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23Z102 - BASICS OF ELECTRICAL AND ELECTRONIC SYSTEMS

(BEES)

Unit 1 : DC Circuits

Unit 2 : AC Circuits

Unit 3 : Magnetic induction and circuits

Unit 4 : Semiconductor devices

Unit 5 : Operational Amplifiers (OP AMP)

DC CIRCUITS :

Components :

i) Resistors

Ohm's Law - $V = IR$

Unit of resistance - Ohm (Ω)

Resistors are made up of carbon, ceramic or metals

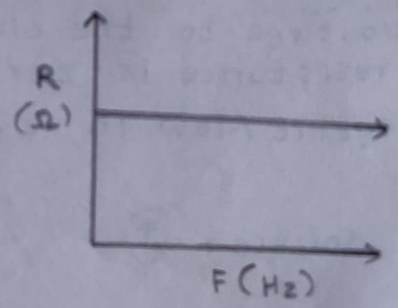
Power : $P = I^2R = VI$

COLOR CODE :

B B R O Y G B V G W

Tolerance : Gold, Silver, Colourless

Resistance is independent of frequency.



ii) Capacitors :

* Unit of Capacitance (C) = Farad (F)
* 1 F = 96500 C
* 1 C = 6.25×10^{18}
* Charge of electron = 1.6×10^{-19} C

$$\boxed{q = CV}$$

$$C = \frac{\epsilon A}{d}$$

* Capacitance varies with frequency.

iii) Inductors :

* Inductance (L)
* Unit - Henry (H)

$X_L = \omega L$ (Ω)

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

*

Power Source :

i) Voltage source

* Constant voltage to the circuit
* Internal resistance is zero for ideal cases and negligeble / low in reality.

ii) Current source :

* Constant current
* Internal resistance is open circuit for ideal case, and infinity for real cases.

Emf & Potential difference :

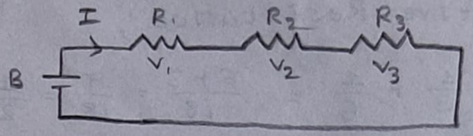
* Emf (Energy conversion)
* Potential difference (No energy conversion)

Resistors in series :

$R = R_1 + R_2 + R_3$

I is same

V is different



$V = iR$

$V_1 = iR_1$

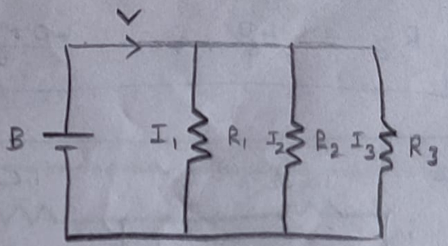
$\frac{V}{R} = \frac{V_1}{R_1}$; $V_1 = V\frac{R_1}{R}$; $\boxed{V_1 = V\frac{R_1}{R_1+R_2+R_3}}$

Resistors in parallel :

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

I is different

V is same



$V = IR$

$V_1 = I_1R_1$

$IR = I_1R_1$; $I_1 = \frac{IR}{R_1}$; $\boxed{I_1 = I\frac{R}{R_1}}$

$i\left[\frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}}\right] = i_1R_1$

$$\boxed{i_1 = i\left(\frac{R_2R_3}{R_1R_2+R_2R_3+R_3R_1}\right)}$$

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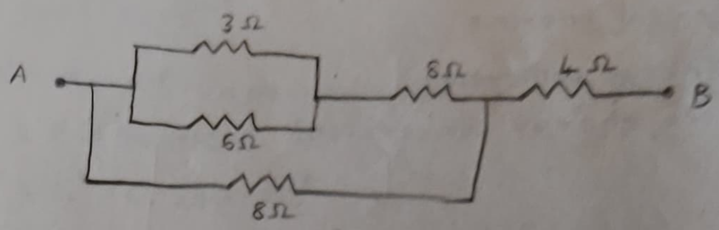
1)



Effective Resistance;

$$\frac{1}{R} = \frac{1}{3} + \frac{1}{6} = \frac{6+3}{18} = \frac{\cancel{9}}{\cancel{18}} = \frac{1}{2}$$

$$\boxed{R = 2\,\Omega}$$

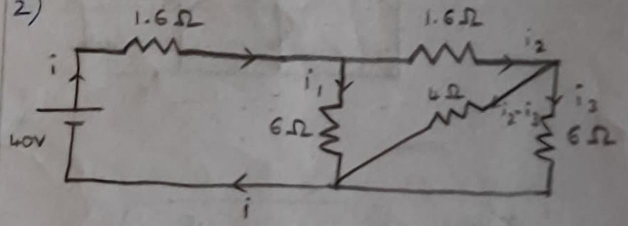
$$R_1 = 2\,\Omega + 8\,\Omega = 10\,\Omega$$

$$\frac{1}{R_2} = \frac{1}{10} + \frac{1}{8} = \cancel{\frac{8+10}{80}} = \cancel{\frac{18}{80}} = \cancel{\frac{9}{45}} = \frac{10+8}{80} = \frac{\cancel{18}}{\cancel{80}} = \frac{9}{40}$$

$$R_3 = \frac{5}{9} + 4 = \frac{5+36}{9} = \frac{41}{9}\,\Omega$$

$$\boxed{R_3 = \frac{40}{9} + 4 = \frac{40+36}{9} = \frac{76}{9}\,\Omega}$$

2)



$$r_1 = 1.6 + 6 = 7.6\,\Omega$$

$$\frac{1}{4} + \frac{1}{6} = \frac{6+4}{24} = \frac{\cancel{10}}{\cancel{24}} = \frac{5}{12}$$

