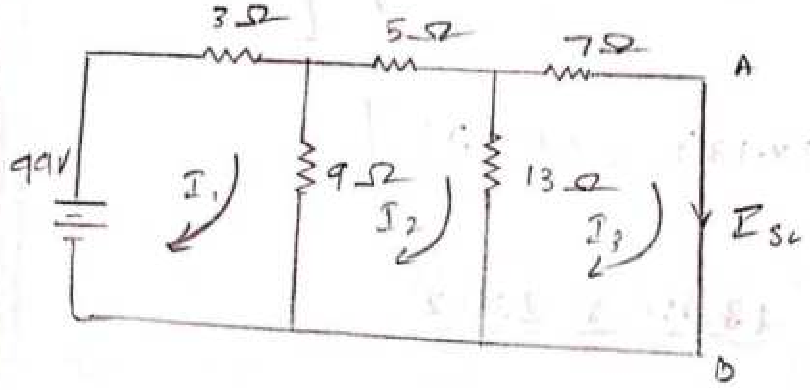
$$I_L = 4.36 \times \frac{(9)}{(29)}$$

$$\boxed{I_L = 1.35\,A}$$

(2) find the current through R_L, by using Norton's theorem



To find :



By mesh current method

$$\begin{bmatrix} R_{11} & R_{12} & R_{13} \\ R_{21} & R_{22} & R_{23} \\ R_{31} & R_{32} & R_{33} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}$$

$$\begin{bmatrix} 3+9 & -9 & 0 \\ -9 & 9+5+13 & -13 \\ 0 & -13 & 13+7 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}$$

$$\begin{bmatrix} 12 & -9 & 0 \\ -9 & 27 & -13 \\ 0 & -13 & 20 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} V_1 \; 99 \\ V_2 \; 0 \\ 0 \end{bmatrix}$$

To find Delta Δ

$$\Delta = 12 \begin{vmatrix} 27 & -13 \\ -13 & 20 \end{vmatrix} + 9 \begin{vmatrix} -9 & -13 \\ 0 & 20 \end{vmatrix} 0 \begin{vmatrix} -9 & 27 \\ 0 & -13 \end{vmatrix}$$

$$12\left[(27\times20)-(-13\times-13)\right]\, 9\left[(-9\times20)-(-13\times0)\right]$$

$$0\left[(-9\times-13)-(27\times0)\right]$$

$$= \boxed{\Delta = 2832}\ \boxed{\Delta = 2832}$$

To find I_3

$$\Delta_3 = \begin{bmatrix} 12 & -9 & 99 \\ -9 & 27 & 0 \\ 0 & -13 & 0 \end{bmatrix}$$

$$\Delta_3 = 12\begin{vmatrix} 27 & 0 \\ -13 & 0 \end{vmatrix} + 9\begin{vmatrix} -9 & 0 \\ 0 & 0 \end{vmatrix}\ 99\begin{vmatrix} -9 & 27 \\ 0 & -13 \end{vmatrix}$$

$$= 12\left[(27\times0)-(0\times-13)\right] + 9\left[(-9\times0)-(0\times0)\right]$$

$$99\left[(-9\times-13)-(27\times0)\right]$$

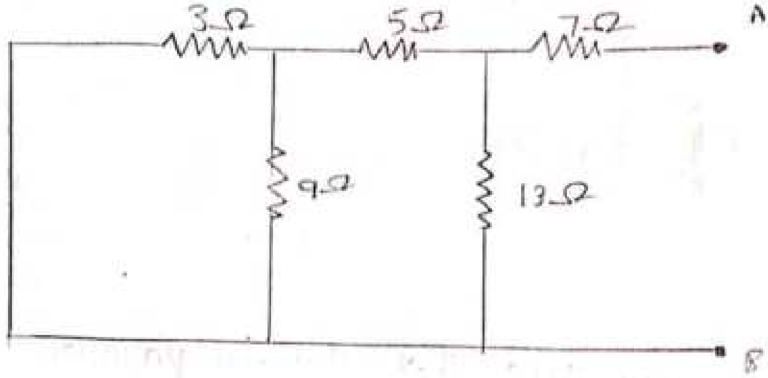
$$\boxed{\Delta_3 = 11583}$$

To find I_3

$$I_3 = \frac{\Delta_3}{\Delta}$$

$$\boxed{I_3 = 4.09\text{ A} = I_{sc}}$$

Step 2 find R_{TH}



The above circuit as 3Ω and 9Ω

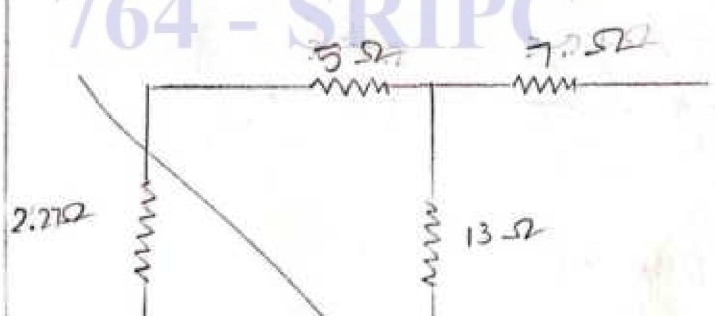
$$\frac{1}{R_{th}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_t} = \frac{1}{3} + \frac{1}{9}$$

