LABORATORY MANUAL

BASIC ELECTRICAL ENGINEERING

B.Tech I YEAR SEM – I&II

A.Y : 2022-23

Prepared by
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Department of Electrical & Electronics Engineering
MALLREDDY ENGINEERING COLLEGE AND MANAGEMENT SCIENCES
(Approved by AICTE New Delhi & Affiliated to JNTU Hyderabad)
Kistapur, Medchal,Medchal – 501401

INSTITUTE VISION

The aspiration is to emerge as a premier institution in technical education to produce competent engineers and management professionals contributing to Industry and Society.

INSTITUTE MISSION

The aspirations are fulfilled and continue to be fulfilled:

MI-1: By providing the student supporting systems:

To impart updated pedagogical techniques with supportive learningenvironment and state-of-the-art facilities.

MI-2: By training the students as per the industry needs:

To cultivate a culture of interdisciplinary approach, problem solving, innovative ecosystem, and entrepreneurship by facilitating critical thinking,teamwork, and research-driven activities with hands-on learning.

MI-3: By educating the students about society's needs:

To instill ethical, social, and environmental values through communityengagement resulting in sustainable development of society.

DEPARTMENT VISION

The aspiration is to produce competent Electrical and Electronics Engineering Graduates capable of making valuable contributions in the field of Electrical and Electronics Engineering.

DEPARTMENT MISSION

MD-1	***Student Support Systems:*** To equip students with advanced learning skills in Electrical and Electronics Engineering, while providing them with the necessary professional competencies to overcome future challenges.
MD-2	***Training the students as per the industry needs:*** To facilitate the students to acquire interdisciplinary skills in renewable energy, electric vehicles, and power electronics applications through practical knowledge and innovative techniques to meet evolving global challenges.
MD-3	***Educating the students, the needs of society:*** To develop professional ethics, self-confidence, and leadership qualities among students.

BASIC ELECTRICAL ENGINEERING LABORATORY

I B.Tech I/II -Semester

Prerequisites: Basic Electrical Engineering

Course Objectives:

- To measure the electrical parameters for different types of DC and AC circuits using conventional and theorems approach.
- To study the transient response of various R, L and C circuits using different excitations.
- To determine the performance of different types of DC, AC machines and Transformers.

Course Outcomes: After learning the contents of this paper the student must be able to

- To analyze and solve electrical circuits using network laws and theorems.
- To understand and analyze basic Electric and Magnetic circuits. Representation of AC Quantities
- To understand working principle, operation of transformers and its types.
- To study the working principles of Electrical Machines.
- To introduce components of Low Voltage Electrical installations and gain the knowledge on batteries and Protective Equipments.

CO	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	PSO 1	PSO 2
C103.1	3	2			-	-	-	-	-	-	-	2	1	1
C103.2	3	2	2	2	-	-						2	1	1
C103.3	3	1	2	2								2	2	2
C103.4	3	2	2	2								2	2	2
C103.5	3	2										2	1	1
AVG	**3**	**1.8**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1.4**	**1.4**

1:Slight (low)	2: Moderate (Medium)	3: Substantial (High)	- : None

SAFETY PRECAUTIONS TO STUDENTS

1. Enter in to the Lab with Apron.
2. Wear shoes
3. Male students should attend with shirts tucked in trousers with Apron.
4. Girl students should tuck in the drapers (chunni) and put on Apron.
5. Girl students should not display loose long plaits hanging. They should be hidden under Apron
6. No student shall tamper main panel (440V), Rectifier (220V D.C/110Amps).
7. They should not switch anything unless the wiring is cleared by Lab In charge or Lab assistant.
8. Students should be away from M/C unless supervisor is present .They should not work with wet hands.

Do's

1. Do wear appropriate safety attire in the lab
2. Perform experiments only when authorized by the instructor.
3. All the apparatus taken should be returned to the concerned Lab Assistant, before leaving the lab.
4. Report immediately to the Lab Incharge for any damages to equipment.
5. All students must follow the Dress Code while in the laboratory.
6. The lab timetable must be strictly followed.
7. Experiment must be completed within the given time.
8. Handle all apparatus with care.
9. All students are liable for any damage to equipment due to their own negligence.
10. Be aware of all the safety devices.
11. Immediately After entering into the lab, fill the login details.
12. Avoid loose connections.

DONT'S

1. Do not wear open-toed shoes (sandals) in the lab.
2. Never overload a circuit by plugging in too many appliances.
3. Do not use any equipment unless you are trained and approved as a user by your instructor or staff.
4. Don't switch on the power supply without getting your circuit connections verified
5. Foods, drinks and smoking are NOT allowed
6. Students are strictly PROHIBITED from taking out any items from the laboratory.

List Of Experiments

1. Verification of KVL and KCL
2. Verification of Thevenin's and Norton's theorem
3. Transient Response of Series RL and RC circuits for DC excitation
4. Resonance in series RLC circuit
5. Calculations and Verification of Impedance and Current of RL, RC and RLC series circuits
6. Measurement of Voltage, Current and Real Power in primary and Secondary Circuits of a Single-Phase Transformer
7. Performance Characteristics of a DC Shunt Motor
8. Torque-Speed Characteristics of a Three-phase Induction Motor
9. Verification of Superposition theorem.
10. Three Phase Transformer: Verification of Relationship between Voltages and Currents.(Star-Delta, Delta-Delta, Delta-star, Star-Star)
11. Load Test on Single Phase Transformer (Calculate Efficiency and Regulation)
12. Measurement of Active and Reactive Power in a balanced Three-phase circuit
13. No-Load Characteristics of a Three-phase Alternator

Beyond the Syllabus

14. Verification of Ohm's Law
15. Demonstration: Safety precautions, measuring instruments, switchgear, Earthing and Cut-out sections of electrical machines.

EXPERIMENT NO-1

VERIFICATION OF KVL AND KCL

AIM: To Verify Kirchhoff's Voltage Law and Kirchhoff's Current Law

APPARATUS REQUIRED:

S.No	NAME	RANGE	TYPE	QUANTITY
1	Ammeter	(0- 200)mA	MC	3
2	Voltmeter	(0-30)V	MC	3
3	Resistors	1 KΩ 2.2 KΩ 3.3KΩ	-	1 2 1
4	Breadboard	-	-	1
5	Regulated power Supply (R.P.S)	(0-30)V	-	1
6	Connecting wires	-	-	Required number

STATEMENTS:

KIRCHOFF'S VOLTAGE LAW: It states that the algebraic sum of all the branch voltages around any closed path in a circuit is always zero at all instants of time.

KIRCHOFF'S CURRENT LAW: It states that the sum of the currents entering into any node is equal to the sum of the currents leaving the node.

PROCEDURE:

For KVL:

1. Connect the circuit as per the circuit diagram shown in figure(1)
2. Apply 10V and measure the voltage drop across each resistor
3. Verify whether the source voltage is equal to the sum of voltage drops or not. If equal KVL is verified
4. Repeat the same procedure by applying 15V and 18V

For KCL:

1. Connect the circuit as per the circuit diagram shown in figure (2)
2. Apply 10V and measure the currents in each branch
3. Verify whether the source current is equal to the sum of the branch currents or not. If equal KCL is verified
4. Repeat the same procedure by applying 15V and 18V

THEORITICAL CIRCUITS:
FOR KVL:

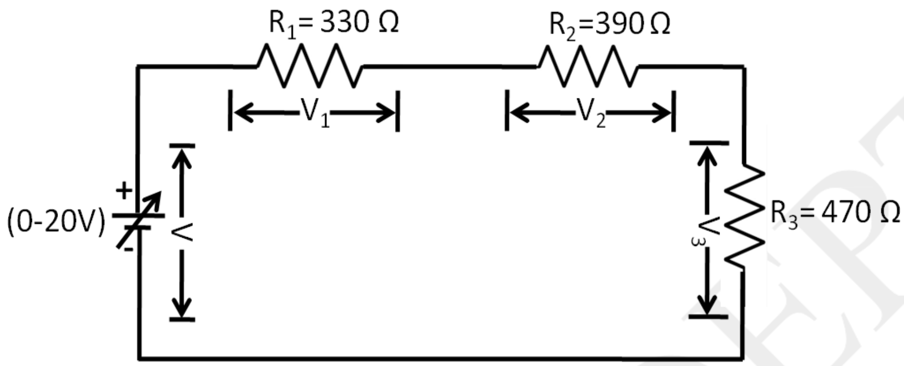


figure (a)

FOR KCL:

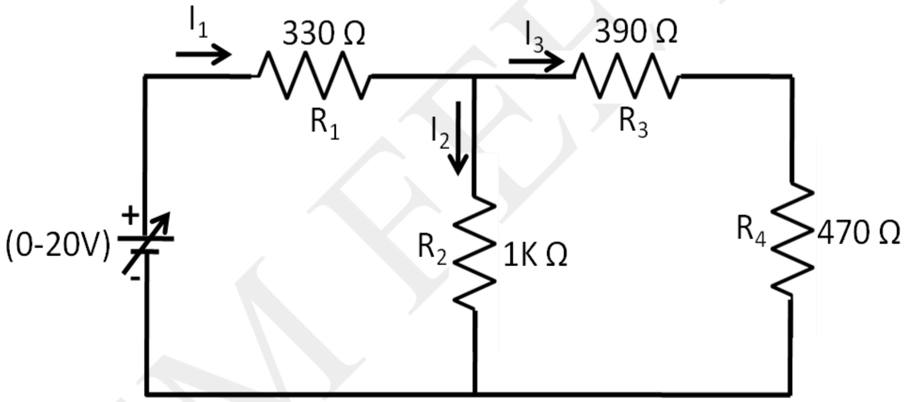


figure (b)

PRACTICAL CIRCUITS:
FOR KVL:

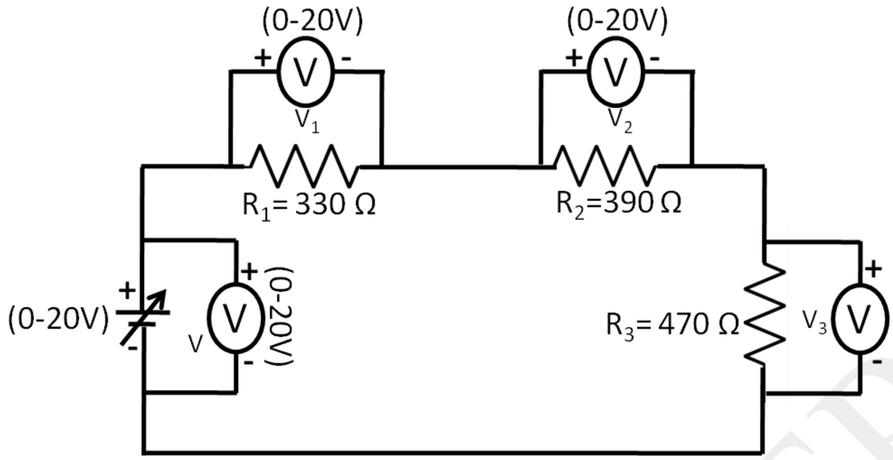


Figure (1)

FOR KCL:

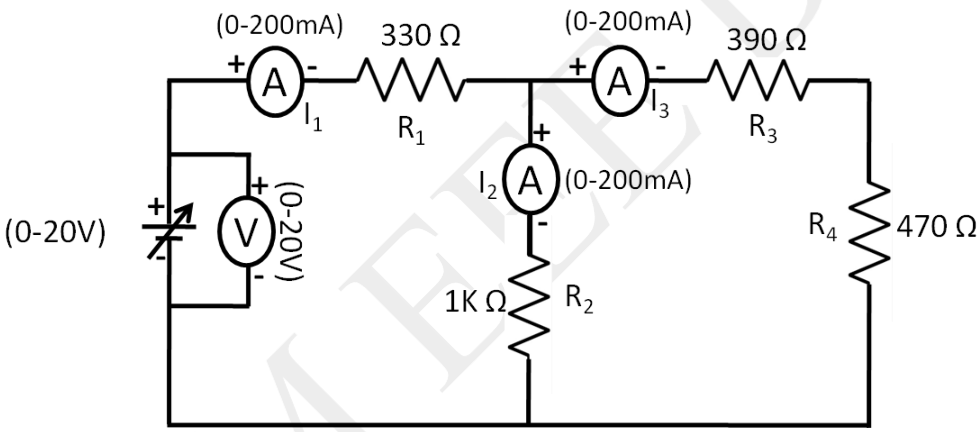


Figure (2)

THEORITICAL CALCULATIONS:

FOR KVL:

$Vs = V_1+V_2+V_3$

$V_1=IR_1$; $V_2=IR_2$; $V_3=IR_3$;

$I=V_S/R_{eq}$

FOR KCL:

Consider voltage at node 1 as V_1

$I_1+I_2+I_3 = 0$

$I_1=(V_s-V_1)/R_1$; $I_2=(0-V_1)/R3$; $I_3=(0-V_1)/R_2$

OBSERVATION TABLE:

FOR KVL:

S.No.	Applied Voltage (V in Volts)	Theoretical (in Volts)				Practical (in Volts)			
		V_1	V_2	V_3	$V=V_1+V_2+V_3$	V_1	V_2	V_3	$V = V_1 + V_2 + V_3$
1.	5V								
2.	10V								
3.	12V								

FOR KCL:

S.No.	Applied Voltage (V in Volts)	Theoretical (in mA)				Practical (in mA)			
		I1	I2	I3	I=I1+I2+I3	I1	I2	I3	I=I1+I2+I3
1.	5V								
2.	10V								
3.	12V								

PRECAUTIONS:

1. Avoid loose connections
2. Take readings without parallax error
3. Set the ammeter pointer at zero position

RESULT:

VIVA-VOCE QUESTIONS:

1. Define KVL and KCL
2. Define network and circuit?

network and circuit?

3. What is the property of resistor, inductor and capacitor?

APPLICATIONS:

- The current distribution in various branches of a circuit can easily be found out by applying **Kirchhoff Current law** at different nodes or junction points in the circuit.
- After that **Kirchhoff Voltage law** is applied, each possible loop in the circuit generates algebraic equation for every loop.

EXPERMENT NO: 2

2.1 VERIFIVATION OF THEVENIN'S THEOREM

AIM: To verify Thevenin's theorem for the given circuit.

Apparatus Required:

S.No.	Name of The Apparatus	Range	Type	Quantity
1.	Voltmeter	(0-20) V	Digital	2 No
2.	Ammeter	(0-200) mA	Digital	1 No
3.	RPS	(0-30V)	Digital	1 No
4.	Resistors	82 Ω,47Ω	-	1 No
		150Ω	-	1 No
		100 Ω	-	1 No
5.	Breadboard	-	-	1 No
6.	DMM	-	Digital	1 No
7.	Connecting wires	-	-	Required number

CIRCUIT DIAGRAM:

THEORITICAL CIRCUITS:

To Find I_L:

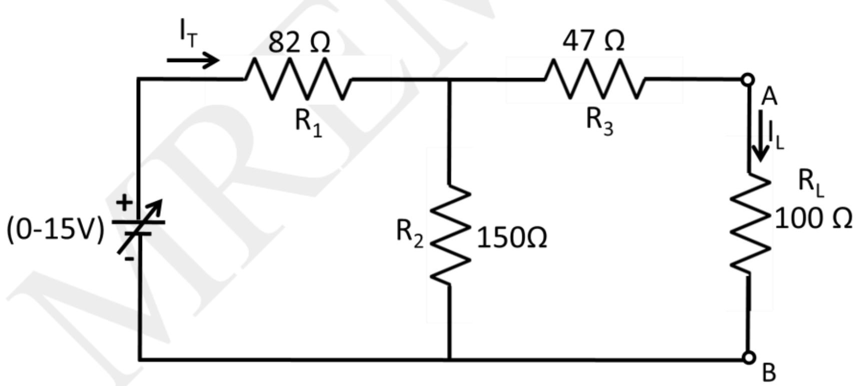
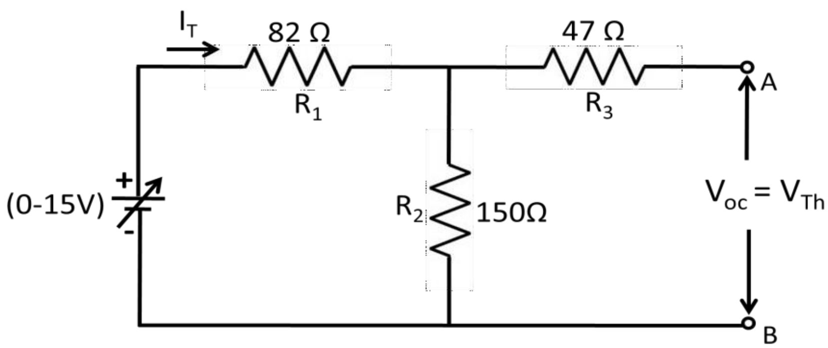
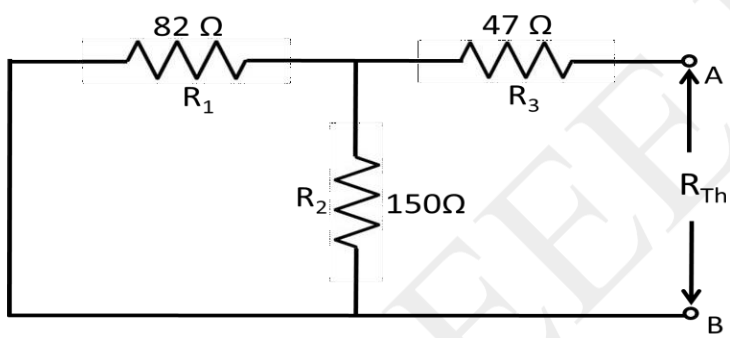


Fig.1

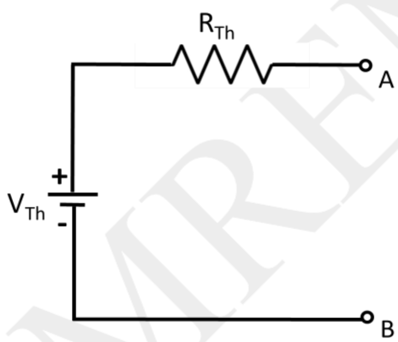
To Find V_{Th}:



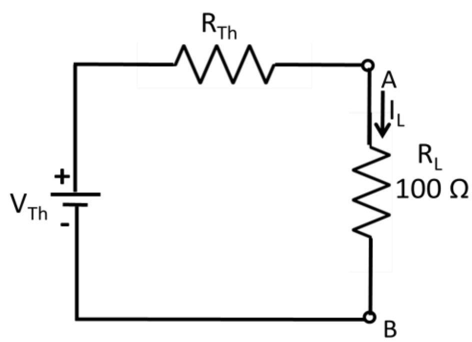
To Find R_{Th}:



Thevenin's equivalent Circuit:

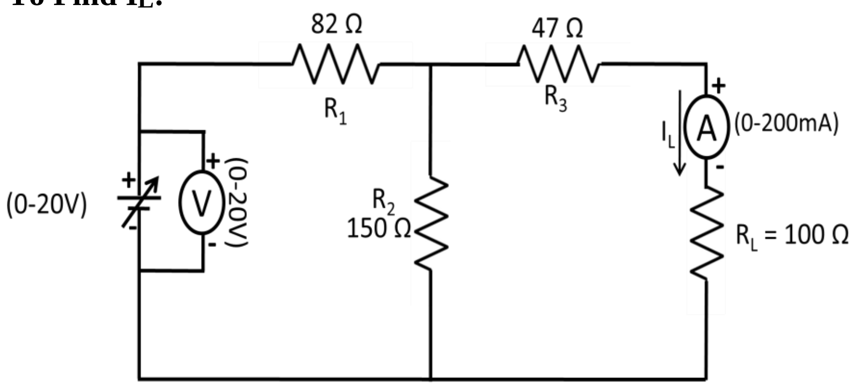


To find IL:

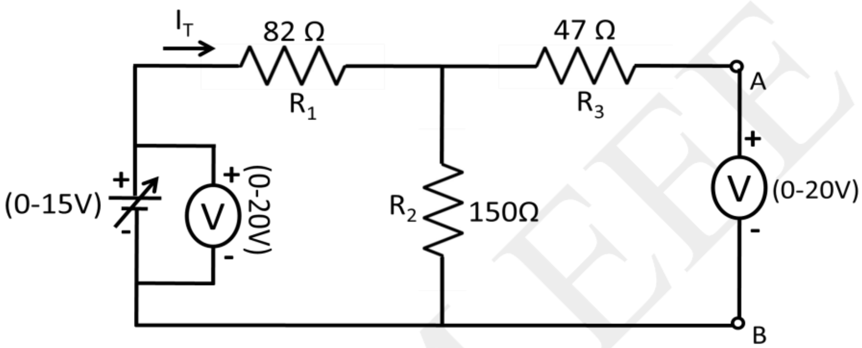


Practical Circuit Diagrams:

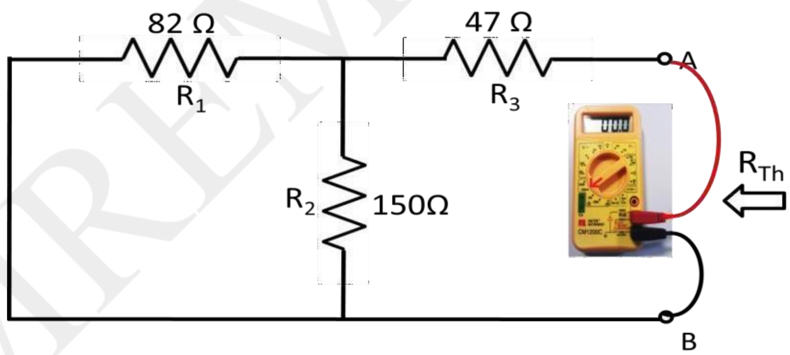
To Find I_L:



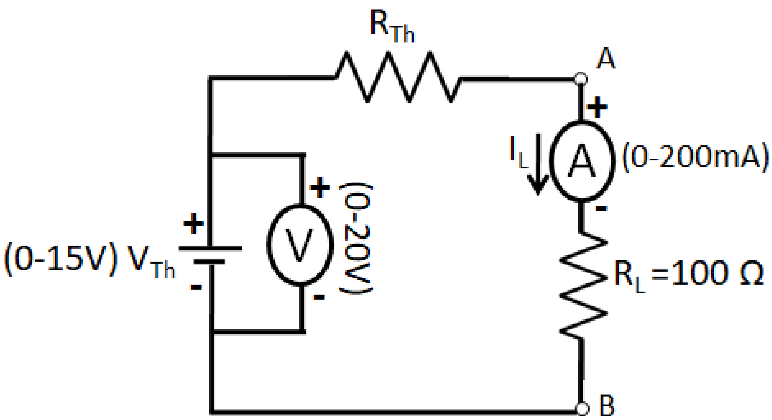
To Find V_{Th}:



To Find R_{Th}:



To Find I_L from Thevenin's equivalent circuit:



Theory:

Thevenin's Theorem:

It states that in any lumped, linear network having a greater number of sources and elements, the equivalent circuit across any branch can be replaced by an equivalent circuit consisting of Thevenin's equivalent voltage source V_{Th} in series with Thevenin's equivalent resistance R_{Th}. Where, V_{Th} is the open circuit voltage across (branch) the two terminals and R_{Th} is the resistance seen from the same two terminals by replacing all other sources with their internal resistances.

