Pr2. CIRCUIT AND SIMULATION LAB

Name of the Course: Diploma in Electrical Engineering			
Course code:		Semester	3rd
Total Period:	90	Examination :	3hrs
Lab. periods:	6 P / week	Sessional:	50
Maximum marks:	100	End Semester Examination ::	50

A. Rationale:

The response of Electrical Circuit can be verified practically by applying different theorems and fundamental techniques. The students will become sure that the theoretical tricks which they have learned from books are true. The students will become competent in the field of circuit analysis

B. Objective:

On completion of the lab course the student will be able to:

1. Verify the theorems using different components.
2. Know the various types of filters.
3. Simulate different circuits using P-Spice/MATLAB software.

C. Course content in terms of specific objectives:

1. Measurement of equivalent resistance in series and parallel circuit
2. Measurement of power and power factor using series R-L-C Load.
3. Verification of KCL and KVL.
4. Verification of Super position theorem
5. Verification of Thevenin's Theorem
6. Verification of Norton's Theorem
7. Verification of Maximum power transfer Theorem
8. Determine resonant frequency of series R-L-C circuit.
9. Study of Low pass filter & determination of cut-off frequency
10. Study of High pass filter & determination of cut-off frequency
11. Analyze the charging and discharging of an R-C & R-L circuit with oscilloscope and Compute the time constant from the tabulated data and determine the rise time graphically.
12. Construct the following circuits using P-Spice/MATLAB software and compare the measurements and waveforms.
    - i. Superposition theorem
    - ii. Series Resonant Circuit
    - iii. Transient Response in R-L-C series circuit

Note: P-Spice/MATLAB software might be loaded in 10 systems.

Aim of the Experiment :-

Varification of Ohm's law.

Apparatus Required :-

1. C.T. Trainer Kit
2. Patch Cord

Theory :-

OHM'S LAW :- This law states that as long as physical conditions remains same. The electric current flowing through a conductor is proportional to the voltage applied across it and is given by :

$$I = V/R$$

Where 'R' is the resistance of the conductor to current flow in ohms.

'V' is the voltage in volts.

'I' is the current in Ampers.

The above expression can be put in different forms as below.

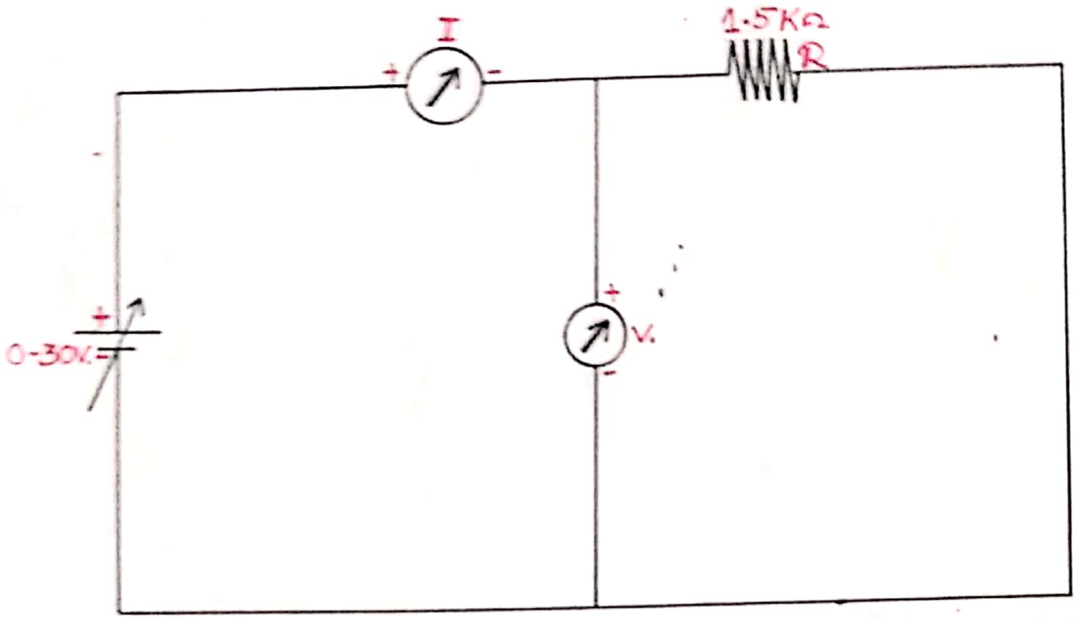
$$V = IR$$

$$R = V/I$$

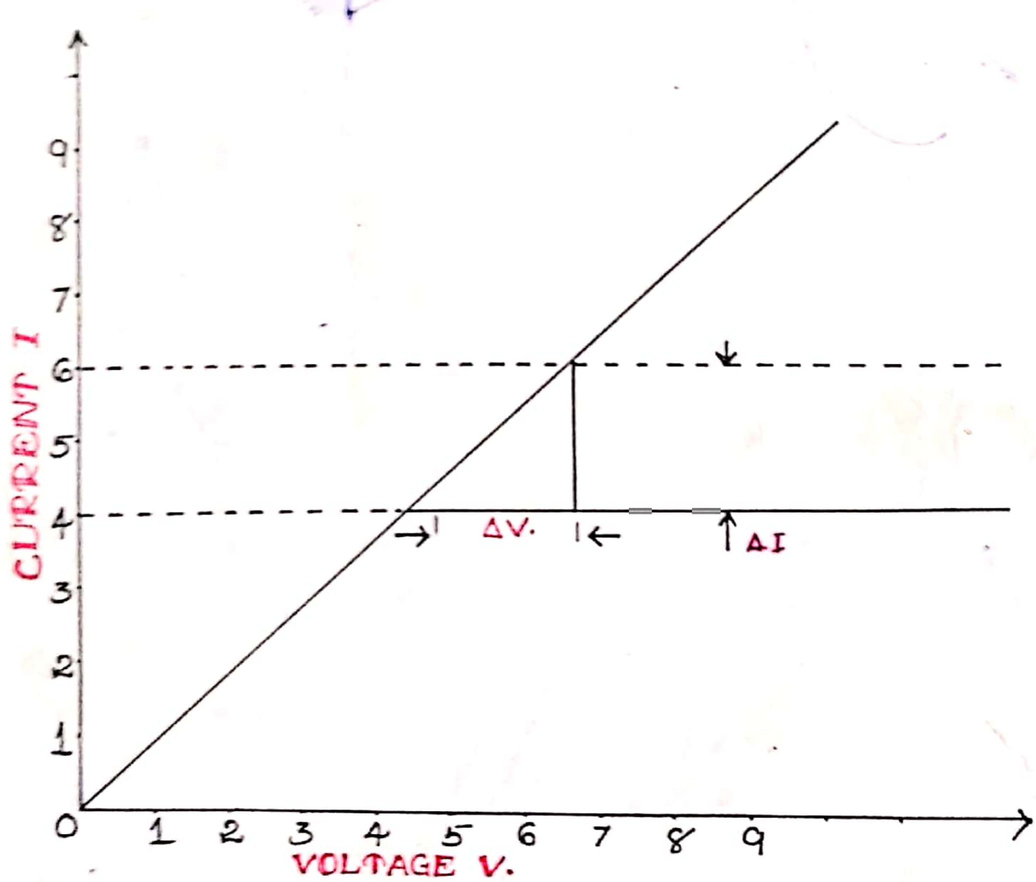
Resistance :- By definition of a conductor is said to have a resistance of one ohm if a voltage of 1 volt applied across its causes a current of 1 amp to flow through the conductor.

Varification of ohms law :-

Ohm's law can be verified by varing the D.C. voltage applied across a resistor & recording the values of corresponding current. The graph " V " verses " I " is a straight line as shown in fig (B). thus the resistor is a linear component.



CKT. FOR VERIFICATION OF OHM'S LAW



V.I. CHARACTERISTICS VERIFYING OF A RESISTOR OHM'S LAW.

Aim of the experiment :-

Verification of law of resistance in series.

Apparatus required :-

1. Patch Cord .
2. C.T. Trainer Kit

Theory :-

A conductor having resistances R1, R2 & R3 are connected in series. The equivalent resistance or total resistance between the two terminals is equal to the sum of three individual resistances. Being a series circuit it should be remember that :-

1. Current is the same through all the three conductors.
2. But voltage drop across each is different due to its different resistances given by ohm's law.
3. Sum of the voltage drop is equal to the voltage applied across the three conductors.

