Chapter-1 Fundamentals of Electronics

-> History of Electronics
-> Applications
    Communication
    Entertainment
    Consumer
    Automobiles
    Biomedical
-> Electrical Fundamentals
    Current, Voltage, DC, Amplitude, Frequency
-> Ohms law, KCL, KVL.
-> Resistance, Capacitance, Inductance
    Series - parallel combinations
-> Concept of Impedence.

History of Electronics

Electronics is a branch of science that deals with the flow of electrons & their effects in materials such as Vacuum, gas & Semiconductors. The main difference blw Electronics & Electrical is that electronics deals with lower voltages and power sources & But it has the capability of controlling

higher range of voltage, current and power in the order of kilo and Mega units

Important milestones in the history of Electronics

1897 - Discovery of e^- by J. J. Thomson

Thomas A. Edison found out that e^- will flow from one metal conductor to another through Vacuum

1904 - John Fleming invented Vacuum tube (Vacuum diode) two element

1906 - Lee De forest invented Vacuum Triode Three-element tube

1927 - Bell laboratories demonstrated first TV.

1947 - William Shockley of Bell laboratories invented Transistor

1956 - Development of Thyristor (SCR - Silicon controlled Rectifier)

1958 - Jack Kilby of Texas instruments introduced idea about IC

1960 - number of components fabricated on a single chip increased.

Small scale	Integration	SSI - 100 Transi
Medium	"	MSI - 100-1000
Large	"	LSI - 1000-10000
Very Large	"	VLSI - >10000
Ultra large	"	ULSI - >100000

1971 - Intel introduced first microprocessor Intel 4004 (4-Bit)

1972 - 8-bit microprocessor

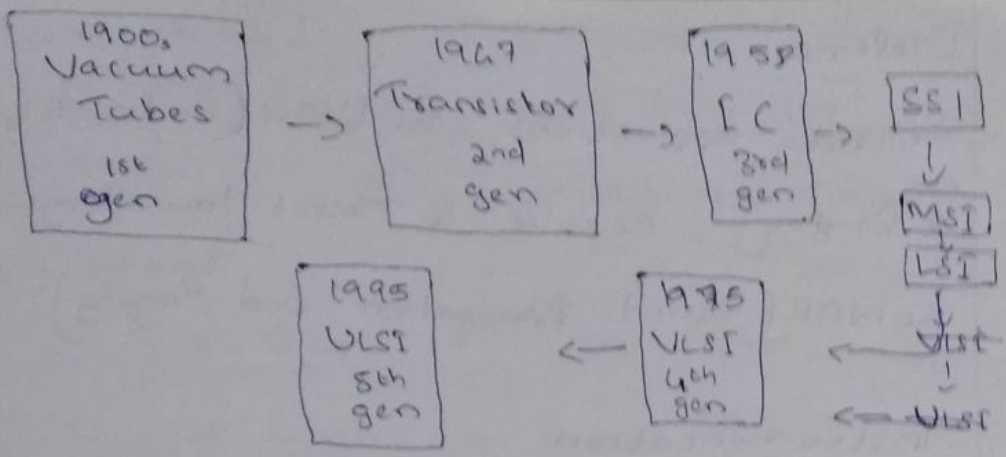
1993 - Pentium microprocessor

1995 - DVD (digital Versatile/video Disc) invented

1997 - Electronics companies rises, also, wifi, Blutooth

2007 - Apple introduced Iphones

2015 - Super computers



*** Applications of Electronics

Communication.

Telegraphy, Telephony, FAX, Radio communication Television, Cable connectivity, mobile communication, Internet usage ; Wifi Bluetooth etc.

Entertainment

Music players, public Addressing systems, Television, ~~Ved~~ video games etc.

Medical Field

ECG (Electro Cardio Gram) EEG, (Electro Encefalo Gram) CT (Computed Tomography) scan, MRI (Magnetic Resonance imaging) Ultra Sound scan, ESU (Electro Surgical unit) etc.

Defence

Military applications, RADAR (Radio detecting and Ranging), Missiles & Rocket launching

SONAR (Sound Navigation And Ranging)

Instrumentation

CRO (Cathode Ray Oscilloscope) Frequency counters Signal generators etc.

Electrical Fundamentals

① Voltage (EMF, Potential Difference)

EMF - Electro Motive force

It is the force required to move electrons from one point to another point. Unit of voltage is 'Volt' (V)

$$1 \text{ Volt} = 1 \text{ Joule} / \text{Coulomb (C)}$$

ⓐ Voltmeter is the instrument used to measure Voltage.