Procedure:

1. Connect the circuit as per the circuit diagram shown in fig. 2.
2. Adjust the input voltage to an appropriate value.
3. Note down the response (current, IL) through the load resistance branch i.e. A B .
4. Reduce the input voltage supply to 0V and switch-off the supply.
5. Now, make the connections as per the circuit shown in fig.2 (a).
6. Adjust the input voltage to an appropriate value.
7. Note down the voltage across the load terminals AB (Voltmeter reading) that gives V_{Th}.
8. Reduce the input voltage supply to 0V and switch-off the supply.
9. Now, make the connections as per the circuit shown in fig.2 (b).
10. Connect the digital multimeter (DMM) across AB terminals and it should be kept in resistance mode to measure Thevenin's resistance (R_{Th}).
11. Now, make the connections as per the circuit shown in fig.2 (c).
12. Note down the current through the load terminals AB (ammeter reading) that gives IL.
13. Tabulate all the measured values.

Calculations:

To find I_L:

As, the resistors R_L and R_3 are connected in series, the total branch resistance is $R_L + R_3$. The total resistance $(R_L + R_3)$ in turn is connected in parallel with R_2 and is given by $(R_L+R_3)*R_2/ R_2+R_3+R_L$

This resistance is connected in series with R_1. Therefore, the equivalent resistance is given by

$$R_{eq} = R1+\frac{(R_L+R_3)*R_2.}{R_2+R_3+R_L}$$

$$I_T = V/R_{eq} \text{ mA}$$

By Applying the Current Division Rule,

$$I_L = I_T * R_2 /(R_2+R_3+R_L) \text{ mA}$$

Step1: $\mathbf{V_{Th}}$

$$V_{Th} = V * R_2 /(R_1+R_2) \text{ volts}$$

Step2: $\mathbf{R_{Th}}$

$$R_{Th} = \frac{R_1 * R_2}{R_1 + R_2} + R_3 \quad \Omega$$

Step3: I_L

From the Thevenin's equivalent circuit:

$$I_L = V_{TH} / (R_{TH} + R_L) \text{ mA}$$

Tabular Column:

Direct method I_L:

S.NO	Theoritical values	Practical values
1	$V_{Th}=$	$V_{Th}=$
2	$R_{Th}=$	$R_{Th}=$
3	$I_L=$	$I_L=$

Result:

EXPERMENT NO: 2

2.2 VERIFIVATION OF NORTON'S THEOREM

AIM: To verify Norton's theorem for the given circuit.

Apparatus Required:

S.No.	Name of The Apparatus	Range	Type	Quantity
1.	Voltmeter	(0-20) V	Digital	2 No
2.	Ammeter	(0-200) mA	Digital	1 No
3.	RPS	(0-30V)	Digital	1 No
4.	Resistors	82 Ω,47Ω	-	1 No
		150Ω	-	1 No
		100 Ω	-	1 No
5.	Breadboard	-	-	1 No
6.	DMM	-	Digital	1 No
7.	Connecting wires	-	-	Required number

CIRCUIT DIAGRAM:

THEORITICAL CIRCUITS:

To Find I_L:

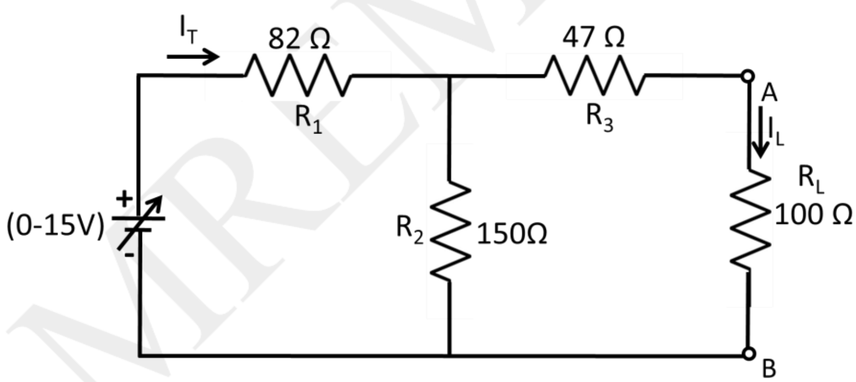
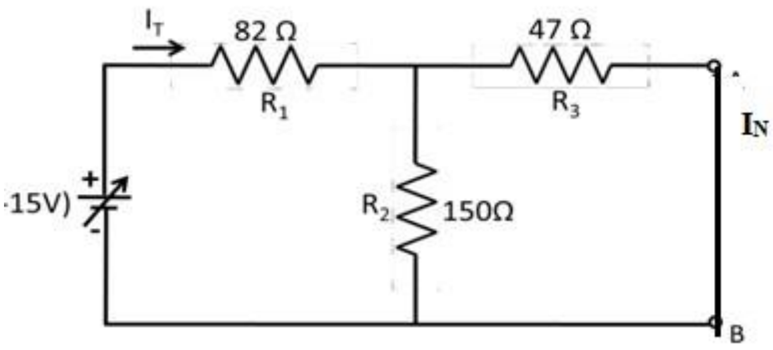
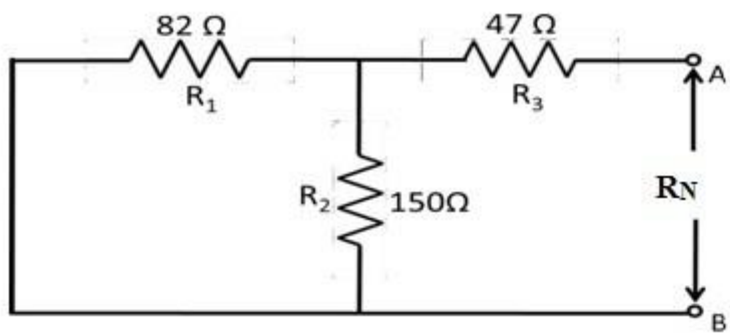


Fig.1

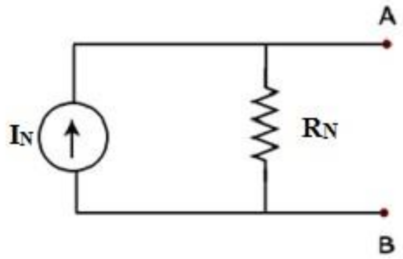
To Find I_N:

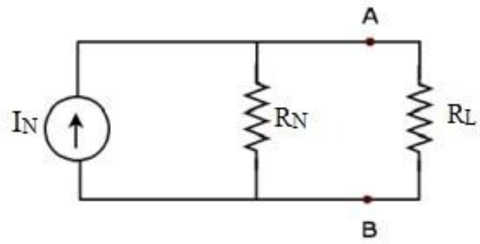


To Find R_N:



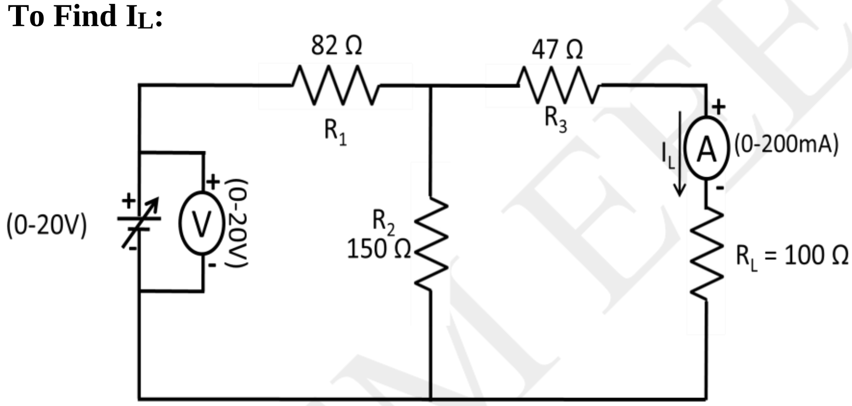
Norton's equivalent Circuit: **To find IL:**



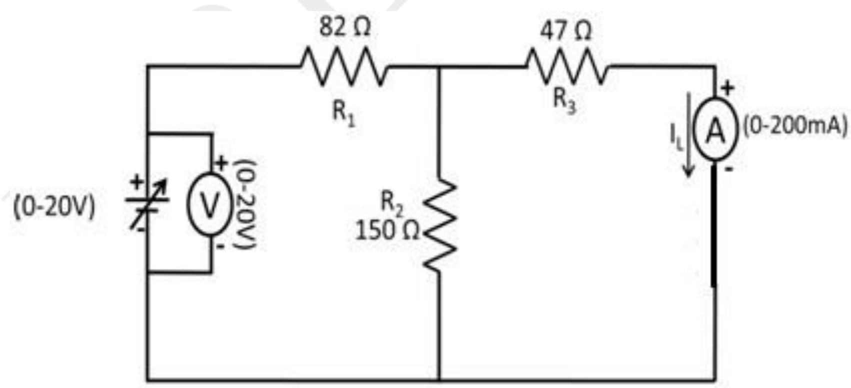


Practical Circuit Diagrams:

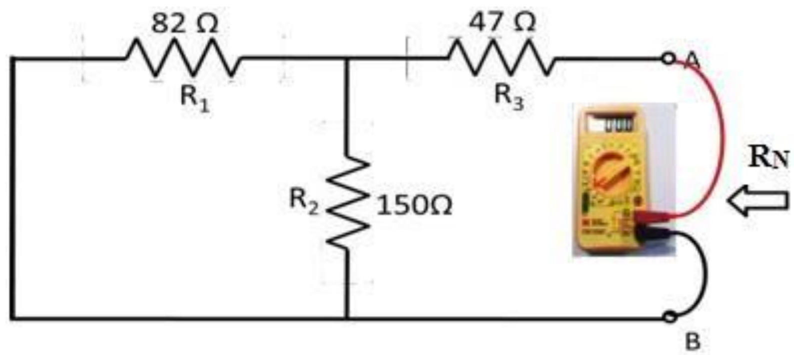
To Find I_L:



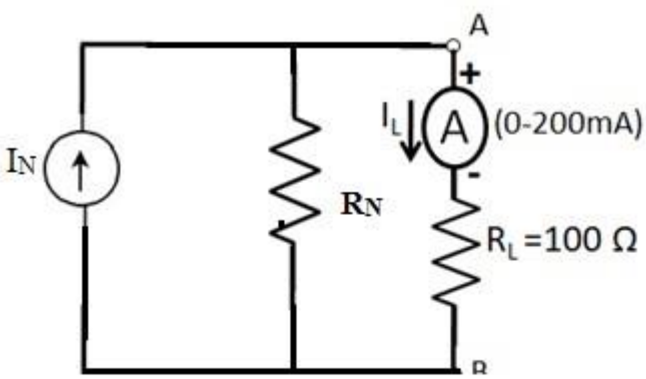
To Find I_N:



To Find R_N:



To Find I_L from Norton's equivalent circuit:



Theory:

NORTON'S THEOREM:

Norton's theorem states that in a lumped, linear network the equivalent circuit across any branch is replaced with a current source in parallel a resistance. Where the current is the Norton's current which is the short circuit current though that branch and the resistance is the Norton's resistance which is the equivalent resistance across that branch by replacing allthe sources sources with their internal resistances

Procedure:

1. Connect the circuit as per the circuit diagram shown in fig. 2.
2. Adjust the input voltage to an appropriate value.
3. Note down the response (current, I_L) through the load resistance branch i.e. A B .
4. Reduce the input voltage supply to 0V and switch-off the supply.
5. Now, make the connections as per the circuit shown in fig.2 (a).
6. Adjust the input voltage to an appropriate value.
7. Note down the current across the load terminals AB (current reading) that gives $\mathbf{I_N}$.
8. Reduce the input voltage supply to 0V and switch-off the supply.
9. Now, make the connections as per the circuit shown in fig.2 (b).
10. Connect the digital multimeter (DMM) across AB terminals and it should be kept in resistance mode to measure Norton's resistance (R_N).
11. Now, make the connections as per the circuit shown in fig.2 (c).
12. Note down the current through the load terminals AB (ammeter reading) that gives I_L.
13. Tabulate all the measured values.

Calculations:

To find I_L:

As, the resistors R_L and R_3 are connected in series, the total branch resistance is $R_L+ R_3$. The total resistance ($R_L+ R_3$) in turn is connected in parallel with R_2 and is given by $(R_L+R_3)*R_2/ R_2+R_3+R_L$

This resistance is connected in series with R_1. Therefore, the equivalent resistance is given by

$$R_{eq} = R_1+\frac{(R_L+R_3)*R_2.}{R_2+R_3+R_L}$$

$I_T = V/R_{eq}$ mA

By Applying the Current Division Rule,

$I_L = I_T * R_2 / (R_2+R_3+R_L)$ mA

Step1: I_N

$I_N = I*(R_2/R_2+R_3)$ mA

where $I = V/R_{eq}$

$R_{eq} = R_1+[(R_2 * R_3) / R_2+R_3]\ \Omega$

Step2: $\mathbf{R_N}$

$$R_N = \frac{R_1 * R_2}{R_1 + R_2} + R_3 \quad \Omega$$

Step3: I_L

From the Thevenin's equivalent circuit:

$I_L = I_N * R_N / (R_N + R_L)$ mA

Tabular Column:

Direct method I_L:

S.NO	Theoritical values	Practical values
1	$I_N =$	$I_N =$
2	$R_N =$	$R_N =$
3	$I_L=$	$I_L=$

Result:

EXPERMENT NO: 3

TRANSIENT RESPONSE OF SERIES RL AND RC CIRCUITS USING DC EXCITATON

AIM:

To construct RL & RC transient circuit and to draw the transient curves.

APPARATUS REQUIRED:

S.NO.	NAME OF THE EQUIPMENT	RANGE	TYPE	QTY.
1.	RPS	(0-30)V	DC	1
2.	Ammeter	(0-10)mA	MC	1
3.	Voltmeter	(0-10)V	MC	1
4.	Resistor	10 K	-	3
5.	Capacitor	1000 µ F	-	1
6.	Bread board	-	-	1
7.	Connecting wires	-	Single strand	As required

THEORY:

Electrical devices are controlled by switches which are closed to connect supply to the device, or opened in order to disconnect the supply to the device. The switching operation will change the current and voltage in the device. The purely resistive devices will allow instantaneous change in current and voltage.

An inductive device will not allow sudden change in current and capacitance device will not allow sudden change in voltage. Hence when switching operation is performed in inductive and capacitive devices, the current & voltage in device will take a certain time to change from pre switching value to steady state value after switching. This phenomenon is known as transient. The study of switching condition in the circuit is called transient analysis.The state of the circuit from instant of switching to attainment of steady state is called transient state. The time duration from the instant of switching till the steady state is called transient period. The current & voltage of circuit elements during transient period is called transient response.

FORMULA:

Time constant of RC circuit = RC

Time constant of RL circuit = L/R

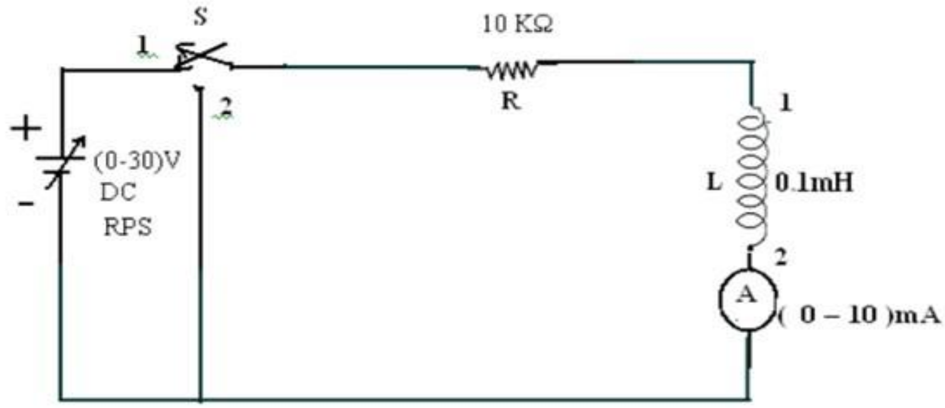
PROCEDURE:

- Connections are made as per the circuit diagram.

- Before switching ON the power supply the switch S should be in off position
- Now switch ON the power supply and change the switch to ON position.