$$\frac{12}{5} + 1.6 = \frac{12+8}{5} = \frac{\cancel{20}}{\cancel{5}} = 4$$

$$\frac{1}{4} + \frac{1}{6} = \frac{6+4}{24} = \frac{\cancel{10}}{\cancel{24}} = \frac{5}{12} = 2.4$$

$$2.4 + 1.6 = 4\,\Omega$$

$$\boxed{R_{eff} = 4\,\Omega}$$

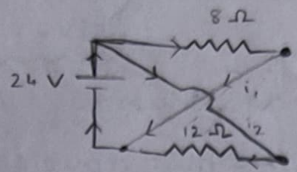
$$\begin{array}{r} \overset{3}{1.6} \\ \times 5 \\ \hline 8.0 \end{array}$$

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

$$I = \frac{\cancel{40}}{\cancel{4}}$$

$$\boxed{I = 10\,A}$$

3)



$$\begin{array}{r} 12 \\ \times 8 \\ \hline 96 \end{array}$$

$i_1 = \frac{V}{r_1} = \frac{24}{8} = 3\,A$

$i_2 = \frac{V}{r_2} = \frac{24}{12} = 2\,A$

$i = i_1 + i_2 = 5\,A$

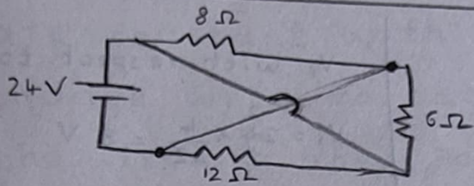
$\frac{1}{R_{eff}} = \frac{1}{8} + \frac{1}{12} = \frac{12+8}{96} = \frac{20}{\cancel{96}_{48}} = \frac{10}{48}$

$= \frac{5}{24}$

$\frac{24}{5} = 4.8$

$I = \frac{V}{R} = \frac{24}{\frac{24}{5}} = 5\,A$

4)



$$\begin{array}{r} 96 \\ \times 6 \\ \hline 576 \end{array} \qquad \begin{array}{r} 12 \\ \times 6 \\ \hline 72 \end{array} \qquad \begin{array}{r} 72 \\ 48 \\ 96 \\ \hline 216 \end{array}$$

$\frac{1}{R_{eff}} = \frac{1}{8} + \frac{1}{12} + \frac{1}{6} = \frac{72+48+96}{576} = \frac{216}{576}$

$R_{eff} = \frac{8}{3}\,\Omega$

$I = \frac{V}{R_{eff}} = \frac{24}{\frac{8}{3}} = 3 \times 3 = 9\,A$

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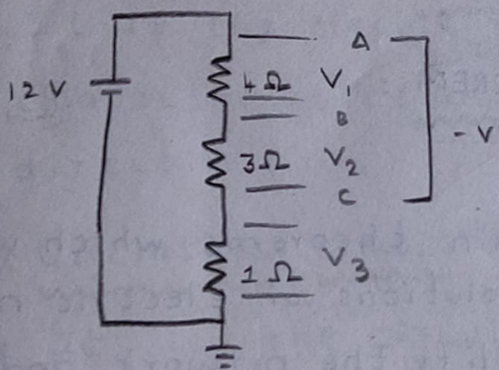


$V_1 = V \times \frac{R_1}{R_1 + R_2 + R_3}$

$R_{eff} = 4 + 3 + 1 = 8\,\Omega$

$V = IR$

$I = \frac{V}{R} = \frac{\cancel{12}}{\cancel{8}} = \frac{3}{2} = 1.5$

$V_1 = IR_1 = 1.5 \times 4 = 6$

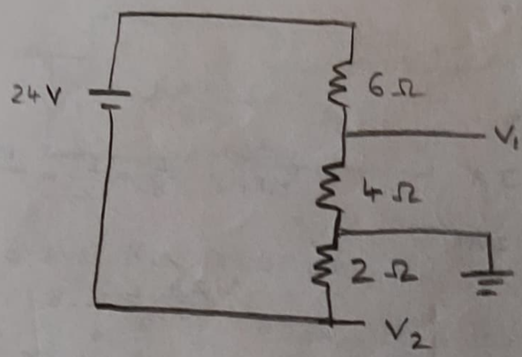
$V_2 = IR_2 = 1.5 \times 3 = 4.5$

$V_3 = IR_3 = 1.5 \times 1 = 1.5$

$V = V_1 + V_2$

$= 6 + 4.5$

$= 10.5\,V$



$R_{eff} = 12\,\Omega$

$I = \frac{V}{R} = \frac{\cancel{24}}{\cancel{12}} = 2\text{ A}$

$V_1 = IR_1 = 2 \times 6 = 12\text{ V}$

$V_2 = IR_2 = 2 \times 4 = 8\text{ V}$

$V_2 = IR_3 = 2 \times 2 = 4\text{ V}$

V_1 with respect to ground:

$V_1 = \overset{2}{\cancel{24}} \times \frac{4}{\cancel{12}} = 8\text{ V}$

$V_2 = \overset{2}{\cancel{24}} \times \frac{2}{\cancel{12}} = -4\text{ V}$ (V_2 is at negati

V_1 is positive with respect to ground.

V_2 is negative with respect to ground.

9/24 DEFINITIONS :

NETWORK THEOREM :

* There are certain theorems which when applied to the solutions of electric network the theorem simplify the network and rende their analytical solutions very easily. These theorems can also be applied to AC network where the impedance replace the ohmic resistance of DC systems.