$$\frac{1}{R_t} = 0.44$$

$$R_t = \frac{1}{0.44}$$

$$R_t = 2.27\,\Omega$$

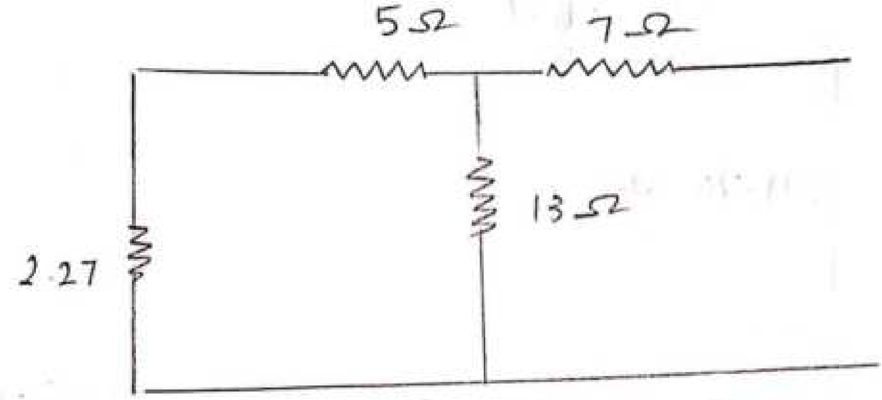


2.27 Ω and 2.27 Ω are in series

$$R_t = R_1 + R_2$$

$$R_t = 2.27 + 2.27$$

$$R_t = 4.54\,\Omega$$

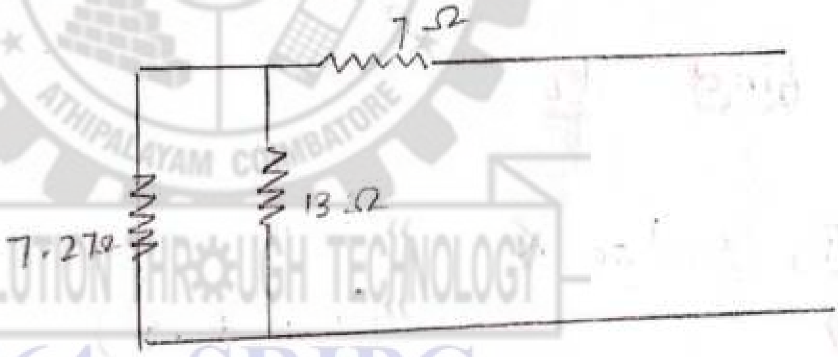


2.27 Ω and 5 ~~13~~ Ω are in series

$R_t = R_1 + R_2$

$R_t = 2.27 + 5$

$R_t = 7.27\ \Omega$



7.27 Ω and 13 are in parallel

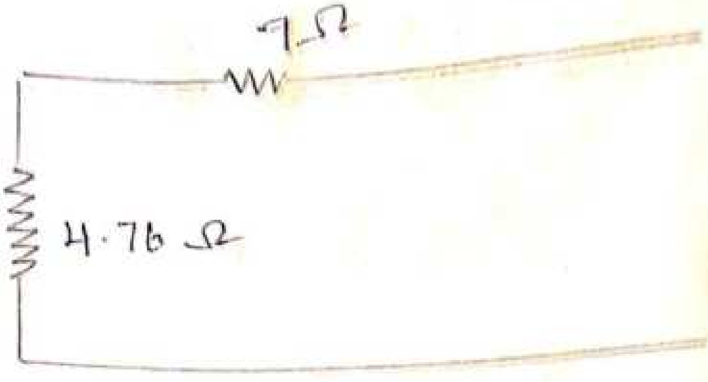
$1/R_t = 1/R_1 + 1/R_2$

$1/R_t = 1/7.27 + 1/13$

$1/R_t = 0.21\ \Omega$

$R_t = \frac{1}{0.21}$

$R_t = 4.76\ \Omega$



4.76 Ω and 7 Ω are in series

$R_T = R_1 + R_2$

$R_T = 4.76 + 7$

$\boxed{R_T = 11.76}$

To find I_L

$$I_L = I_{sc} \times \frac{R_{TH}}{(R_{th} + R_L)}$$

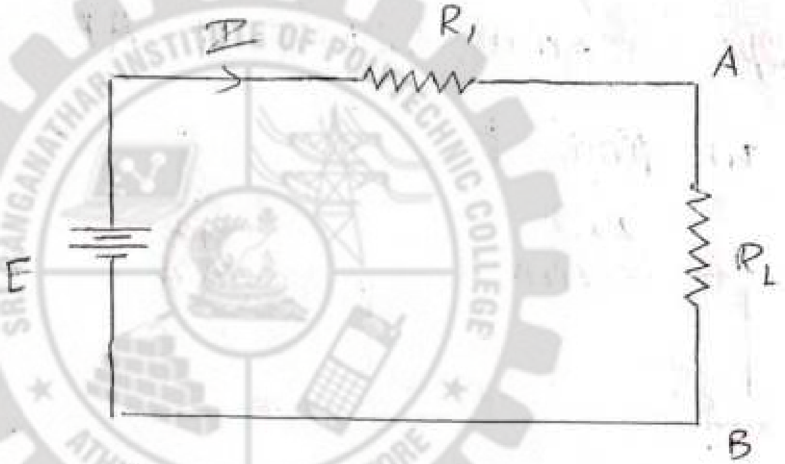
$$I_L = (4.09) \times \frac{(11.76)}{(11.76 + 26)}$$

$I_L = 1.27\,A$

01.09.2022
Thursday

Maximum power Transfer Theorem

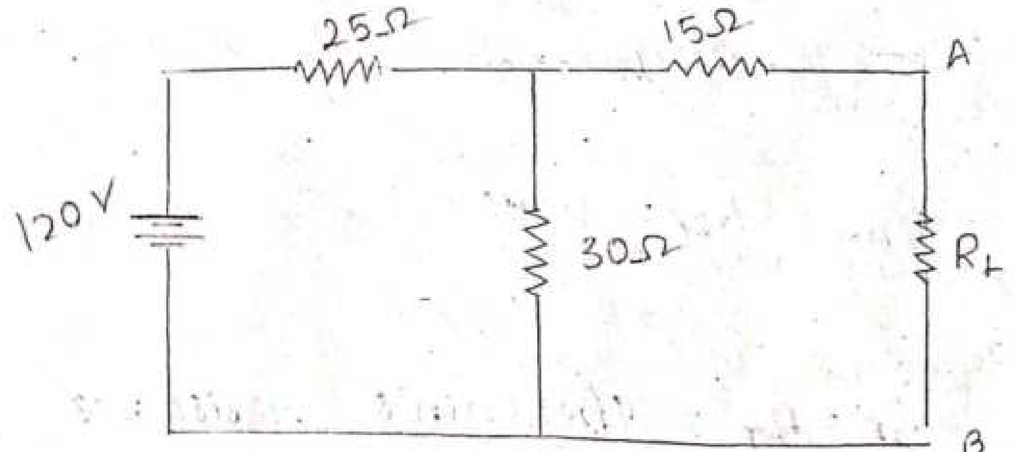
In dc circuits maximum power is transfered from a sources to load resistance is made equal to the internal resistance or looking back resistance of the network from the load terminals.



Maximum power $P_{max} = \dfrac{E^2}{4R_L}$ watts

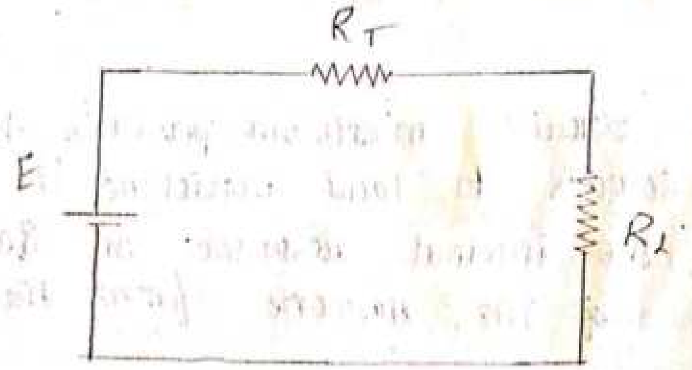
Where, E^2 = Voltage
R_L = load resistance

(1) Calculate the value of the load resistance for maximum power transfered from the circuit. Also find the value of maximum power.



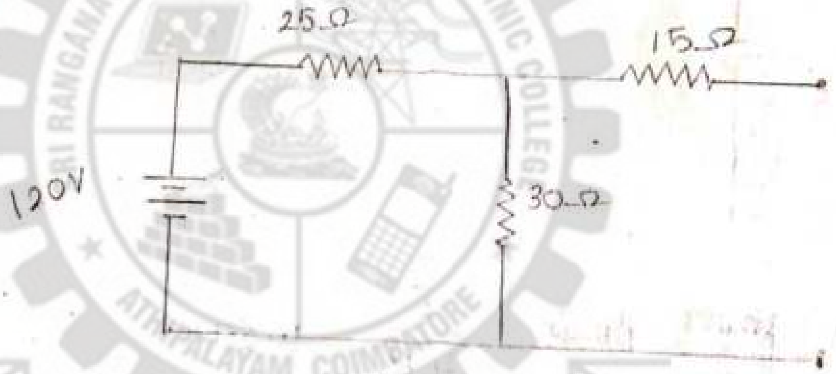
Soln

Thevanin's Equivalent circuit.



Open circuit voltage of AB

Step-1 To find E



$E = V_{AB}$ = Voltage across 30 Ω resistance

$$V_{AB} = I \times 30$$

$$V_{AB} = \left(\frac{V}{R}\right) \times 30 \quad \left(\begin{matrix}\text{Since} \\ I = V/R\end{matrix}\right)$$

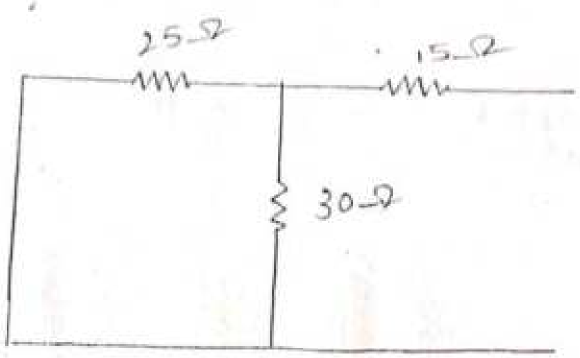
$$V_{AB} = \left[\frac{(120)}{(25+30)}\right] \times 30$$

$$V_{AB} = 2.18 \times 30$$

$$\boxed{V_{AB} = 65.4 \text{ volts} = E}$$

Step 2:

$R_L = R_T$ = Thevenin's resistance

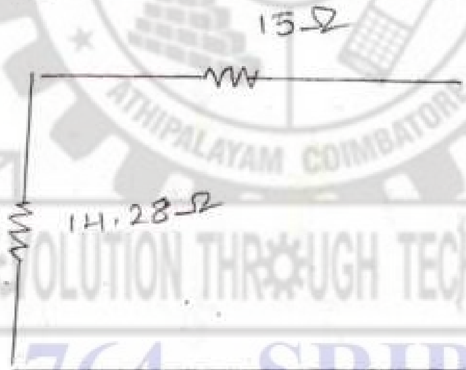


25Ω 30Ω are in parallel

$$1/R_T = 1/R_1 + 1/R_2$$

$$1/R_T = 1/25 + 1/30$$

$$R_T = 14.28\,\Omega$$



14.28Ω are in series

$$R_T = R_1 + R_2$$

$$R_T = 14.28 + 15$$

$$2_T = 29.28\,\Omega$$

Step 3 maximum power $P_{max} = E^2/4R_L$

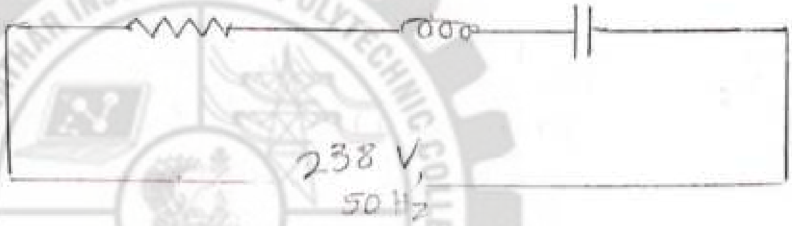
$$P_{max} = \frac{(65.4)^2}{(4) \times (29.8)}$$

$$\boxed{P_{max} = 35.88\,W}$$

UNIT - III 06.09.2022

Tuesday

A series RLC series circuit with a resistance of 72 ohm, a capacitor of 63.2 microfarad ~~and~~ 2 an Inductance of 0.29 H is connected across 238 V, 50 Hz supply. Determine the impedance power factor and power consumed by the circuit.