CIRCUIT DIAGRAM:

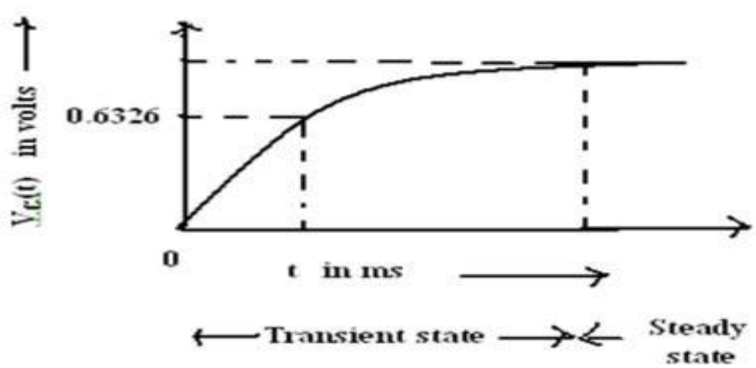
RL CIRCUIT:



TABULATION:

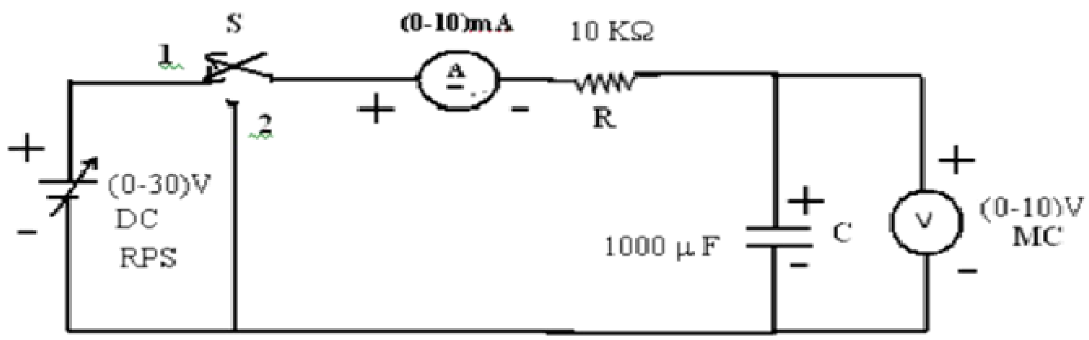
S.NO.	TIME (msec)	CHARGING CURRENT (I) A	DISCHARGING CURRENT (I) A

MODEL GRAPH:

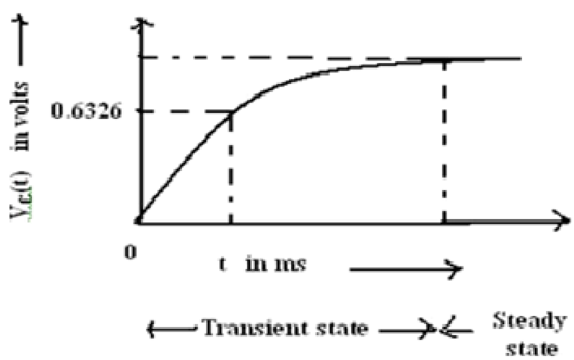


CIRCUIT DIAGRAM:

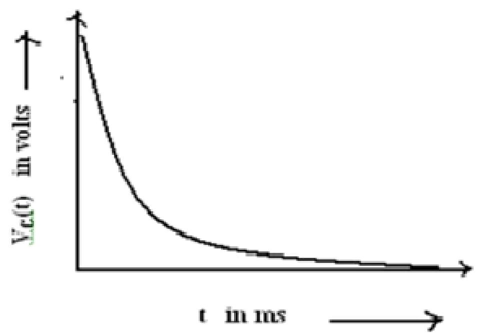
RC CIRCUIT:



CHARGING



DISCHARGING



TABULATION:

CHARGING:

S.NO.	TIME (msec)	VOLTAGE ACROSS 'C' (volts)	CURRENT THROUGH 'C' (mA)

MODEL CALCULATION & ANALYSIS:

TABULATION:

DISCHARGING:

S.NO.	TIME (msec)	VOLTAGE ACROSS 'C' (volts)	CURRENT THROUGH 'C' (mA)

RESULT:

Thus the transient response of RL & RC circuit for DC input was verified.

VIVA VOICE QUESTIONS:

1. Define steady state response
2. Define transient response
3. Why transient occurs in electric circuits
4. Define time constant of RL circuit
5. Define time constant of RC circuit
6. Voltage across capacitor cannot change instantaneously. Justify
7. Current through an inductor cannot change instantaneously. Justify.

APPLICATIONS:

RC, RL and LC circuits are essential building blocks in many circuit applications.

1. For example, RC and RL circuits are commonly used as filters (taking advantage of the fact that capacitors tend to pass high frequency signals but block low frequency signals, while the opposite is true for inductors).

2. They are also useful for electrical signal processing, for example, taking the derivative or integral of an electrical signal. The LC circuit is a simple example of an electrical "oscillator" or resonance circuit and is a common component in circuits used for amplifiers, radio tuning, *etc.*

EXPERIMENT NO- 4

RESONANCE IN SERIES RLC CIRCUIT

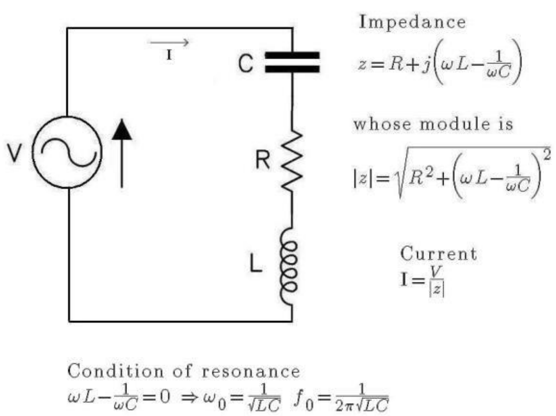
AIM:

To verify resonant frequency, bandwidth and quality factor of RLC series resonant circuits.

APPARATUS REQUIRED:

S.No	NAME	RANGE	TYPE	QUANTITY
1	Function Generator	(70-10000)Hz	-	1
2	Ammeter	(0-200)mA	MI	1
3	Decade Resistance Box	(0-1Mohms)	-	1
4	Decade Inductance Box	(0-100H)	-	1
5	Decade Capacitance Box	(0-100µF)	-	1
6	Connecting wires	-	-	Required

Theoritical Circuit Diagram For Series Resonance:



Practical Circuit Diagram For Series Resonance:

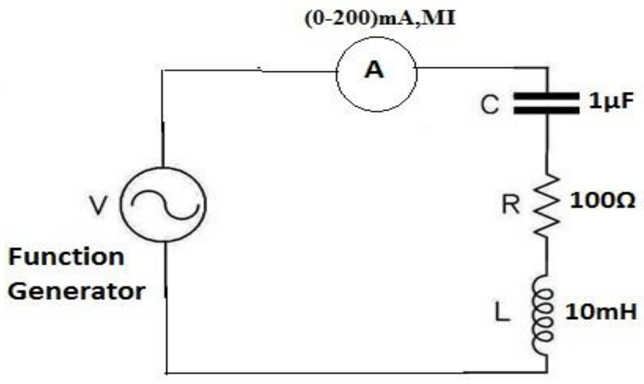


Fig.1

THEORY:

An electrical circuit is said to undergo resonance when the net (total) current is in phase with the applied voltage. A circuit at resonance exhibits certain characteristic properties.
The frequency at which the resonance occurs in a circuit is called resonant frequency.

In series RLC circuit, the resonance occurs when

i) The net reactance in a circuit is zero. ($X_L = X_C$)
ii) The circuit impedance is equal to resistance in a circuit (Z = R)
iii) Current in phase with voltage
iv) Power factor is unity.
v) The current in a circuit is maximum.

UNDER RESONANCE CONDITIONS, $X_L = X_C$ or $\omega L = 1/\omega C$

$$\omega_o^2 = 1/LC$$

$$\omega_o = \frac{1}{\sqrt{LC}} \quad \text{or} \quad f_o = \frac{1}{2\pi\sqrt{LC}}$$

In parallel resonance, the resonant frequency is same as the series resonance but the current in circuit is minimum and net suceptance is equal to zero.

Formulae:

a) Resonant frequency : $f_o = \dfrac{1}{2\pi\sqrt{LC}}$ Hz

b) Half power frequencies:

$f_1 = f_o - R/4\pi L$ Hz

$f_2 = f_o + R/4\pi L$ Hz

c) Band width:

$BW = f_2 - f_1$ (or) $R/2\pi L$

d) Q –factor: $Q = \dfrac{1}{R}\sqrt{\dfrac{L}{C}}$

PROCEDURE:

SERIES RESONANCE:

1. Make the connections as per the circuit diagram shown in fig1.
2. Apply the sinusoidal voltage of peak-peak value is 10V

3. Vary the frequency of sine wave between 100 Hz – 10000 Hz in steps, and note down the readings of ammeter.

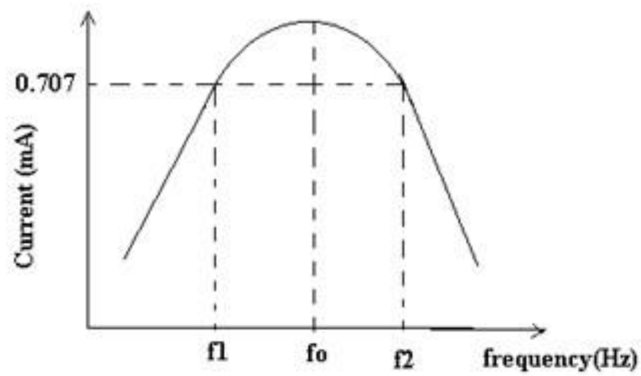
4. Tabulate the readings in table1.

TABULAR COLUMN:

(SERIES RESONANCE)

S.NO.	Frequency (Hz)	Current (mA)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

Model Graph:



Series Resonance

PRECAUTIONS:

1. Avoid loose connections
2. Take readings without parallax error
3. Set the ammeter pointer at zero position

RESULT :

VIVA-VOCE QUESTIONS:

1. Define resonance frequency.
2. What is the value of power factor in series RLC circuit under resonance condition?
3. Define Bandwidth?
4. Define Q-factor?

APPLICATIONS:

The resonant RLC circuits has many applications like

1. Oscillator circuit, radio receivers and television sets are used for the tuning purpose
2. Since **resonance in series RLC circuit** occurs at particular frequency, so it is used for filtering and tuning purpose as it does not allow unwanted oscillations that would otherwise cause signal distortion, noise and damage to circuit to pass through it.
3. The series RLC circuit mainly involves in signal processing and communication system
4. The Series resonant LC circuit is used to provide voltage magnification

EXPERIMENT NO- 5
CALCULATIONS AND VERIFICATION OF IMPEDANCE AND CURRENT OF RL, RC AND RLC SERIES CIRCUITS

AIM:

To calculate and to verify the impedance and current of RL, RC and RLC series circuits.

APPARATUS:

Sl. No.	Name of the Equipment	Range	Type	Quantity
01	Function Generator	(0-10K)Hz	AC	01
02	Resisstance box	1Kohms	DC	01
03	Inductance box	100mH	DC	01
04	Capacitance box	0.001µF	DC	01
05	Multimeter	Multi range	Digital	01
06	Breadboard	-----	-----	01
07	CRO	-----	-----	01
08	Connecting Wires	------	------	As required

CIRCUIT DIAGRAMS:

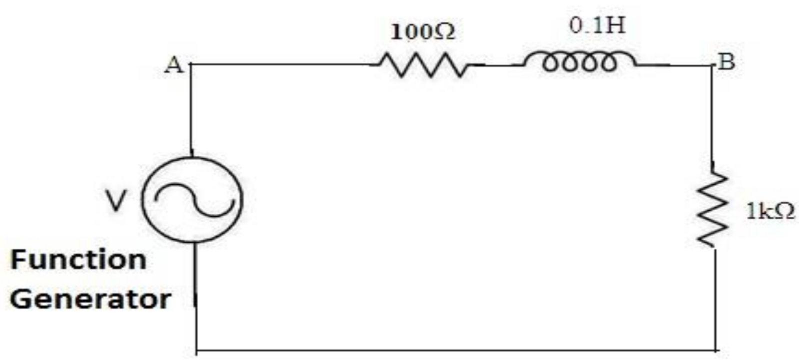


Fig1: Series RL circuit

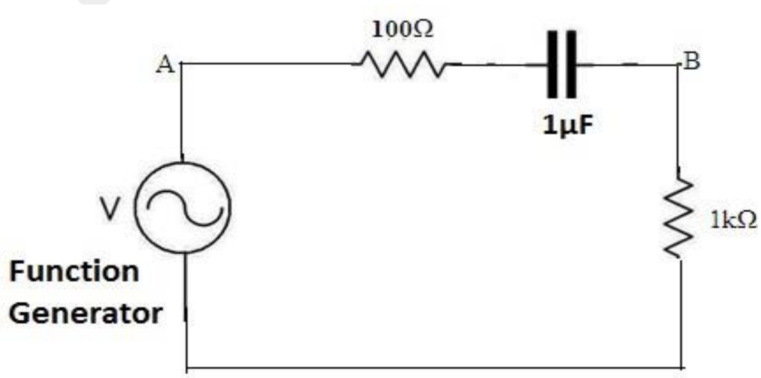


Fig2: Series RC circuit

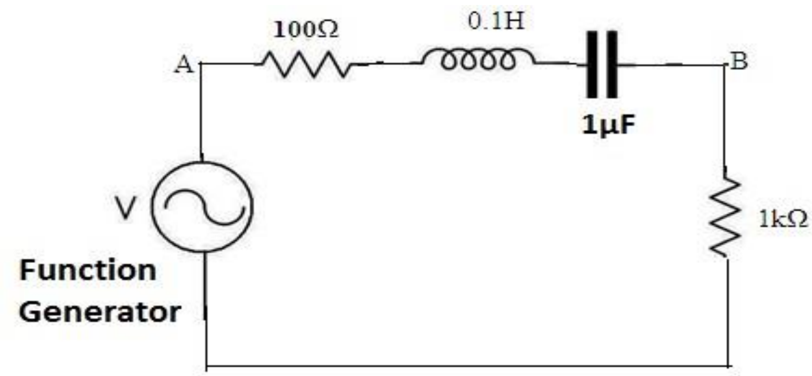


Fig3: Series RLC circuit

THEORY:

Impedance is the total measure of opposition to electric current and is the complex (vector) sum of (“real”) resistance and (“imaginary”) reactance

PROCEDURE:

1. Give the connections as per the circuit diagram.
2. Connect the CRO probe at point A to get voltage waveform and at B to get the current waveform.
3. Adjust vertical deflection of each channel such that the waveform fills the whole screen.
4. Adjust the sweep rate and the horizontal position control until one half cycle of the waveform spans 9 divisions on the scope’s scale.
5. Since one half cycle covers 9 divisions, it means each major division on the scope represents 20^0
6. Since each major division consists of 5 smaller divisions, each smaller division represents $20/5 = 4^0$
7. Phase difference between two waveforms is determined by simply counting the number of small divisions between corresponding points on the 2 waveforms.
8. Phase Angle φ = (no.of divisions) * (degree / divisions).
9. Power Factor is given by Cos φ.

FORMULAS :

Power Factor (P.F) = Cos φ = (practical value) = R / Z

Impedance Z = R / Cos φ

Current I = V/Z

THEORETICAL VERIFICATION:

- $X_L = 2\pi fL$
- $X_C = 1/ 2\pi fC$ $Z = \sqrt{R^2 + X_L^2}$

- Impedance for RL circuit is,
- Current in RL circuit is, I=V/Z (for RL)
- Impedance for RC circuit is, $Z = \sqrt{R^2 - X_C^2}$
- Current in RC circuit is, I=V/Z (for RC)
- Impedance for RLC circuit is, $Z = \sqrt{R^2 + (X_L - X_C)^2}$
- Current in RL circuit is, I=V/Z (for RLC)

TABULAR COLUMN:

S.No	RL Circuit		RC Circuit		RLC Circuit	
	Z	**I**	**Z**	**I**	**Z**	**I**
Theoritical Values						
Practical Values						

RESULT:

APPLICATIONS:

1. R L circuits like in tubelight.
2. R C circuit in many electronic application like multi vibrator, filters, differentiators and integrators
3. R L C circuit is used as Ac variable load in engineering experiment

VIVA –VOCE QUESTIONS:

1. What is impedance ? what are its units?
2. What is meant by inductive reactance and capacitive reactances? What are its units?

EXPERIMENT NO: 6

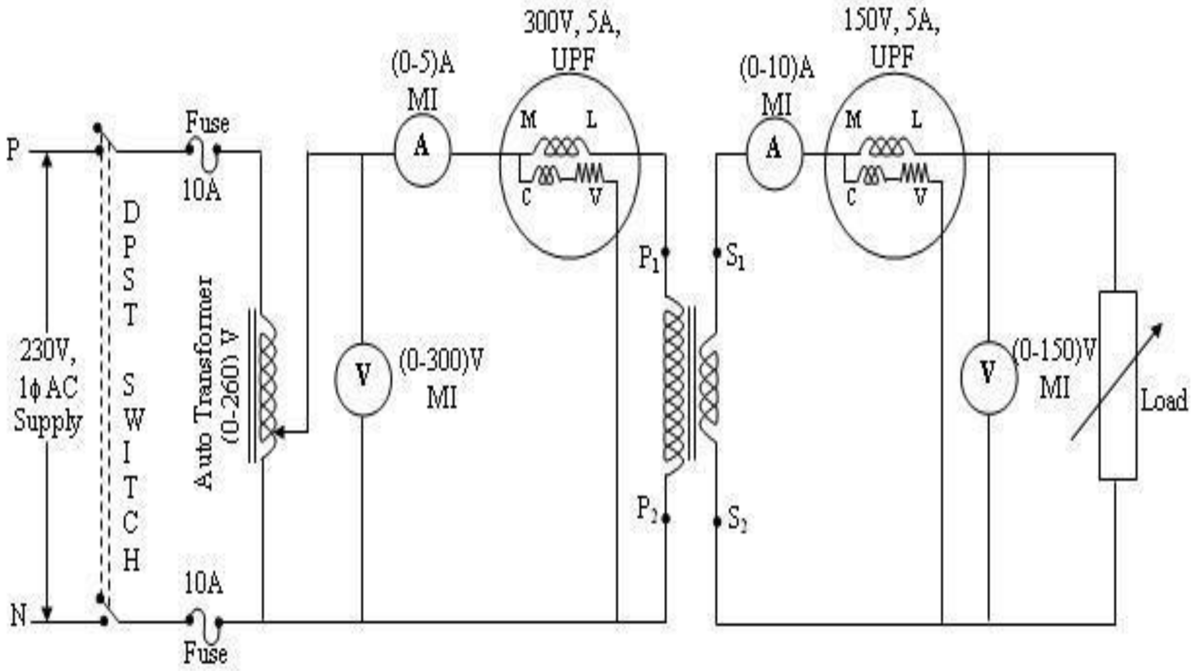
MEASUREMENT OF VOLTAGE, CURRENT AND REAL POWER IN PRIMARY AND SECONDARY CIRCUITS OF A SINGLE PHASE TRANSFORMER

AIM: To measure voltage current and real power in primary and secondary circuits of a single phase Transformer

APPARATUS REQUIRED:

Sl.No.	APPARATUS	RANGE	TYPE	QUANTITY
1.	Auto traonsformer (1 ϕ)	220V/(0-270)V	----	1
2.	Ammeter	(0-10)A 2. (0-5)A	MI MI	11
3.	Voltmeter	(0-150)V(0-300)V	MI MI	1 1
4.	Wattmeter	(5A,150V) (5A,300V)	UPF UPF	1 1
5.	Connecting wires	------	----	Required number

CIRCUIT DIAGRAM:



FUSE RATING:

125% of rated current

$$\frac{125 \times 5}{100} = 6.25A$$

NAME PLATE DETAILS:

	Primary	Secondary
Rated Voltage :	230V	115V
Rated Current :	5A	10 A
Rated Power :	1KVA	1KVA

TABULAR COLUMN:

S.No	Load	V_1 (V)	I_1 (A)	W_1 (W)	V_2 (V)	I_2 (A)	W_2 (W)	Input power (W)	Output power (W)

PROCEDURE:

1. Connectuons are made as per the circuit diagram.
2. After checking the no load condition, minimum position of autotransformer and DPST Switch is closed
3. Note down the corresponding readings of all the meters connected in the circuit.
4. Increase the loasd and for each loadNote down the corresponding readings of all the meters connected in the circuit.
5. Now open the DPST switch after gradually reducing the auto transformer's secondary voltage to a minimum value.

FORMULE:

Output power = W2*multiplication factor
Input power=W1* multiplication factor
Efficiency=output/input

$$\text{Regulation} = \frac{V_{NL} - V_{FL}}{V_{NL}}$$

PRECAUTIONS:

1. DPST switch should be kept open.
2. The auto transformer should be kept in minimum potential position.

RESULT:

APPLICATIONS

The typical applications of single phase transformers are:

- Distribute power at high voltage
- Transformers are also used extensively in electronic products to decrease (or step-down) the supply voltage to a level suitable for the low voltage circuits they contain Signal and audio transformers are used to couple stages of amplifiers and to match devices such as microphones and record players to the input of amplifiers.
- Audio transformers allowed telephone circuits to carry on a two-way conversation over a single pair of wires.