Current (I)

Current is the rate of flow of charges ($\bar{e}$). Simply we can say that no: of charges per second.

$$I = Q/T = \text{Charge} / \text{Time}$$

Unit of Current is Ampere (A)

Ammeter is the device used to measure current

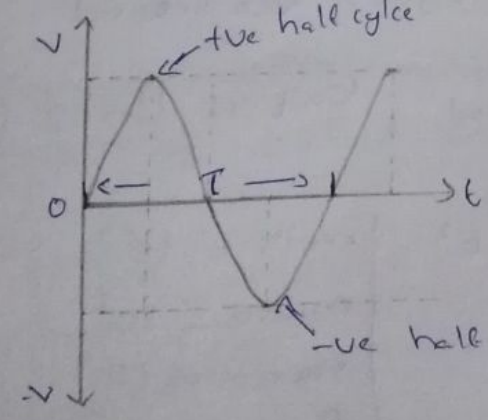
Resistance (R)

It is defined as the property of the ~~substan~~ substance to oppose the flow of electrons

Unit of electrons is 'ohm' (Ω).

AC - Alternating Current

AC wave form

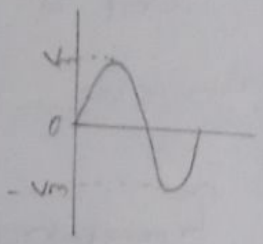


The +ve portion of an AC waveform is called +ve half cycle and -ve portion is -ve half cycle

A complete cycle is the combination of a +ve and -ve half cycle.

Amplitude (Peak Value or Max Value)

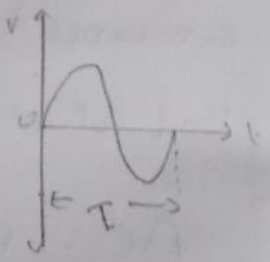
It is the maximum value during a half cycle



represented by Vm for voltage
Im for current

Time Period (T)

The time taken to complete one full cycle.



Frequency (f)

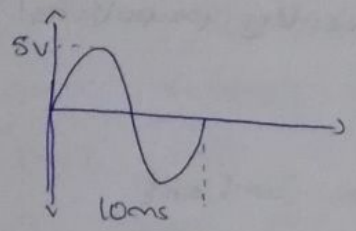
It is the no: of cycles per second.

$f = \frac{1}{T} = \frac{1}{\text{Time period}}$ Unit is Hertz (Hz)

Kilo $= 10^3$	Tera $= 10^{12}$
Mega $= 10^6$	
Giga $= 10^9$	

milli $= 10^{-3}$	
micro $= 10^{-6}$	
nano $= 10^{-9}$	
Pico $= 10^{-12}$	

Q. Find the time period, ~~Fere~~ Frequency and Amplitude of wave given below.



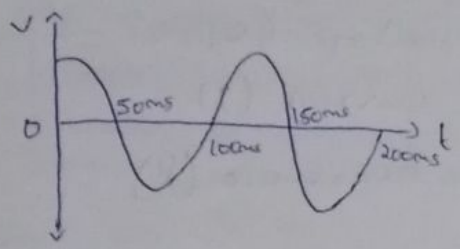
$V_m = 5V$

$T = 10ms = 10 \times 10^{-3}$

$f = \frac{1}{T} = \frac{1}{10 \times 10^{-3}} = \frac{1000}{10}$

$= 100\ Hz$

Q. Find Time period and Frequency.

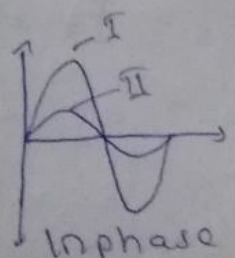


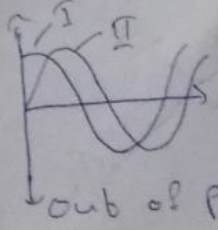
Ans $T = 100ms = 100 \times 10^{-3}\ s.$

$f = \frac{1}{T} = \frac{1}{100 \times 10^{-3}} = 10\ Hz$

Phase difference

Angular displacement b/w Two or more signals is called ~~a~~ phase difference.





OHM's Law

At constant Temperature current flowing through a conductor is directly proportional to its applied voltage

$$V \propto I \quad | \text{ Temperature Constant}$$

$$\frac{V}{I} = \text{Constant}$$

$$V/I = R \text{ (Resistance)}$$

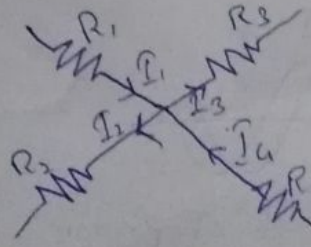
$V = IR$ V = Voltage (V)

$I = V/R$ I = Current (I)

$R = V/I$ R = Resistance (R)

KCL (Kirchoff's Current Law) or Junction Rule

In any Closed Circuit ~~Junction~~, the Algebraic sum of Current meeting at a junction is equal to zero. ie Incoming Current to a junction is equal to Outgoing Current.