Given data

Resistance = 72 ohm

capacitor = 63.2 microfarad $\Rightarrow 63.2 \times 10^{-6}$

Inductance = 0.29 H

Voltage = 238 V

frequency = 50 Hz

To find

impedance = ?

power factor = ?

power consumed = ?

Soln..

To find impedance ?

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

Where

$$X_L = 2\pi f L$$

$$X_L = (2)\times(3.14)\times(50)\times(0.29)$$

$$X_L = 91.06\ \Omega$$

$$X_C = \frac{1}{2\pi f C}$$

$$X_C = \frac{1}{(2)\times(3.14)\times(50)\times(63.2\times10^{-6})}$$

$$X_C = \frac{1}{0.019}$$

$$X_C = 52.63\ \Omega$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$Z = \sqrt{(72)^2 + (91.06 - 52.63)^2}$$

$$Z = \sqrt{(5184) + (1476.86)}$$

$$= \sqrt{6660.86}$$

$$Z = 81.61\ \Omega$$

Step 2:

To find power factor ?

$\cos\phi$ or $\frac{R}{Z}$

$\frac{R}{Z}$

$\frac{72}{81.61}$

0.88

power factor = 0.88

Step 3

To find current = ?

$I = V/Z$

$I = \frac{238}{81.61}$

$\boxed{I = 2.91\,A}$

Step iv

To find power = ?

power $P = VI \cos\phi$

$P = (238) \times (2.91) \times (0.88)$

$\boxed{P = 609.47 \text{ watts}}$

Friday

Polar and Rectangular forms

Polar form $\rightarrow 10 \angle 40^\circ$

Rectangular form $\rightarrow 10 + j40^\circ$

(1) convert the vector $10 + j22$ into polar form

Ans $24.16 \angle 65.55$

(1) convert the Vector $23.5 + j39.9$ into polar form

$46.30 \angle 59.50$

(2) convertthe polar form $10 \angle 30^\circ$ into vector form

$8.66 + j5$

~~convert the polar form~~ ~~$21 \angle -45$~~

convert the vector $15 - j22.3$ into polar form.

$26.87 \angle 56.07$

convert the polar for $21 \angle -45^\circ$ into vector form

~~$14.84 + j - 14.84$~~ $14.84 - j14.84$

(1) Two impedances $Z_1 = 8 + j6$ and $Z_2 = 3 - j4$ are connected in parallel across a 230V, 50Hz supply calculate (a) current in each branch (b) total current of the circuit (c) power factor (d) power taken by the circuit.

Given data:

Impedance $Z_1 = (8 + j6) \Rightarrow 10 \angle 36.86$

Impedance $Z_2 = (3 - j4) \Rightarrow 5 \angle -53.1$

Voltage $V = 230V$

frequency $F = 50\,Hz$

To find:

Branch current I_1 and I_2 = ?

Total current (I) = ?

Power factor = ?

power = ?

Solution:

(i)

$$I_1 = \frac{V}{Z_1} = \frac{230 \angle 0^\circ}{10 \angle 36.86}$$

$$I_1 = 23 \angle -36.36^\circ \text{ Amps}$$

$$I_2 = V/Z_2 = \frac{230 \angle 0^\circ}{5 \angle -53.1}$$

$$I_2 = 46 \angle 53.1 \text{ Amps.}$$

(ii) Total current

Both Impedance are in parallel

$$1/Z_T = 1/Z_1 + 1/Z_2$$

L.C.M =>

$$\frac{Z_2 Z_1}{Z_1 + Z_2}$$

$$Z = \frac{Z_1 Z_2}{Z_1 + Z_2}$$

By L.C.M

$$Z = \frac{Z_1 Z_2}{Z_1 + Z_2}$$

$$Z = \frac{(8+j6) \times (3-j4)}{(8+j6) + (3-j4)}$$

$$Z = \frac{24 - 32j + 18j - j^2 24}{11 + j2}$$

$$Z = \frac{24 - 14j - (-1) 24}{11 + j2}$$

(since $j^2 = -1$)

$$Z = \frac{24 - 14j + 24}{11 + j2}$$

$$Z = \frac{48 - 14j}{11 + j2}$$

$$Z = \frac{50 \angle -16.2}{11.1 \angle 10.3}$$

$$Z = 4.50 \angle -26.5 \ \Omega$$

Total current

Both Impedance are in parallel

$$1/Z_T = 1/Z_1 + 1/Z_2$$ L.C.M => $\frac{Z_2 Z_1}{Z_1+Z_2}$

By L.C.M

$$Z^{\cdot} = \frac{Z_1 Z_2}{Z_1+Z_2}$$

$$Z = \frac{Z_1 Z_2}{Z_1 + Z_2}$$

$$Z = \frac{(8+j6)\times(3-j4)}{(8+j6)+(3-j4)}$$

$$Z = \frac{24-32j+18j-j^2 24}{11+j2}$$

$$Z = \frac{24-14j-(-1)24}{11+j2}$$ (since $j^2 = -1$)

$$Z = \frac{24-14j+24}{11+j2}$$

$$Z = \frac{48-14j}{11+j2}$$

$$Z = \frac{50\angle -16.2}{11.1\angle 10.3}$$

$$Z = 4.50\angle -26.5\ \Omega$$

$$I = V/Z = \frac{230 \angle 0^\circ}{4.5 \angle -26.5}$$

$$I = 51.1 \angle 26.5 \text{ A}$$

(iii) power factor

$$P.F = \cos\theta \text{ (or) } R/Z$$

$$P.F = \cos(26.5)$$

$$P.F = 0.89$$

(iv) power

$$P = VI \cos\theta$$

$$P = 230 \times 51.1 \times 0.89$$

$$P = 10480.17 \text{ watts}$$

(2) Two impedance $Z_1 = 14 + j16$ and $Z_2 = 6 - j9$ are connected in parallel across a 210V, 50 Hz supply calculate (a) current in each branch (b) total current of the circuit (c) circuit power factor (d) power taken by the circuit.

Given data //.

$Z_1 = 14 + j16 \rightarrow 21.26 \angle 48.81$

$Z_2 = 6 - j9 \rightarrow 10.81 \angle -56.30$

Voltage = 210 V

frequency = 50 Hz

To find

Branch current I_1 and I_2 = ?

Total current = ?

power factor = ?

Power = ?

Soln//.

i $I_1 = V/Z_1 = \dfrac{210 \angle 0^\circ}{212 \angle 48.81}$

$I_1 = 9.90 \angle -48.81$ Amps

$I_2 = V/Z_2 = \dfrac{210 \angle 0^\circ}{10.8 \angle -56.30}$

$I_2 = 19.44 \angle 56.30$ Amps

(ii) Total current

both impedance are parallel

$$\frac{1}{Z_T} = \frac{1}{Z_1} + \frac{1}{Z_2}$$

By L.C.M

$$Z = \frac{Z_1 Z_2}{Z_1 + Z_2}$$

$$Z = \frac{(14+j16)(6-j9)}{(14+j16)+(6-j9)}$$

$$Z = \frac{84 - 126j + 96j - j^2\,144}{20+7j}$$

$$Z = \frac{84 - 30j - (-1)\,144}{20+7j}$$

$$Z = \frac{84 - 30j + 144}{20+7j}$$

$$Z = \frac{228 - 30j}{20+7j}$$

$$Z = \frac{229.96 \angle -7.49}{21.18 \angle 19.29}$$

$$Z = 10.8 \angle -26.78 \ \Omega$$

$$I = V/Z = \frac{210 \angle 0^\circ}{10.8 \angle -26.78}$$

$$I = 19.4 \angle 26.78 \text{ Amps}$$

(iii)

Power factor = ?

$P.F = \cos\theta$ (or) R/Z

$P.F = \cos(26.78)$

$P.F = 0.89$

Power

$P = VI \cos\theta$

$P = 210 \times 19.4 \times 0.89$

$P = 3625.86$ watts

15. 09. 2022
Thursday

Resonance

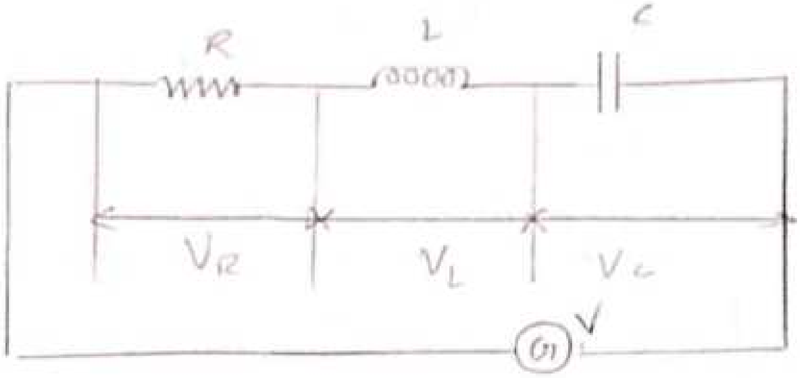
R.L.C series resonance

An R.L.C series circuit is said to be in resonance when circuit power factor is Unity.

At resonance $X_L = X_C$

X_L = Inductive reactance

X_C = capacitive reactance



Resistance frequency $(F_R) = \dfrac{1}{2\pi\sqrt{LC}}$

L - Inductor

C - capacitor

16.09.2022
friday :-

<u>Effect of Series resonance</u>

1. When series resonance occurs the inductive reactance X_L and capacitive resistance reactance are equal and opposite and cancel each other.

2. The impedance of the circuit is minimum and equal to the resistance of the circuit.

3. The current in the circuit maximum.

4. The power factor of the circuit is Unity.

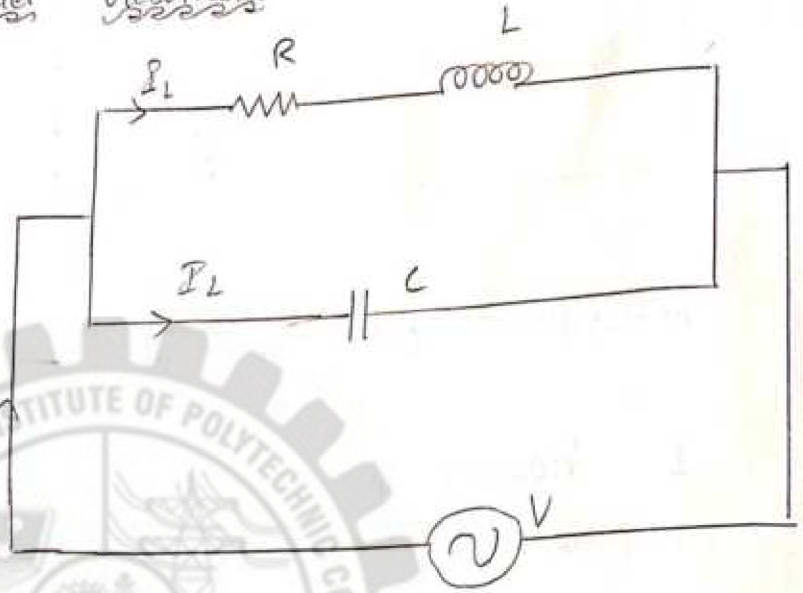
5. The voltage drop accross L and C is very large.

<u>Quality factors of series resonant circuit</u>

At series resonance the voltage across L and C is many times greater than the applied voltage. Q - factor = $\dfrac{\text{Voltage drop drop accros L or C}}{\text{Applied Voltage}}$

Q - factor $= \frac{1}{R} \frac{L}{C}$

Parallel resonance



At resonance $I_c = I_L$

Resonant frequency $F_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \left[\frac{R}{L}\right]^2}$

Dynamic resistance at series

when the series resonance occur the inductive reactance X_L and capacitive reactance are equal and opposite and cancel each other.

Dynamic resistance = "R"

Dynamic resistance at parallel

$\frac{L}{CR}$ is known as the impedance at parallel resonance or dynamic impedance or dynamic resistance

Dynamic resistance $= \frac{L}{CR}$

Q - factor for parallel circuit

At parallel resonance the circulating current between the two branches is many times greater than the supply current.

$$Q\text{-factor} = \frac{\text{Circulating current between L and C}}{\text{Supply current}}$$

$$Q\text{-factor} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

Comparision of series and parallel resonance

S.no	Particulars	Series current	Parallel circuit
1.	Impedance at resonance	minimum	maximum
2.	current at resonance	maximum	minimum
3	Dynamic resistance	R	$\frac{L}{CR}$
4.	power factor at resonance	Unity	Unity
5.	frequency at resonance	$f_r = \frac{1}{2\pi\sqrt{LC}}$	$f_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \left[\frac{R}{L}\right]}$
6.	It magnifies	voltage	current
7.	Q - factor	$\frac{1}{R}\sqrt{\frac{L}{C}}$	$\frac{1}{R}\sqrt{\frac{L}{C}}$

Application of resonance

1. Resonance circuit can be employed to maintain Ac circuit. oscillations at a constant frequency

2. It is used in tuning circuit.

3. It is used in filter circuits to block a particular frequency or a range of frequencies.

4. It is used in radio transmitter and receivers.

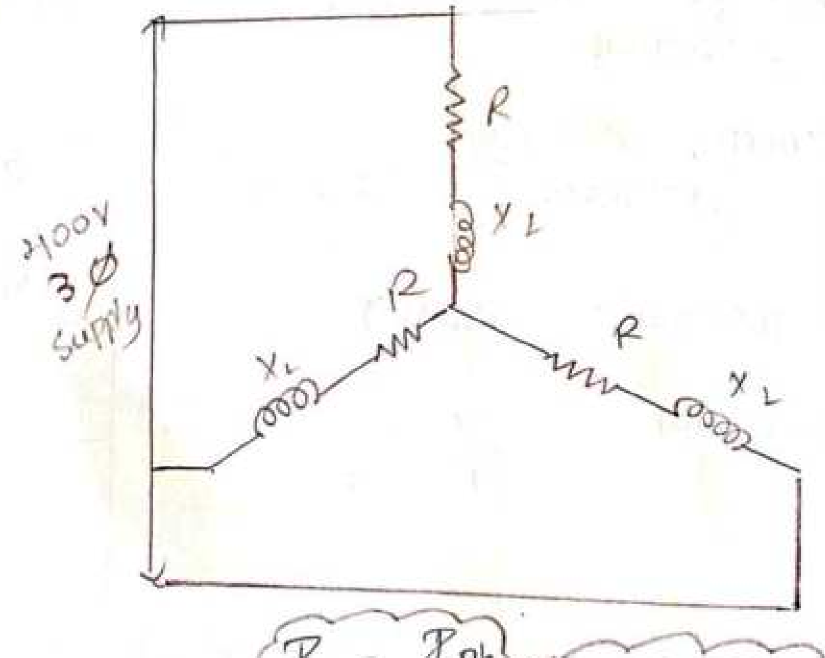
5. It is used in tv transmitter and receiver.

19.09.2022
Monday

UNIT - II

THREE PHASE CIRCUITS

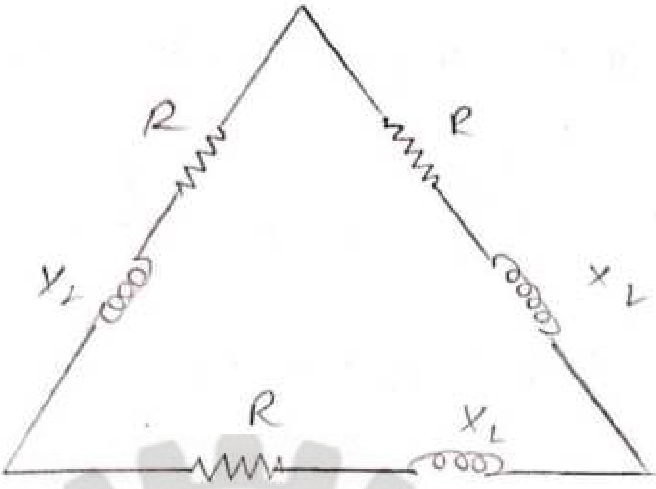
Star connection



$I_L = I_{ph}$

$V_L = \sqrt{3}\, V_{ph}$

Delta connection



$$I_L = \sqrt{3}\, I_{ph}$$

$$V_L = V_{ph}$$

Q) Three Identical coils with resistance of 15Ω and Reactance of 15Ω are connected in Delta across 400V, 50Hz supply. find

i) line current

ii) power factor

iii) power draw from the supply

Given data.

Resistance $R = 15\Omega$

Inductive Reactance $X_L = 15\Omega$

line voltage $V_L = 400V = V_{ph}$

To find:

i) line current $(I_L) = ?$

ii) power factor $= ?$

iii) power draw from the supply $= ?$

Soln:

line current (I_L)

$$I_L = \sqrt{3}\, I_{ph} \text{ [Delta connection]} \rightarrow (1)$$

$$\therefore I_{ph} = \frac{V_{ph}}{Z_{ph}} \text{ [since } V = IZ \text{]}$$

$$\text{and } Z_{ph} = \sqrt{R^2 + X_L^2}$$

To find Z_{ph}

$$Z_{ph} = \sqrt{(15)^2 + (15)^2}$$

$$\cancel{Z_{ph} = \sqrt{21.21\Omega}}$$

$$Z_{ph} = 21.21\Omega$$

$$\cancel{\therefore I_{ph} = \frac{V_{ph}}{Z_{ph}} \text{ [since } V = IZ \text{]}}$$

$$\cancel{\text{and } Z_{ph} = \sqrt{R^2 + X}}$$

To find I_{ph}

$$I_{ph} = \frac{V_{ph}}{Z_{ph}}$$

$$I_{ph} = \frac{400}{21.21} \quad \left[\begin{array}{c}\text{Delta connection} \\ V_{ph} = V_L\end{array}\right]$$

$$I_{ph} = 18.85A$$

Sub I_{ph} value in equ (1)

$$I_L = \sqrt{3}\, I_{ph} \longrightarrow (1)$$

$$I_L = \sqrt{3} \times 18.85$$

$$\boxed{I_L = 32.64\,A}$$

ii) power factor

$$P.F = \cos\theta \text{ (or) } R/Z$$

$$P.F = R/Z = \frac{15}{21.21} = 0.70$$

$$\boxed{P.F = 0.70}$$

iii) power drawn from the supply

$$P = \sqrt{3}\, V_L\, I_L \cos\theta$$

$$P = \sqrt{3} \times 400 \times 32.64 \times 0.70$$

$$\boxed{\text{Power} = 15829.55 \text{ watts}}$$

(2) Three identical coil with resistance of 20 Ω and reactance of 25 Ω are connected in delta across 420V, 50Hz supply. find i) line current ii) power factor iii) power drawn from the supply.

Given data:

Resistance = 20 Ω

Inductive reactance (X_L) = 25 Ω

line voltage (V_L) = 420 V = V_{ph}

To find

i) line current (I_L) = ?

ii) Power factor = ?

iii) power drawn from the supply = ?

Soln/

line current (I_L) = ?

$$I_L = \sqrt{3}\, I_{ph} \text{ (delta connection)} \longrightarrow (1)$$

$$I_{ph} = \frac{V_{ph}}{Z_{ph}} \quad (V = IZ)$$

and $Z_{ph} = \sqrt{R^2 + X_L^2}$

To find Z_{ph}

$$Z_{ph} = \sqrt{(20)^2 + (25)^2}$$

$$Z_{ph} = 32.01\ \Omega$$

To find I_{ph}

$$I_{ph} = \frac{V_{ph}}{Z_{ph}}$$

$$I_{ph} = \frac{420}{32.01} \quad [V_{ph} = V_L]$$

$$I_{ph} = 13.12\text{A}$$

sub I_{ph} value in equ (1)

$$I_L = \sqrt{3}\, I_{ph} \longrightarrow (1)$$

$$I_L = \sqrt{3} \times 13.12$$

$$I_L = 22.72\ A$$

39.36
6.27
22.7

ii) power factor

$$P.F = \cos\theta \text{ or } R/Z$$

$$P.F = R/Z = \frac{\cancel{20}}{\cancel{13.12}} \quad \frac{20}{32.01}$$

$$P.F = \cancel{1.52}\ 0.62$$

iii) power drawn from the supply

$$P = \sqrt{3}\, V_L I_L \cos\theta$$

$$P = \sqrt{3} \times 420 \times 22.72 \times 0.62$$

$$P = 10247.31 \text{ watts}$$

Three identical coils with resistance ~~#~~ 20 Ω and reactance of 15 Ω are connected in Star across 400V, 50 Hz supply. find i) line current ii) power factor iii) power drawn from the supply.

Given data:

Resistance $R = 20\,\Omega$

Inductive reactance $X_L = 15\,\Omega$

line voltage $V_L = 400V$

To find

i) line current $(I_L) = ?$

ii) power factor $f = ?$

iii) power drawn from the supply = ?

Soln:

i) line current (I_L)

$I_L = I_{ph}$ [star connection] $\rightarrow$ (I)

$\therefore I_{ph} = \dfrac{V_{ph}}{Z_{ph}} \rightarrow$ (A)

To find $V_{ph} = \dfrac{V_L}{\sqrt{3}} \rightarrow$ (B) [since $V_L = \sqrt{3} V_{ph}$]

$Z_{ph} = \sqrt{R^2 + X_L^2} \longrightarrow$ (C)

To find Z_{ph}

Impedance $Z_{ph} = \sqrt{R^2 + X_L^2}$

$$Z_{ph} = \sqrt{20^2 + 15^2}$$

$$Z_{ph} = 25\,\Omega$$

To find V_{ph}

$$V_{ph} = \frac{V_L}{\sqrt{3}} = \frac{400}{\sqrt{3}}$$

$$V_{ph} = 230.94\ V$$

To find I_{ph}

$$I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{230.94}{25}$$

$$I_{ph} = 9.24\ A$$

Sub I_{ph} value in equ (1)

$$I_L = I_{ph} = 9.24A \quad [\text{star connection}]$$

ii) power factor

$$P.F = \cos\phi \text{ or } R/Z$$

$$R/Z = \frac{20}{25}$$

$$P.F = 0.8$$

iii) power drawn from the supply

$$P = \sqrt{3}\, V_L I_L \cos\phi$$

$$P = \sqrt{3} \times 400 \times 9.24 \times 0.8$$

$$P = 5121.32 \text{ Watts}$$

Three identical coils with resistance of 32 Ω and reactance of 29 Ω are connected in star across 415V, 50Hz supply. Find i) line current ii) power factor iii) power drawn from the supply.

Given data

$$\text{Resistance } (R) = 32\,\Omega$$

$$\text{Inductive reactance } (X_L) = 29\,\Omega$$

$$\text{line voltage } (V_L) = 415\,V$$

To find

i) line current $(I_L) = ?$

ii) power factor = ?

iii) power drawn from the supply = ?

Soln:

i) To find line current $(I_L) = ?$

$$I_L = I_{ph} \text{ (star connection)} \longrightarrow (1)$$

$$\therefore I_{ph} = \frac{V_{ph}}{Z_{ph}} \longrightarrow (A)$$

To find V_{ph}

$$V_{ph} = \frac{V_L}{\sqrt{3}} \rightarrow (B) \quad (V_L = \sqrt{3} V_{ph})$$

$$Z_{ph} = \sqrt{R^2 + X_L^2} \longrightarrow (C)$$

To find Z_{ph}

impedance $Z_{ph} = \sqrt{R^2 + X_L^2}$

$Z_{ph} = \sqrt{(32)^2 + (29)^2}$

$Z_{ph} = 43.18\ \Omega$

To find V_{ph}

$V_{ph} = \frac{V_L}{\sqrt{3}} = \frac{415}{\sqrt{3}}$

$V_{ph} = 239.60\ V$

To find I_{ph}

$I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{239.60}{43.18}$

$I_{ph} = 5.54\ A$

Sub value in equ (1)

$I_L = I_{ph} = 5.54\ A$

ii) power factor

$P.F = \cos\phi$ or R/Z

$P.F = R/Z = \frac{32}{43.18}$

$P.F = 0.74$

Power drawn from the supply

$$P = \sqrt{3}\ V_L\ I_L\ \cos\theta$$

$$P = \sqrt{3} \times 415 \times 5.54 \times 0.74$$

$$P = 2946.79 \text{ watts}$$

21.09.2022
Wednesday

① A 415V, 3 phase voltage is applied to a balanced delta connected load of phase impedance $(27 + J43)\Omega$. find the line current, power factor and power consumed by circuit.

Given data

(R) Resistance $= 27\Omega$

(X_L) Inductive reactance $= 43\Omega$

(V_L) Voltage $= 415V = V_{ph}$

To find

i) line current = ?

ii) power factor = ?

iii) power consumed by circuit = ?

solution

line current (I_L) = ?

$I_L = \sqrt{3}\ I_{ph}$ (delta connection) $\longrightarrow$ ①

$$\therefore I_{ph} = \frac{V_{ph}}{Z_{ph}} \quad (V = IZ)$$

To find Z_{ph} =

$$Z_{ph} = \sqrt{R^2 + X_L^2}$$

$$Z_{ph} = \sqrt{(27)^2 + (43)^2}$$

$$\boxed{Z_{ph} = 50.77\ \Omega}$$

To find I_{ph}

$$I_{ph} = \frac{V_{ph}}{Z_{ph}}$$

$$I_{ph} = \frac{415}{50.77} \quad (V_{ph} = V_L$$

$$\boxed{I_{ph} = 8.17\ A}$$

sub I_{ph} value in equ (1)

$$I_L = \sqrt{3}\ I_{ph} \longrightarrow (1)$$

$$I_L = \sqrt{3} \times 8.17$$

$$\boxed{I_L = 14.15\ A}$$

(ii) power factor

$$P.F = \cos\theta \text{ or } R/Z$$

$P.F = R/Z$

$$= \frac{27}{50.77}$$

$$P.F = 0.53$$

iii) power consumed by the circuit

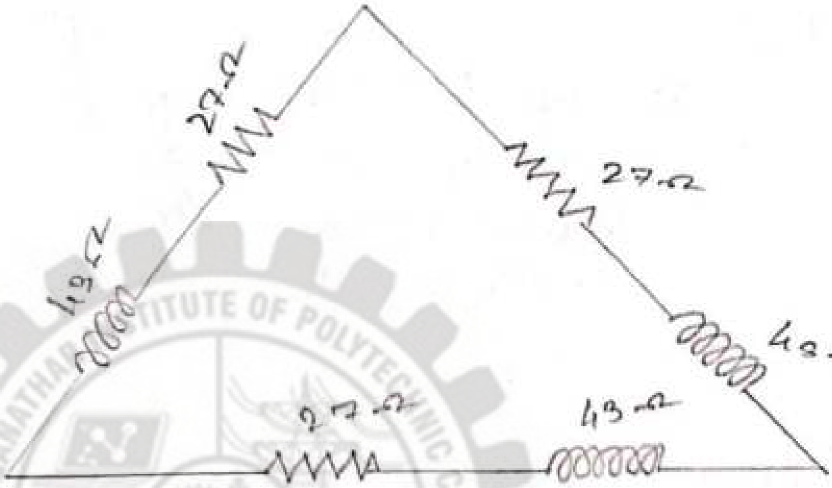
$$P = \sqrt{3}\, V_L\, I_L \cos\theta$$

$$P = \sqrt{3} \times 415 \times 14.15 \times 0.53$$

$$P = 5390.64 \text{ watts}$$

Diff question model sum with same answer

(2) A 415V, 3 phase voltage is connected in a balanced delta connection as shown in the fig. find the line current, power factor and power drawn from the circuit.



22.09.2022
Thursday

(1) A 410V, 3 phase voltage is applied to a balanced star connected load of phase Impedance (24 + j42). find the current power factor and power consumed by the circuit.

A 410V, 3 phase voltage is connected in a star connection as shown in the diagram. find the current, power factor and power drawn from the supply.

i) The power input of 400V, 3ϕ 50 Hz motor is measured by two wattmeter, which indicates 2500W and 500W respectively. find the power and power factor of the circuit.

Given data:

Voltage $(V) = 400V$

frequency $(f) = 50$ Hz

wattmeter $(W_1) = 2500W$

wattmeter $(W_2) = 500W$

To find

i) power $(P) = ?$

ii) power factor = ?

i) power (P)

Total power $= W_1 + W_2$

power $= 2500 + 500$

power $= 3000W$

ii) power factor :

power factor = $\cos\theta$ or R/Z

To find $\cos\theta$

$$\tan\theta = \sqrt{3}\left[\frac{W_2 - W_1}{W_1 + W_2}\right]$$

$$\tan\theta = \sqrt{3}\left[\frac{500 - 2500}{2500 + 500}\right]$$

$$\tan\theta = \sqrt{3}\left[-0.66\right]$$

$\tan\theta = -1.14$

$\theta = \tan^{-1}[-1.14]$

$\theta = -118.74$

Sub θ value in power factor formula

power factor = $\cos\theta$

P.F = $\cos(-118.74)$

power factor = 0.65

power input of a 425 V, 3 ϕ 50 Hz motor is measured by two wattmeter, which indicates 3499 w and 649 w respectively. find the power and power factor of the circuit.

Given data

Voltage (V) = 425V

frequency (F) = 50 Hz

wattmeter (W_1) = 3499 w

wattmeter (W_2) = 649 w

To find

power = ?

Power factor of the circuit = ?

Soln//..

i) Power

Total power = $W_1 + W_2$

$= 3499 + 649$

$\boxed{\text{Power} = 4148\ W}$

ii) Power factor = ?

Power factor = $\cos\theta$ or P/Z

To find $\cos\theta$

$$\tan\theta = \sqrt{3}\left[\frac{W_2 - W_1}{W_1 + W_2}\right]$$

$$\tan\theta = \sqrt{3}\left[\frac{649 - 3499}{3499 + 649}\right]$$

$$\tan\theta = \sqrt{3}\left[\frac{-2850}{4148}\right]$$

$$\tan\theta = \sqrt{3}\left[-0.68\right]$$

$$\tan\theta = -1.17$$

$$\theta = \tan^{-1}(-1.17)$$

$$\boxed{\theta = -49.47}$$

Sub θ value in power factor formula

$$P.F = \cos\theta$$

$$P.F = \cos(-49.47)$$

$$P.F = 0.64$$

26.09.2022
Monday

UNIT - V

STORAGE BATTERY

Battery

Battery is an electrochemical device which delivers electric energy by chemical reaction.

Classification of cells

1. primary cell

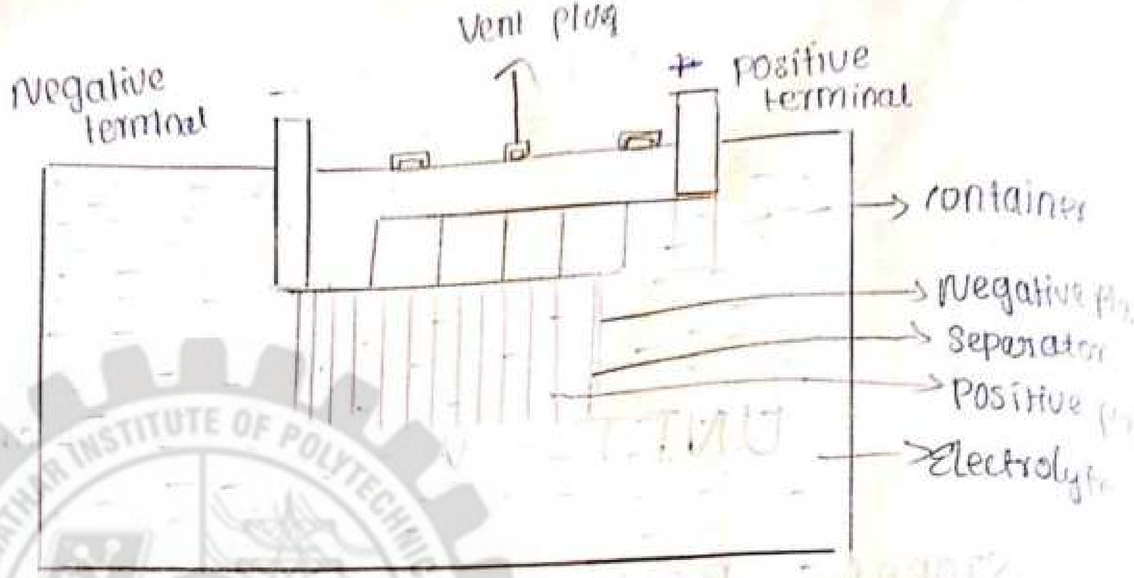
A cell which cannot be recharged is known as primary cell. ex: dry cell, voltaic cell.

2. Secondary cell

The cell which can be recharged and brought to the original state is known as secondary cell. ex: lead acid cell, alkaline cells.

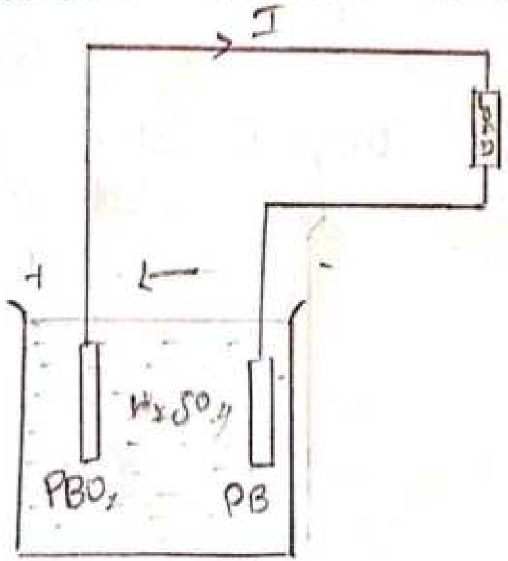
$$R_1 = \frac{R_{31} R_{12}}{R_{12} + R_{23} + R_{31}}$$

LEAD ACID BATTERY

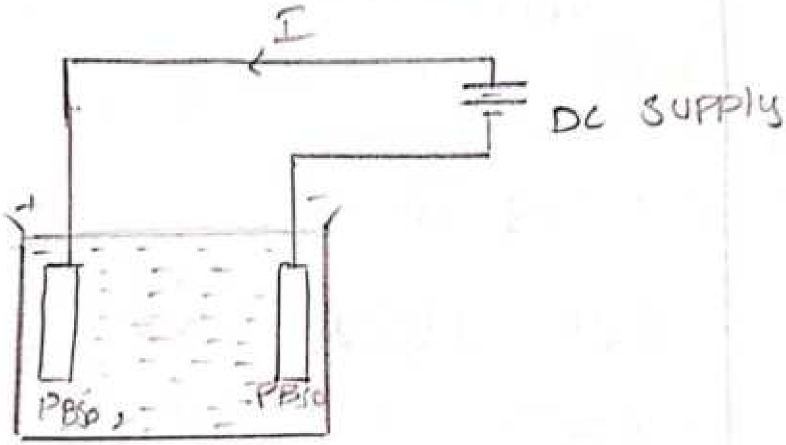


1. container
2. Positive plate - Anode - lead peroxide (PbO_2)
3. Negative plate - cathode - spongy lead (Pb)
4. Separator.
5. Electrolyte - sulphuric acid (H_2SO_4)
6. cell covers - Vent plug
7. cell connector
8. Battery terminal

Chemical reaction During discharging



Chemical reaction during charging

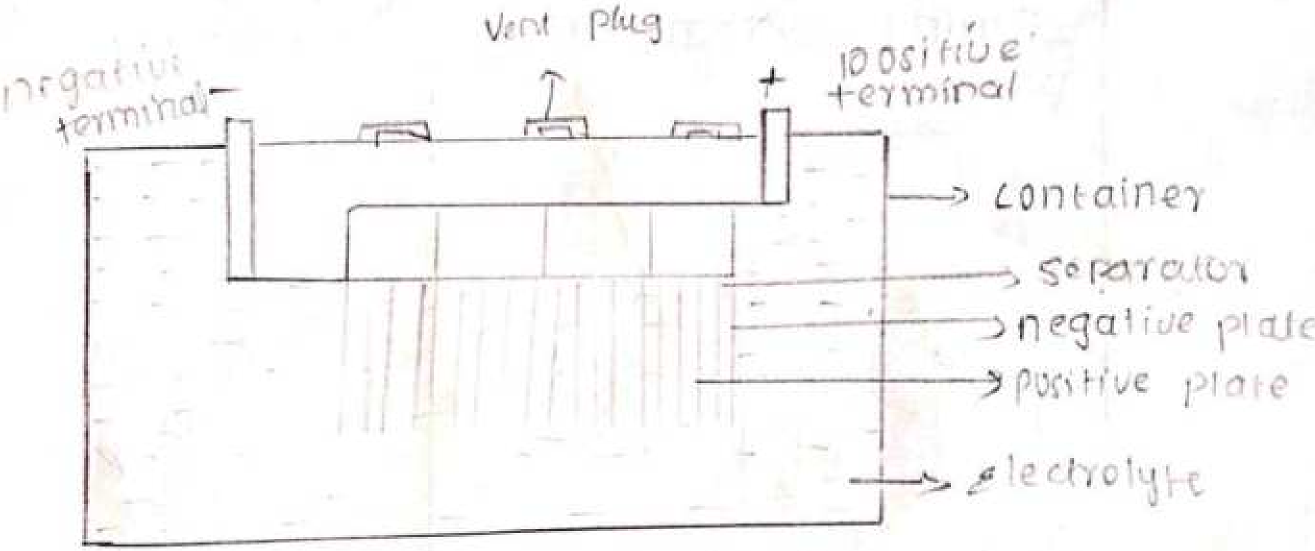


Alkaline cells

1. Nickel - Iron cell
2. Nickel - cadmium cell

Nickel - Iron cell

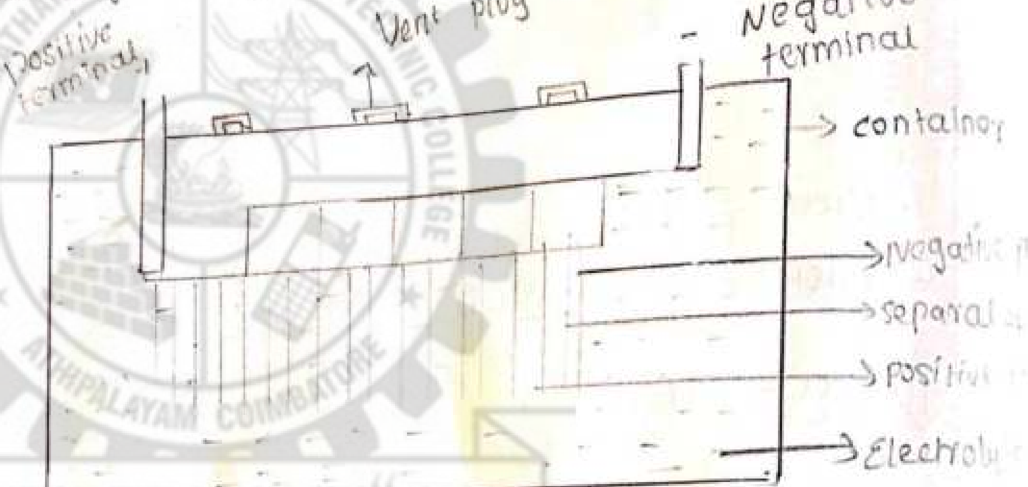
Positive plate - Nickel hydroxide $[Ni(OH)_4]$
Negative plate - Iron $[Fe]$
Electrolyte - potassium hydroxide (KOH)



4. Separator
5. container
6. cell covers - Vent plug
7. cell connectors
8. Battery terminals

Nickel cadmium cell

1. positive plate - Nickel hydroxide $[Ni(OH)_4]$
2. Negative plate - cadmium (Cd)
3. Electrolyte - pottassium hydroxide (KOH)

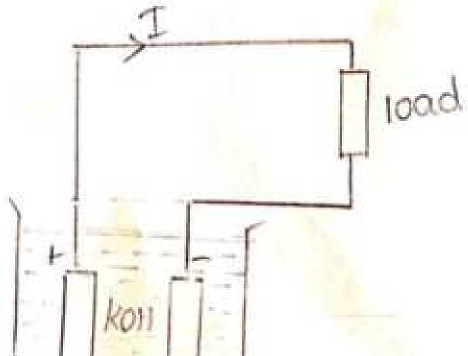


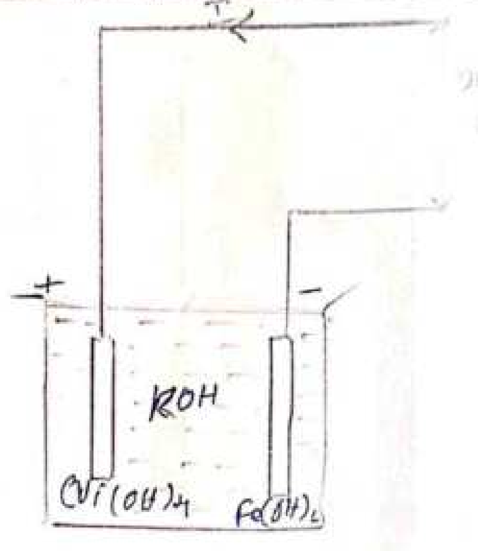
Nickel Iron cell

28. 09. 22
Wednesday:

During Discharging

During charging

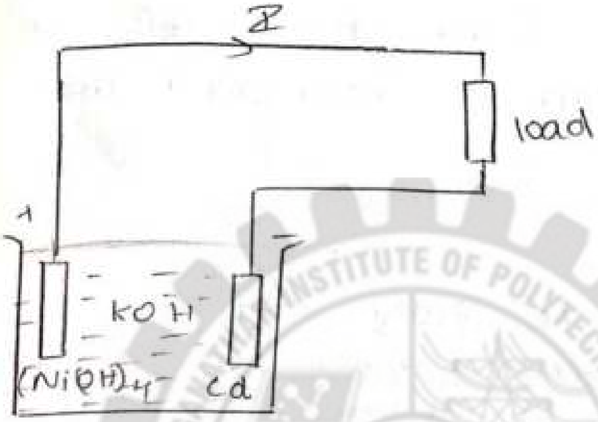




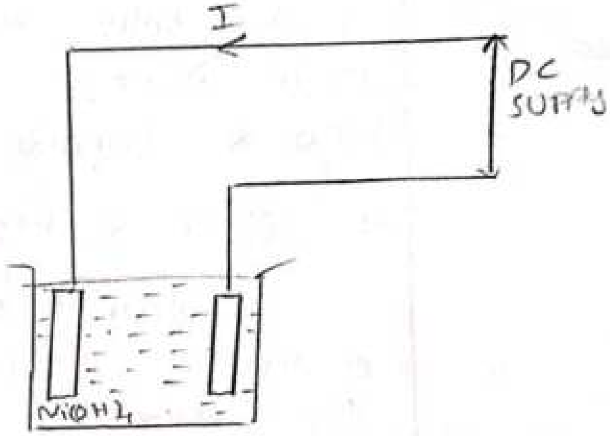
$Ni(OH)$ - Nickel hydroxide
Fe - Iron
KOH - pottasium hydroxide

Nickel cadmium cell

During discharging



During Chargi



$Ni(OH)_4$ - Nickel hydroxide
Cd - Cadmium
KOH - pottassium hydroxide

Indication of fully charged cell

1. Voltage
2. Grassing
3. Specific gravity of the electrolyte
4. colour of the plates

1. Voltage

- During charging the terminal voltage of a cell increases. The voltage per cell is 2.1 volts. This can be checked with the help of cell tester.

2. Grassing

When the cell is fully charged it freely gives of hydrogen at cathode and oxygen at anode.

3. Specific gravity of the electrolyte:

The specific gravity of the electrolyte of a fully charged lead acid cell is about 1.28. This can be measured with the help of hydro meter.

4. colour of plate

When the cell is fully charged the colour of positive plate becomes dark brown and the negative plate is grey.

~~de~~

Defects and their remedies in lead acid battery.

1. Sulphation
2. buckling
3. Internal short circuit
4. Sedimentation

1. Sulphation

If the discharged battey is not charged imediately or over discharged the sulphate deposit on the plates will become crystal.

To prevent this carbonate of soda and charging the battery at low rate for a long time.

2. buckling

buckling means bending of battey plates to ~~rectifiey~~ this replace the buckling plates.

Internal Short circuit:

The Short circuit may occur with damage of Separator. To rectify this replace the separators.

4. Sedimentation

due to charging and discharging small amout of active materials deposit in the container or electrolyte. To rectify this replace the electrolyte and clean the bottom surface.

29.09.2022
Thursday

Battery capacity

The capacity of battery is expressed in " Ampere - hours.

It depend upon

1. Size number of Plates
2. Quantity of electrolyte
3. Specific gravity of electrolyte
4. Rate of discharging.
5. Temperature.

Efficiency:

1) Ampere - hour Efficiency

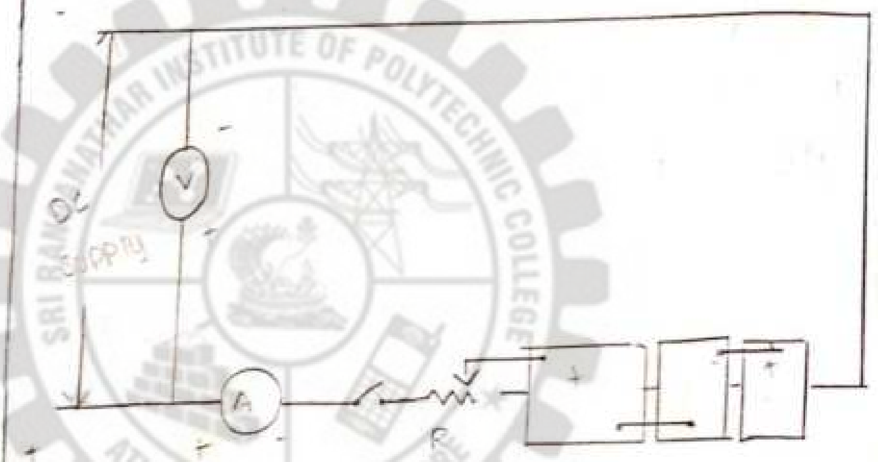
$$\text{AH Efficiency} = \frac{\text{Ampere hour output}}{\text{Ampere hour Input}} \times 100$$

2) Watts hour efficiency

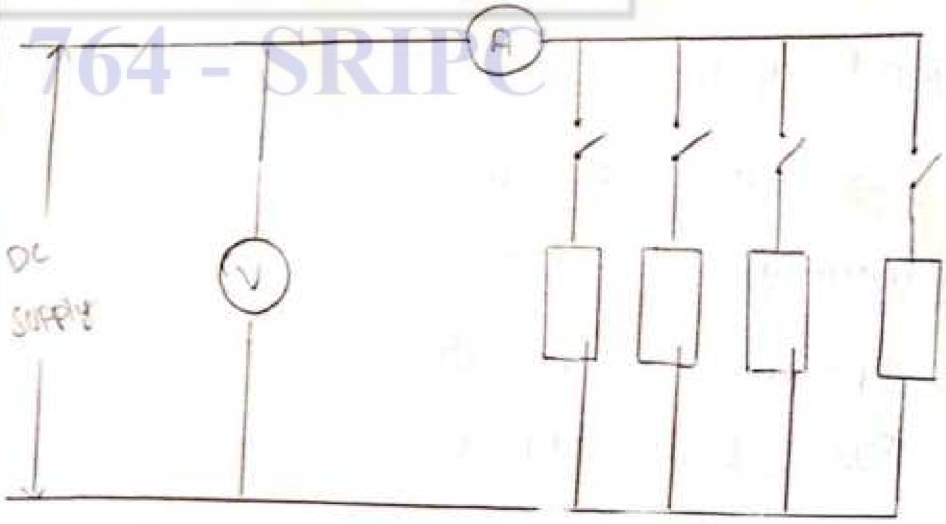
$$\text{Wh efficiency} = \frac{\text{watts hour output}}{\text{watts hour input}} \times 100$$

Methods of charging

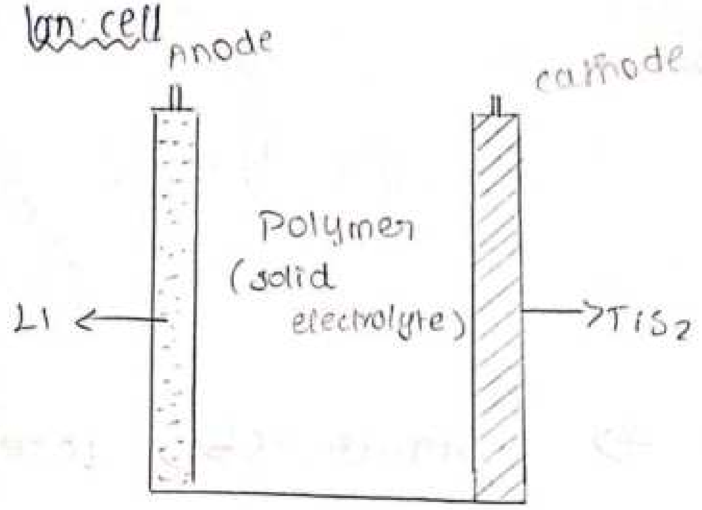
① constant current method :



② constant voltage method



lithium ion cell



Types

1. lithium cobalt oxide battery
2. lithium Iron phosphate battery.
3. lithium magnese oxide battery.
4. lithium Nickel cobalt aluminium oxide battery.
5. lithium Nickel magnese cobalt oxide battery
6. lithium titnate oxide battery.

Anode - Lithium - Li
cathode - Titanate sulphide [TiS_2]
~~Electrolyte~~ - polymer
Electrolyte

MERCURY CELL

30. 09. 2022