- A balun transformer converts a signal that is referenced to ground to a signal that has balanced voltages to ground, such as between external cables and internal circuits.
- Transformers made to medical grade standards isolate the users from the direct current. These are found commonly used in conjunction with hospital beds, dentist chairs, and other medical lab equipment

EXPERIMENT NO: 7

PERFORMANCE CHARACTERISTICS OF A DC SHUNT MOTOR

Aim:-

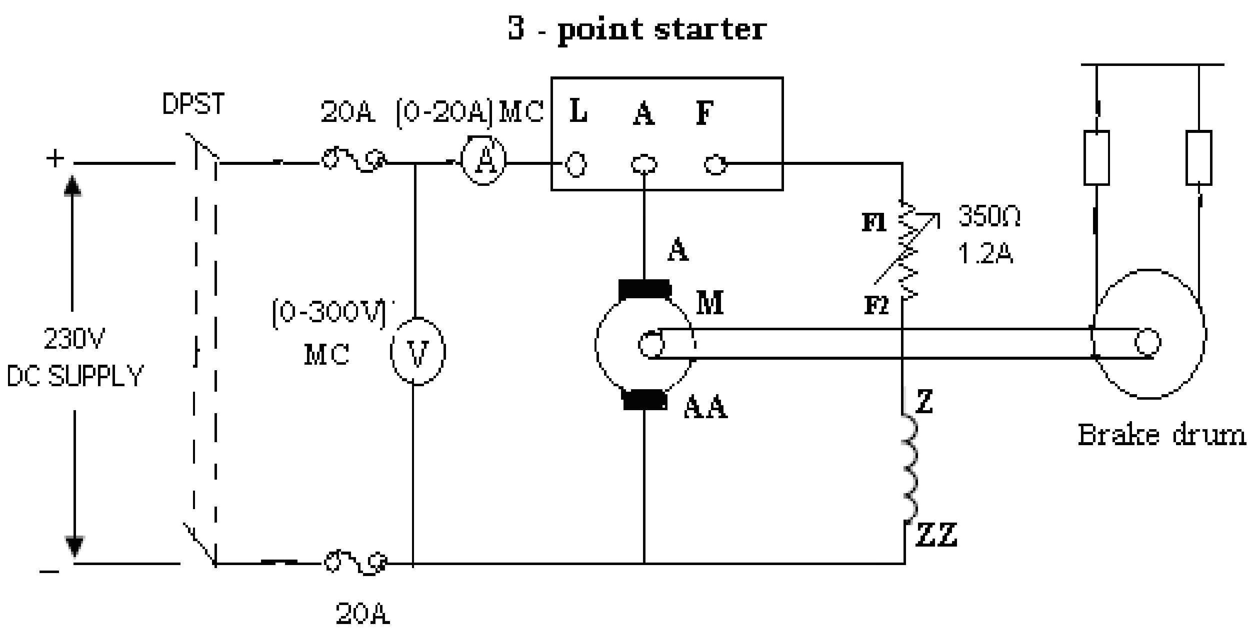
To obtain performance curves dc shunt motor and to draw the of the motor

- In dc shunt motor we calculate the speed , torque, efficiency & load current
- Whenever we increases the load the current will increases and seed will decrease

Apparatus Required:-

1.	Ammeter	(0-20A) MC	1NO
2.	Voltmeter	(0-300V) MC	1NO
3.	Rheostat	350Ω, 1.7A	1NO
4.	Tachometer	(0-10,000) RPM	1NO

Circuit diagram:-



Theory:-

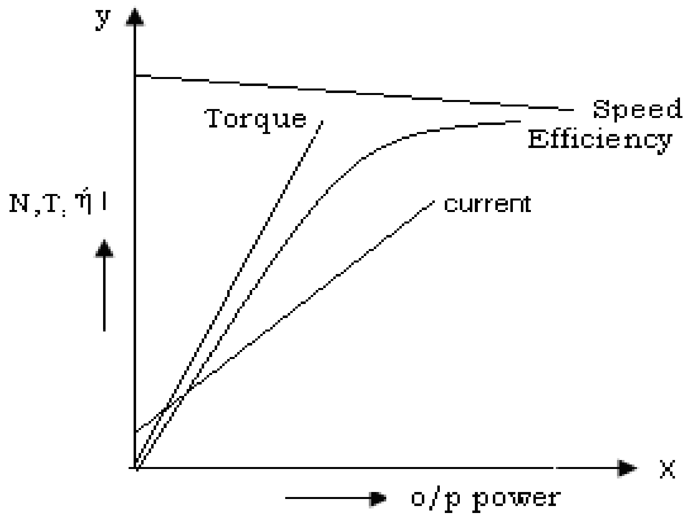
It is the direct method of testing. By this method the efficiency and losses of only small machines can be determined .In this method full load is applied to the machine and output is directly measured. Though this method is very simple in looking but involves complication in the measurement of mechanical power input in the case of generator, and output in the case of motor. In the case of generator the input mechanical power is measured by connecting some form of dynamometer to the prime mover and water resistance load is applied.

In the case of small motor,some form of the brake must be tight before the motor is started ,otherwise the armature may get damaged and fly to pieces. In the case of large motors the motor is coupled to a generator and generator is loaded by means of a resistance. This method is wasteful, since all the input is to be wasted can only be used in case of small machines due to the difficulty of having enough power and suitable brake arrangement in case of large machines.

Procedure:-

1. Make the connections as per the circuit diagram.
2. Initially keep the motor field rheostat in minimum resistance position.
3. Give the supply by closing DPST switch and start the motor with the help of 3- point starter.
4. Adjust the motor field rheostat till the rated speed is obtained.
5 Apply the load on brake drum in steps.
6. Note down the readings of speed, voltmeter, ammeter and spring balance.
6 Repeat step 5 and 6 until rated current is obtained.
7 Remove the load on the motor before switching off the supply.

Model graph:- Draw the graph between output power on x-axis and speed , torque, efficiency & load current are on y-axis as shown below.



Tabular columns:-

Voltage (volts)	Current (amp)	Speed (rpm)	i/p=VI (watts)	S_1 Kg	S_2 Kg	Torque= **(S1≈S2)* r* 9.81** (N-m)	o/p = 2ΠNT/60 (watts)	%ή= output / input*100

Result:-

Brake test is conducted on dc shunt motor and hence performance curves are plotted

Viva voce

1. Define Torque?

2. What is the need of starter?
3. What are the types of starters?

EXPERIMENT NO: 8

TORQUE-SPEED CHARACTERSTICS OF 3 PHASE INDUCTION MOTOR

AIM: To conduct the direct load test on the given 3-phase induction motor and Obtain the performance characteristics.

APPARATUS REQUIRED:

S.No	NAME OF THE APPARATUS	RANGE	TYPE	QUANTITY
1.	Watt meter	(0-10A,0-600V UPF)		2
2.	Ammeter	(0-10A)	MI	1
3.	Voltmeter	(0-600V)	MI	1
4.	Tachometer		Digital	
5.	Connecting wires			

PRECAUTIONS:

1. TPST should be in open position.
2. There should be no load on the motor before starting.
3. The 3-ϕ auto transformer should be in minimum potential position.

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Close the TPST switch.
3. Start the 3-ϕ Induction motor with direct on line starter.
4. Note down the no load readings of the ammeter, voltmeter, wattmeter readings & speed of the Induction motor.

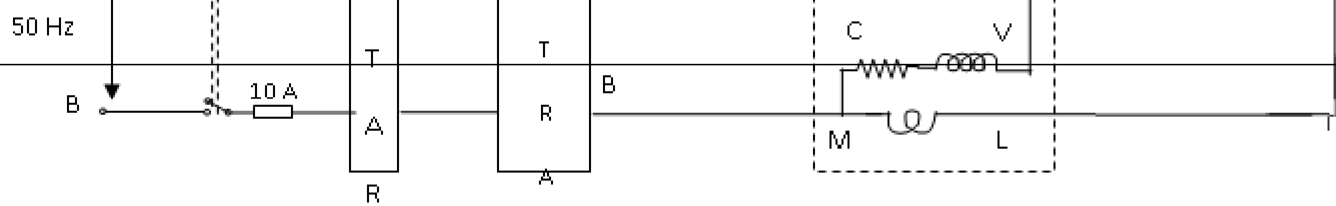
5. Apply the mechanical load in Kg' s on the induction motor gradually in steps till the rated load current. And note down the corresponding meter readings, speed and tabulate them.
6. Reduce the load and switch off the three phase supply.

FORMULAE:

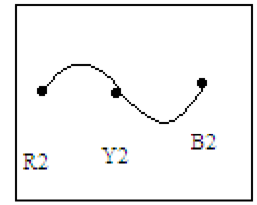
1. I/P to motor in watts (W) = wattmeter reading.
2. Torque T= ($S_1 \sim S_2$) x R x 9.81 N-m.
   Where R is radius of brake drum = Circumference / 2 π metres.
3. O/P of motor in Watts (W_{out})=($2\pi NT$)/60watts.
4. % Efficiency of the motor = (O/P of motor / I/P of motor) x100.
5. Percentage slip %S= ((N_s – N)/ N_s) x100.
   Where N_s is synchronous speed=120f/P
   N is the actual speed of the motor.
6. Power factor COS ϕ= W/ ($\sqrt{3}\ V_L I_L$)

THEORY:

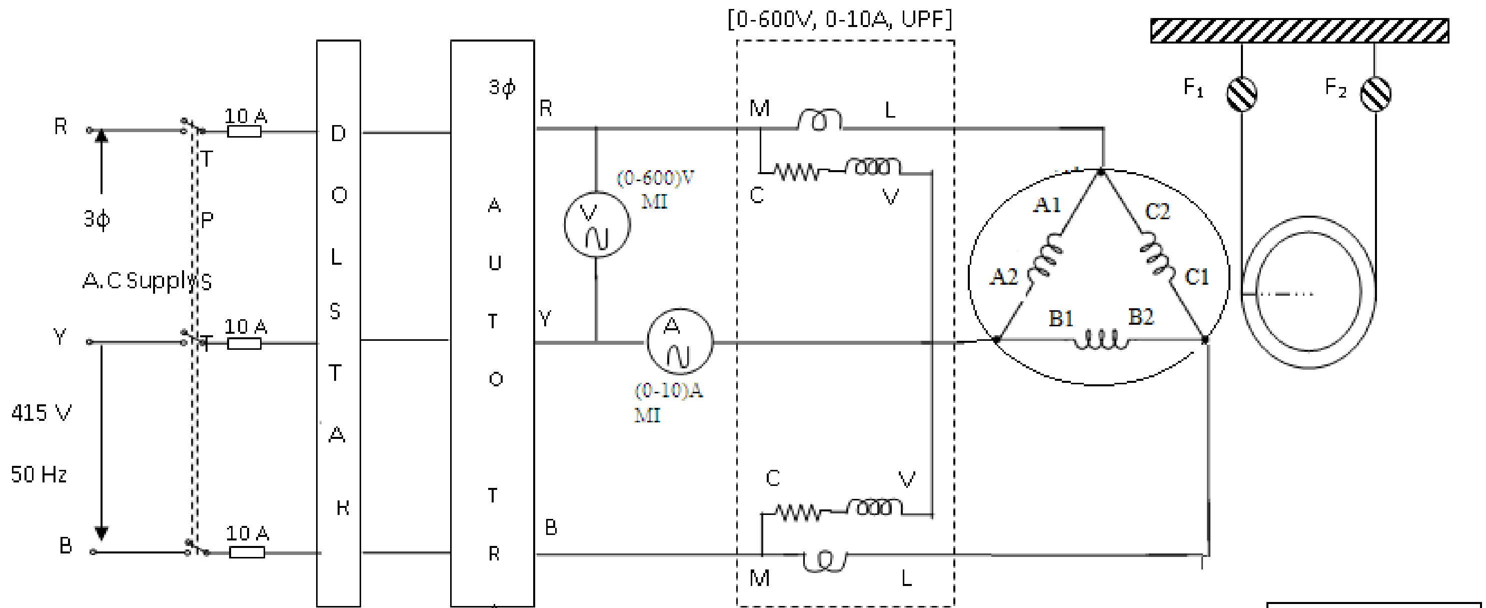
A 3-phase induction motor consists of stator and rotor with the other associated parts. In the stator, a3-phase winding is provided. The windings of the three phase are displaced in spaceby120º. A 3-phasecurrent is fed to the 3-phase winding. These windings produce a resultant magnetic flux and it rotates in space like a solid magnetic poles being rotated magnetically.



50 Hz
B
10 A
T
A
R
T
R
A
B
C
V
M
L



R2
Y2
B2



[0-600V, 0-10A, UPF]
R
Y
B
10 A
10 A
10 A
3ϕ
A.C Supply
415 V
50 Hz
T
P
S
D
O
L
S
T
A
R
3ϕ
A
U
T
O
T
R
R
Y
B
(0-600)V
MI
(0-10)A
MI
M
L
C
V
C
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A1
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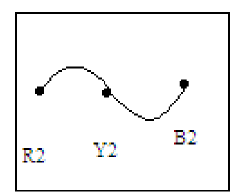
C2
C1
B1
B2
F1
F2

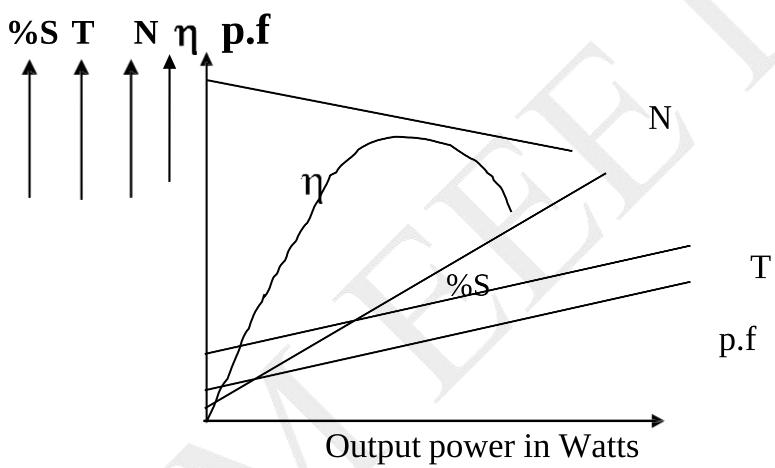


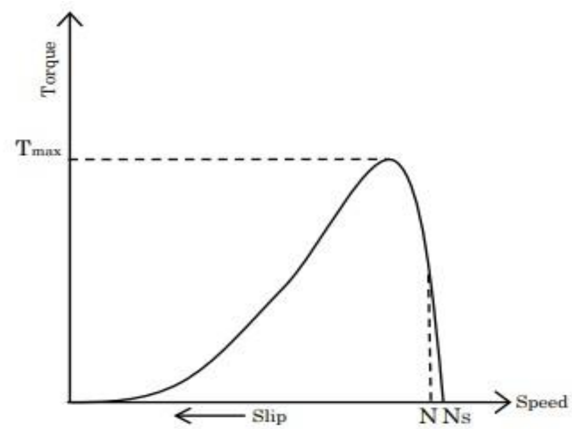
R2
Y2
B2

TABULAR COLUMN:

SL/ NO	Load Voltage in Volts V_L	Load Current in Amps I_L	Power in Watts W_{in}	Speed in rpm N	Weight in Kgs $S=S_1 \sim S_2$		Torque in N-m T	Output power in Watts W_{out}
					S_1	S_2		

MODEL GRAPH:





RESULT:

Thus the load test on the 3phase induction motor was performed and performance characteristics were obtained.

APPLICATIONS: 1). Electric Train engine

2). cooling fans used to cool large machines like alternators etc

3). chimneys at power plants

4). printing machines

5). Rolling mills

VIVA QUESTIONS:

1. What is the working principle of 3 – phase induction motor?
2. What are the different types of 3 – phase induction motor?
3. As the load increases, what happens to the speed of the motor?
4. Why 3 – phase induction motor is widely used for industrial applications?
5. What are the various losses in induction motors?
6. Why induction motor is called as rotating transformer?

EXPERMENT NO: 9

VERIFICATION OF SUPERPOSITION THEOREM

Aim:

To verify the superposition theorem for the given circuit .

Apparatus Required:

S.No	Name of The Apparatus	Range	Type	Quantity
1.	Bread board	-	-	1 No
2.	Ammeter	(0-20)mA	Digital	1 No
3.	RPS	0-30V	Digital	1 No
4.	Resistors	82Ω	-	1 No
		100Ω	-	1 No
		47Ω	-	1 No
5.	Connecting Wires	-	-	Required number

Circuit Diagram:

Given Circuit:

To Find I, when V_1 and V_2 sources acting simultaneously:

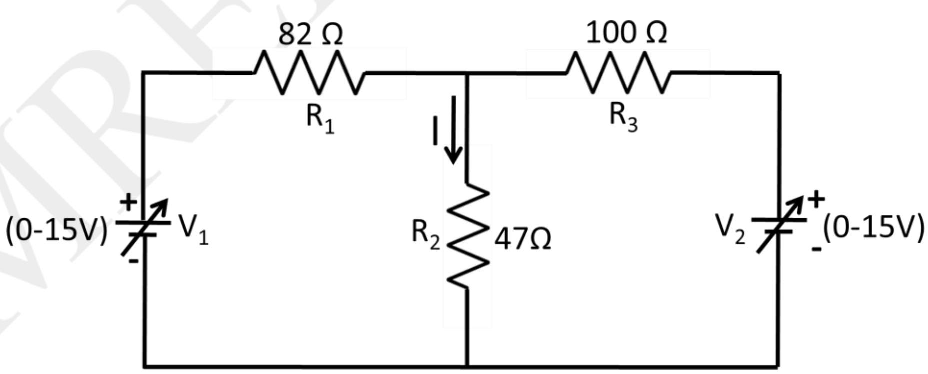


Fig.1

To Find I_1, when only V_1 source is acting alone:

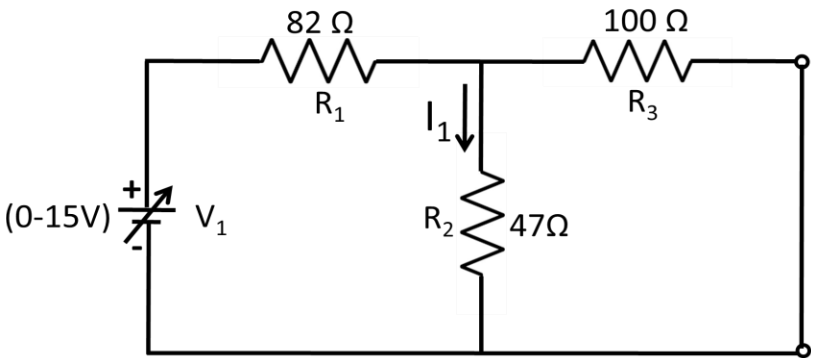


Fig.1(a)

To Find I_2, when only V_2 source is acting alone:

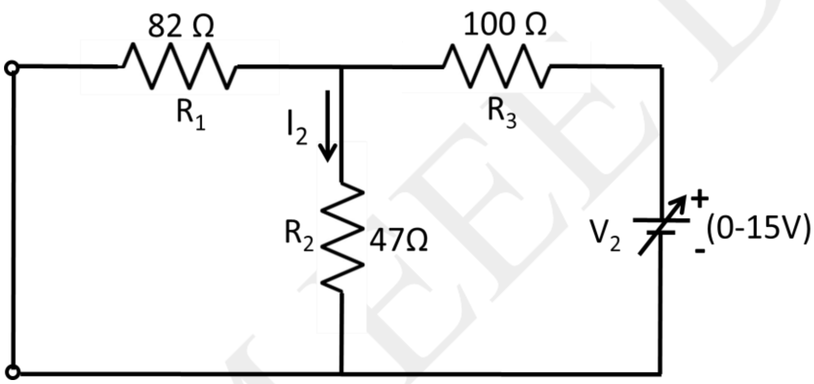


Fig.1(b)

Practical Circuits:

Case1: To Find I, when V_1 and V_2 sources acting simultaneously:

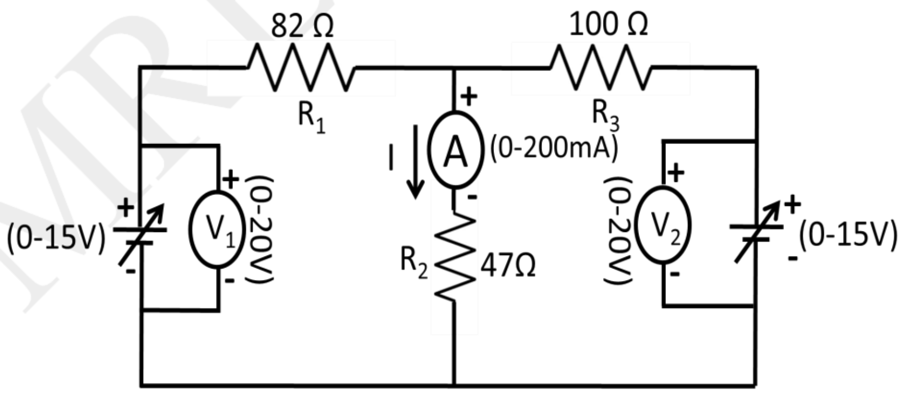


Fig.2

Case2: To Find I_1, when only V_1 source is acting alone:

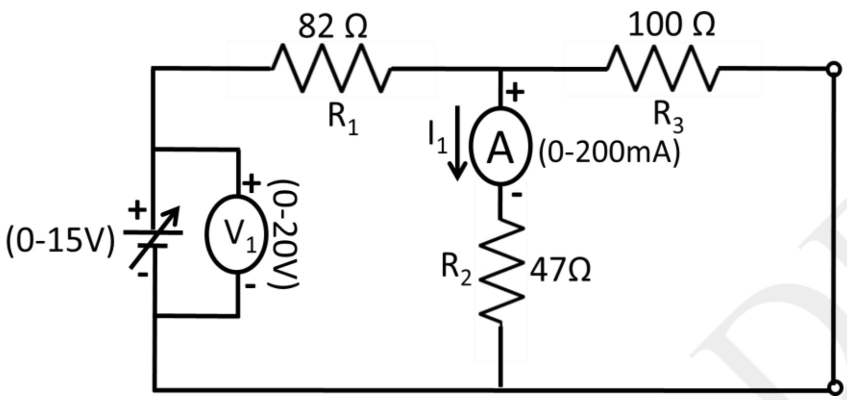


Fig.2(a)

Case2: To Find I_2, when only V_2 source is acting alone:

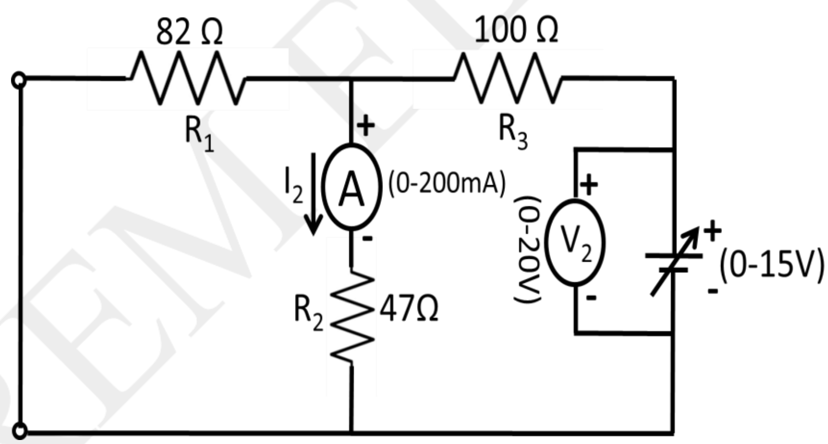


Fig.2(b)

Theory:

Superposition Theorem:

It states that for a linear, bilateral network having more than one independent source, the response (voltage or current) in any branch is equal to the algebraic sum of the responses caused by each independent source acting alone, where all the other independent sources are replaced by their internal resistance i.e., independent voltage sources with a short circuit and independent current sources with an open circuit .

Procedure:

1. Connections are made as per the circuit shown in fig (2).

2. Adjust the input voltage of sources V1 and V2 to appropriate values (Say 10V and 15V respectively).

3. Note down the current (I) through the 47 0hm resistor by using the ammeter.

4. Connect the circuit as per fig 2(a) and set the source V1 (say 10V).

5. Note down the current (I1) through 47ohm resistor by using ammeter.

6. Connect the circuit as per fig 2(b) and set the voltage source V2 (say 15V).

7. Note down the current (I2) through the 47ohm resistor by using ammeter.

8. Reduce the output voltage of the sources to 0V and switch off the supply.

9. Disconnect the circuit.

Calculations:

Case 1: when both the voltage sources V1 and V2 are active: Assume the unknown voltage at node “A” as VA,

$$\frac{V_A - V_1}{R_1} + \frac{V_A}{R_2} + \frac{V_A - V_2}{R_3} = 0 \text{ ------------ (1)}$$

On substituting the values of V_1, V_2, R_1, R_2 and R_3 in the above equation and on solving we getthe unknown voltage at node V_A. Then, the current through the resistor R_2 is given by

$$I = \frac{V_A}{R_2} \text{ mA}$$

Case2: When the voltage source V_1 alone is active i.e., V_2 is short circuited (V_2=0):

$$R_{eq} = R_1 + [(R_2*R_3)/(R_2+R_3)]$$

$$I_T = \frac{V}{R_{eq}} \text{ mA}$$

$$I_1 = I_T \text{ x } \frac{R_3}{R_2 + R_3}$$

Case 3: When the voltage source V_2 alone is active i.e., V_1 is shorted circuited (V_1=0)

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

$$I_T = \frac{V}{Req} \text{ mA}$$

$$I_2 = I_T * \frac{R_1}{R1 + R2} \text{ mA}$$

The algebraic sum of the individual responses I_1 and I_2 gives the current I flowing through theresistor R_2 (say 47 **Ω**) when both the sources acting at a time i.e.,

$I=I_1+I_2$ mA

Tabular Column:

S. No	Voltage Source (in Volts)	Current through the resistor R_2	
		Theoretical Values (in mA)	Practical Values (in mA)
1.	When both the sources are active: V_1= ; V_2 =	I =	I =
2.	When only one source is active: V_1 =	I_1 =	I_1 =

3.	When only one source is active: V_2 =	I_2 =	I_2 =
	Algebraic sum of currents: $I = I_1 + I_2$		

Result:

Viva Questions:

1) What do you man by Unilateral and Bilateral network?
   Give the limitations ofSuperposition Theorem?
2) What are the equivalent internal impedances for an ideal voltage source and for a Current source?
3) Transform a physical voltage source into its equivalent current source.
4) If all the 3 star connected resistors are identical and equal to R, then what is the Delta connectedresistors.

EXPERIMENT NO- 10

THREE PHASE TRANSFORMER

II) VERIFICATION OF RELATIONSHIP BETWEEN VOLTAGES AND CURRENTS (STAR- DELTA, DELTA-DELTA, DELTA-STAR, STAR-STAR)

AIM: To verify the relationship between Voltages and Currents of a given 3-ϕ Transformer

(STAR- DELTA, DELTA-DELTA, DELTA-STAR, STAR-STAR)

APPARATUS REQUIRED:

S.NO	Name of the equipment	Rating/Range	Type	Quantity
1	Three phase Transformer	3000VA, 240/415:138/240,Δ/Y	AC	1
2	Three Phase Auto Transformer	415/(0-600)V	AC	1
3	Voltmeters	(0-600)V	MI	3
4	Ammeters	(0-20)A	MI	3
5	Connecting Wires	-------		Required Number

THEORY & PROCEDURE:

Four common ways of connecting transformer windings to form a three-phase transformer are: delta-delta, Star-Star (wye-wye) ,delta-Star(wye) and Star(wye)-delta as shown in figure below. In order to set up a wye connection, first connect the three components (windings) together at a common point for interconnection with the neutral wire, then connect the other end of each component in turn to the three line wires. To set up a delta connection, connect the first component in series with the second, the second in series with the third and the third in series with the first to close the delta loop. The three line wires are then separately connected to each of the junction nodes in the delta loop.

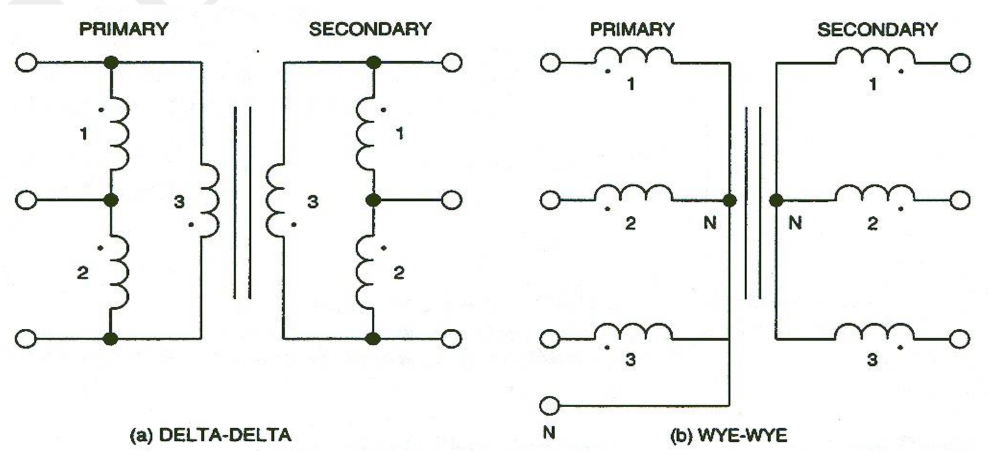
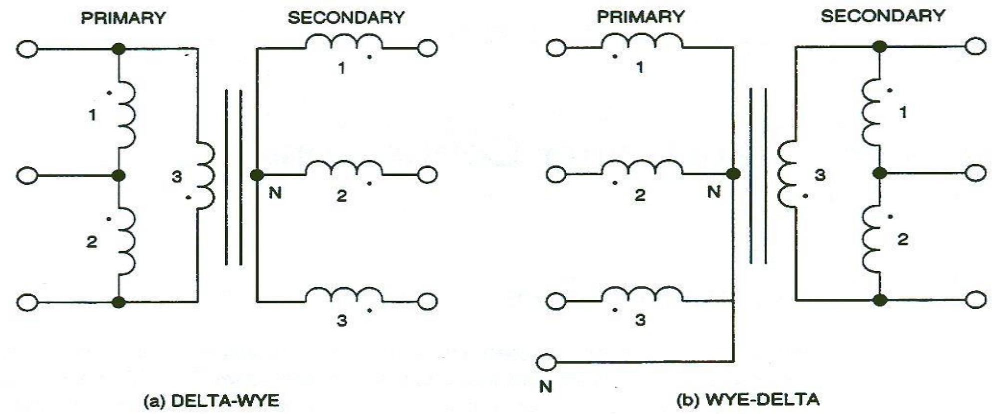


Fig1: Delta-Delta and Star(Wye)-Star(Wye)Connections



Before a three-phase transformer is put into service, the phase relationship must be verified. For a wye configuration, the line voltages at the secondary windings must all be √3 times greater than the corresponding phase voltages. If not, winding connections must be reversed. To verify that the phase relationships are correct for a wye configuration, the voltage between two windings (E_{AB}) is measured as shown in **Figure 5-3 (a)** to confirm that it is √3 times greater than the line-to-neutral voltage across either winding (for example E_{AN}). The voltages between the third winding and the others (E_{BC} and E_{CA}) are then measured to confirm that they are also √3 times greater than the phase voltage (E_{AN}) as shown in **Figure 5-3 (b).**

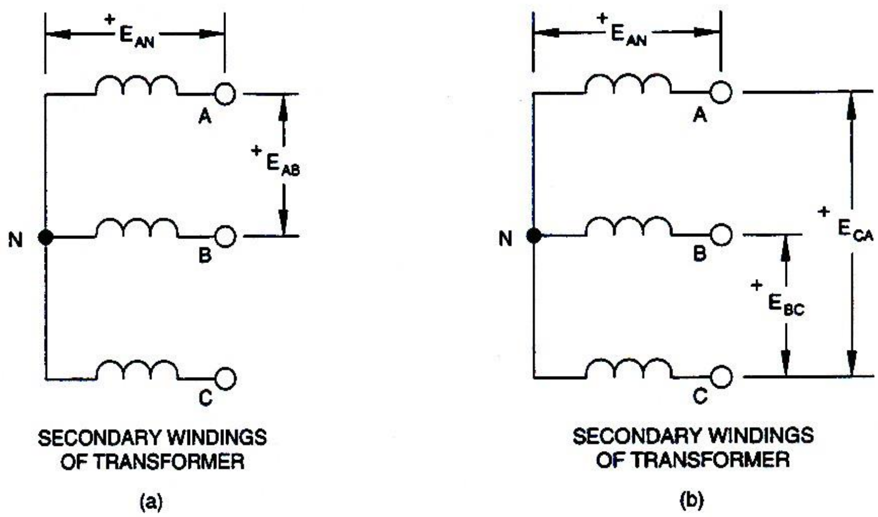


Figure 5-3 Confirming Phase Relationships in a Wye-Connected Secondary

For a delta configuration, the line voltages at the secondary windings must all be equal. If not, winding connections must be reversed. To verify that phase relationships are correct for a delta configuration, the voltage across two series-connected windings (E_{CA}) is measured as shown in **Figure 5-4 (a)** to confirm that it equals the voltage across either winding (E_{AB} and E_{BC}). The third winding is then connected in series, and the voltage across the series combination of the three windings is measured to confirm that it is zero before delta is closed, as shown in **Figure 5-4 (b)**. This is extremely important for a delta configuration because a very high short-circuits current will flow if the voltage within the delta is not equal to zero when it is closed.

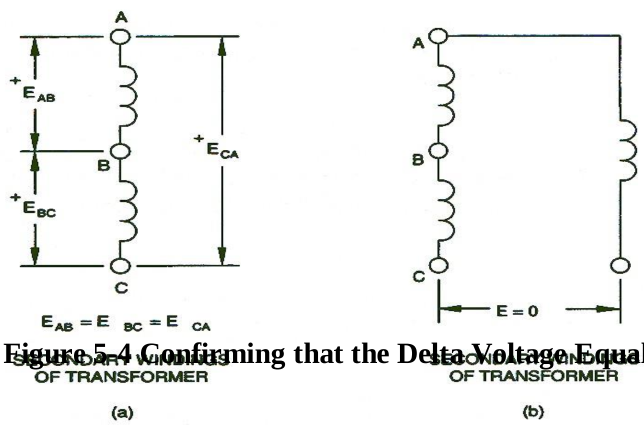


Figure 5-4 Confirming that the Delta Voltage Equals Zero.

TABULAR COLUMN:

Type of connections	Primary Voltage		Secondary Voltage		Voltage Ratio
	Line	Phase	Line	Phase	
Delta/Star					
Star/Star					
Star/Delta					
Delta/Delta					

RESULT:

APPLICATIONS:

1. Distribute power at high voltage
2. Eliminate double wiring
3. Operate 120 volt equipment from power circuits
4. Isolate electrical circuits
5. Separately establish branch circuits
6. Provide 3 wire secondary circuits
7. Buck Boost connexion

8. Provide electrostatic shielding for transient noise protection

VIVA-VOCE QUESTIONS:

1. Can Single Phase Transformers be used for Three Phase applications?
2. What is tertiary winding? What is Three Winding Transformer? What are its advantages?
3. Which transformer connections are more feasible to use in the distribution ends

EXPERIMENT NO: 11

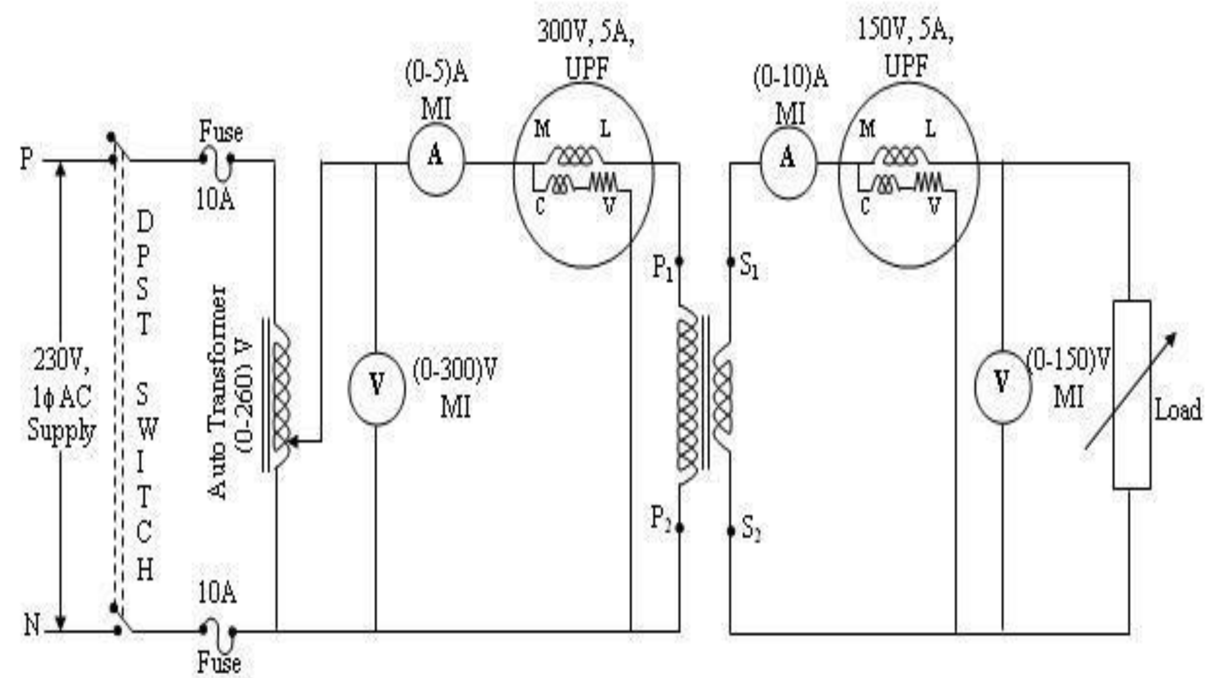
LOAD TEST ON SINGLE PHASE TRANSFORMER

AIM: To conduct load test on single phase transformer and to find efficiency and percentage regulation.

APPARATUS REQUIRED:

Sl.No.	APPARATUS	RANGE	TYPE	QUANTITY
1.	Auto traonsformer (1 ϕ)	220V/(0-270)V	----	1
2.	Ammeter	(0-10)A 2. (0-5)A	MI MI	11
3.	Voltmeter	(0-150)V(0-300)V	MI MI	1 1
4.	Wattmeter	(5A,150V) (5A,300V)	UPF UPF	1 1
5.	Connecting wires	------	----	Required number

CIRCUIT DIAGRAM:



FUSE RATING:

125% of rated current

$$\frac{125 \times 5}{100} = 6.25A$$

NAME PLATE DETAILS:

	Primary	Secondary
Rated Voltage :	230V	115V
Rated Current :	5A	10 A
Rated Power :	1KVA	1KVA

TABULAR COLUMN:

S.No	Load	V_1 (V)	I_1 (A)	W_1 (W)	V_2 (V)	I_2 (A)	W_2 (W)	Input power (W)	Output power (W)	Efficiency	Regulation

PROCEDURE:

1.Connectuons are made as per the circuit diagram.

2.After checking the no load condition, minimum position of autotransformer and DPST Switch is closed

3.Note down the corresponding readings of all the meters connected in the circuit.

4.Increase the loasd and for each loadNote down the corresponding readings of all the meters connected in the circuit.

5.Now open the DPST switch after gradually reducing the auto transformer's secondary voltage to a minimum value.