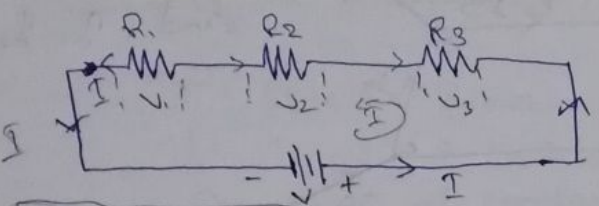
$$I_1 + I_4 = I_2 + I_3$$

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

KVL (Kirchoff's Voltage Law)

The Algebraic sum of voltage drops across each resistor in a closed path and EMF in that path is equal to zero

ie, sum of voltage sources = sum of resistive drops



$V_1 = IR_1$

$V_2 = IR_2$

$V_3 = IR_3$

by conversion
+ve to -ve → +ve sign
-ve to +ve → -ve sign

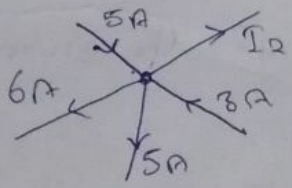
So, by KVL

$$V - IR_1 - IR_2 - IR_3 = 0$$

$$V = IR_1 + IR_2 + IR_3$$

Problems

Q. Fin I_2

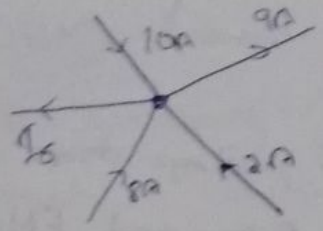


Ans By KCL Sum of incoming currents = sum of outgoing currents

So, $5 + 3 = 6 + 5 + I_2$

$8 = 11 + I_2 \Rightarrow I_2 = -3A$ //

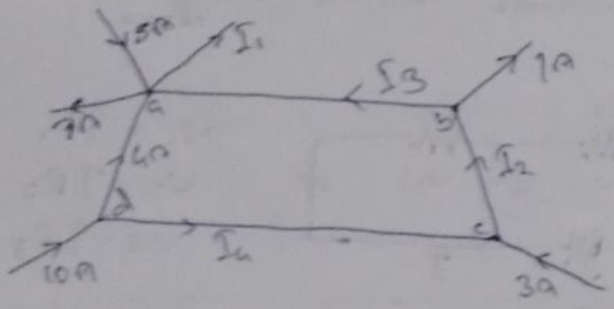
Q1



Find I_5

$10 + 8 + 2 = 9 + I_5 \Rightarrow I_5 = 11A$ //

Q2



Find I_1, I_2, I_3, I_4?

(a) d $10 = 4 + I_4 \Rightarrow I_4 = 6A$ //

(a) c $I_4 + 3 = I_2 \Rightarrow I_2 = 6 + 3 = 9A$

(a) b $I_2 = I_3 + 1 \Rightarrow 9 = I_3 + 1 \Rightarrow I_3 = 8A$

(a) a ~~$I_3 + 5 = 7 + I_1 \Rightarrow 8 + 5 = 7 + I_1 \Rightarrow I_1 =$~~

$I_3 + 5 + 4 = 7 + I_1 \Rightarrow 8 + 5 + 4 = 7 + I_1$

$\Rightarrow I_1 = 10A$ //

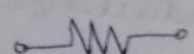
Q Find the value of R, if the given $V = 12V$ and $I = 3A$

$R = \frac{V}{I} = \frac{12}{3} = 4\Omega$

Resistance (R)

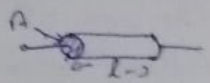
It is the fundamental property of conductor to oppose the flow of current through it.

Unit is ohm (Ω).

Symbol for Resistor - 

Resistance of a Conductor (R) = $\rho \frac{l}{A}$

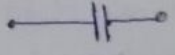
ρ = Specific Resistance of a Conductor
l = length of Conductor
A = Area of ~~Conductor~~ Crossection



Capacitance (C)

It is the measure of ability to store electric charges b/w two charged plates.

Unit - ~~F~~ Farad (F) device - Capacitor

Symbol - 

Capacitance (C) = $\frac{Q}{V}$

Q = charge in Coloumb
V = Potential difference in Volt

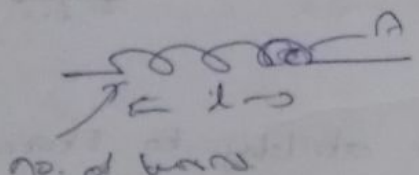
Inductance (L)

It is the property of a coil to oppose the change of current flowing through it.