$V = IR$

$V = V1 + V2 + V3$

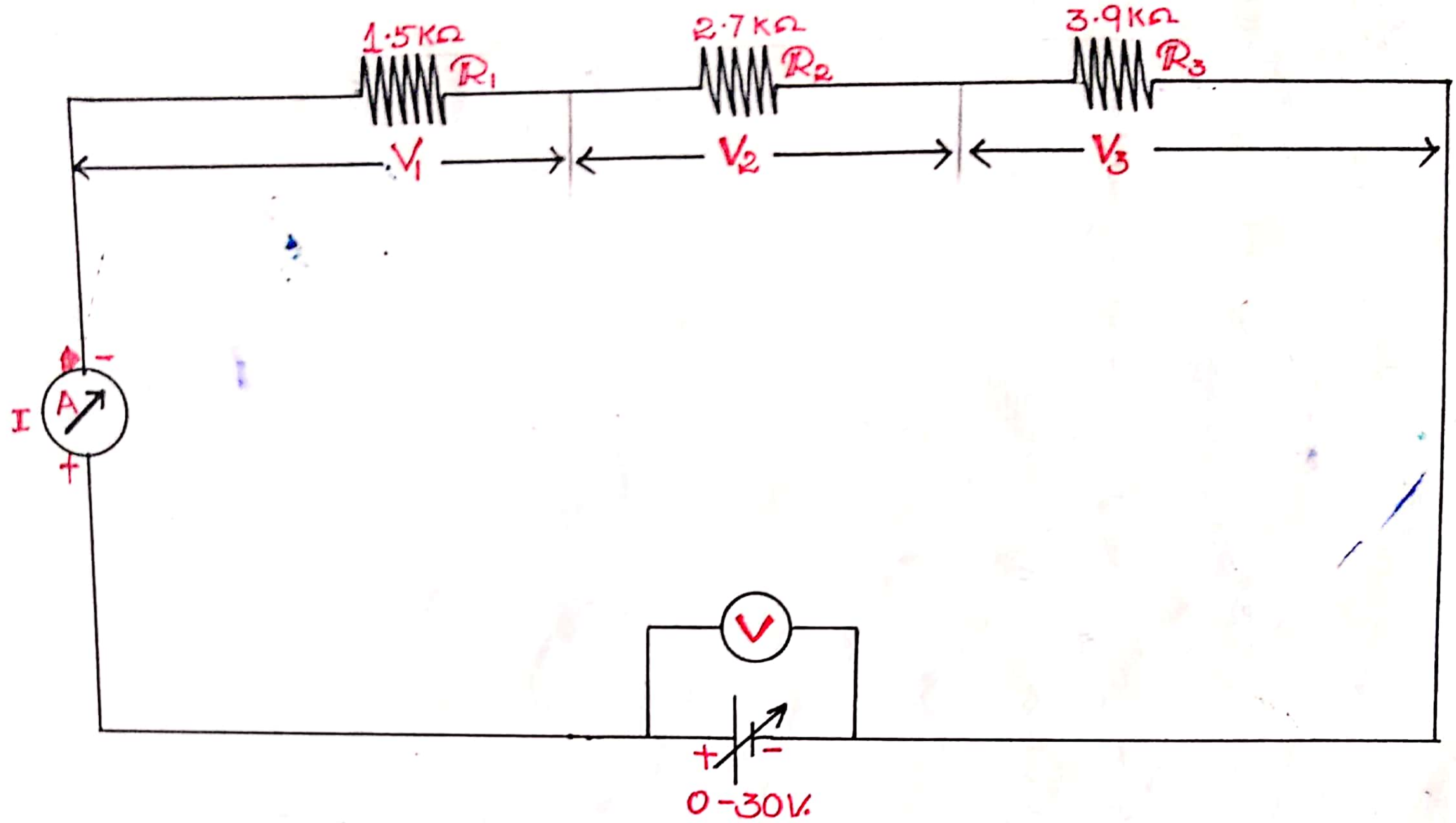
$IR = IR1 + IR2 + IR3$

R equivalent of the series combination

$R = R1+R2+R3$

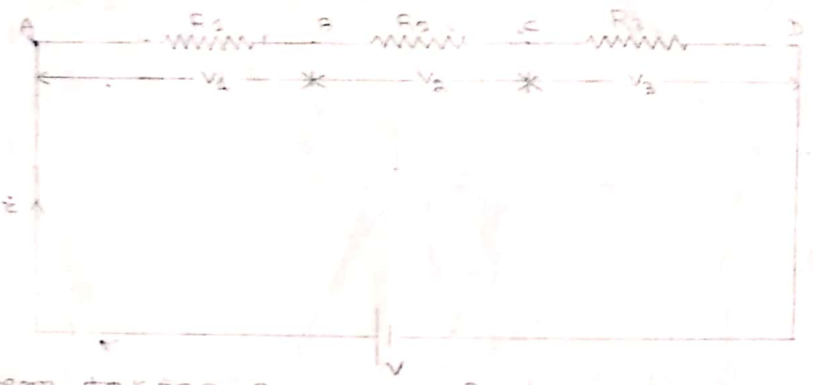
Characteristics :-

1. Same current flows through all parts of the circuit .
2. Different resistors of there individual voltage drop.
3. Voltage drop are additive.
4. Applied voltage equals the sum of different voltage drop.
5. Resistances are additive.
6. Powers are additive.



$R_1 \rightarrow 1.5\,K\Omega$, $R_2 \rightarrow 2.7\,K\Omega$, $R_3 \rightarrow 3.9\,K\Omega$, $V \rightarrow (0\text{-}30)\,V$

CKT. DIA. OF SERIES RESISTANCE.



Procedure :-

1. Connect the ammeter, voltmeter, resistor to the source by using patch cord as per the circuit diagram.
2. Check one's more the connection of parameter as per the circuit diagram.
3. Then switch on the supply.
4. Measure the total current I & source voltage V.
5. Calculate the value of R equivalent as Req = V/I.
6. Measure V1, V2, V3 across the resistor R1, R2 & R3 respectively.
7. Calculate the value of R1,R2 & R3 as ,R1=V1/I, R2=V2/I, R3=V3/I. Find the Req' which is equal to R1+R2+R3. Then difference between Req & Req'

Tabulation :-

No	Voltage in Volt	Current in Amp	Req=V/I in ohm	V1 in volt	V2 in volt	V3 in volt	R1=V1/I in ohm	R2=V2/I in ohm	R3=V3/I in ohm	Req' in ohm	Differen Req & Req'

Conclusion :-

From the above experiment we observed the laws of resistances in series is satisfied.

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Aim of the Experiment :

To verification of laws of resistance in parallel.

Apparatus Required :-

1. Patch cord
2. C.T. Trainer kit.

Theory :-

Three resistance are joined as in circuit diagram are said to be connected in parallel. In this case (1) potential difference across all resistances is the same (2). Current in each resistor different and is given by ohm's law. (3) The total current is the sum of three separate currents.

$I = I1 + I2 + I3 = V/R1 + V/R2 + V/R3$

Now $I = V/R$ where V is the applied voltage.

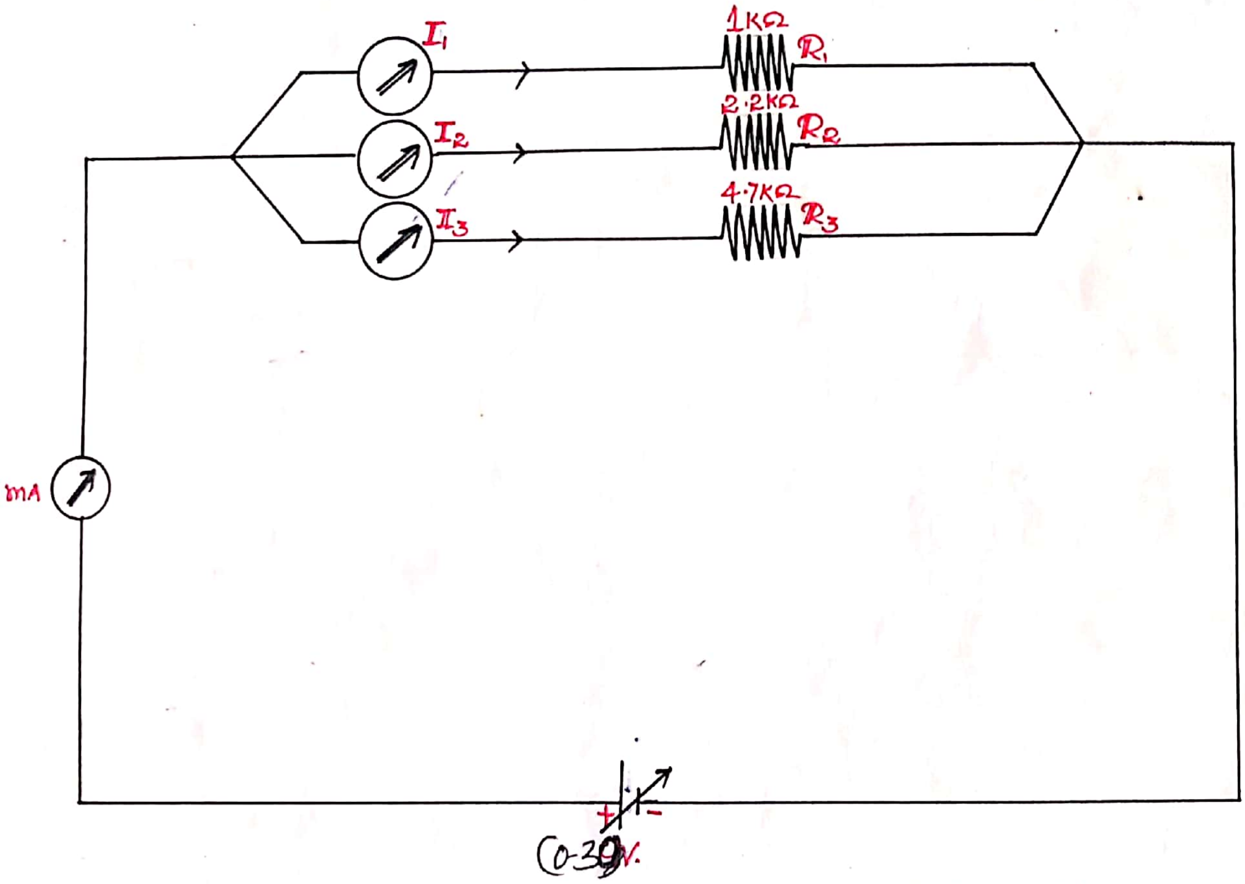
And R = Equivalent resistance of the parallel combination.

$V/Req = V/R1 + V/R2 + V/R3$

⇨ $1/Req = 1/R1 + 1/R2 + 1/R3$

Characteristics :-

1. Same voltage acts across all parts of circuits.
2. Different resistors have there indivisual current.
3. Branch current are additive.
4. Conductance are additive.
5. Power are additive.



$R_1 \rightarrow 1K\Omega$, $R_2 \rightarrow 2.2K\Omega$, $R_3 \rightarrow 4.7K\Omega$, V = [redacted](0-30)V

CKT. DIA. OF PARALLEL RESISTANCE

Circuit Diagram :-

Procedure :-

1. Connect the ammeter, Voltmeter & resistor to the source by using patch cord as per the circuit diagram.
2. Check one's more the connection of parameter as per the circuit diagram.
3. Then switch on the supply.
4. Measure the total voltage V & Current I.
5. Calculate the value of R equivalent as Req = V/I
6. Measure I1,I2 & I3 across the resistor R1, R2 & R3 respectively.
7. Calculate the value of R1,R2 & R3 as R1=V/I1, R2=V/I2, R3=V/I3. Find the 1/Req' which is equal to 1/R1+1/R2+1/R3. Then find the difference between Req & Req'.

Tabulation :-

Req' = 1/(1/Req)

Sl.no	Voltage in volt	Current in ma	Req = V/I in K ohm	I1 Amp	I2 Amp	I3 Amp	R1 = V/I1 In K ohm	R2 = V/I2 In K ohm	R3 = V/I3 In K ohm	1/Req' = 1/R1+1/R2+1/R3 In K ohm	Req' = 1/(1/Req') in Kohms	Difference Req & Req'

Conclusion :- From the above experiment we observed the laws of resistance in parallel is satisfied.

AIM OF THE EXPERIMENT :-

Verification of Superposition Theorem.

APPARATUS REQUIRED :-

1. C.T. Trainer Kit.
2. Patch Cord.

THEORY :-

Superposition thorem state's that , if there are a number of there of emfs acting simultaneously in any linear bilateral network, then each emf acts independently of the others i.e if the other emf acts independently of the others. i.e. as the other emfs didn't exist. The value of current in any conductor is the algebraic sum of the currents due to each emf. Similarly voltage across any conductor is the algebraic sum of the voltages which each emf would have produced which acting singly.

Superposition theorem applicable only to linear networks where current is linearly related to voltage as per ohm's law.

EXPLANATION :-

The theorem states that, in a network of linear resistances containing more then one source of emf or generator the current which flows at any point is the sum of all current which would flow at that point in each generator were considered separately and all the other generator replaced for the time being by resistances equal to there internal resistances.

i1,i2,i3 & i represent the value of currents which are due to simultaneous action of the two sources of emf in the network.

i = i1+i2+i3

Circuit Diagram :-

Fig-1

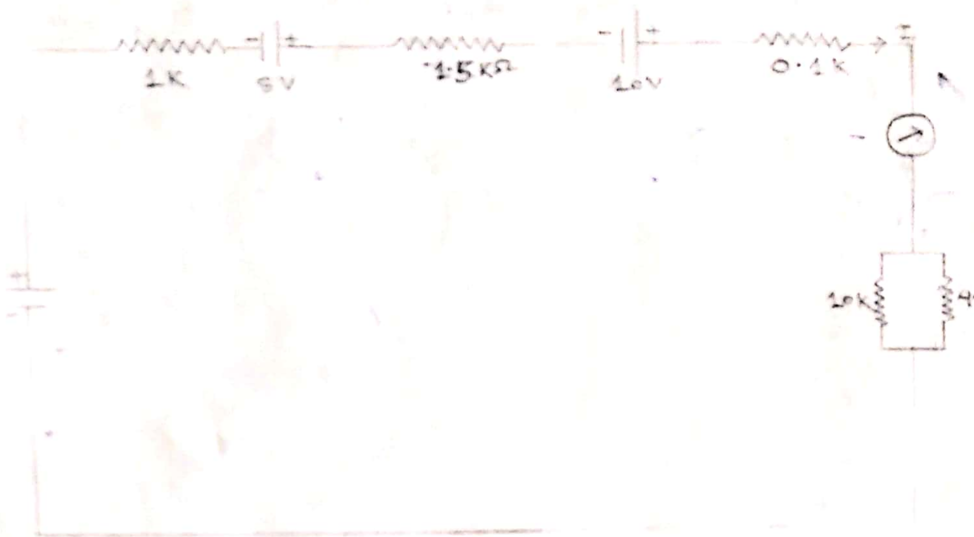


Fig-2

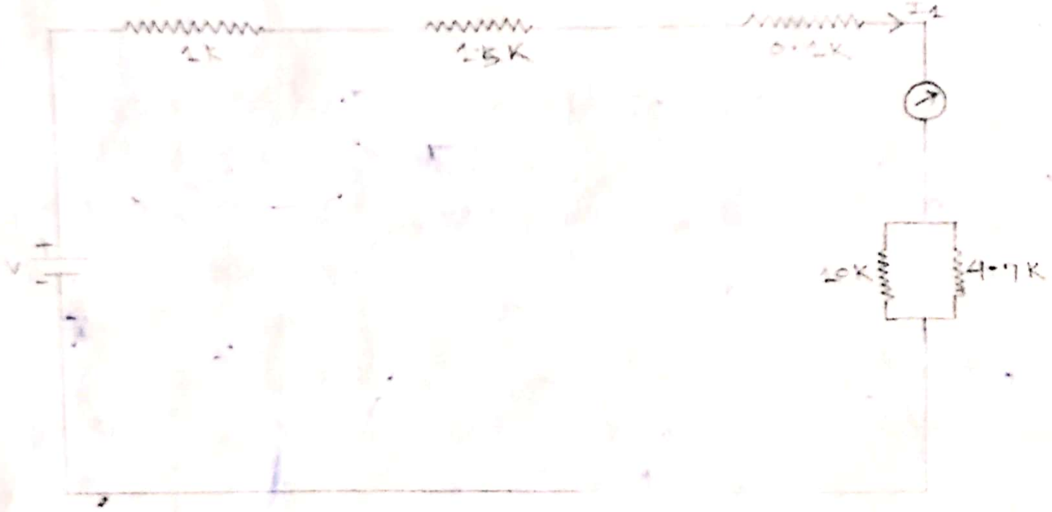


Fig-3

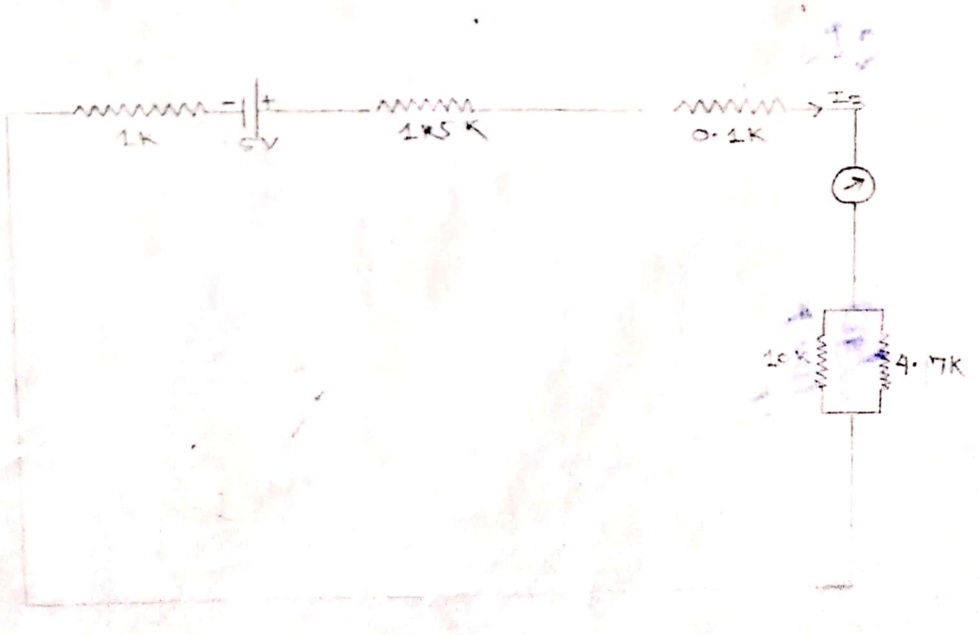
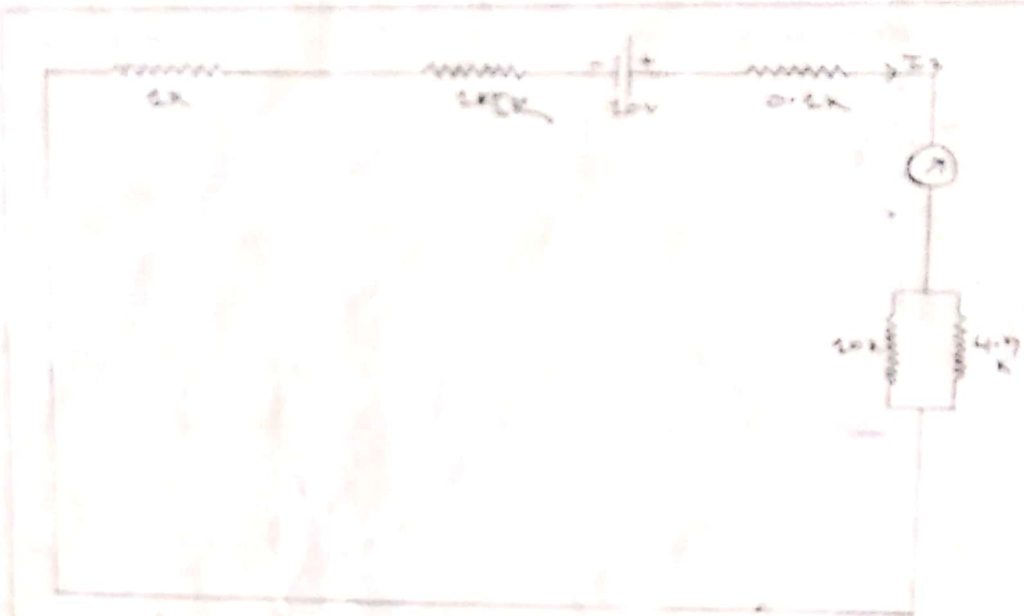


Fig - 4



PROCEDURE :-

1. Connect the ammeter, Voltmeter & resistor to the source by using patch cord as per the circuit diagram.
2. Check one's more the connection of parameter.
3. Then switch on the supply.
4. Measure the total current i,i1,i2 & i3 .
5. If there is more than one source, then measure the i1,i2 & i3 one.
6. Consider all the sources as one source as one by one source as shows in circuit diagram and short the other sources.
7. Then calculate the i1,i2 & i3 and find the difference between i & i' is equal to i' = i1+i2+i3

TABULATION :-

SL NO	CURRENT (i) IN MA	CURRENT (i1) IN MA	CURRENT (i2) IN MA	CURRENT (i3) IN MA	i' = i1+i2+i3 MA	DIFF betn i & i1
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						

CONCLUSION
TABULATION :-

From the above experiment we get a brief knowledge about the Superposition Theorem.

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Aim of the experiment :-

Verification of Thevenin's theorem.

Apparatus Required :-

1. Patch Cord
2. C.T. trainer board.

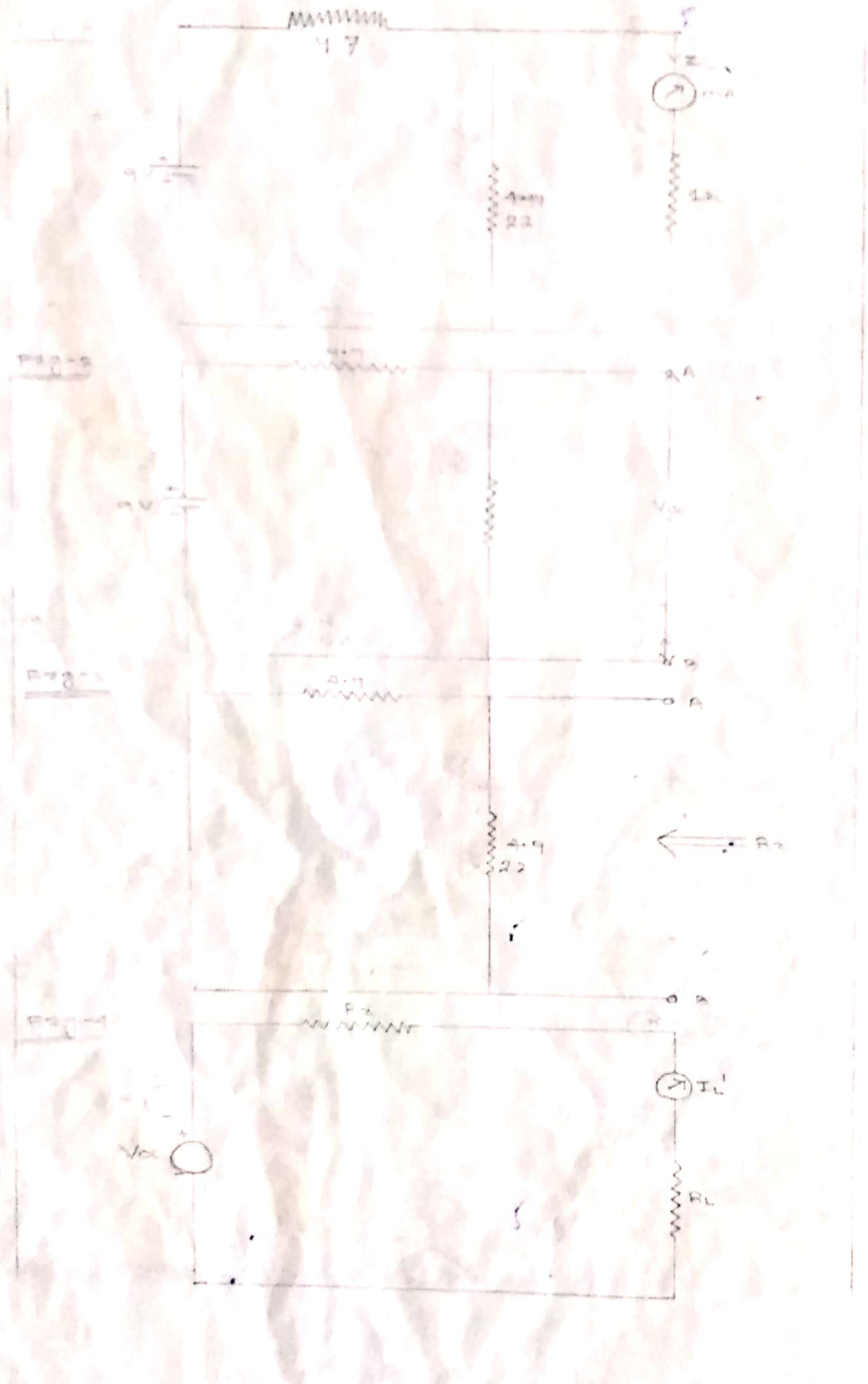
Theory :-

Thevenin's theorem stated as, current flowing through a land resistances Rl across any two terminal of a linear, active, bilateral network is given by Vcc/Ri+Rl Where Voc is the open circuit voltages (Voltage across two terminal when Rl is removed) and Ri is the internal resistances of network as viewed back into the open circuited network from terminals will all energy sources removed and replaced by their internal resistance (if any) .

Calculate the Thevenin's Circuit :-

1. Temporarily remove the resistance as Rl whose current.
2. Find the open circuit voltage which appears across the two terminals from where resistances has been removed. It is also known as Thevenin's voltage.
3. Compute the resistances of whole networks as looked into these two terminals after removed the all sources leaving behind their internal resistances & current sources has been replaced by open circuit i.e infinite resistances. It is also called Thevenin's resistance Rth or Ri.
4. Replace the entire network by a single Thevenin sources whose voltage is Vth or Voc and whose terminal resistances Rth or Ri.
5. Constant Rl back to its terminals from where it previously removed.
6. Calculate the current flowing through Rl by using the equation.
   $I = V_{th}/(R_{th}+R_l)$ or $I = V_{oc}/(R_i+R_l)$

Circuit Diagram :-



Procedure :-

1. Connect the ammeter, voltmeter and resistor to the source by using patch cord as per the circuit diagram.
2. Check ones more the connections of the parameter as per the circuit diagram.
3. Then switch on the supply.
4. Measure the total current i.
5. If there is more than one source , the measure i1', i1", i''' are by one.
6. Considered all the sources as one sorce showsin circuit diagram & short the voltage sources & in current source open the circuit.
7. Then calculate the Voc & internal resistance Ri such as equivalent resistances.
8. After that calculate iL & iL' and their differences.

Tabulation :-

Sl.no	Voltage in Volt	Current iL in mA	Voc in Volt	Internal resistance Ri in ohms	iL' in m.A	Difference iL & iL'

Conclusion :-

From the above experiment we get knowledge about the Thevenin's theorem.

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AIM OF THE EXPERIMENT :-

Verification of the maximum power Transform theorem.

APPARATUS REQUIRED :-

(1) Patch Cord
(2) C.T. Trainer Kit.

THEORY :-

Maximum Power transform theorem states that, A resistive load obstract maximum power from a network when the load resistance is equal to the resistance of network as views from the output terminals,with all energy sources removed leaving behind their internal resistances.

A load resistance RL is connected across the two terminal of the network which consist of a generator emf E & internal resistance Rg & a series resistance R which infact,represents the lumped resistance of the connecting wires.

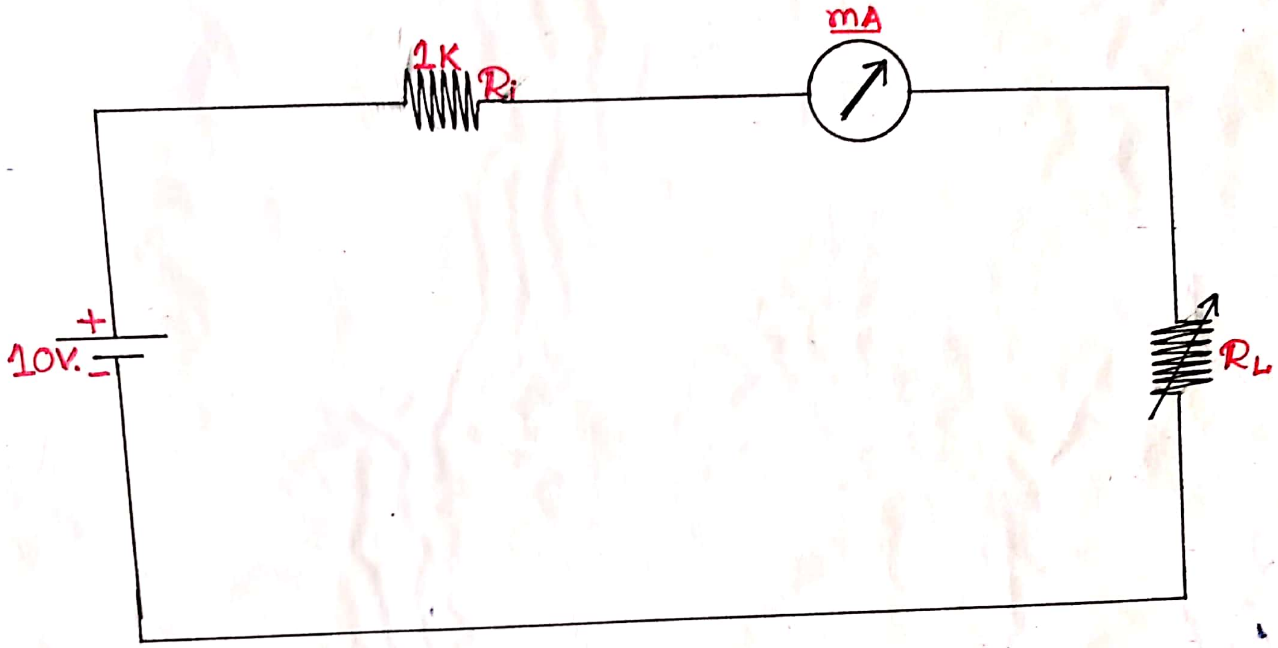
Let Ri=RG+R= internal resistance of network.
According to this theorem,RL will abstract maximum power from the network when RL=Ri

Circuit current=I

Power consumed by the load is P= i^2 RL

CIRCUIT DIAGRAM :-

CKT. DIA. MAXIMUM POWER THEOREM.



PROCEDURE :-

(1) Connect the ammeter,Voltmeter & Resistor to the source by using patch cord asper the circuit diagram.
(2) Check one's more the connection of parameter as per the circuit diagram.
(3) Then switch on the supply.
(4) Measure the current "i" for different value of load register RL.
(5) Calculate the power for different value of current i and different load register RL & maximum power P max of the circuit.

TABULATION :-

Sl. No	Resistance (R) in Kohm	Load Resistance RL in Kohm	Current (i) in m.A.	Power $P = i^2 RL$ in mA
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				

CONCLUSION :-

From the above experiment we get knowledge about maximum power transform theorem.

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Aim of the Experiment :

Verification of Norton's theorem.

Apparatus Required :

1. CT trainer board.
2. Patch Cord.

Theory :

Norton's theorem states that, any two terminal active network containing voltage sources & resistances when viewed from its output terminal, is equivalent to a constant current source and a parallel resistance. The constant current is equal to the current which would flow in a short circuit placed across the terminal and parallel resistance is the resistance of the network when viewed from these open circuited terminals after all voltage & current sources have been removed and replaced by their internal resistances.

The voltage between any two points in a network is equal to Isc . Ri where Isc is the short circuit current and Ri is the internal resistance of the network as viewed from these terminal with all voltage sources being replced by their internal resistances (if any) and current sources replaced by open circuit.

Calculate the Norton's circuit :-

1. Remove the resistance (if any) given the two across the two given terminals and put a short circuit across between these two points.
2. Then compute the short circuit current Isc.
3. Remove all voltage sources but retain their internal resistances (if any). Similararly remove all current sources & replace them by open circuits i.e. by infinite resistances.
4. Then find Ri & RN of the network as looked into from the given terminals.

5. The current sources (Isc) joined in parallel across Ri between the two terminals gives Norton's equivalent circuit.

Circuit Diagram :-

Circuit Diagram

Fig - 1

Fig - 2

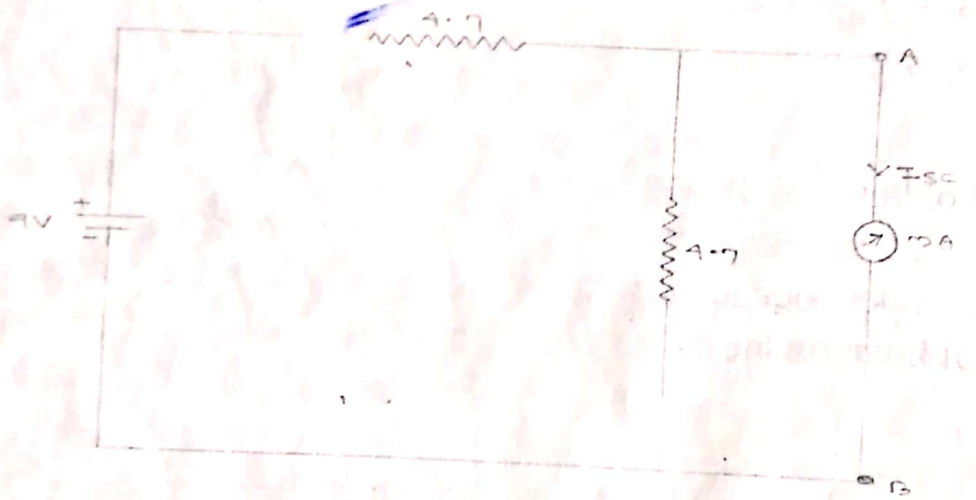
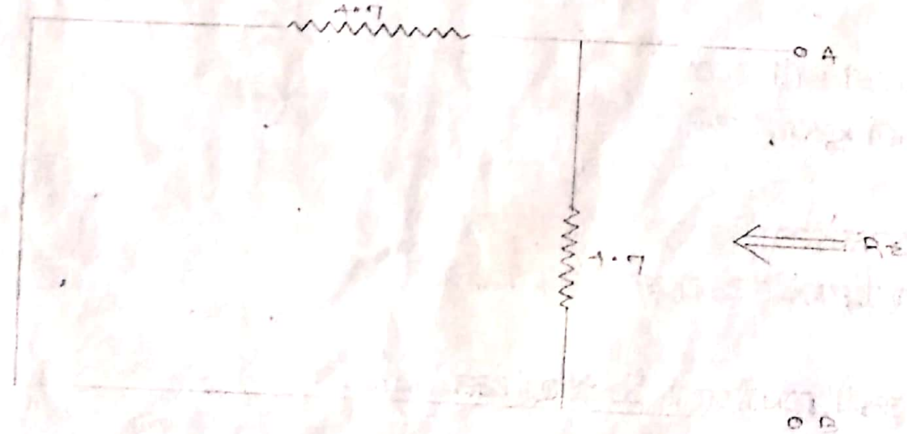
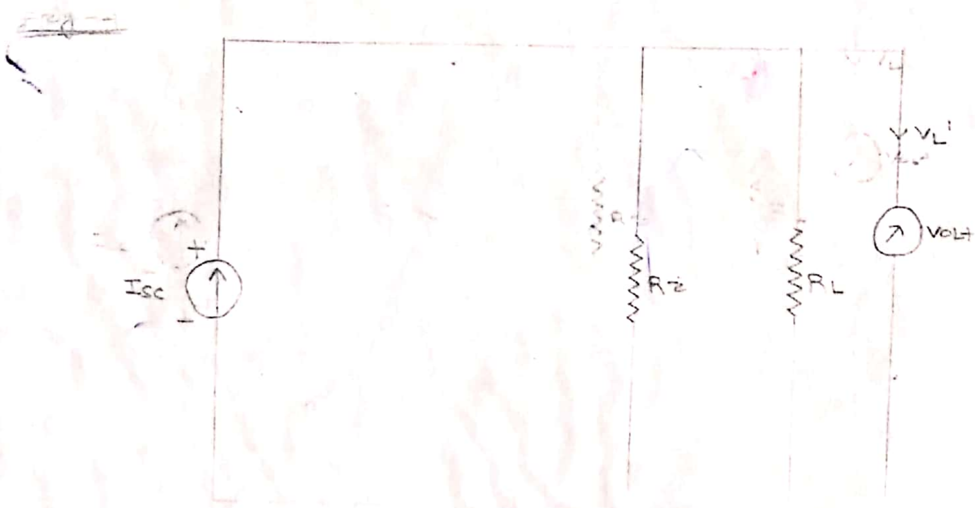


Fig - 3





Procedure :-

1. Connect the ammeter, Voltmeter and resistance to the source by using patch cord as per circuit diagram.
2. Checked ones more the parameter connections as per as circuit diagram.
3. Then switch on the supply.
4. If there is more than one source then measure i1',i1",i1'" one by one.
5. Measure the total voltage VL.
6. Consider all the sources as one source shows in circuit diagrams & short the voltage sources & in current source open the circuit.
7. Then calculate the isc & internal resistance Ri such as equivalent resistance.
8. After calculated the VL & VL' then find the difference between them.

Tabulation :-

Sl.no	Voltage in Volt	VL in Volt	Isc in m.A	Internal Resistance Ri in Ohm	Load Resistance RL in Ohms	VL' in Volt	Difference VL-VL'

Conclusion :-

From the above experiment we get a brief knowledge about Norton's theorem.

Aim of the experiment:-

To study the low pass filter and its impemantation.

Apparatus required:-

1.low pass filter trainer kit
2.CRO
3.Patch chord

Theory:-

A low pass filter is a circuit which allow low frequency of the signal to pass and reject all the other frequency. It is evident from fig. that with increase infrequence of the signal at input side shunt capacity reactance decreases. This will be allow more current to be returning back to the source through the impedance path. At the high frequency, the entire input current returns to the source through shunt branch which become practically a short circuit link at this frequency.

Thus it is evident that the low pass section can only allow passage of signal through it, till signal frequency is at low magnitude. At higher frequency in inductive reactance in the series are also increases to a very high value rendering the blockage of the input signal in practice LPF operation is said to be satisfactory for increasing frequency till the gain is 0.707.

cut-off frequency is given by :- $F_C=1/\pi\sqrt{(1/LC)}$

Design impedance $R_0=\sqrt{(L/C)}$

Impedance across inductor $X_L=\omega L$

Impedance across capacitor $X_C=1/\omega C$

For low frequency $\omega L<<1/\omega C$ so $V_{in}\sim V_{out}$

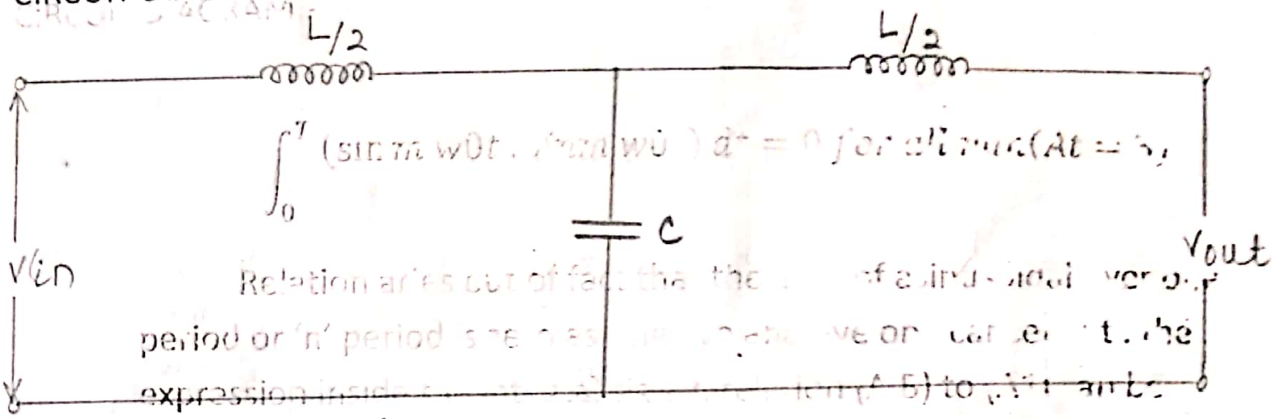
For high frequency $\omega L>>1/\omega C$ so $V_{out}\sim 0$

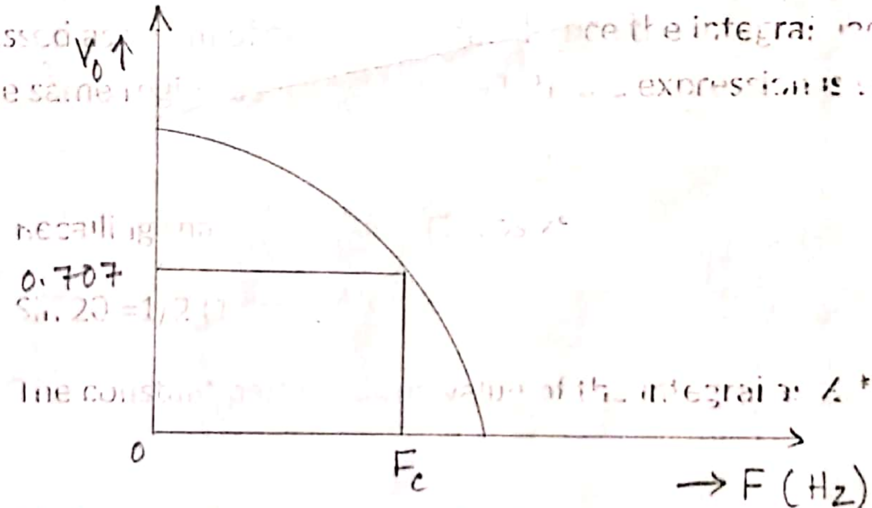
Since output voltage signal is equal to the signal strength across capacitor. Hence in above ckt the signal will only arises across capacitor at low frequency. Hence this type of filter allows a signal to appear across capacitor from low value of frequency (F), it will attenuate the signal across capacitor for high value of frequency. Hence it acts as LPF.

Procedure:-

We have to connect the circuit as per the circuit diagram then increase the inpt frequency and determine output from CRO

CIRCUIT DIAGRAM:-





Tabulation:-

SL. no.	V_o(in volt)	T	F=1/T	ω=2πf

Conclusion:-

From the above experiment ,we study about the LPF and plot a graph between V_0 and F_0

Aim of the experiment:-

To study the bandpass filter and its implementation.

Apparatus required:-

1.band pass filter trainer kit

2.CRO

3.Patch chord

Theory:-

A band pass filter is a circuit which pass a certain range of frequency and rejects all other frequencies. This frequency lies between the lower cut off frequency and upper cut off frequency in RLC type band pass filter.

$V_0=V_i*R/\surd[R^2+(X_L-X_C)^2]$

$=V_i*R/\surd[R^2+(2\pi fL-1/2\pi fc)^2$

Here $R=[(R_F+R_L)/R_F*R_L]*L$

Where

R_F =Filter resistance

R_L =Load resistance

V_i =input voltage

V_0 =output voltage

From the frequency of series resonance, varies in frequency is given by,

$F_0=1/2\pi\surd LC$ Hz

The Q factor is given by

$Q=\omega_0 L/R$

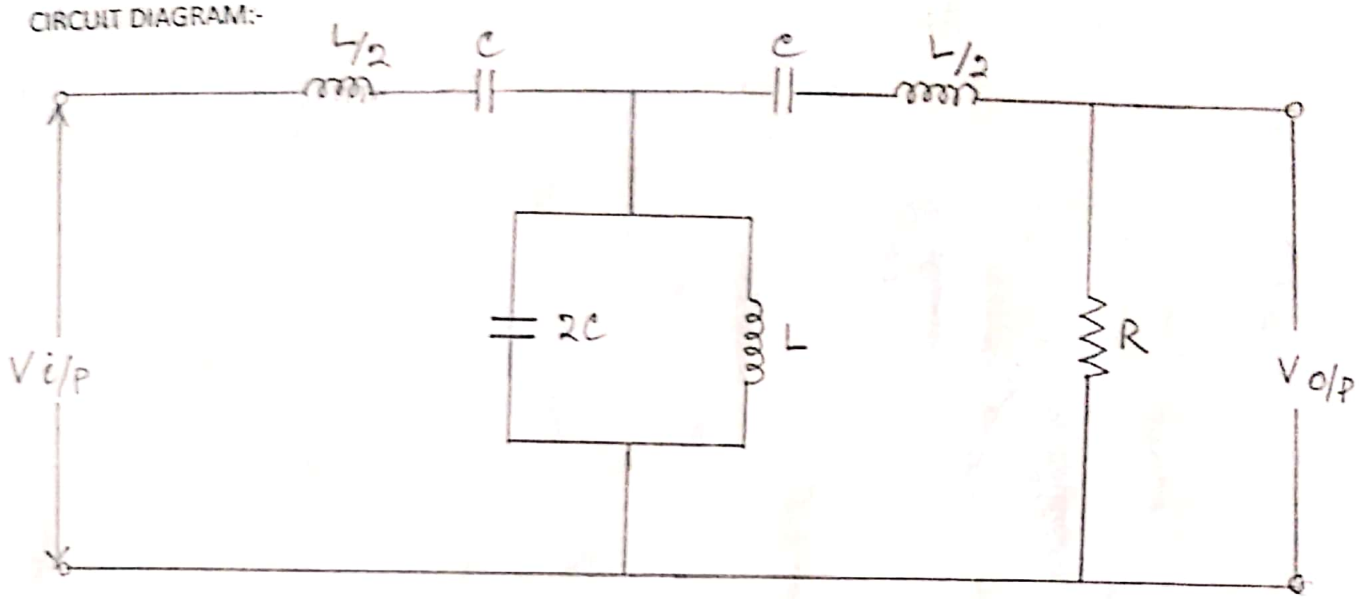
Bandwidth=F_0/Q Hz

$F_1=F_2=B.W/2$ HZ

$F_2=F_0+B.W/2$ HZ

Where f1 and f2 are lower and upper cut off frequency.

CIRCUIT DIAGRAM:-



PROCEDURE:-

We have to connect the circuit as per the circuit digram then determine the maximum resonant frequency. Determine the upper cutoff frequency f1 and by determining f1 the lower cutoff frequency and the range between f1 & f2 is known as bandwidth which is determined by band pass filter.

Tabulation:-

SL. no.	T(ms)	F(KHZ)	V_o(mv)	$\omega=2\pi f$(KHZ)

Conclusion:-

From the above experiment ,we study about the band pass filter circuit which flows the signal of certain ranges and reject all other.

AIM OF THE EXPERIMENT :-

Determine resonant frequency of R-L-C series circuit. (Bandwidth, Q-factor)

APPARATUS REQUIRED

1) Power supply
2) Function Generator.
3) CRO
4) series Resonance kit
5) connecting leads.
6) Multi-meter.

THEORY :-

The circuit is said to be in resonance if the current is in phase with the applied voltage. thus a Resonance, the equivalent complex impedance of the circuit consists of only resistance (R). Since V & I are in phase, the power factor of resonant ckt is unity.

The Total impedance for the series R-L-C ckt is,

$$Z = R + j(X_L - X_C) = R + j\left(\omega L - \frac{1}{\omega C}\right)$$

$$= R + jX$$

The ckt. is in resonance when $X = 0$, i.e. $Z = R$

Series Resonane occurs when $X_L = X_C$

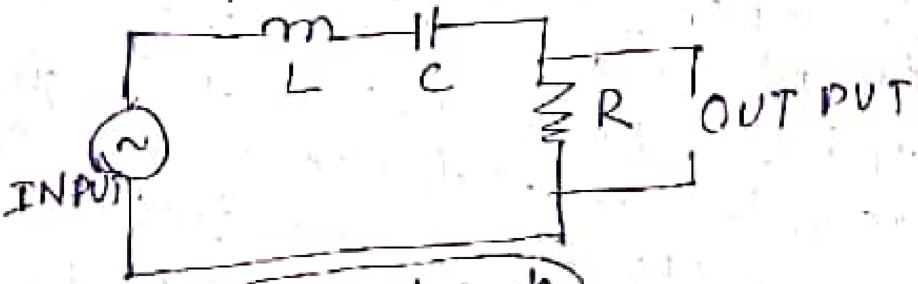
i.e $\omega L = \frac{1}{\omega C}$

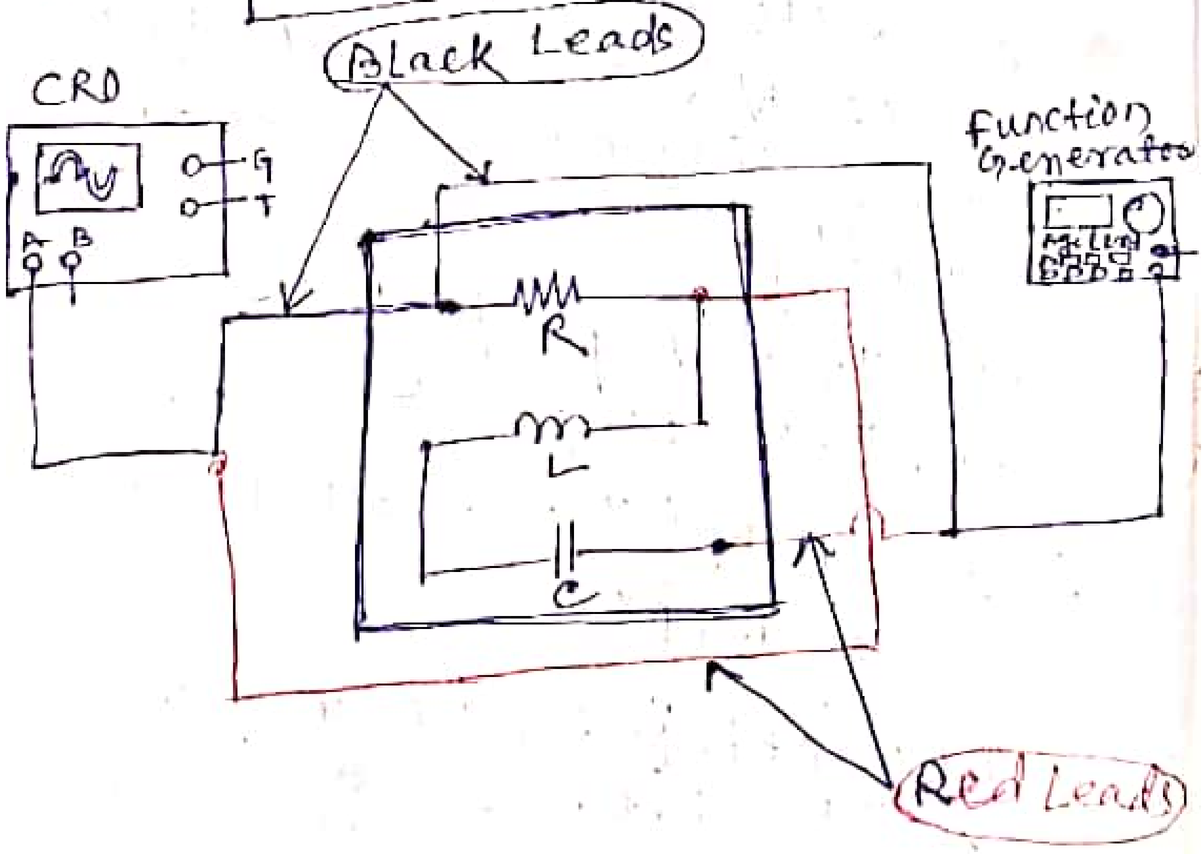
~~$2\pi f_r L = \frac{1}{2\pi f_r C}$~~ $= 2\pi f_r L = \frac{1}{2\pi f_r C}$

$\Rightarrow f_r^2 = \frac{1}{4\pi^2 LC}$

$$\Rightarrow \boxed{f_r = \frac{1}{2\pi}\sqrt{LC}}$$

CIRCUIT DIAGRAM





SIMPLE CALCULATION

$F_r = V_{max}$

Band width $= (f_2 - f_1)$ KHz

$f_2 - f_1 = 0.707\ V_{max}$

$Q = \frac{F_r}{\text{Band width}}$

TABULATION Table-1

Table-1

Ckt. Parameter

R = ——

L = ——

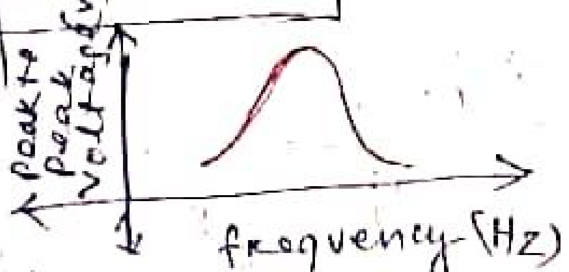
C = ——

Calculated Resonant frequency		
Experimental Resonant frequency		
% Difference.		

TABLE-2

frequency (Hz)	Peak to peak voltage
50	
100	
⋮	
Resonant frequency	

Graph



CONCLUSION :-

The resonance frequency, Bandwidth and Q-factor of R-L-C Series circuit has been calculated.

AIM OF THE EXPERIMENT :-

To study and plot the transient responce of RC circuit.

APPARATUS REQUIRED :-

1) Power supply
2) Circuit Board kit.
3) CRO
4) function Generator.
5) connecting leads.

THEORY :-

Let initially the switch 'K' is at position '1', when it is moved to position '2' then apply KVL

$$\frac{1}{C}\int i\,dt + Ri = V.$$

Now differentiating w.r.t 't'

$$\frac{1}{C} i + R\frac{di}{dt} = 0.$$

$$\Rightarrow R\frac{di}{dt} = -\frac{1}{C} i$$

$$\Rightarrow \frac{di}{i} = -\frac{1}{RC} dt$$

Integrating w.r.t 'i' & then taking log on both side.

This is general soln of RL ckt.
if the value of C_2 is calculated
then the result is known as
particular soln.

Just before switching at t=0

$$i(0) = \frac{V}{R}$$

putting this in equn ①

$$i(0) = C_2 \quad ②$$

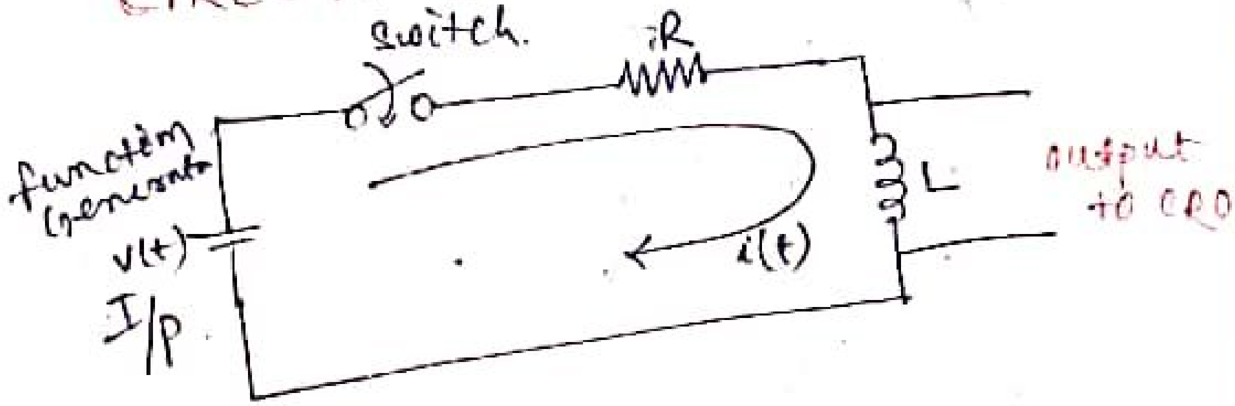
$$\Rightarrow \frac{V}{R} = C_2$$

$$\Rightarrow C_2 = \frac{V}{R}$$

∴ particular solution is

$$i = \frac{V}{R} e^{-\frac{Rt}{L}}$$

CIRCUIT DIAGRAM



PROCEDURE :-

1) connect the circuit according to the figure and switch ON the supply.

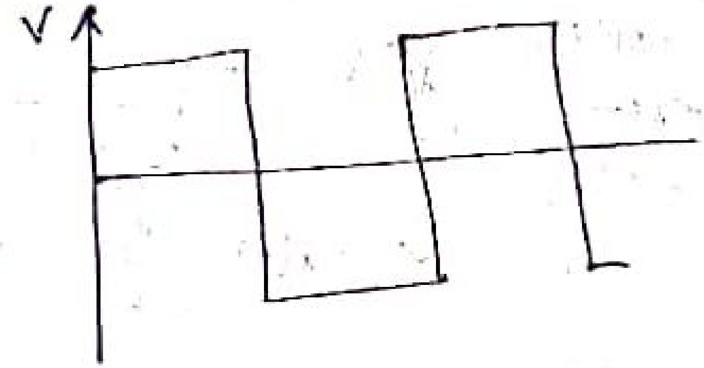
2) feed square wave from the function Generator to the I/p terminal of the ckt.

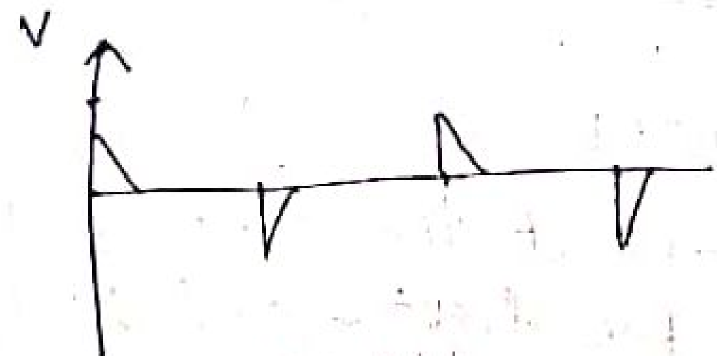
3) connect the CRO to the O/p terminal and note down the O/p wave.

4) Draw the I/p and O/p wave on the graph paper.

5) switch off the power supply after taking the wave.

GRAPH :-





CONCLUSION :-

Transient response of RL ckt has been studied and the results obtained are shown on the graph.

AIM OF THE EXPERIMENT:-

To study and plot the transient response of RL circuit.

APPARATUS REQUIRED:-

1) Power supply
2) Circuit Board kit
3) CRO
4) function Generator.
5) connecting leads.

THEORY:-

Let switch 'K' be at position 1. When it is switch to 2 then

$$L\frac{di}{dt} + Ri = 0$$

$$\Rightarrow L\frac{di}{dt} = -Ri$$

$$\Rightarrow \frac{di}{dt} = -\frac{R}{L}i$$

$$\Rightarrow \frac{di}{i} = -\frac{R}{L}dt$$

Integrating & then taking log on both sides

$$\log i = -\frac{Rt}{L} + \log c$$ where c is const

$$\Rightarrow i = c e^{-\frac{Rt}{L}} \longrightarrow (1)$$

$$\log i = -\frac{1}{RC} t + C_2$$

$$i = c_2 e^{-\frac{t}{RC}} \quad \text{--- (1)}$$

on putting $i = \frac{V}{R}$ in equn (1)

we get.

$$\frac{V}{R} = c_2 e^{\frac{-t}{RC}}$$

At $t = 0$

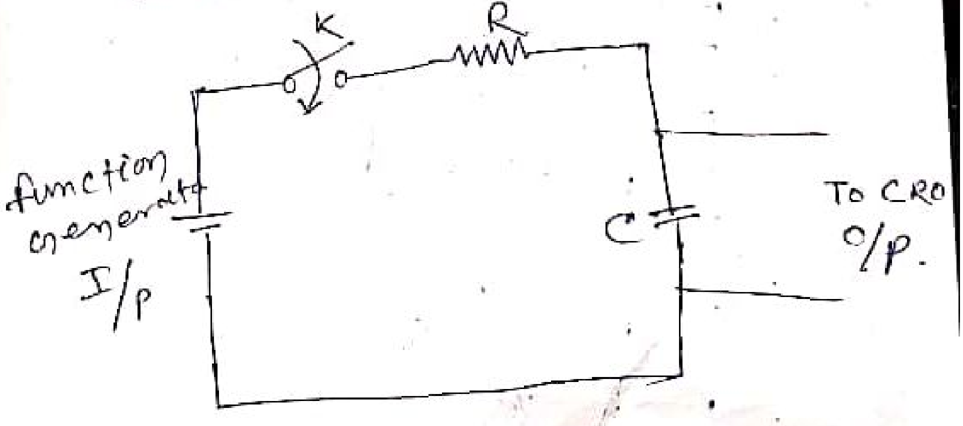
$$\frac{V}{R} = c_2 e^{0}$$

$$\Rightarrow c_2 = \frac{V}{R}$$

putting the value of c_2 in equn

$$i = \frac{V}{R} e^{-\frac{t}{RC}}$$

CIRCUIT DIAGRAM:-



PROCEDURE:-

1) connect the ckt according to the figure & switch ON the supply.

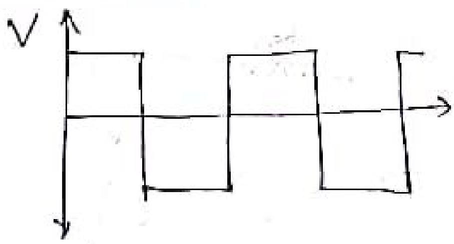
2) feed square wave from function generator to the I/p terminal of the ckt.

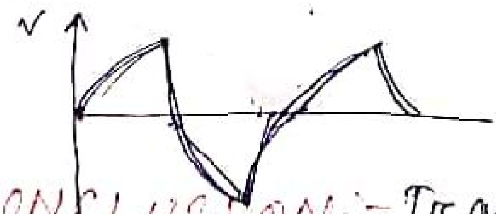
3) connect the CRO to the o/p terminal & notedown the o/p wave.

4) Draw the I/p and o/p wave on the graph paper.

5) Switch off the power supply after taking the wave.

GRAPH:-





CONCLUSION:- Transient response of RC ckt has been studied and the result obtained are shown on the graph.