FORMULE:

Output power = W2*multiplication factor

Input power=W1* multiplication factor

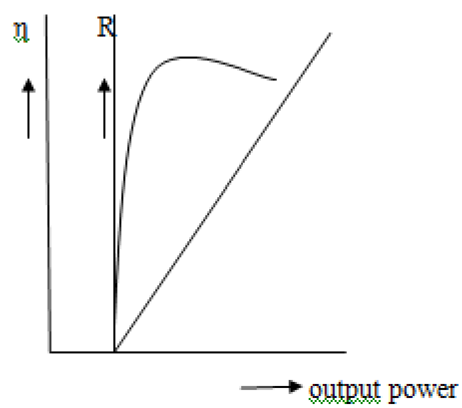
Efficiency=output/input

$$\text{Regulation} = \frac{V_{NL} - V_{FL}}{V_{NL}}$$

PRECAUTIONS:

1. DPST switch should be kept open.
2. The auto transformer should be kept in minimum potential position.

Model Graph:



RESULT:

APPLICATIONS

The typical applications of single phase transformers are:

- Distribute power at high voltage
- Transformers are also used extensively in electronic products to decrease (or step-down) the supply voltage to a level suitable for the low voltage circuits they contain Signal and audio transformers are used to couple stages of amplifiers and to match devices such as microphones and record players to the input of amplifiers.
- Audio transformers allowed telephone circuits to carry on a two-way conversation over a single pair of wires.
- A balun transformer converts a signal that is referenced to ground to a signal that has balanced voltages to ground, such as between external cables and internal circuits.
- Transformers made to medical grade standards isolate the users from the direct current. These are found commonly used in conjunction with hospital beds, dentist chairs, and other medical lab equipment

EXPERIMENT NO – 12

MEASUREMENT OF ACTIVE AND REACTIVE POWER IN A BALANCED THREE-PHASE CIRCUIT

3. a) MEASUREMENT OF ACTIVE POWER FOR STAR AND DELTA CONNECTED BALANCED LOAD

AIM:

To measure the active power for the given star and delta network.

APPARATUS:

Sl. No.	Name of the Equipment	Range	Type	Quantity
01	Auto Transformer	415V/(0-440), (0-20)A	3–Φ	01
02	U.P.F. Wattmeter	(150/300/600) (0-5/10)A	Dynamometer Type	01
03	L.P.F. Wattmeter	(150/300/600)V(0-5/10)A	Dynamometer Type	01
04	Ammeter	(0-10)A	MI	01
05	Voltmeter	(0-600)V	MI	01
06	Connecting Wires	------	------	As required

THEORY:

A three phase balanced voltage is applied on a balanced three phase load when the current in each of the phase lags by an angle Φ behind corresponding phase voltages. Current through current coil of $w_1=I_r$, current through current coil of $W_2=I_B$, while potential difference across voltage coil of $W_1=V_{RN}-V_{YN}=V_{RY}$(line voltage), and the potential difference across voltage coil of $W_2= V_{RN}-V_{YN}=V_{BY}$.Also, phase difference between I_R and V_{RY} is (300+ Φ).While that between I_B and V_{BY} is (300- Φ).Thus reading on wattmeter W_1 is given by $W_1=V_{RY}\ I_Y Cos(300+ Φ)$While reading on wattmeter W_2 is given by $W_2=V_{BY}I_B Cos(300-Φ)$Since the load is balanced, $|I_R|=|I_Y|=|I_B|=I$ and $|V_{RY}|=|V_{BY}|=V_L W_1=V_L ICos(300+ Φ)W_2=V_L ICos(300- Φ)$.

Thus total power P is given by

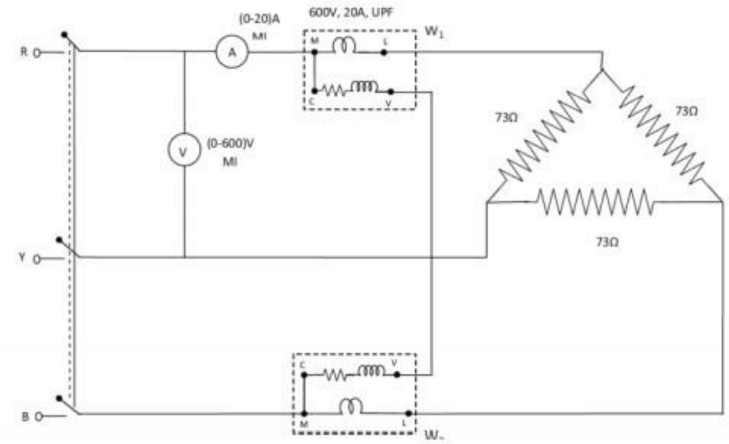
$$W= W_1 +W_2 = V_L ICos(300+ Φ) + V_L ICos(300- Φ)$$

$$= V_L I[Cos(300+ Φ) + Cos(300- Φ)]$$

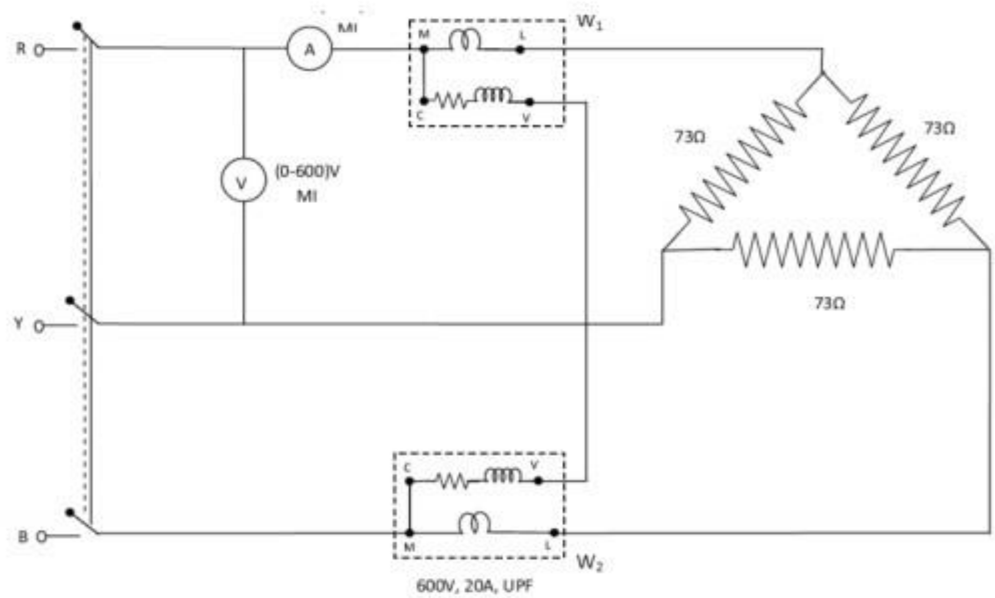
$$= [√3/2 *2Cos Φ]V_L I = √3V_L ICos Φ$$

CIRCUIT DIAGRAM:

Star connected load:



Delta connected load:



PROCEDURE:

(STAR CONNECTION):

1) Connect the circuit as shown in the figure.
2) Ammeter is connected in series with wattmeter whose other end is connected to one of the loads of the balanced loads.
3) The Y-phase is directly connected to one of the nodes of the 3-ph supply.
4) A wattmeter is connected across R-phase & Y-phase as shown in fig. The extreme of Bphase is connected to the third terminal of the balanced 3-ph load.
5) Another wattmeter is connected across Y & B phase, the extreme of B-phase is connected to the third terminal of the balanced three phases load.

6) Verify the connections before switching on the 3-ph power supply.

(DELTA CONNECTION):

1) Connect the circuit as shown in the figure.
2) Ammeter is connected in series with wattmeter whose other end is connected to one of the loads of the balanced loads.
3) The Y-phase is directly connected to one of the nodes of the 3-ph supply.
4) A wattmeter is connected across Y & B phase, the extreme of B-phase is connected to the third terminal of the balanced 3-ph load.
5) Another wattmeter is connected across R & Yphase, the extreme of R-phase is connected to the third terminal of the balanced three phases load.
6) Verify the connections before switching on the 3-ph power supply.

TABULAR COLUMN:

S.No	Voltage V (Volts)	Line Current I_L (Amps) I	W_1 (Watts)	W_2 (Watts)	W= W_1 + W_2

CALCULATIONS:

For a star connected load

Line voltage(V_L) = VL/$3^{1/2}$

Line current(I_L) = I_L

$\text{Ø} = \tan^{-1} 3^{1/2}(W_1-W_2)/(W_1+W_2)$

$P = 3^{1/2} V_L I_L \cos\text{Ø}$

$P = W_1+W_2$

For a delta connected load

Line voltage(VL) = VL

Line current(IL) = $I_L/3^{1/2}$

$\text{Ø} = \tan^{-1} 3^{1/2} (W1-W2)/(W1+W2)$

$P = 3^{1/2} V_L I_L \cos\text{Ø}$

$P = W_1+W_2$

PRECAUTIONS:

1. Avoid making loose connections.

2. Readings should be taken carefully without parallax error.

RESULT:

VIVA-VOCE:

1. Define active power, reactive power & apparent power.
2. Define power factor?
3. What are the different types of loads?
4. Write the equations of active power, reactive power & apparent power.

APPLICATIONS:

1. Active power used to enhance voltage profile and improve the power factor.
2. To maintain voltage stability, high power factor and less transmission losses

b) MEASUREMENT OF REACTIVE POWER FOR STAR AND DELTA CONNECTED BALANCED LOADS

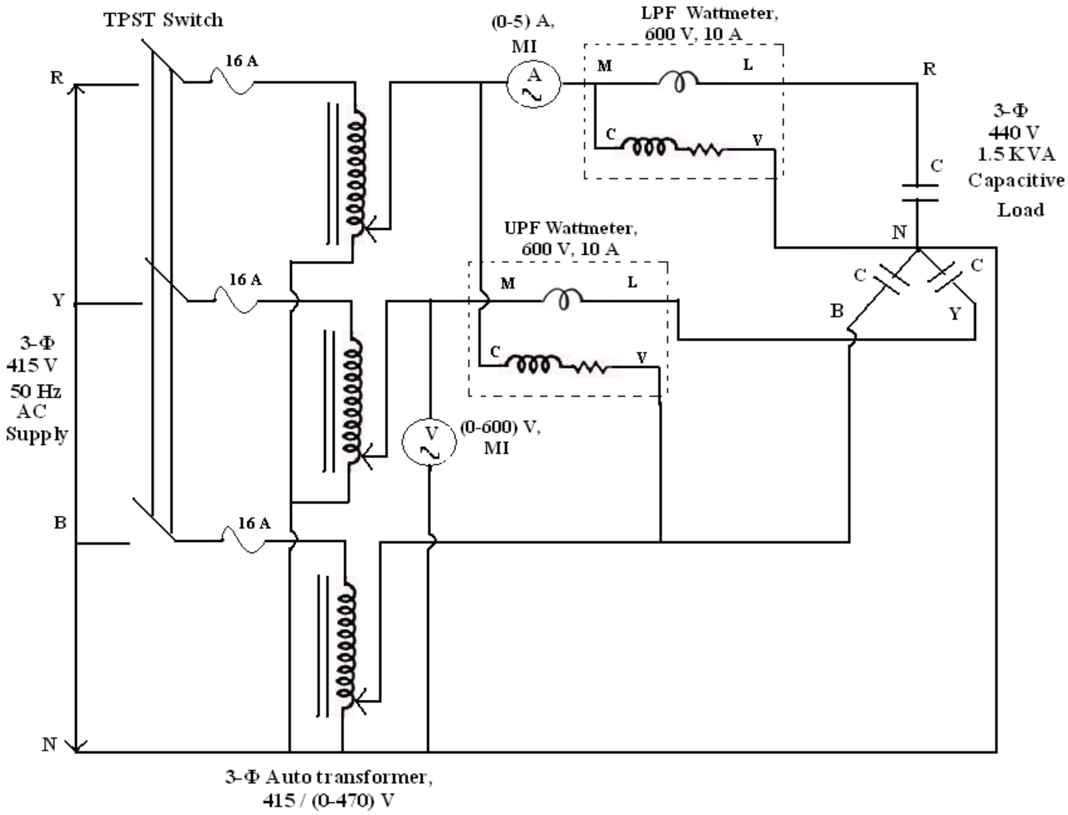
AIM:

To measure the total reactive power of a three phase balanced load using single phase wattmeter method.

APPARATUS REQUIRED:

Sl. No.	Name of the Equipment	Range	Type	Quantity
01	Capacitive Load	440V, 1.5KVA	3–Φ	01
02	Auto Transformer	415V/(0-440), (0-20)A	3–Φ	01
03	U.P.F. Wattmeter	(150/300/600) (0-5/10)A	Dynamometer Type	01
04	L.P.F. Wattmeter	(150/300/600)V(0-5/10)A	Dynamometer Type	01
05	Ammeter	(0-10)A	MI	01
06	Voltmeter	(0-600)V	MI	01
07	Connecting Wires	------	------	As required

CIRCUIT DIAGRAM:



PROCEDURE:

1. Make the Connections as per circuit diagram.
2. Keep the 3-Phase Autotransformer is in minimum output position.
3. Switch on the supply and by slowly varying the autotransformer, rated value is applied to motor.
4. Note down the readings of Ammeter, Voltmeter, Wattmeter's readings (Wr & Wa)
5. After noting the values slowly decrease the Auto Transformer till Volt meter comes to zero voltage position, and switch of the supply.

PRECAUTIONS:

1. There should not be any loose connections.
2. Meter readings should not be exceeded beyond their ratings
3. Readings of the meters must be taking without parallax error.
4. Ensure that setting of the Auto Transformer at zero output voltage during starting.

THEORETICAL CALCULATIONS:

Ammeter reading = I_{ph} =

Voltmeter reading = V_{ph} =

Wattmeter reading (W_a) = Active power / Phase
Wattmeter reading (W_a) =
i.e. total active power = 3×Wa Total active power = 3VIcosϕ = $3W_a$
Cosϕ = W_a / VI
Sin^2ϕ = 1- Cos2ϕ
Total calculated reactive power = W_{RC} = 3VISin ϕ
Total measured reactive power = 3Wr

Observation Table:

S.No	Voltage V (Volts)	Line Current I_L (Amps) I	W_1 (Watts)	W_2 (Watts)	W= W_1 + W_2

Result:

Viva-Voice:

1. Define active power, reactive power & apparent power.
2. Define power factor?
3. What are the different types of loads?
4. Write the equations of active power, reactive power & apparent power.

Applications:

1. Reactive power is essential to excite any electrical equipment. Once equipments are excited, equipments start to produce the real power. Without reactive power we can't produce the real power.
2. Reactive power used to enhance voltage profile and improve the power factor.

EXPERIMENT NO: 13

NO-LOAD CHARACTERSTICS OF A THREE-PHASE ALTERNATOR

AIM: To perform the open circuit & short circuit tests on 3phase alternator and to predetermine the regulation by Synchronous impedance method (also called as EMF and MMF method)

APPARATUS REQUIRED:

Sl. No	NAME OF THE APPARATUS	RANGE	TYPE	QUANTITY
1	Ammeter	(0-10A)	MI	1
2	Ammeter	(0-2A)	MC	1
3	Voltmeter	(0-600v)	MI	1
4	Voltmeter	(0-300v)	MC	1
5	Rheostat	(370Ω /1.7A)	WW	2
6	Connecting wires			

PRECAUTIONS:

1. TPST should be in open position.
2. DPST should be in open position.
3. The field rheostat should be kept in minimum position.

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Close the DPST switch, keep the TPST open.
3. Start the motor with the help of three-point starter.
4. Adjust the motor field rheostat to get rated speed of motor.
5. Close the DC supply switch S2 (field exciter) and excite the alternator in steps.
6. Note down all the meter readings, vary the excitation of the alternator of the field exciter (S2) till the voltmeter reads the rated voltage of the

alternator.

7. Tabulate the readings under open circuit test (OC Test).
8. Reduce the field exciter to its minimum position.
9. Close the TPST, and vary the field exciter (S2) till the AC ammeter (I_L) reads the rated current of the alternator.
10. Tabulate the readings of AC & DC Ammeters under short circuit test.
11. Reduce the field exciter to its minimum position and bring the field rheostat of motor to its original position and open the DPST.
12. Measure the resistance of the winding on per phase basis using the drop test circuit .

FORMULE:

1. Synchronous impedance Z_s = (Open ckt emf / Short ckt current) -------Ω per phase.
   Short circuit current =rated power(name plate)/rated voltage.
2. Synchronous reactance $X_s=\sqrt{(Z_s^2-R_a^2)}$ ----- Ω per phase.
3. $E=\sqrt{\{(V\cos\Phi+I_lR_a)^2+(V\sin\Phi\pm I_l X_s)^2\}}$ volts per phase.

Where E : induced EMF per phase

V: rated voltage /phase.

I_L : rated current /phase.

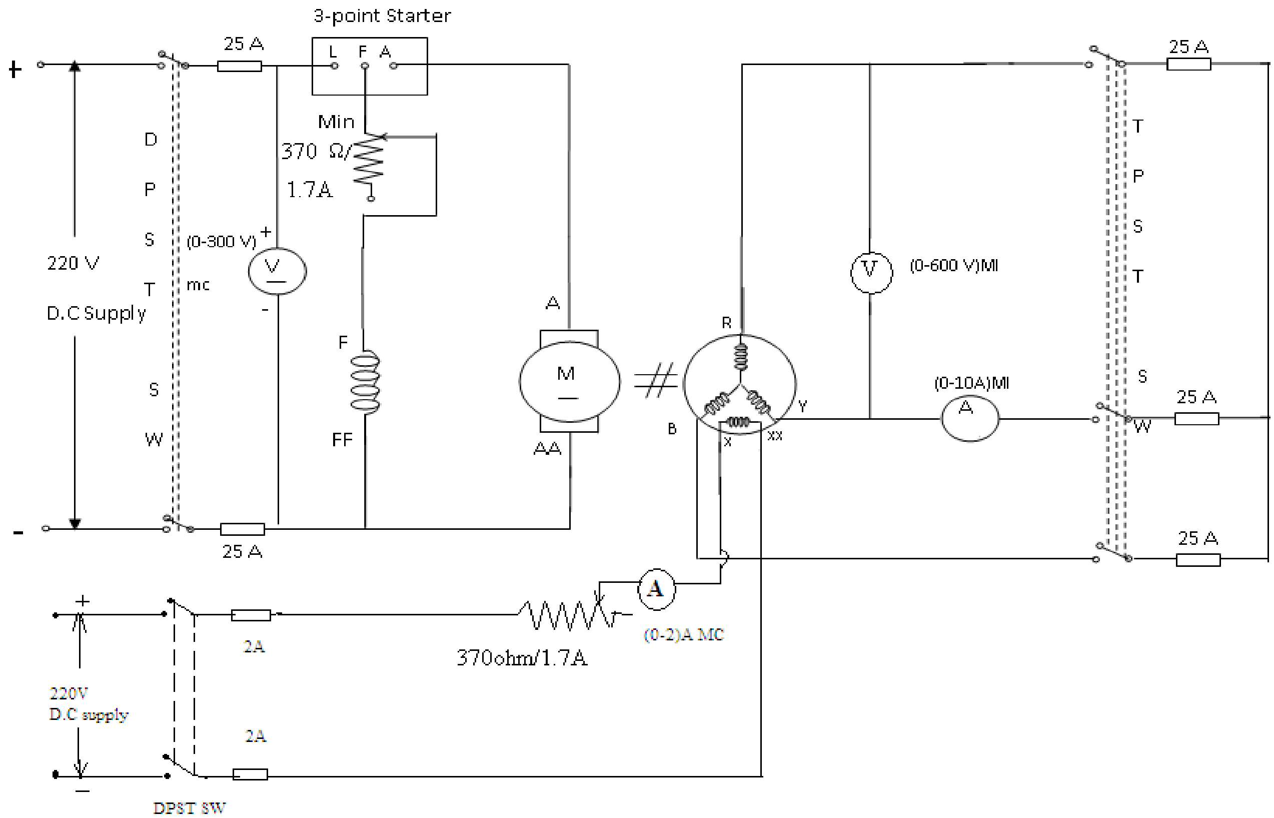
R_a : is the winding resistance per phase.

X_s : is the synchronous reactance per phase.

Here assume the value of power factor $\cos\phi$ as indicated in the tabular column.

% Regulation = ((E-V)/V)*100

REGULATION OF ALTERNATOR BY SYNCHRONOUS IMPEDANCE METHOD:



TABULAR COLUMNS:

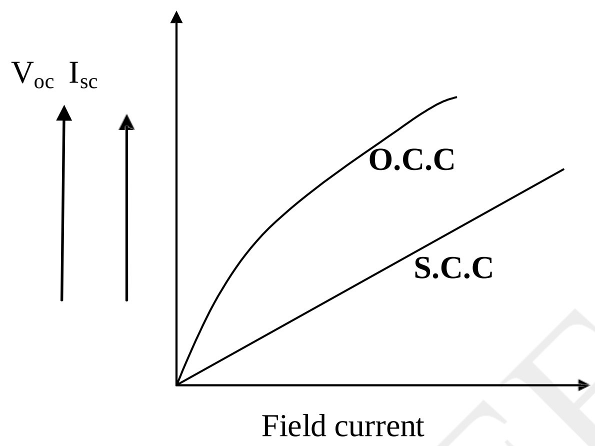
OPEN CIRCUIT TEST:

Sl. No	Field Current in Amps I_F	Line Voltage in Volts V	Open Circuit Voltage in Volts V_0/line	Open Circuit Voltage in Volts V_0/Phase

SHORT CIRCUIT TEST

Sl. No	Field Current in Amps I_F	Line Current in Amps I_L

MODEL GRAPH:



APPLICATIONS:

Synchronous machines are very important machinery in electrical engineering. Following are the important applications of a synchronous motors or machines : -
It is used in power houses and sub-stations in parallel to the bus bars to improve power factor. For this purpose it is run without mechanical load on it and over excited.