Unit of Inductance = Henry (H)

$$\text{Inductance}(L) = \frac{N^2 \mu A}{l}$$

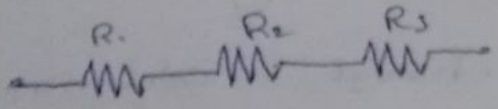
where N = no. of turns
μ = Permiability of core
A = Area of cross section
l = length of core.



Symbol of inductor -

Series & Parallel Combinations

Series connection



components are connected end to end in a line to form a single path.

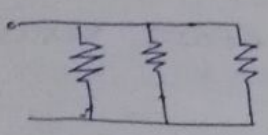
Only one path for current flow

$R_T = R_1 + R_2 + R_3$

$I = V/R_T$

V_1, V_2, V_3 are different I same

Parallel connection



many path for current flow

Components are connected across each others leads

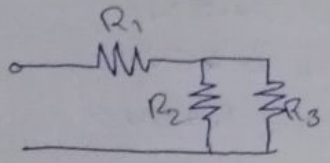
$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

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

V_1 are same

I different.

Series & Parallel

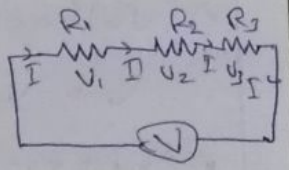


Here R_2 and R_3 are in Parallel ~~with~~ and both are ~~to~~ serially connected to R_1

Series connection

- In series connection

Voltage across each component are different but currents same



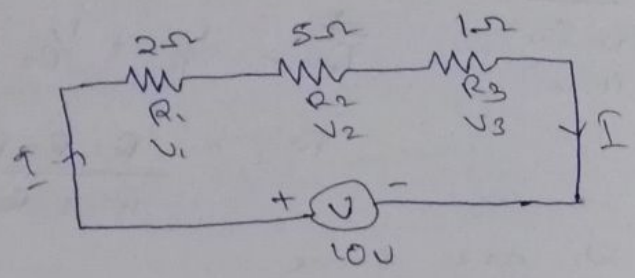
$\therefore$ i.e $V = V_1 + V_2 + V_3$

- Total Resistance = sum of individual Resistance.

$$R_T = R_1 + R_2 + R_3 \ldots + R_n$$

* In series effective resistance is higher than the highest value of Resistance connected ie, this connection increases resistance

Eg :-



$R_T = 2 + 5 + 1 = 8\Omega$

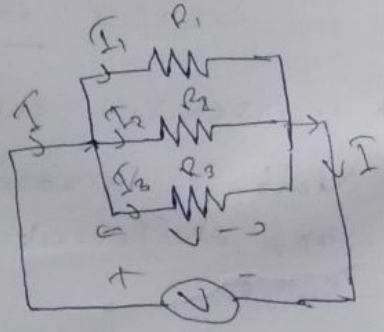
$I = 10/8 = 1.25A$ //

$V_1 = 1.25 \times 2 = 2.5V$ //

$V_2 = 1.25 \times 5 = 6.25V$ //

$V_3 = 1.25 \times 1 = 1.25V$ //

Parallel combination



* Voltage same

$V = V_1 = V_2 = V_3 \ldots$

* Current different

$I = I_1 + I_2 + I_3$

The effective resistance of 'n' resistors in parallel

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

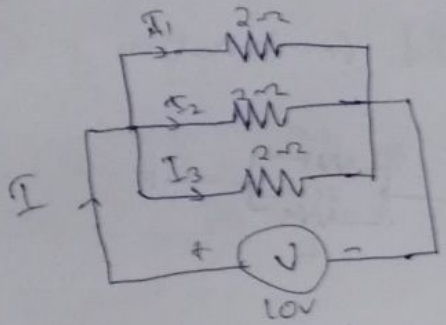
c) Total Resistance will be less than lowest resistance connected to parallel.

d) This combination used to reduce total Resistance

e) If 'n' no. of same resistors connected in parallel

$$R_T = \frac{R}{n}$$ n = no of Resistors

Eg:



$V = 10 = V_1 = V_2 = V_3$

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

$1/R_T = 1/2 + 1/2 + 1/2 = 3/2$

$R_T = 2/3 = 0.66\overline{6}$

$= 0.67\Omega$

$I = 5 + 5 + 5 = 15A$

or $I = \frac{V}{R_T} = \frac{10}{0.66}$

$= 15.15A$

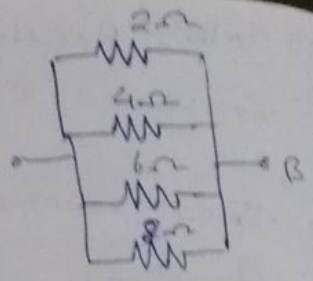
$I_1 = \frac{V_1}{R_1} = \frac{10}{2} = 5A$

$I_2 = \frac{V}{R_2} = \frac{10}{2} = 5A$

$I_3 = \frac{V}{R_3} = \frac{10}{2} = 5A$

Problems

Find Total Resistance -

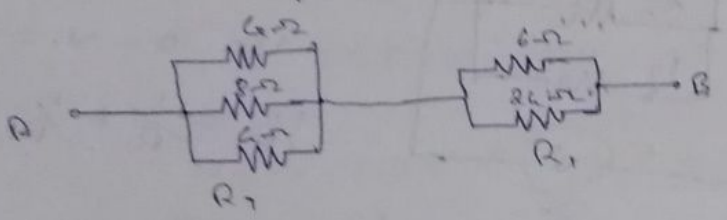


$$\frac{1}{R_T} = \frac{1}{2} + \frac{1}{4} + \frac{1}{6} + \frac{1}{8}$$

$$= \frac{12 + 6 + 4 + 3}{24} = \frac{25}{24}$$

$$R_T = 24/25 = 0.92\,\Omega$$

Series - Parallel Combination



$$\frac{1}{R_1} = \frac{1}{4} + \frac{1}{8} + \frac{1}{4} = \frac{2+1+2}{8} = \frac{5}{8}$$

$$R_1 = 8/5 = 1.6\,\Omega$$

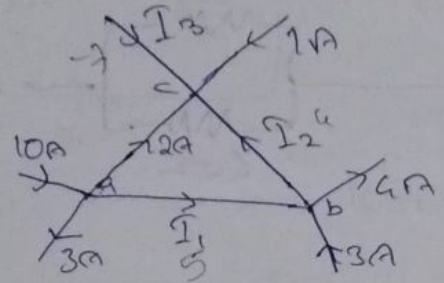
$$\frac{1}{R_2} = \frac{1}{6} + \frac{1}{24} = \frac{4+1}{24} = \frac{5}{24}$$

$$R_2 = 24/5 = 4.8\,\Omega$$

$$R_T = R_1 + R_2 = 1.6 + 4.8$$

$$= 6.4\,\Omega$$

a



Find, I_1, I_2, I_3

a)

(g) ~~a $10 + 2 = 2 + I_1 \Rightarrow I_1 = 10$~~

(g) a $10 = 3 + 2 + I_1 \Rightarrow I_1 = 5A$

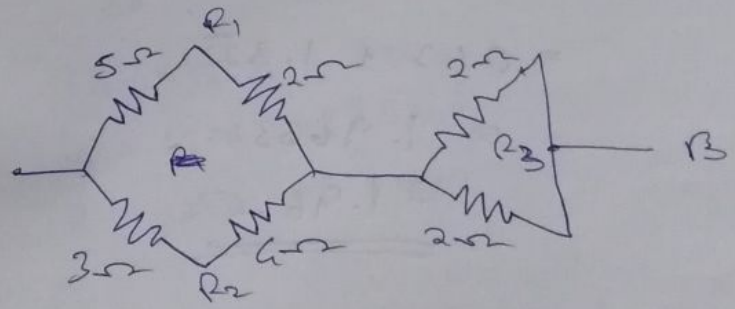
(g) b $I_1 + 3 = 4 + I_2 \Rightarrow I_2 = 4A$

(g) c $I_2 + 1 + 2 + I_3 = 0$

$4 + 1 + 2 = -I_3 \Rightarrow I_3 = -7A$

So, I_3 is outgoing not incoming

b)

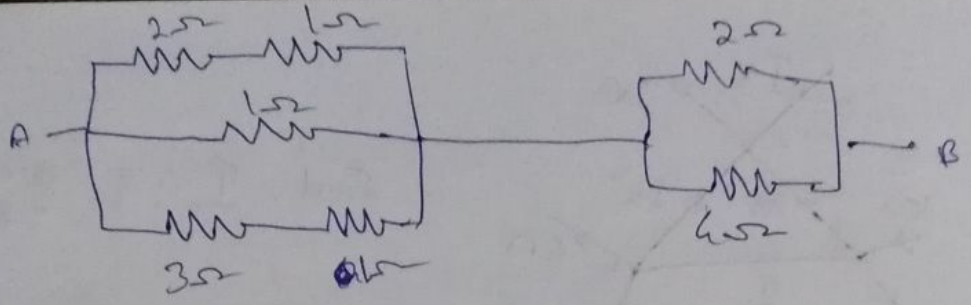


$R_1 = 5 + 2 = 7\Omega$ $\quad R_2 = 3 + 4 = 7\Omega$

$R_1 \| R_2 = \frac{1}{7} + \frac{1}{7} = \frac{2}{7} \rightarrow \frac{7}{2} = 4.5\Omega$

$R_3 = \frac{R}{n} = \frac{2}{2} = 1\Omega$

$R_T = 1 + 4.5 = 5.5\Omega$



4.

5)

① $\frac{1}{R_T} = \frac{1}{3} + 1 + \frac{1}{4} = \frac{12+3+4}{12} = \frac{19}{12}$

$R_T = \frac{12}{19}\,\Omega$

$\frac{1}{R_{T.2}} = \frac{1}{2} + \frac{1}{4} = \frac{3}{4}$

$R_{T_2} = 4/3\,\Omega$

$R_T = \frac{12}{19} + \frac{4}{3}$

$= 0.63 + 1.3\bar{3}$

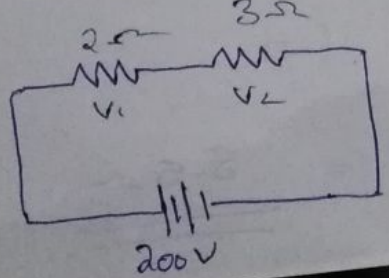
$= 1.9633\ldots$

$\approx 1.96\,\Omega$

5

.63
19 | 120
114
60
57
3
19
5
95
5
19
6
114
3
19
1
57

Q. Calculate the total Resistance in the ckt and also find Current and voltage drop across each resistor

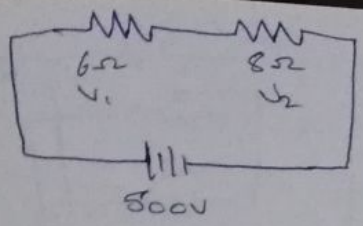


$R_T = 2 + 3 = 5\,\Omega$

$I = 200/5 = 40\,A$

$V_{2\Omega} = 2 \times 40 = 80\,V$ //

$V_{3\Omega} = 3 \times 40 = 120\,V$ //

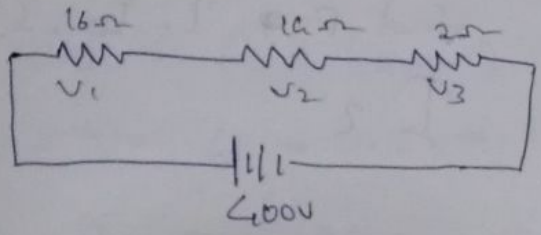
4. 

Find R_T, I, V_1 and V_2

a) $R_T = 6 + 8 = 14\Omega$ $\quad I = \frac{500}{14} = 35.7A$

$V_{6\Omega} = 35.7 \times 6 = 214.2V$

$V_{8\Omega} = 35.7 \times 8 = 285.8V$

5 

Find out R_T, I, V_1, V_2, V_3

$R_T = 16 + 14 + 2 = 32\Omega$

$I = \frac{400}{32} = 12.5A$

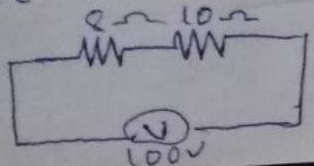
$V_1 = 16 \times 12.5 = 200V$

$V_2 = 14 \times 12.5 = 175V$

$V_3 = 2 \times 12.5 = 25V$

Q Two Resistors 8Ω, 10Ω are connected in series across a 100V supply. Findout the Total Resistance total current and voltage drop across each resistor with the help of Ckt.

Ans Ckt of the given situation -



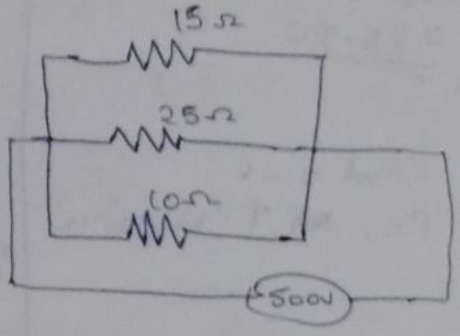
4 $R_T = 8 + 10 = 18\Omega$

$I = \frac{100}{18} = 5.55A$ //

$V_1 = 8 \times 5.55 = 44.4V$ //

$V_2 = 10 \times 5.55 = 55.5V$ //

Q



Find R_T, I, I_1, I_2, I_3

I ?

a) $\frac{1}{R_T} = \frac{1}{15} + \frac{1}{25} + \frac{1}{10} = \frac{10 + 6 + 15}{150} = \frac{31}{150}$

$R_T = \frac{150}{31} = 4.83\Omega$

$I_1 = \frac{500}{15} = 33.33A$ //

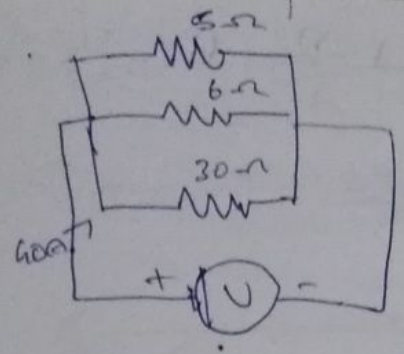
$I_2 = \frac{500}{25} = 20A$

$I_3 = \frac{500}{10} = 50A$ //

$I = 50 + 20 + 33.33A$

$= 103.33A$

8



Find R_T, V, I_1, I_2, I_3

a) $\frac{1}{R_T} = \frac{1}{5} + \frac{1}{6} + \frac{1}{30} = \frac{6+5+1}{30} = \frac{12}{30}$

$R_T = \frac{30}{12}\Omega = 2.5\Omega$

$I = 40A$ (given)

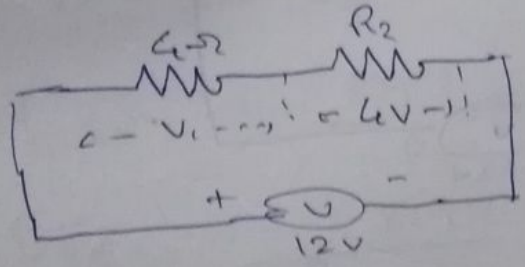
$V = 40 \times 2.5 = 100V$ //

$I_1 = \frac{100}{5} = 20A$

$I_2 = \frac{100}{6} = 16.66A$

$I_3 = \frac{100}{30} = 3.33A$

4.



Find V_1, I_1, R_2 and R_T

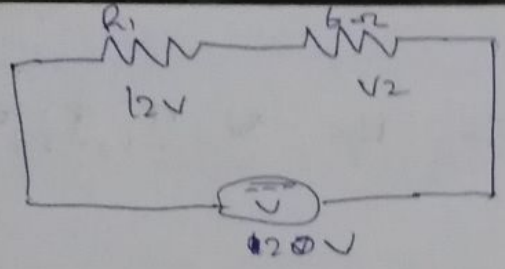
a) $V_1 = 12 - 4 = 8V$

$I = \frac{8}{4} = 2A$

$R_2 = \frac{4}{2} = 2\Omega$

$R_T = 6\Omega$

(4+2)

10. 

Find R_1, R_T, V_2 and I

a) $V_2 = 20 - 12 = 8V$

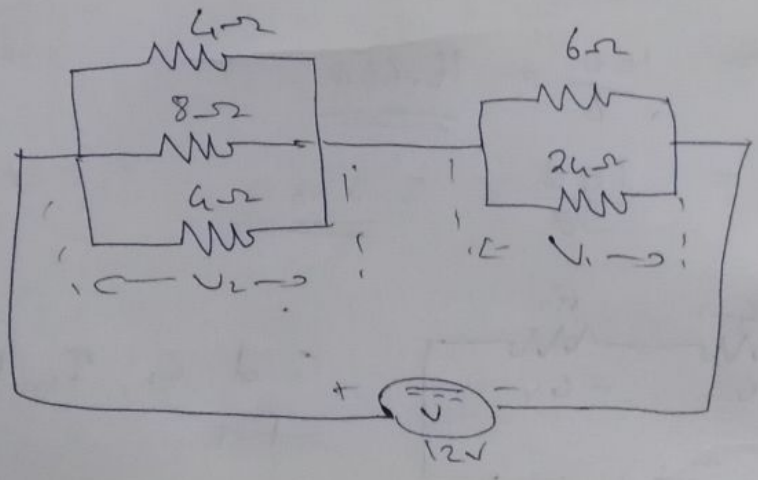
$I = \frac{8}{6} = \underline{1.33A}$

$R_T = 6 + 9.022$

$= \underline{15.02\Omega}$

$R_1 = \frac{12}{1.33} = \underline{9.022\Omega}$

11 Find current flowing through each resistor using given data



$\frac{1}{4} + \frac{1}{8} + \frac{1}{4} = \frac{5}{8} \Omega = \frac{8}{5} = \underline{1.66\Omega}$

$\frac{1}{6} + \frac{1}{24} = \frac{5}{24} \Omega \quad \frac{24}{8} = 4.8\Omega$

$R_T = 4.8 + 1.6 = \underline{6.4\Omega}$

$I_{4\Omega} = \frac{12}{4} = 3A$

$I_{8\Omega} = \frac{12/6}{8} \frac{3}{2} = 1.5A$

$I_{4\Omega} = 12/4 = 3A \quad I = 3+3+1.5 = 7.5$

$V_{1.66\Omega} = 1.66 * 7.5$

$I = \frac{12}{6.4} = 1.87A$

$V_{1.66\Omega} = 1.87 \times 1.66 = 2.99V$

$V_{4.8\Omega} = 1.87 \times 4.8 = 8.97V$

$I_{4\Omega} = \frac{2.99}{4} = 0.7475A$

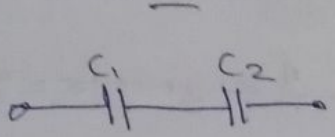
$I_{8\Omega} = \frac{2.99}{8} = 0.3737A$

$I_{6\Omega} = \frac{8.97}{6} = 1.495A$

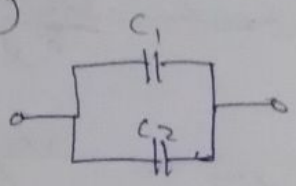
$I_{24\Omega} = \frac{8.97}{24} = 0.3737A$

Capacitor & Inductor Ckt connecting

Capacitor - Capacitance (C)

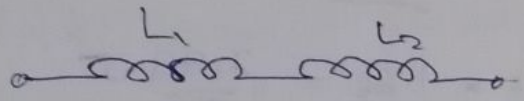


$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2}$$

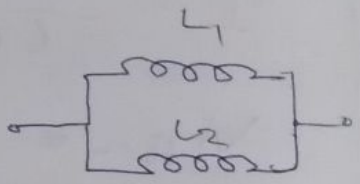


$$C_T = C_1 + C_2$$

Inductor - Inductance (L)



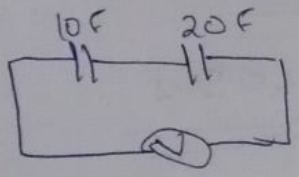
$$L_T = L_1 + L_2$$



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

Q Find the effective Capacitance and Inductance of the following Ckt

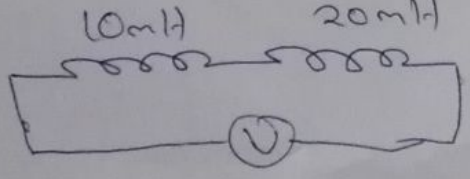
1)



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

$$= \frac{1}{10} + \frac{1}{20} = \frac{3}{20} \Omega \qquad \frac{20}{3} = \underline{6.66\,F}$$

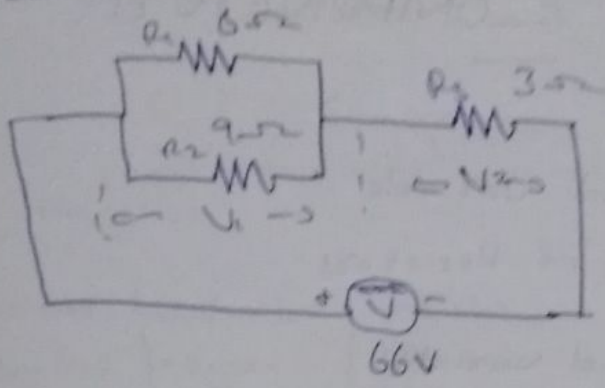
2)



$$\therefore L_T = L_1 + L_2$$

$$\therefore L_T = 10 + 20 = \underline{30\,mH}$$

Q Find Total Resistance, current passing through each resistor and voltages across each resistor



$$\frac{1}{6} + \frac{1}{9} = \frac{3+2}{18} = \frac{5}{18} \quad \Omega \quad \frac{18}{5} = \underline{3.6\Omega}$$

$$R_T = 3.6 + 3 = 6.6\Omega$$

$$I = \frac{66}{6.6} = 10A //$$

$$V_{3.6\Omega} = 10 \times 3.6 = 36V //$$

$$V_{3\Omega} = 10 \times 3 = 30V //$$

$$I_{6\Omega} = \frac{36}{6} = \underline{6A}$$

$$I_{9\Omega} = \frac{36}{9} = \underline{4A}$$

$$I_{3\Omega} = \underline{10A} = I$$