- In factories having large number of induction motors or transformers operating at lagging power factor, it is used for improving power factor.
- It is used to generate electric power at power station, one of the most important application of synchronous machines.
- it is used to control the voltage at the end of transmission line by varying its excitation.
- It is also used in rubber mills, textile mills, cement factories, air compressors, centrifugal pumps which requiring constant speed.
- It is used in motor generator sets requiring constant speed.

RESULT:

VIVA VOCE QUESTIONS:

1. What is the basic principle and operation of alternators?
2. What are the various types of rotors used in alternators?

BEYOND THE SYLLABUS

EXPERIMENT NO-1

VERIFICATION OF OHM'S LAW

AIM:

To verify the ohm's law

APPARATUS REQUIRED:

S.NO.	NAME OF THE EQUIPMENT	RANGE	TYPE	QTY.
1.	RPS	(0-30)V	DC	1
2.	Ammeter	(0-10)mA	MC	3
3.	Voltmeter	(0-10)V	MC	3
4.	Resistor	10K	-	3
5.	Bread board	-	-	1
6.	Connecting wires	-	Single strand	As required

THEORY:

OHM`S LAW STATEMENT:

Ohm's law states that at constant temperature the current flow through a conductor is directly proportional to the potential difference between the two ends of the conductor.

$$I \alpha V$$

Or $$V \alpha I$$

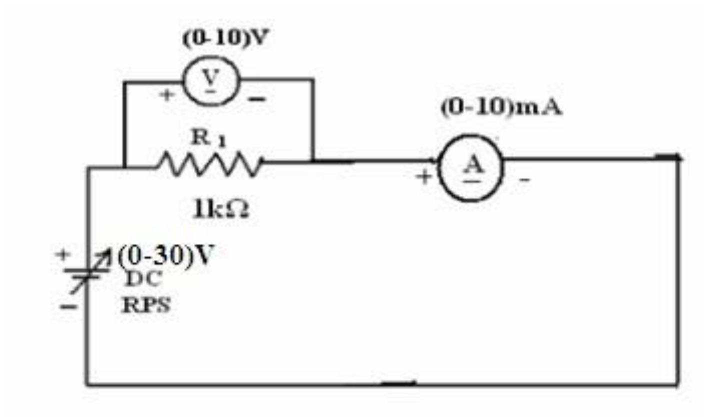
$$V = IR$$

Where R is a constant and is called the resistance of the conductor.

PROCEDURE:

- ❖ Connections are made as per the circuit diagram
- ❖ Switch on the power supply.
- ❖ For various values of voltage V, note the values of current I.
- ❖ Draw a graph of Voltage Vs Current.
- ❖ The Slope of the graph gives the resistance value.
- ❖ Ohm's law is verified by measuring the value of R using multimeter and comparing with the experimental value.

CIRCUIT DIAGRAM



TABULATION: (Practical values)

S.NO	APPLIED VOLTAGE V (Volts)	CURRENT I (mA)	R=V/I ((Ω)

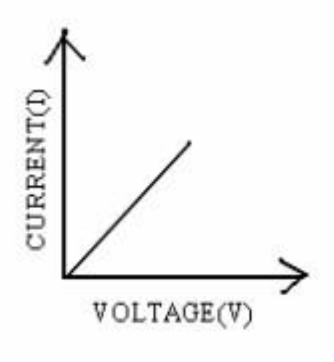
THEORITICAL CALCULATION:

Let applied voltage Vs=8V

R=1KΩ

I=Vs/R=8/1000=0.008mA

MODEL GRAPH.



RESULT:

Thus the ohm's law is verified theoretically and practically.

VIVA-VOCE QUESTIONS:

1. Define Ohms law
2. What are the limitations of ohms law?

APPLICATIONS:

1. We can find Power Supplied to Electrical Heater while manufacturing
2. In Selection of Fuses
3. for Speed Control of Conventional Fans
4. In Design of Electronic Devices
5. For Sizing of Resistors in consumer electronics

EXPERIMENT NO-2

DEMONSTRATION OF MEASURING INSTUMENTS AND ELECTRICAL COMPONENT

Aim:

To know the general rules and precautions are to be observed for safe handling of electricity at differentworking conditions and how to use different measuring instruments.

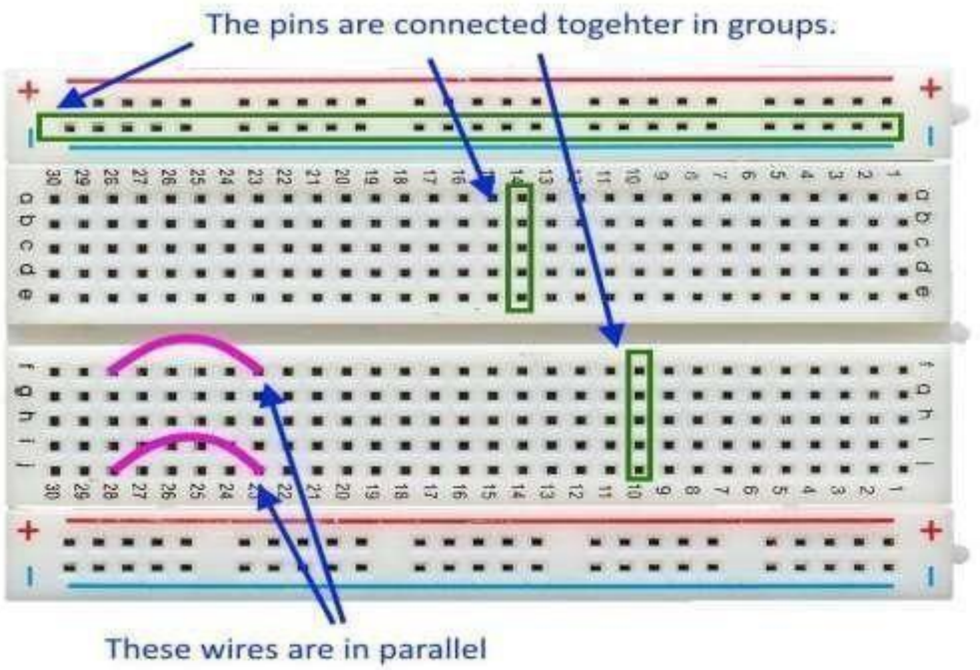
Apparatus Required:

S. No.	Name of The Apparatus	Range	Type	Quantity
1.	RPS	(0-30) V	Digital	1No
2.	Ammeter	(0-200) mA	Digital	1No
3.	Voltmeter	(0-20) V	Digital	1No
4.	Resistors	470Ω, 560Ω, 1KΩ	-	Required number
5.	DMM	-	Digital	1No
6.	Bread Board	-	-	1No
7.	Oscilloscope	30MHz	Digital	1No
8.	Connecting Wires	-	-	Required number

Demonstration on Measuring Instruments:

1. Multi-Meter

The multimeter can be used as a voltmeter, ammeter, or ohmmeter, depending on how it is configured. The work stations have other equipment, which will be investigated in more detail in later sessions. Please be careful with these (and all other) measuring instruments. A voltmeter is designed to measure the voltage between any two points in a circuit, when the circuit is energized. If the voltage to be measured is $V_{12} = V_1 - V_2$, then the black probe is placed on node 2 (corresponding to V_2) and the red probe is placed on node 1 (corresponding to V_1). Since the voltmeter is placed in parallel with a part of the circuit it potentially can disrupt circuit operation. Ideally, a voltmeter’s resistance is infinite in which case there would be no change in circuit operation.



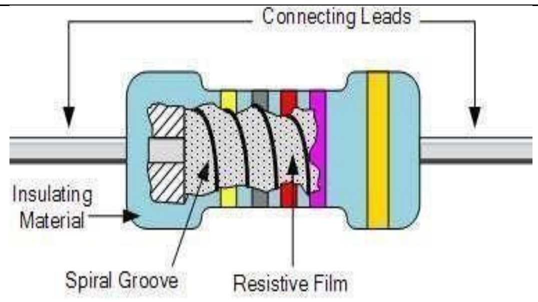
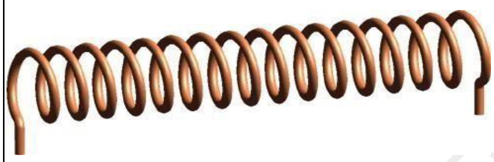
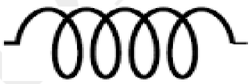
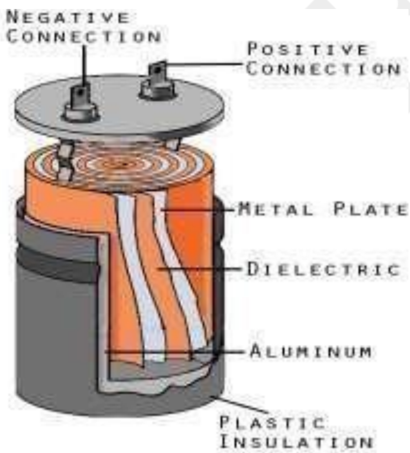
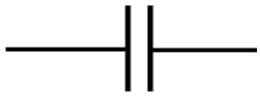
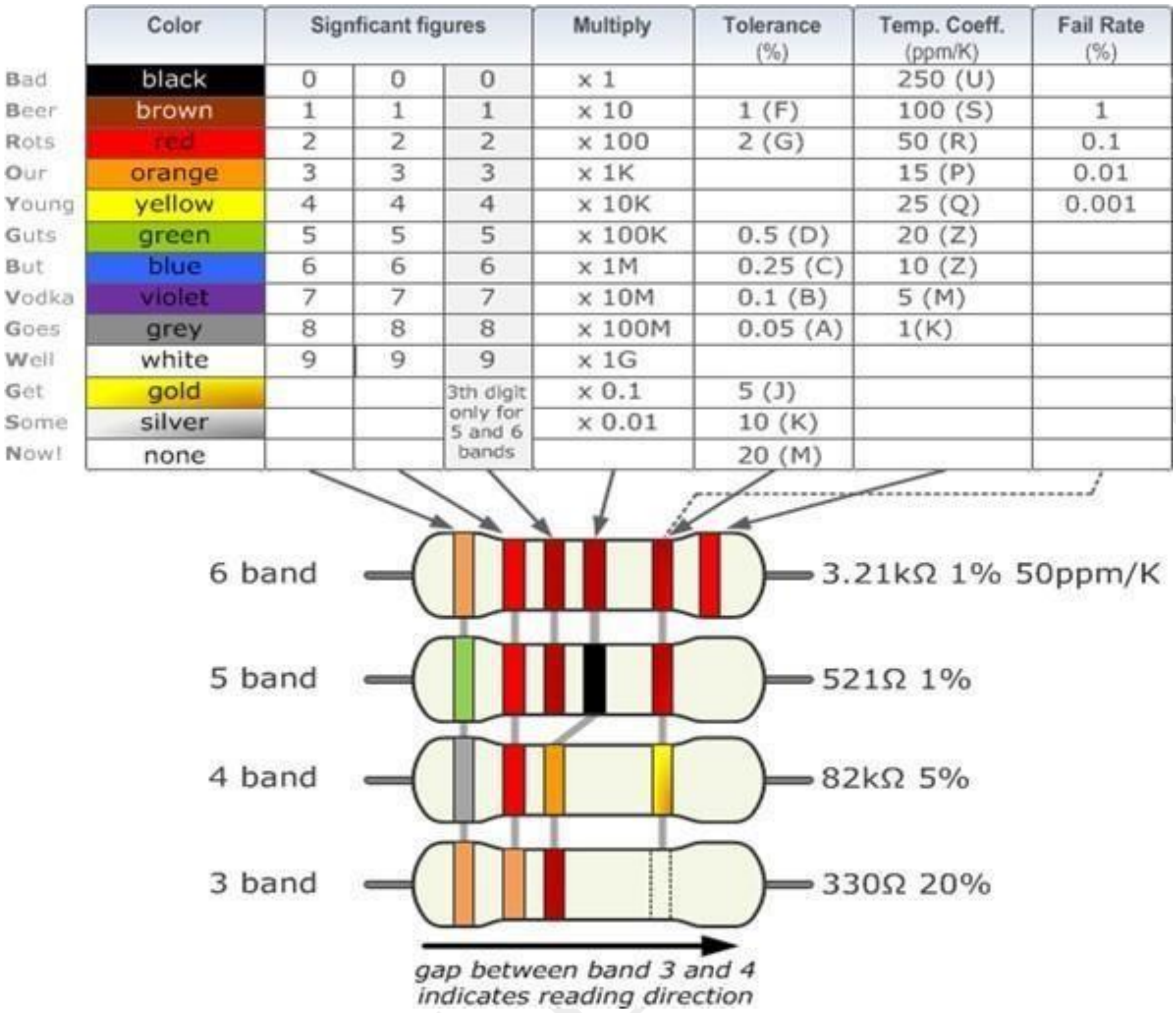
Element	Sectional view	Symbol
Resistor (R)		
Inductor (L)		
Capacitor (C)		

Fig.3: Model sectional view and symbol of Resistor, Inductor and Capacitor



	Color	Signficant figures			Multiply	Tolerance (%)	Temp. Coeff. (ppm/K)	Fail Rate (%)
Bad	black	0	0	0	x 1		250 (U)	
Beer	brown	1	1	1	x 10	1 (F)	100 (S)	1
Rots	red	2	2	2	x 100	2 (G)	50 (R)	0.1
Our	orange	3	3	3	x 1K		15 (P)	0.01
Young	yellow	4	4	4	x 10K		25 (Q)	0.001
Guts	green	5	5	5	x 100K	0.5 (D)	20 (Z)	
But	blue	6	6	6	x 1M	0.25 (C)	10 (Z)	
Vodka	violet	7	7	7	x 10M	0.1 (B)	5 (M)	
Goes	grey	8	8	8	x 100M	0.05 (A)	1(K)	
Well	white	9	9	9	x 1G			
Get	gold			3th digit only for 5 and 6 bands	x 0.1	5 (J)		
Some	silver				x 0.01	10 (K)		
Now!	none					20 (M)		

Fig.4: Resistance value calculation

Fig.5: Model inductors and capacitors

Voltmeter and Ammeter

Fig.6: Analog Voltmeter and Ammeter

Fig.7: Digital Voltmeter and Ammeter

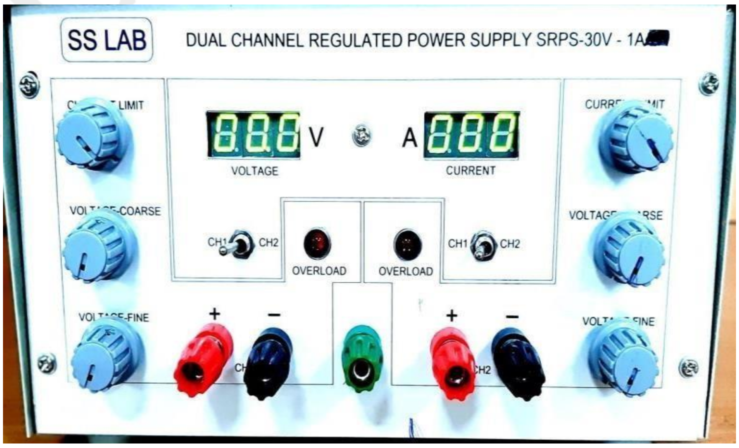


Fig.8: Regulated Power Supply.

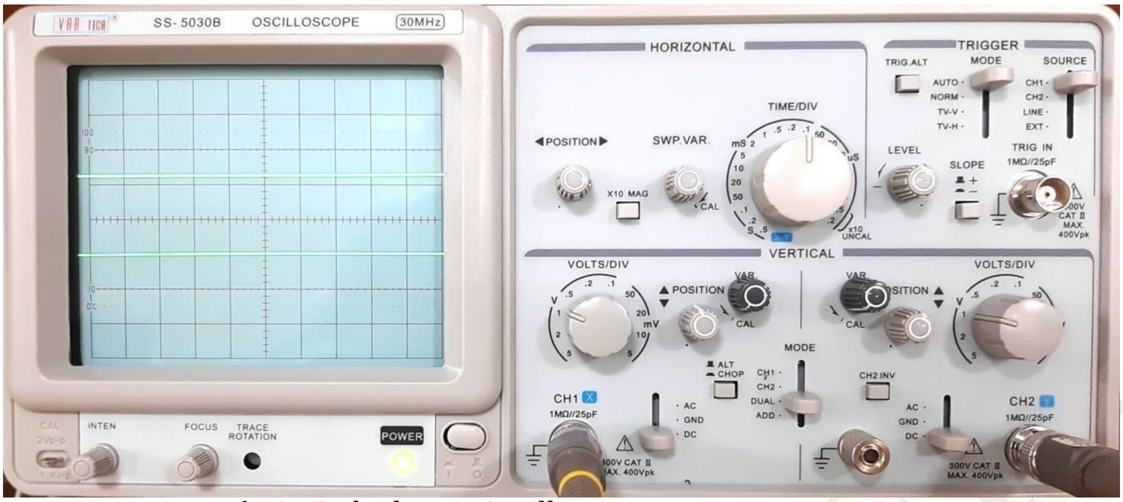


Fig.9: Cathode Ray Oscilloscope

Fig.10: Function generator

Demonstration of Components of LT Switchgear (SFU, MCB, ELCB, MCCB) and Earthing:

1. **Switching Fuse Unit (SFU):**

It has one switch unit and one fuse unit. When we operate the breaker, the contactsclose through switch and then the supply will pass through the fuse unit to the output.

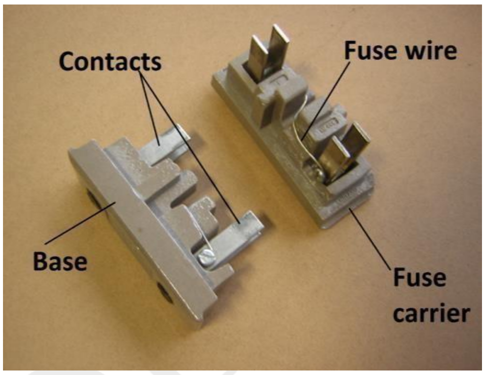
The Rewireable Switch Fuse Units are used for distributing power and protecting electrical devices and cables from damage due to fluctuations. This fuse unit is housed in an enclosure made using quality Cold Rolled (CR) steel sheet.

Porcelain Fuse Units (Kit Kat) are specifically utilized in industrial, commercial and domestic electrical fittings for ensuring flawless power distribution.

Features:

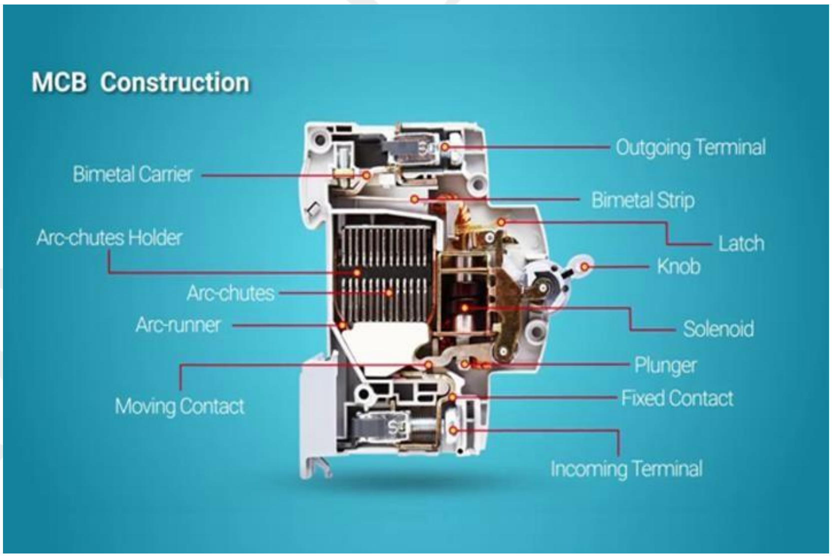
- Excellent overload protection
- Shock proof
- Compact and sturdy design

- Cable is connected at both ends
- High conductivity
- Protection from short circuit
- Rewireable



2. MCB'S or Miniature Circuit Breakers:

Now-a-days we use more commonly miniature circuit breaker or MCB in low voltage electrical network instead of fuse. The MCB has some advantages compared to fuse. It automatically switches offthe electrical circuit during abnormal condition of the network means in over load condition as well as faulty condition.



3. Earth Leakage Circuit Breaker :

If any current leaks from any electrical installation, there must-be any insulation failure in the electrical circuit, it must be properly detected and prevented otherwise there may be a high chance of electrical shock if-anyone touches the installation. ELCB detects the earth leakage current and makes the power supply off by opening the associated circuit breaker. There are two types of earth leakage circuit breaker, one is voltage ELCB and other is current ELCB.

I. Voltage ELCB:

The working principle of Voltage ELCB is quite simple. One terminal of the relay coil is connected to the metal body of the equipment to be protected against earth leakage and other terminal is connected to the earth directly. If any insulation failure occurs or live phase wire touches the metal body, of the equipment, there must be a voltage difference appears across the terminal of the coil connected to the equipment body and earth.

This voltage difference produces a current to flow the relay coil. If the voltage difference crosses, a predetermined limit, the current through the relay becomes sufficient to actuate the relay for tripping the associated circuit breaker to disconnect the power supply to the equipment. The typicalityof this device is, it can detect and protect only that equipment or installation with which it is attached. Itcannot detect any leakage of insulation in other installation of the system.

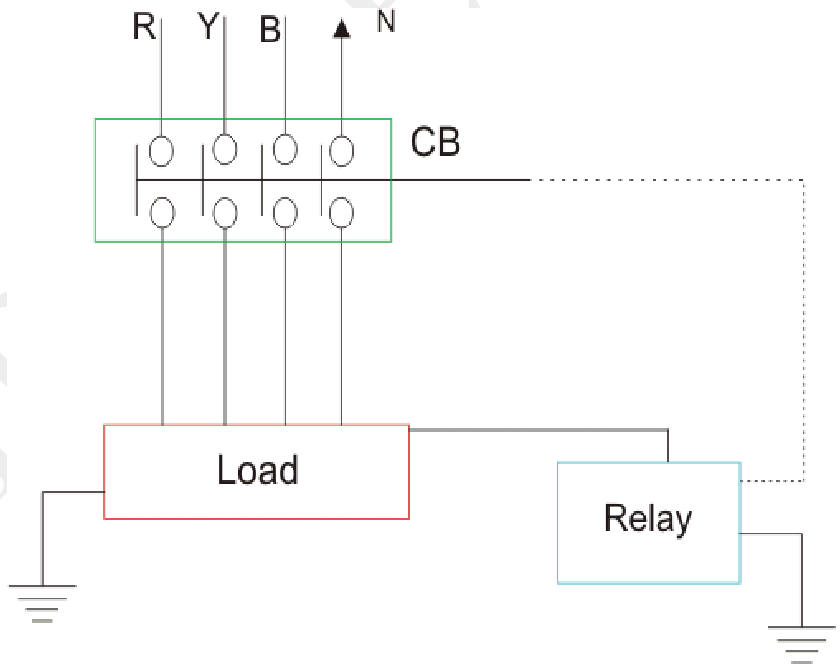


Fig.3: Voltage ELCB

II. Current ELCB :

Actually, ELCBs are of two kinds, but it is general practice to refer voltage based ELCB as simple ELCB. And current based ELCB is referred as residual current device (RCD) or RCCB. Here one CT core is energized from both phase wise and neutral wire. Current ELCB consists of a 3-windingtransformer, which has two primary windings and 1 secondary winding.

Neutral and line wire act as the two primary windings. During balanced condition current through the secondary winding is zero. Normal (Balanced) condition – the flux due to current through the phase wire will be neutralizing the current through the neutral wire. Current is same for lineand neutral. Fault (Unbalanced) condition – flux produced in the secondary winding (Line current not equal-= neutral current). This induces the current through the secondary winding. This is connected to the sensing circuit. This will sense the leakage and send a signal to the tripping system and trips the contact.

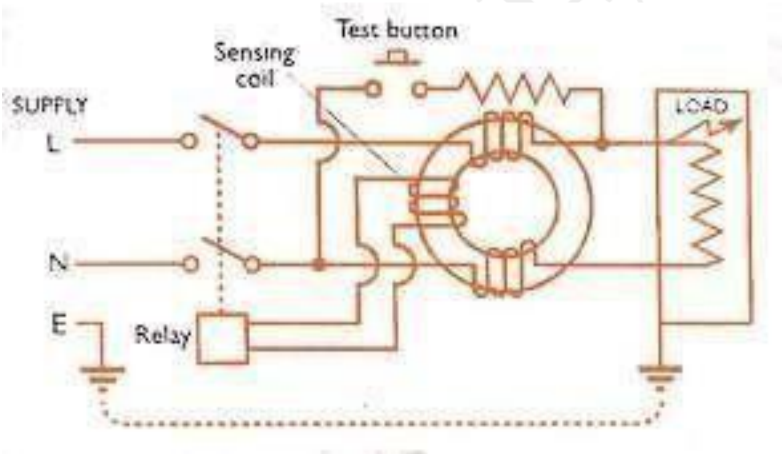


Fig.4: Current ELCB

2 Molded Case Circuit Breaker:

A MCCB is a type of electrical protection device that can be used for a wide range of voltages, and frequencies of both 50 Hz and 60Hz.The main distinctions between MCCB and MCB are that the MCCB can have current ratings that range from 15 A to 2,500 amperes, and its trip settings are normally adjustable. An additional difference is that MCCBs tend to be much larger than MCBs.

MCCB has three main functions:

Protection against overload – currents above the rated value that last longer than what is normal for the application.

Protection against electrical faults – During a fault such as a short circuit or line fault,there are extremely high currents that must be interrupted immediately.

Switchingacircuitonandoff–Thisisalesscommonfunctionofcircuitbreakers, but they canbe used for that purpose if there isn't an adequate manual switch.

Operating Mechanism:

Overloadprotectionisaccomplishedbymeansofathermalmechanism.MCCBs have a bimetallic contact what expands and contracts in response to changes in temperature. Under normal operating conditions, the contact allows electric current through the MCCB. However, as soon as the current exceeds the adjusted trip value, the contact will start to heat and expand until the circuit isinterrupted.Thethermalprotectionagainstoverloadisdesignedwithatimedelaytoallow short duration over current, which is a normal part of operation for many devices. However, any over current conditionsthat last more than what is normally expected represent an overload, and the MCCB is tripped to protect the equipment and personnel.

3. Earthing:

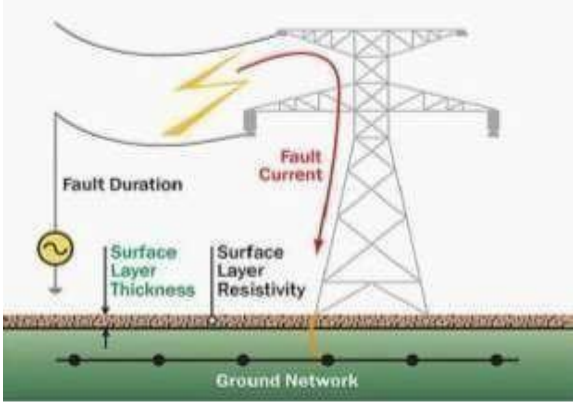
Themainreasonfordoingearthinginelectricalnetworkisforthesafety.Whenallme tallic parts in electrical equipment are grounded then if the insulation inside the equipment fails there are no dangerous voltages present in the equipment case. If the live wire touches the grounded case then the circuit is effectively shorted and fuse will immediately blow. When the fuse is blown then the dangerous voltages are away.

Purpose of Earthing

1. Safety for Human life / Building/Equipment
2. Over voltage protection
3. Voltage stabilization

Conventional methods of earthing

1. Plate type Earthing
2. Pipe type Earthing



Grounding or Earthing :

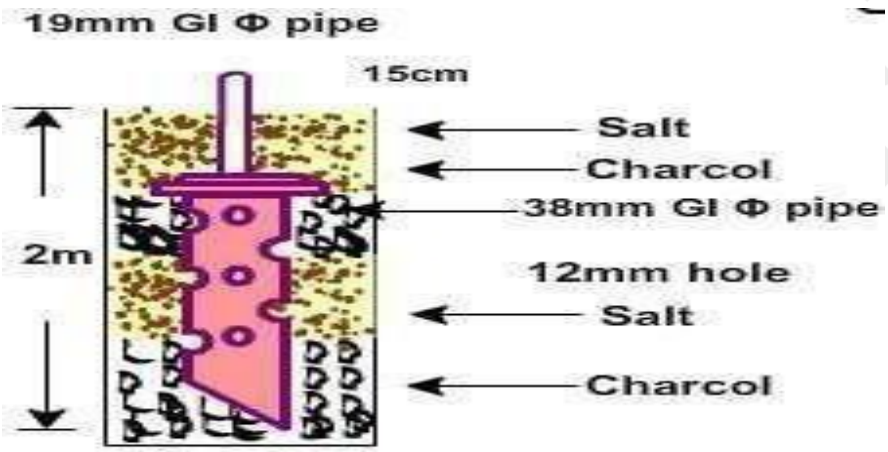
To connect the metallic (conductive) Parts of an Electric appliance is called Earthing or Grounding.

1. Earthing through a Galvanized iron (G.I.) Pipe:

- Pipe earthing is best form of earthing, It is cheap
- GI pipe used as an earth electrode.
- The size of the pipe depends upon the **current to be carried** and the **type of soil** in which the earthelectrode is buried.

2.Earthing through a plate:

GI or copper plate is used as an earth electrode



If a GI plate is used it shall be of dimensions 0.3m × 0.3 m and 6.35 mm thick and if a copper plate is used it shall be a dimension 0.3m × 0.3 m and 3.2 mm thick. The plate is buried to a depth of not less than 2 m in as moist a place as possible preferably in close proximity of water tap and at least

0.6 m away from all the building foundations. The plate shall be completely covered by 80 mm of charcoal with the layer of common salt 30 mm all around it, keeping the face of the vertical. The charcoal and salt decreases the earth resistance.

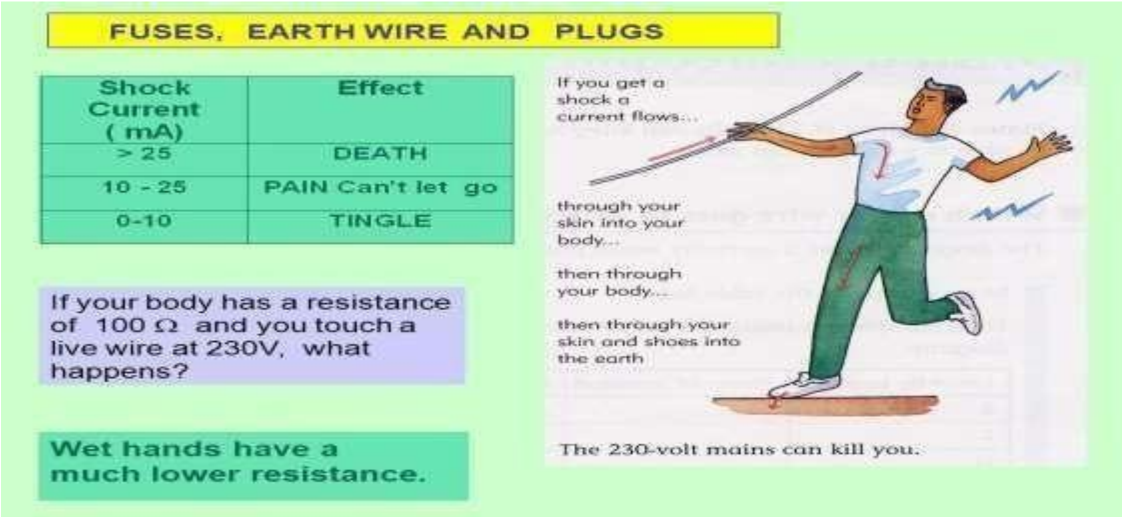


Fig.7: Effect of earthing

Demonstration of Cut-Out Sections of Machines: DC Machine SynchronousMachine and Single-Phase Induction Machine

Single Phase Induction Motor:

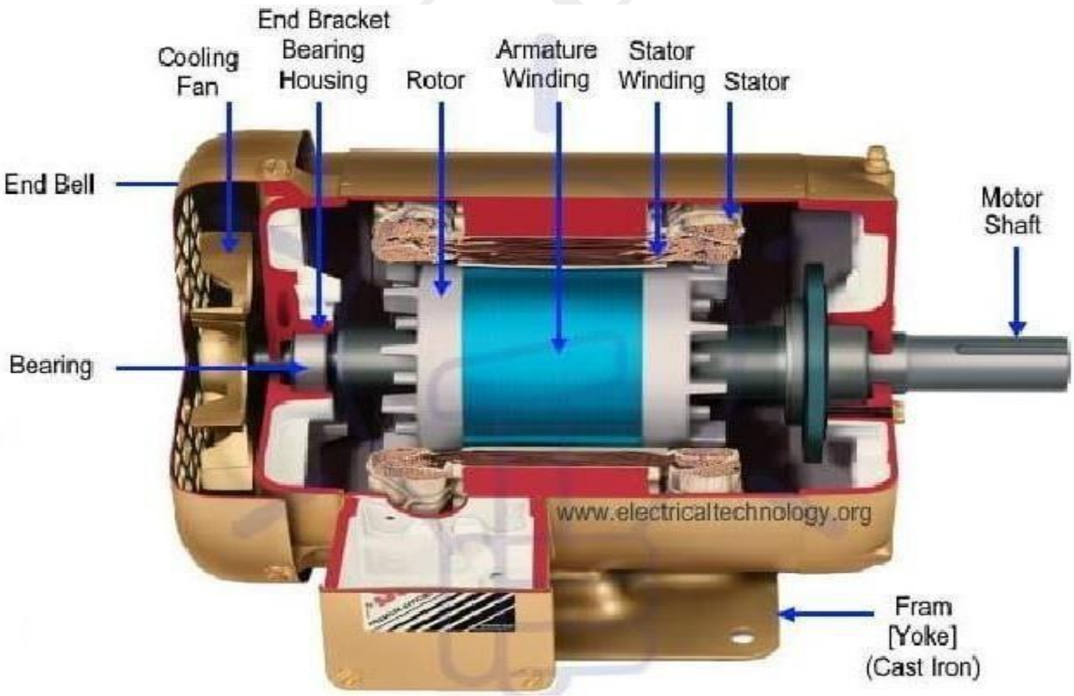


Fig .1: Single Phase Induction Motor

Single Phase Transformer:

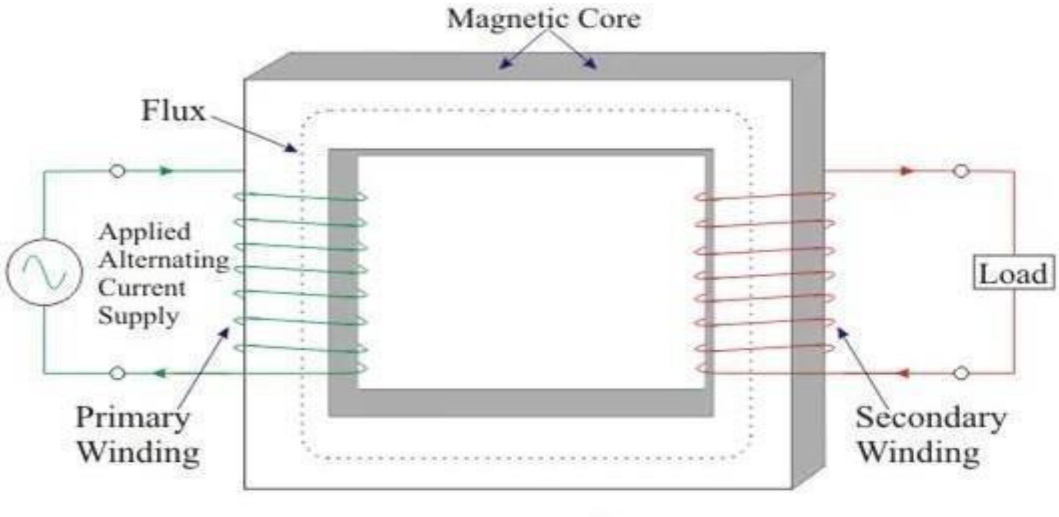


Fig.2: Single Phase Transformer

Synchronous Machine:

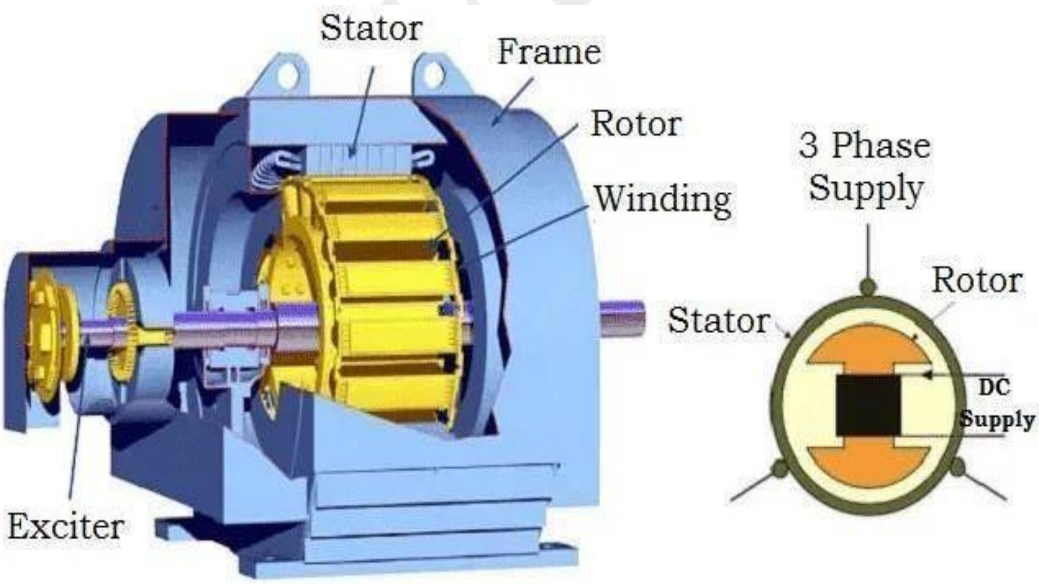


Fig.3. Synchronous machine

DC Machine:

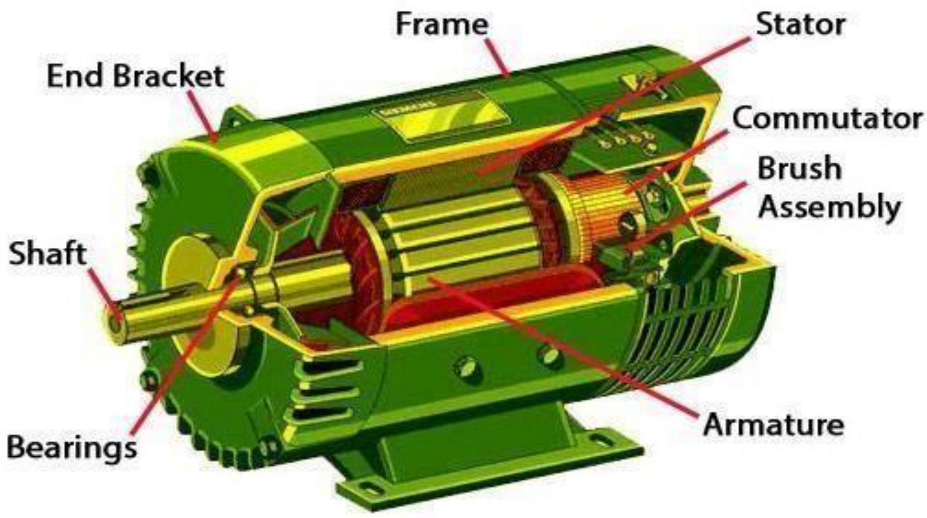


Fig.4: DC machine

Result: