DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

LABORATORY MANUAL

OF

BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

FOR

III SEM CIVIL & IV SEM MECHANICAL & MME

(MR22 REGULATION)

MAHATMA GANDHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

Chaitanya Bharathi P.O., Gandipet, Hyderabad – 500 075

MAHATMA GANDHI INSTITUTE OF TECHNOLOGY (Autonomous)

Civil Engineering

III Semester Syllabus

EE361ES: Basic Electrical and Electronics Engineering Laboratory

L	T	P	C
0	0	2	1

Prerequisite: **Basics of Electrical and Electronics Engineering**

Course Objectives:

1. To study a given network by applying various electrical laws
2. To understand the performance characteristics of DC and AC machines
3. To understand the characteristics of PN junction and Zener Diode
4. To understand the applications of diode as rectifiers
5. To understand the characteristics of BJT and FET

Course Outcomes:

After completion of the course, students will be able to:

1. Analyze network by applying various electrical laws
2. Analyze performance characteristics of DC and AC machines
3. Analyze the characteristics of PN junction and Zener Diode
4. Acquire the knowledge of various rectifier configurations
5. Analyze the characteristics of BJT and FET

List of Experiments/ Demonstrations:

PART A: ELECTRICAL

1. Verification of KVL and KCL
2. Measurement of Voltage, Current and Real Power in primary and Secondary Circuits of a Single-Phase Transformer
3. Measurement of Active and Reactive Power in a balanced Three-phase circuit
4. Performance Characteristics of a DC Shunt Motor
5. Performance Characteristics of a Three-phase Induction Motor
6. No-Load Characteristics of a Three-phase Alternator

PART B: ELECTRONICS

1. Study and operation of
   (i) Multi-meter (ii) Function Generator (iii) Regulated Power Supply (iv) Cathode Ray Oscilloscope.
2. PN Junction diode characteristics
3. Zener diode characteristics and Zener as voltage Regulator
4. Input & Output characteristics of Transistor in CE configuration
5. Full Wave Rectifier with & without filters
6. Input and Output characteristics of FET in CS configuration

Any 5 experiments from PART-A and 5 experiments from PART-B are to be conducted.

TEXT BOOKS:

1. Basic Electrical and electronics Engineering –M S Sukija TK Nagasarkar Oxford University
2. Basic Electrical and electronics Engineering-D P Kothari. I J Nagarath, McGraw Hill Education

REFERENCE BOOKS:

1. Electronic Devices and Circuits – R. L. Boylestead and Louis Nashelsky, PEI/PHI, 9^{th} Ed, 2006.
2. Engineering circuit analysis- by William Hayt and Jack E. Kemmerly, McGraw Hill Company, 6^{th} edition.
3. Network Theory by N. C. Jagan& C. Lakshminarayana, B.S. Publications.
4. L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.
5. E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.
6. V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989

MAHATMA GANDHI INSTITUTE OF TECHNOLOGY (Autonomous)

Common to ME & MME

IV Semester Syllabus

EE461ES: Basic Electrical and Electronics Engineering Laboratory

L	T	P	C
0	0	2	1

Prerequisite: **Basics of Electrical and Electronics Engineering**

Course Objectives:

1. To study a given network by applying various electrical laws
2. To understand the performance characteristics of DC and AC machines
3. To understand the characteristics of PN junction and Zener Diode
4. To understand the applications of diode as rectifiers
5. To understand the characteristics of BJT and FET

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After completion of the course, students will be able to:

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3. Analyze the characteristics of PN junction and Zener Diode
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List of Experiments/ Demonstrations:

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PART B: ELECTRONICS

7. Study and operation of
   (i) Multi-meter (ii) Function Generator (iii) Regulated Power Supply (iv) Cathode Ray Oscilloscope.
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9. Zener diode characteristics and Zener as voltage Regulator
10. Input & Output characteristics of Transistor in CE configuration
11. Full Wave Rectifier with & without filters
12. Input and Output characteristics of FET in CS configuration

Any 5 experiments from PART-A and 5 experiments from PART-B are to be conducted.

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PART A

1. VERIFICATION OF KVL AND KCL

Aim:- To Verify KVL & KCL for the given circuit

APPARATUS REQUIRED:-

S.NO.	Name of the Apparatus	Range	Quantity
1	Bread Board trainer	-	1
2	Resistor	1 KΩ, 2.2KΩ and 470Ω	Each 1
3	Ammeter	(0-200) mA	3
4	Voltmeter	(0-20) V	2
5	Variable DC Power Supply	30V,2A DC Regulated Power Supply, Dual Channel	1

Theory:-

Kirchhoff's Voltage Law (KVL) states that the algebraic sum of all branch voltages around any closed path in a circuit is always zero at all instants of time. In the following figure Fig.2.1, if KVL is applied then the equation is

$$V_s = V_1+V_2+V_3$$

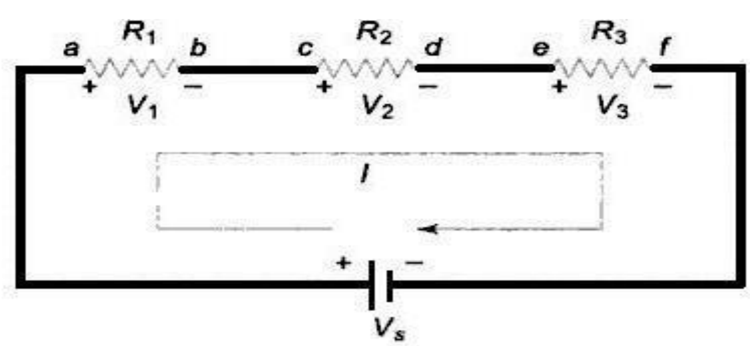


Fig.2.1

Kirchhoff's Current Law (KCL) states that the sum of the currents entering into any node/junction is equal to the sum of the currents leaving that node/junction. In the Fig. 2.2, if KCL is applied then the equation is

$$I_T = I_1 + I_2 + I_3$$

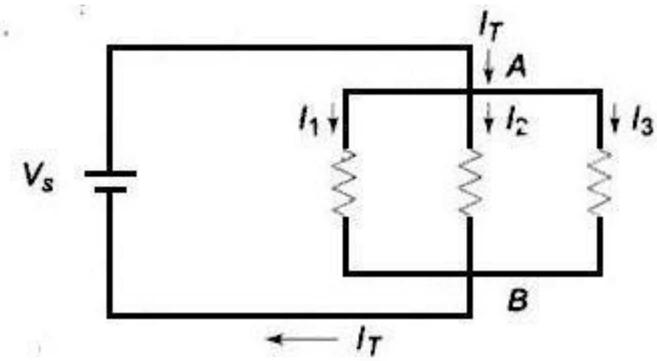


Fig.2.2

Circuit Diagrams:-

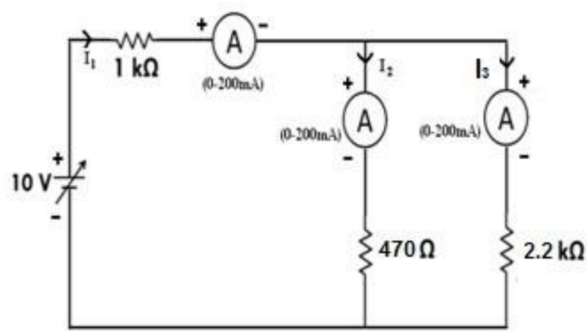


FIG. 2.3 CIRCUIT FOR VERIFICATION OF KCL

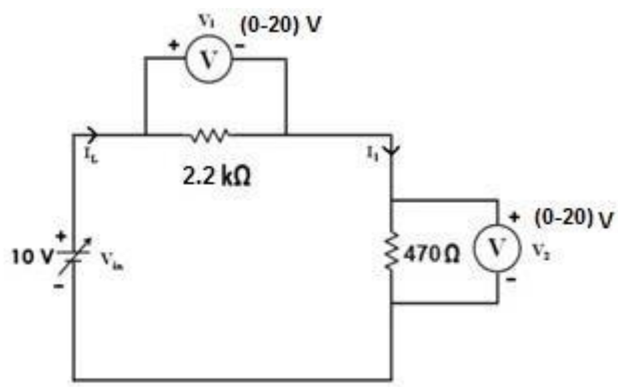


FIG. 2.4 CIRCUIT FOR VERIFICATION OF KVL

Procedure:-

a. Verification of KCL

1. Implement the circuit as per circuit diagram shown in Fig.2.3
2. Vary the supply voltage (say 10 or 15V) and take the corresponding readings of I_1, I_2& I_3 from the ammeters and verify the KCL.
3. Verify the reading with theoretical values.

b. Verification of KVL

1. Connection are made as per the circuit diagram shown in figure 2.4
2. Vary the supply voltage (say 10 or 15V) and take the corresponding readings V_1& V_2 from the voltmeter and verify the KVL
3. Verify the reading with theoretical values.

Tabular Column:

Table 1(for KCL):

V_{in} (v)	I_1 (mA)		I_2 (mA)		I_3 (mA)		$I_1 = I_1 + I_2 + I_3$ (mA)	
	Theoretical	Practical	Theoretical	Practical	Theoretical	Practical	Theoretical	Practical

Table 2 (for KVL):

V_{in} (v)	V_1 (v)		V_2 (v)		$V_{in} = V_1 + V_2$ (v)	
	Theoretical	Practical	Theoretical	Practical	Theoretical	Practical

Note:-All theoretical values can be found by using either mesh analysis or nodal analysis and also using voltage division rule and current division rule where it is applicable.

RESULT :

VIVA–VIOCE:

1. If a network contains ‘b’ branches and ‘n’ nodes, what are the formulae for no.of mesh current equations & no.of nodal voltage equations?
2. What is Voltage Division Rule & Current Division Rule?
3. Kirchhoff’s laws are based on which fundamental laws?

2. MEASUREMENT OF VOLTAGE, CURRENT AND REAL POWER IN PRIMARY AND SECONDARY CIRCUITSOF A SINGLE PHASE TRANSFORMER

Aim:-

To measure the voltage, current and real power in primary and secondary circuits of a given single phase transformer.

Theory: -

Transformer is a simple static (or stationary) electro-magnetic passive electrical device that works on the principle of Faraday's law of induction by converting electrical energy from one voltage level to another. Transformers are capable of either increasing or decreasing the voltage and current levels of supply, without modifying its frequency, or the amount of electrical power being transferred from one winding to another via the magnetic circuit. The ratio of the primary voltage to the secondary voltage and the turn's ratio of any given transformer will be the same as its voltage ratio. In other words for a transformer: "turns ratio = voltage ratio". This voltage ratio is also called transformation ratio (K) of the transformer.

$$V_2/V_1 = N_2/N_1 = K$$

Specifications / Technical details of Equipment and instruments: -

a. Equipment:

S.no	Equipment	Range	Quantity
1	Transformer	1 – phase, 1:2, 230/115V , 500VA	1 No
2	Auto transformer	230/(0 – 270) Volts, 6 A	1
3	Resistive Loads	50Ω	2

b. Instruments:

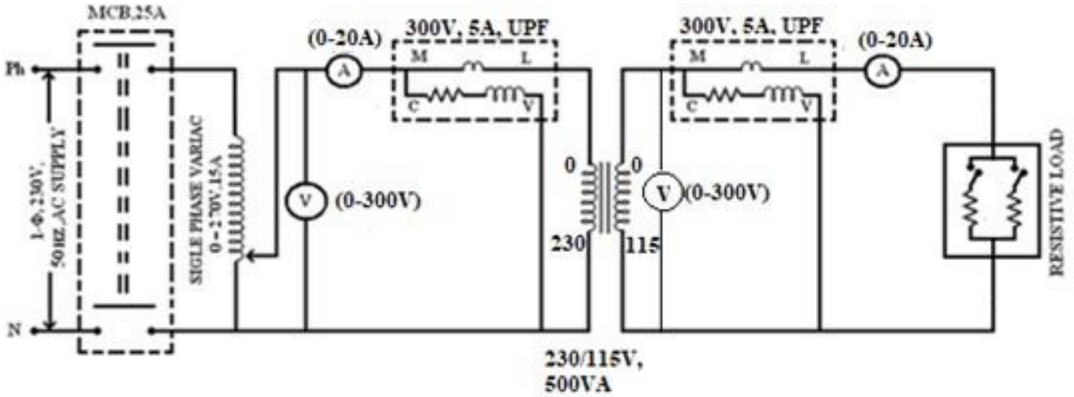
S.no	Name of the Instrument	Range	Type	Quantity
1	Ammeter	(0-20) A	Digital	2
2	Voltmeter	(0-300)V	Digital	2
3	Wattmeter	5A, 300V,UPF	Digital	1

Name Plate Details: -

1-Φ Transformer

Power	=	VA
L.V Side Voltage	=	Volts
H.V Side Voltage	=	Volts
L.V Side current	=	Amps
H.V Side current	=	Amps

Circuit Diagram: -



CIRCUIT DIAGRAM FOR MEASUREMENT OF VOLTAGE, CURRENT AND ACTIVE POWER ON BOTH PRIMARY AND SECONDARY SIDES OF SINGLE PHASE TRANSFORMER

Procedure: -

1. Make the connections as per the circuit diagram
2. Auto transformer must be in zero output position before giving the supply.
3. Initially the load should be at minimum (or OFF) position.
4. Switch on the supply by closing the MCB.
5. By using 1- Φ variac,apply rated voltage on the primary side and note down the no-load readings.
6. Now increase the load in steps and note down the readings of voltmeters, ammeters& wattmeter.
7. Now reduce the voltage given to the transformer to Zero and Switch off the supply.

.

Observation Tables: -

S. No	Load	Primary			Secondary			TRANSFORMATION RATIO (K)
		V_1 (Volts)	I_1 (Amps)	W_1 (Watts)	V_2 (Volts)	I_2 (Amps)	W_2 (Watts)	
1	No Load							
2	Load 1 (50Ω)							
3	Load2 (50+50Ω)							

Precautions:

General:

1. There shouldn't be any loose connections.
2. The readings must be taken without any parallax error.

Technical:

1. Don't exceed the rated voltage and rated current while varying the Autotransformers.
2. Ensure that Auto transformer must be in minimum output position before energizing the circuit.

Result: -

VIVA–VIOCE:

1. What is step-up and step-down transformer?
2. What is turns ratio, write all possible formulae?
3. What is the difference between an ideal and practical transformer?
4. What are the no-load components of transformer?

3. MEASUREMENT OF ACTIVE AND REACTIVE POWER IN ABALANCED THREE PHASE CIRCUIT

***Aim*: -**

To measure the active and reactive power in a balanced three phase circuit.

List of apparatus required:

S.no	Name of instrument	Range	Type	Quantity	Make
1	Ammeter	(0-10) A	MI	1	Swastik
2	Voltmeter	(0-500) V	MI	1	Swastik
3	Wattmeter	600V, 5A	Digital	1	Swastik
4.	3-Phase R-L load	R=150ohms L=320mH	-	1	Devi

***Theory*:-**

Active power:

To measure the active power in a three phase circuit by using the single wattmeter method the load should be balanced and star connected. The current coil of wattmeter should be connected in one line and the pressure coil should be connected between same line and neutral by shorting M and C as shown in the below figure (a).

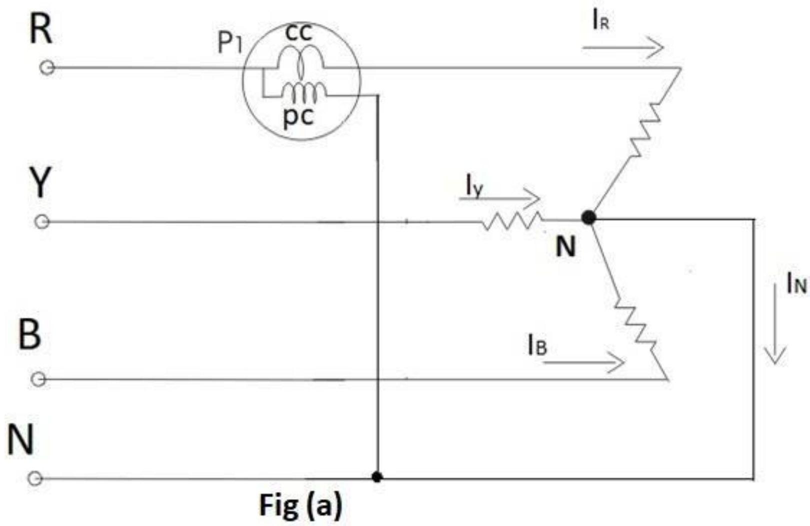


Fig (a)

The wattmeter will measure the active power consumed per phase of the star connected balanced load. The total three phase power consumed by the star connected balanced load is three times the wattmeter reading.

Wattmeter Reading $W = V_{RN} I_R \cos\Phi$ .... Per Phase Active Power

Total Active power drawn by the load is $W_T = 3 * W$

Reactive power:

Reactive power in a balance 3-ϕ load can also be calculated by using single wattmeter. Inthis method, the current coil of the wattmeter is connected in any line and the pressure coils across the other two lines as shown in fig (b).

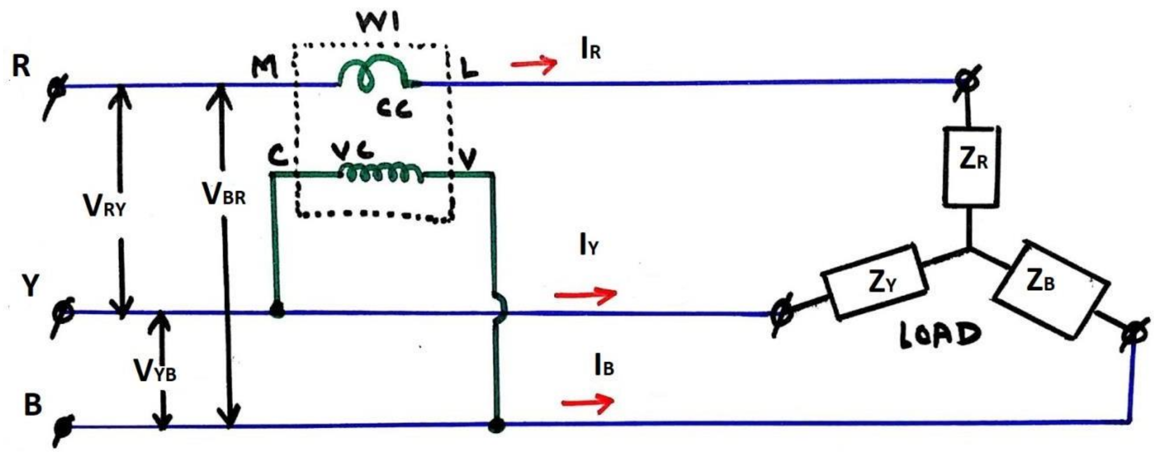


Fig (b)

The current coil is connected in R phase and pressure coil is connected across 'Y'and 'B' phases. Assuming phase sequence RYB and an inductive load of an angle 'ϕ'

Here current through current coil = I_RVoltage

across pressure coil = V_{YB}

The phase angle between V_{YB} and I_R from the phasor diagram is 90°-ϕWattmeter

reading = $V_{YB} I_R \cos(90°-\phi) = V_{YB} I_R \sin\phi = V_L I_L \sin\phi$

In terms of line current and voltage the reactive power consumed by the load perphase is $V_{ph} I_{ph} \sin\Phi$. The total three phase reactive power consumed by the load is

$3 * V_{ph} I_{ph} \sin\Phi$ (or) $\sqrt{3} V_L I_L \sin\phi$

So the total three phase reactive power drawn by the load is given as$Q_T = \sqrt{3}$ * Wattmeter reading

Circuit Diagram: -

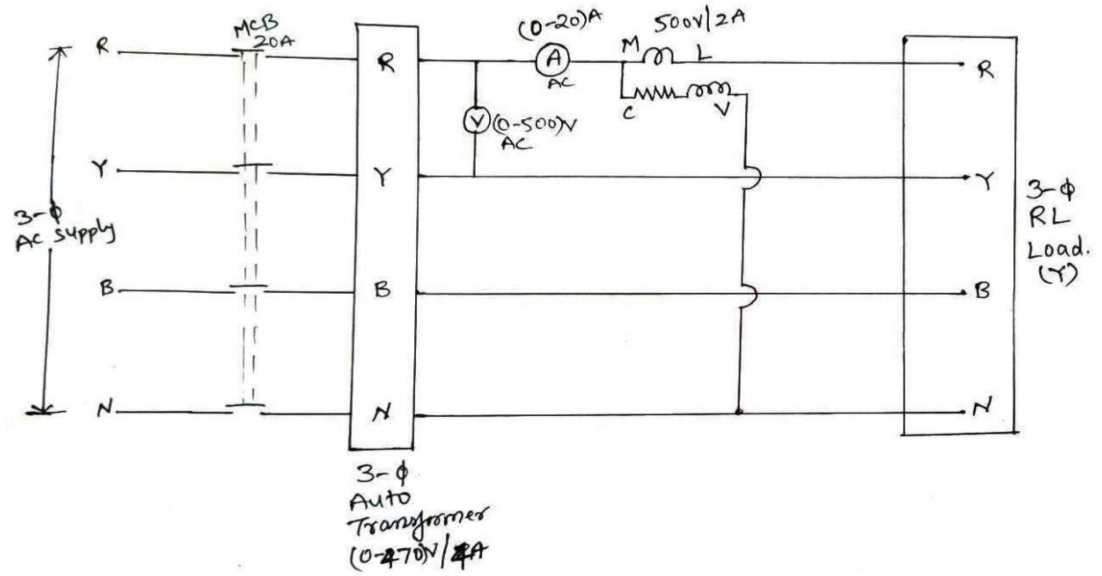


Fig.1 Circuit diagram for measurement of 3-Phase Active power using one wattmeter method for balanced load

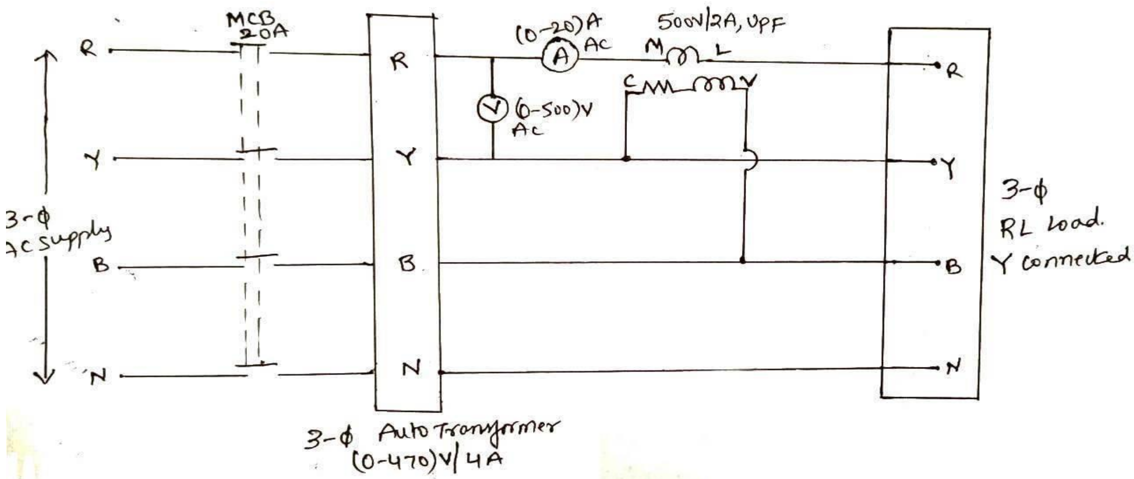


Fig 2 Circuit Digram for measurement of 3-phase Reactive power using one wattmeter

Procedure: -

Active Power:

1.Connect the circuit as per Fig.1
2.Switch on the MCB and vary the autotransformer until the voltmeter reads therated voltage of 415V.
3.Switch on the balanced loads and note down the readings of Ammeter, Voltmeterand wattmeter.
4.Tabulate the readings in the given table and calculate the Total three phase activepower consumed by the load.

Reactive Power:

1.Connect the circuit as per Fig.2
2.Switch on the MCB and vary the autotransformer until the voltmeter reads therated voltage of 415V.
3.Switch on the balanced loads and note down the readings of Ammeter, Voltmeterand wattmeter
4.Tabulate the readings in the given table and calculate the Total three phasereactive power consumed by the load.

Theoretical Calculation:

R/ph = 150ohms, L/ph=320mH, Supply frequency = 50Hz, Line Voltage = 415V, star connection

Active power consumed by the load per phase is given as 3 * $V_{ph} I_{ph}$ COSΦ

Where $V_{ph} = V_L / \sqrt{3}$ & $I_{ph} = I_L$ ……. For Star connection

$I_{ph} = I_L / \sqrt{3}$ & $V_{ph} = V_L$ ……. For Delta connection

$$X_{L/\text{ph}} = 2\prod f\ L$$

$$IZI/ph = \sqrt{{R_{ph}}^2 + {X_{L/ph}}^2}$$

$$\Phi = \tan^{-1}\frac{X_L}{R}$$

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

The per phase Active power consumed by the load = $V_{ph} I_{ph}$ COSΦ =

Total three phase Active power consumed by the load = P_T = 3* $V_{ph} I_{ph}$ COSΦ =

The Reactive power consumed by the load per phase = $V_{ph} I_{ph}$ Sin Φ =

Total three phase Reactive power consumed by the load

Q_T = 3* $V_{ph} I_{ph}$ SinΦ (or) $\sqrt{3}\ V_L\ I_L$ Sin ϕ =

The total apparent power drawn by load is given by $S_T = \sqrt{{P_T}^2 + Q_T}$

***Observation Tables*: -**

Active power:

S.no	V_L	I_L	*W*	Three phase Active power consumed by the load = 3*W

Reactive power:

S.no	V_L	I_L	*W*	Three phase Reactive power consumed by the load = √3 *W

Precautions:

1.There shouldn't be any loose connections.
2.The readings must be taken without any parallax error.

***Result*: -**

The 3 Phase active power and reactive power for balanced load ismeasured using one single phase wattmeter.

***VIVA VOCE*:**

1.Write the relationship of line and phase voltage and current in star andDelta?

2.Define balanced load?

3.Define unbalanced load?

4.How many wattmeters are required to measure the total three phase activepower for unbalanced load?

5.How many wattmeters are required to measure the total three phase activepower for balanced load?

4. PERFORMANCE CHARACTERISTICS DC SHUNT MOTOR

***Aim*: -**

To obtain the performance characteristics of DC shunt motor byconducting brake test.

Theory:-

The DC shunt motor is a constant speed motor and has a poor starting torque. This motor is used in applications requiring constant speed and starts on No load so that not much starting torque is required. However, speed of the shunt motor decreases with an increase in load. The performance characteristics of motor can be determined by conducting load test on it. In brake test or the direct load test the shaft of the motor is equipped with brake drum and belt arrangements. The load on the motor is applied by tightening the belt. As we tighten the belt, the friction increases with increasing load. In this method the load on the drum is not uniform and lot of energy is wasted. So this is not the best method for testing the machine. However, the efficiency obtained in this test is exactly equal to the real time conditions.

***Specifications / Technical details of Equipment and instruments:* -**

a) Equipment:

S.no	Name of equipment	Range	Quantity	Make
1	DC shunt motor	220V, 5Hp, 1.8/20A,1500 rpm	1 No	Bharath Electronics
2	Rheostats	25Ω, 10A	1 No	Stead
3	Rheostats	370Ω, 1.7A	1 No	Stead

b) Instruments:

S.no	Name of instrument	Range	Type	Quantity	Make
1.	Voltmeter	(0-250V)	MC	1 No	Swastik
2.	Ammeter	(0-2A)	MC	1 No	Swastik
3.	Ammeter	(0-20A)	MC	1No	Swastik
4.	Tachometer	0-10,000 rpm	Digital	1 No	Systems

Circuit Diagram: -

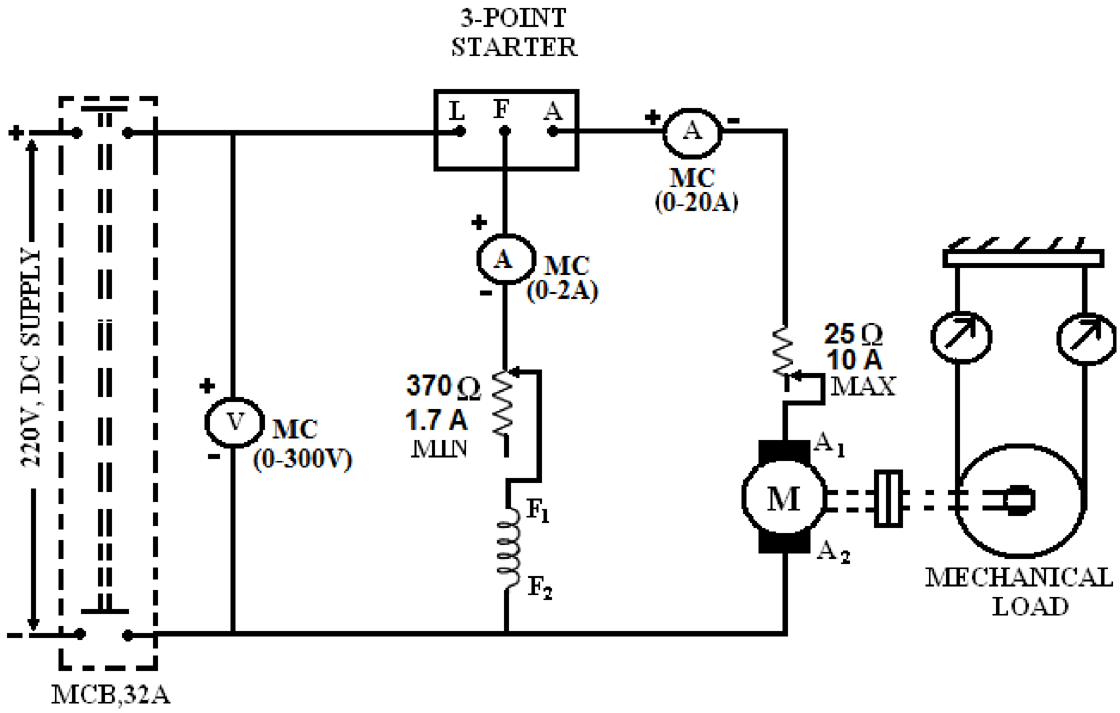


FIG. 11 CIRCUIT FOR CONDUCTING BRAKE TEST ON DC SHUNT MOTOR

Procedure: -

1. Make the connections as per the circuit diagram shown in the FIG.12.1
2. Initially the field rheostat of motor should be in minimum position and armaturerheostat should be at maximum position.
3. Give the supply by closing the MCB and start the motor by using 3-point starter.
4. Cut out the armature rheostat and adjust the motor speed up to rated speed byvarying the field rheostat.
5. At rated (1500 rpm) speed, note down the readings of all meters correctly i.e., noload readings.
6. Apply load in steps by tightening the belt and note down the correspondingreadings until full-load current is reached.
7. Carryout calculations and plot graph of η, T & N Vs O/P

Observation Table: -

S.No.	Terminal Voltage (V_t)	Armature Current (I_a)	Field Current (I_f)	Line Current (I_L)	Speed (N)	Load balance Reading (W_1)	(W_2)	Torque (T)	Output power ($P_{o/p}$)	Efficiency (η)
	Volts	Amps	Amps		rpm	Kg	Kg	N-m	Watts	%

Formulae:-

Drum Radius = r =

Torque $T = (W_1 - W_2)\ 9.81 \times r$ in N-m

Output power= $\dfrac{2\pi NT}{60}$ in watts

Input power = VI_L

Efficiency (η)= $\dfrac{\text{Output}}{\text{Input}}$ in %

Model Calculations:-

$I_L = I_a + I_f =$

Power input=$V_t I_L$=

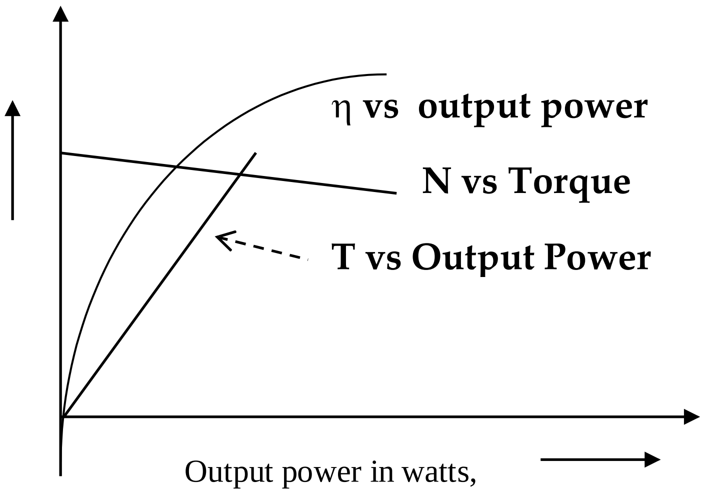
Torque(T)=$(W_1 - W_2) \times 9.81 \times r$ =

Power output=$2\pi NT/60$ =

Efficiency=power output/ power input x 100 =

Model Graphs:-

Speed (N) in rpm**,**
Efficiency (η) in %,
Torque (T)



Precaution:-

General:

1. There shouldn't be any loose connections.
2. The readings must be taken without any parallax error.

Technical:

1. The motor field rheostat should be in minimum resistance position.
2. Be sure that the brake drum is water cooled.

Result: -

Viva Voce:-

1. Why shunt motor is called a constant speed motor?
2. What are the applications of D.C shunt motor depending on its characteristics?
3. How the starting torque of D.C shunt motor can be compared with D.C series motor?
4. What is the purpose of starter?
5. Define the base speed?
6. One D.C motor drives another D.C motor. When excited and driven the second D.C motor runs as __________________
7. How the direction of rotation of a D.C shunt motor is reversed?
8. Why Armature rheostat position of motor should be kept at maximum position initially?
9. Why Field rheostat position of motor should be kept at minimum position initially.

5. PERFORMANCE CHARACTERISTICS OF A THREE PHASE INDUCTION MOTOR

***Aim*: -**

To obtain the performance characteristics of a given 3- ϕ Induction Motor by conductingbrake test.

***Theory*:-**

A three phase induction motor works on the principle of transformer action and is called as transformer with rotating short circuit secondary. The three phase induction motors are of Squirrel Cage Induction Machine(SCIM)and Slip Ring Induction Machine(SRIM) type.Comparatively there is not much of difference in performance between a SCIM and SRIM but the current carrying capacity of SRIM is a little bit higher and obviously slightly lower efficiency.Where as in SRIM the starting torque and power factor can be improvedby incorporating external resistance the SCIM has fixed starting torque and poorer powerfactorsofoperation. Brake test is a universal test on any rotating machine and is accomplished by loading the machine with brakes for convenient loads upto 150% the rated current value. Graphical plots of the variation of percentage efficiency, the line current(I_l),power factor (cosϕ),actual speed(N),percentage slip(s%) and shaft torque(T_{SH}) referred to the load.

***Specifications / Technical details of Equipment and instruments:*-**

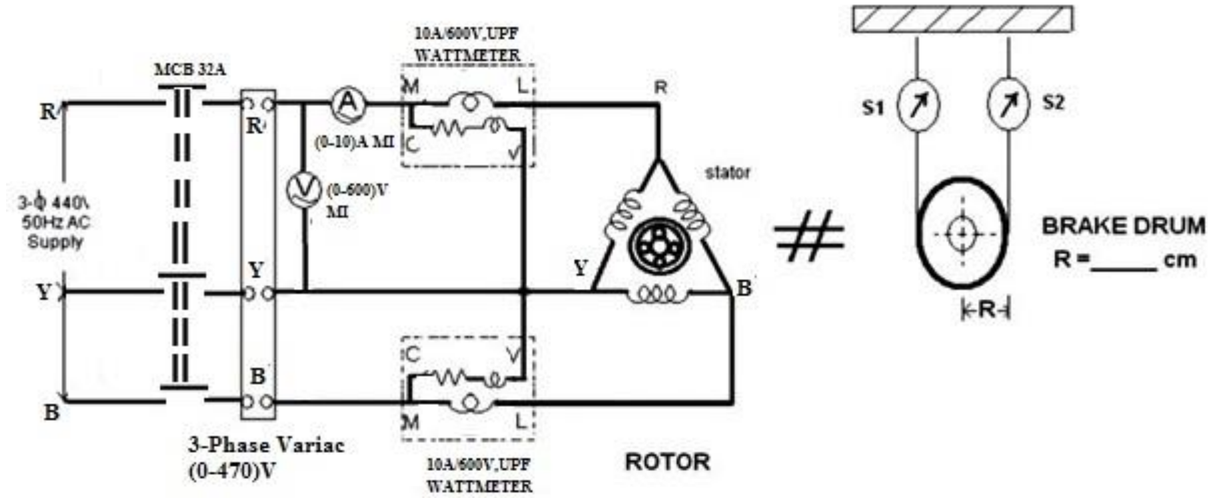
a) Equipment:

S.No	Name of the equipment	Specifications	Make	Quantity
1	3-phase squirrel cage induction motor	5hp, 415v,6.5A	Bharath Electronics	1
2.	3-pahse variac	415v, 8A	Bharath Electronics	1

b) Instruments:

Sl.no	Name of the Instrument	Range	Type	Quantity
1	Voltmeter	0-500V	Digital	1
2	Ammeter	0-20A	Digital	1
3	Wattmeter	150/600V, 5/10A, UPF	Dynamometer	2
4	Tachometer	0-10,000rpm	Digital	1

Circuit Diagram: -



Name Plate Details: -

KW	:	RPM	:
Volts	:	Frequency	:
Amps	:	Connection	:

Observation Table: -

S. No	V_L	I_L	Watt meter readings			Force in kgs			N (rpm)	T (N-m)	P_{out} (watts)	%η
			W_1	W_2	P_{in}	F_1	F_2	F				

***Model Calculation*: -**

Input power $P_{in} = W_1+W_2$

Force $F= (F_1-F_2)$

Torque=9.81*F*r=

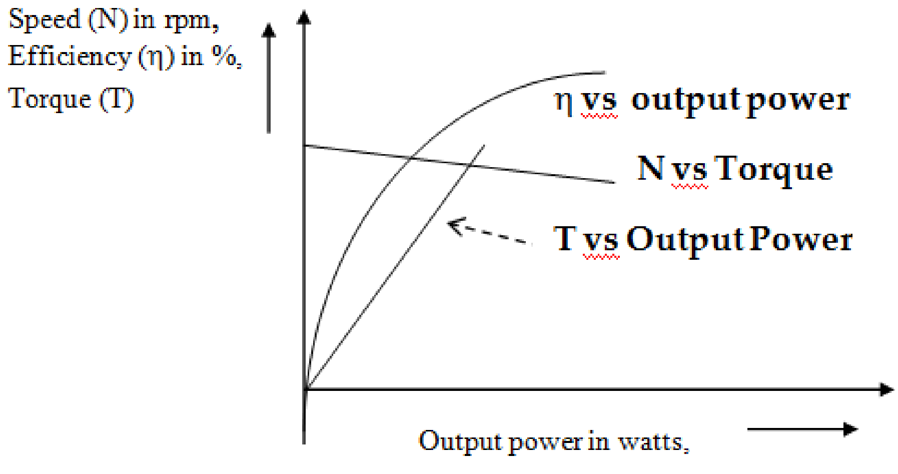
Electrical power output = $P_{OUT}=(2\Pi NT)/60$ =

%Efficiency = P_{out}/P_{in} x 100

***Procedure*: -**

1. Connect the circuit as per the circuit diagram.
2. Before giving supply see that the motor is at no load.
3. Apply rated voltage by closing the MCB and the motor is started by using 3ph Dimmerstat.
4. The motor is made to run at no load and note down readings corresponds to No load condition.
5. Increase the load gradually by small steps (say 0.5A) by tightening the brakes and note down all the meter readings.
6. Repeat the above step till the rated current ofthe motor is reached.
7. Tabulate the readings and draw the graphs.

Model Graph:-



***Precautions*: -**

General:

1. There shouldn't be any loose connections.

Technical:

1. Don't exceed the rated voltage and rated current while applying the loads.
2. Ensure that the pulley is water cooled to avoid melting of belt.

***Result*: -**

***Viva voce*: -**

1. What is slip in induction motor operation?
2. How high starting torques are obtained in slip ring induction motors?
3. How to reverse the direction of rotation in 3ph induction motor?
4. Why the rotor of an induction motor cannot run at synchronous speed, if it rotates at N_s what will be torque value?
5. If the fuse in one of the phases burn while running condition, what happens to the motor.

6.NO-LOAD CHARACTERISTICS OF THREE PHASE ALTERNATOR

***Aim:* -**
To determine the No-Load Characteristics of the three phase alternator**.**

***Theory*:-**
An alternator is an electrical machine which converts mechanical energy into alternatingelectric energy. They are also known as synchronous generators.

There are two types of rotor used in an AC generator / alternator:

1. Salient pole type: Salient pole type rotor is used in low and medium speed alternators. This type of rotor consists of large number of projected poles (called salient poles), bolted on a magnetic wheel. These poles are also laminated to minimize the eddy current losses. Alternators featuring this type of rotor are large in diameters and short in axial length.
2. Cylindrical type: Cylindrical type rotors are used in high speed alternators, especially in turbo alternators. This type of rotor consists of a smooth and solid steel cylinder having slots along its outer periphery. Field windings are placed in these slots.

The DC supply is given to the rotor winding (filed winding) through the slip rings and brushes arrangement. The flux produced by the rotating field system links the armature conductors on stator and induces an e.m.f as per Faraday laws.

***Specifications / Technical details of Equipment and instruments:* -**

a) Equipment:

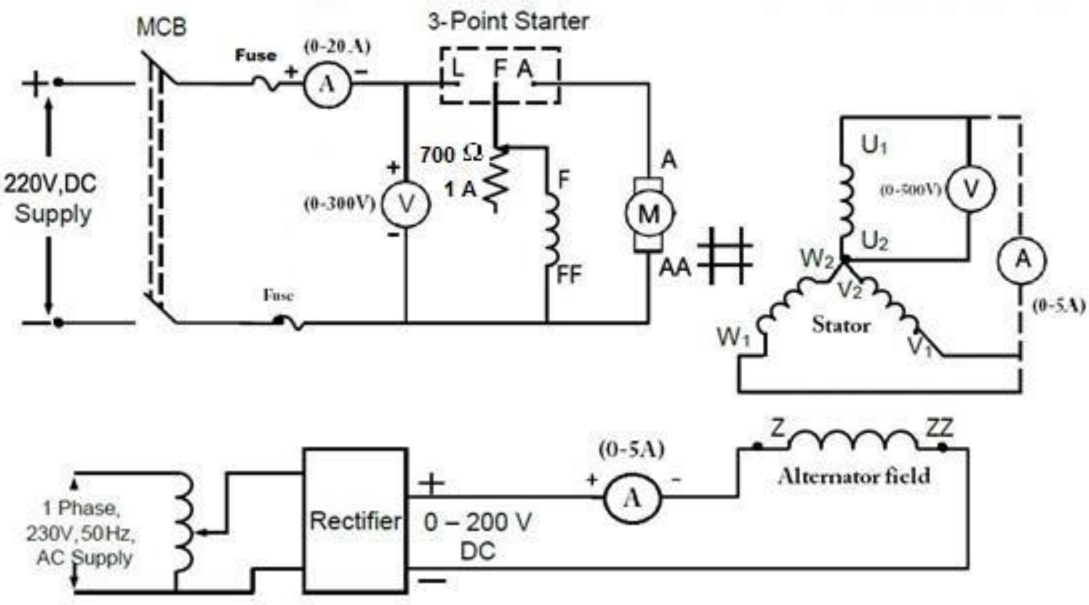
S.No	Name of the equipment	Specifications	Make	Quantity
1	3-phase Alternator	(3KVA,1.5A, 4.6A)	Bharath Electronics	1

b) Instruments:

Sl.no	Name of the Instrument	Range	Type	Quantity
1	Voltmeter	0-500V – AC	Digital	1
2	Voltmeter	0-300V – DC	Digital	1
3	Ammeter	0-20A – DC	Digital	1
4	Ammeter	0-5A – AC	Digital	1

5	Ammeter	0-5A – DC	Digital	1
6	Tachometer	0-10,000 rpm	Digital	1
7	Rheostat	700Ω /1 A	Stead	1

***Circuit Diagram*: -**



Name Plate Details: -

KW	:	RPM	:
Volts	:	Frequency	:
Amps	:	Connection	:
Filed system	:		

***Observations*: -**

S. No	Field Current (I_f)	Open circuit voltage(E_0)
1		
2		
10		

***Procedure*: -**

1. Connect the circuit as shown in the circuit diagram.
2. Field rheostat of the motor should be kept in minimum position and single phase variac should be in minimum output position.
3. Switch on the DC supply and start the motor-alternator set with the help of a three point starter.

4. Adjust the field rheostat of the motor to set motor-alternator set to the rated speed.
5. Slowly vary the Variac to increase the field excitation of the synchronous machine. Note down the value for filed current I_f and open circuited voltage E_0
6. Repeat the above step till the rated voltage of the alternator.
7. Bring back the single phase Variac to the initial position, field rheostat to the minimum resistance position and switch off the MCB.

***<u>Precautions</u>*: -**

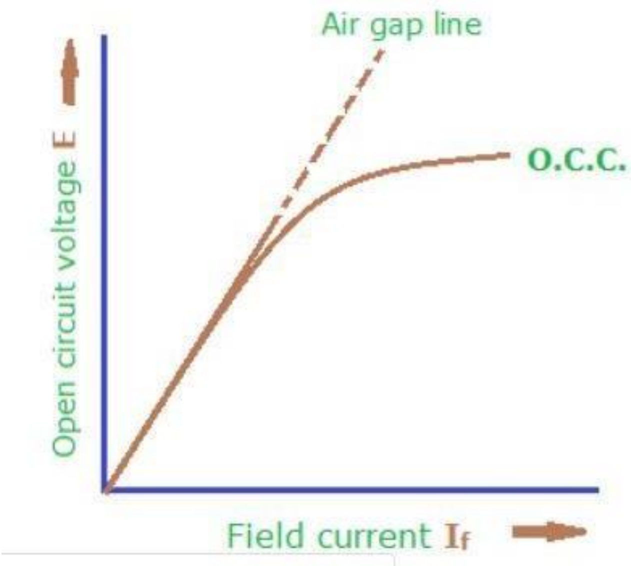
General:

1. There shouldn't be any loose connections.
2. Check the initial starting conditions before stating the set.

Technical:

1. Don't exceed the rated voltage and rated current values.

<u>Graph:</u>



***<u>Result</u>*: -**

***<u>Viva voce</u>*: -**

1. What is the working principle of alternator?
2. What are the types of synchronous alternator?
3. What is meant by synchronous speed of alternator?
4. What is meant by turbo alternators?
5. Will the alternator have rotating armature system or stationary armature system? why?

PART B

1.Study and Operation of multi-meters, function generator, regulated power supply and Cathode ray oscilloscope

Aim:

1. To study and operation of multimeter, function generator, regulated power supply and Cathode ray oscilloscope.
2. To observe front panel control knobs and to find amplitude, time period and frequency for given waveform.

Apparatus:

1. Regulated power supply
2. Function generator
3. Multimeter
4. Cathode ray oscilloscope

Theory:

1.Regulated power supply:-

A regulated power supply is an embedded circuit, or stand alone unit, the function of which is to supply a stable voltage (or less often current), to a circuit or device that must be operated within certain power supply limits. The output from the regulated power supply may be alternating or unidirectional, but is nearly always DC (Direct Current) .

The type of stabilization used may be restricted to ensuring that the output remains within certain limits under various load conditions, or it may also include compensation for variations in its own supply source. The latter is much more common today.

2.Function generator:

A function generator is usually a piece of electronic test equipment or software used to generate different types of electrical waveforms over a wide range of frequencies. Some of the most common waveforms produced by the function generator are the sine, square, triangular and sawtooth shapes. These waveforms can be either repetitive or single-shot (which requires an internal or external trigger source). Integrated circuits used to generate waveforms may also be described as function generator ICs.

Although function generators cover both audio and RF frequencies, they are usually not suitable for applications that need low distortion or stable frequency signals. When those traits are required, other signal generators would be more appropriate.

Some function generators can be phase-locked to an external signal source (which may be a frequency reference) or another function generator.

Function generators are used in the development, test and repair of electronic equipment. For example, they may be used as a signal source to test amplifiers or to introduce an error signal into a control loop.

Designation	Specification
Waveform	Sin, square and triangular
Amplitude	0-20V
Frequency range	0.1Hz to 1MHz
Offset	Continuously variable 10V
Output impedance	600ohms,5%

Range selector is used to select the range of frequency

3. Multimeter:

A multimeter or a multitester, also known as a VOM (Volt-Ohm meter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter would include basic features such as the ability to measure voltage, current, and resistance. Analog multimeters use a microammeter whose pointer moves over a scale calibrated for all the different measurements that can be made. Digital multimeters (DMM, DVOM) display the measured value in numerals, and may also display a bar of a length proportional to the quantity being measured. Digital multimeters have all but replaced analog moving coil multimeters in most situations. Analog multimeters are still manufactured but by few manufacturers.

Quantities measured:

Contemporary multimeters can measure many quantities. The common ones are:

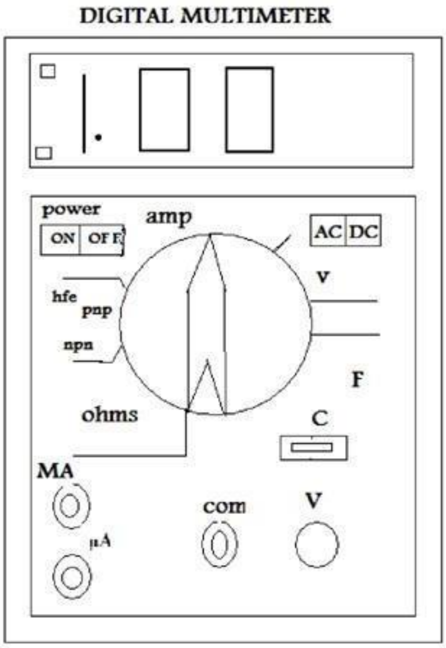
- Voltage, alternating and direct, in volts.
- Current, alternating and direct, in amperes.
- The frequency range for which AC measurements are accurate must be specified.
- Resistance in ohms.

Additionally, some multimeters measure:

- Capacitance in Farads.
- Conductance in Siemens.
- Decibels.
- Duty cycle as a percentage.
- Frequency in Hertz.
- Inductance in Henrys.
- Temperature in degrees Celsius or Fahrenheit, with an appropriate temperature test probe, often a thermocouple.

Digital multimeters may also include circuits for:

- Continuity tester; sounds when a circuit conducts
- Diodes (measuring forward drop of diode junctions), and transistors (measuring current gain and other parameters)
- Battery checking for simple 1.5 volt and 9 volt batteries. This is a current loaded voltage scale which simulates in-use voltage measurement.



4.Cathode Ray Oscilloscope:

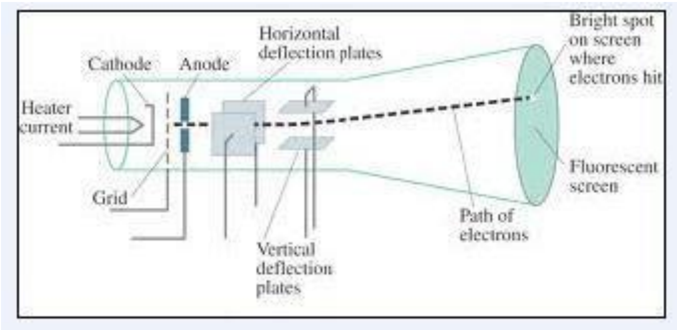
An oscilloscope, previously called an oscillograph, and informally known as a scope,CRO (for cathode-ray oscilloscope), or DSO (for the more modern digital storage oscilloscope), is a type of electronic test instrument that allows observation of constantly varying signal voltages, usually as a two-dimensional graph of one or more electrical potential differences using the vertical or y-axis, plotted as a function of time (horizontal or x-axis). Many signals can be converted to voltages and displayed this way. Signals are often periodic and repeat constantly, so that multiple samples of a signal which is actually varying with time are displayed as a steady picture. Many oscilloscopes (storage oscilloscopes) can also capture non-repeating waveforms for a specified time, and show a steady display of the captured segment.

Oscilloscopes are commonly used to observe the exact wave shape of an electrical signal. Oscilloscopes are usually calibrated so that voltage and time can be read as well as possible by the eye. This allows the measurement of peak-to-peak voltage of a waveform, the frequency of periodic signals, the time between pulses, the time taken for a signal to rise to full amplitude (rise time), and relative timing of several related signals.

Oscilloscopes are used in the sciences, medicine, engineering, and telecommunications industry. General-purpose instruments are used for maintenance of electronic equipment and laboratory work. Special-purpose oscilloscopes may be used for such purposes as analyzing an automotive ignition system, or to display the waveform of the heartbeat as an electrocardiogram. Some computer sound software allows the sound being listened to be displayed on the screen as by an oscilloscope.

Before the advent of digital electronics oscilloscopes used cathode ray tubes as their display element (hence were commonly referred to as CROs) and linear amplifiers for signal processing.

More advanced storage oscilloscopes used special storage CRTs to maintain a steady display of a single brief signal. CROs were later largely superseded by digital storage oscilloscopes (DSOs) with thin panel displays, fast analog-to-digital converters and digital signal processors. DSOs without integrated displays (sometimes known as digitisers) are available at lower cost, and use a general-purpose digital computer to process and display waveforms.



CRO

The main parts are

1. Electron gun: it is used to produce sharply focused beam of electron accelerated to very high velocity.
2. Deflection system: it deflects the electron both in horizontal and vertical plan.
3. Florescent screen: the screen which produces, spot of visible light . when beam of electrons are incident on it the other side of tube is coated with phosphorus material.

FRONT PANNEL:

ON-POWER: toggle switch for switching on power.

INTENCITY: controls trace intensity from zero to maximum.

FOCUS: It controls sharpness of trace a slight adugestement of focus is done after changing intensity of trace.

AC-DC: GROUND: It selects coupling of ACDC ground signal to vertical amplifier.

X-MAG: It expands length of time base from 15 times continuously and to maximum time base to 40 ns/cm.

SQUARE: This provides square wave 2v (pP) amplitude and enables to check y calibration of scope.

SAWTOOTH WAVE FORM: This provides saw tooth wave form output coincident to sweep speed with an output of saw tooth wave (pp)

VERTICAL SECTION: y position:This enables movement of display along y-axis.

Y-INPUT: It connects input signal to vertical amplifier through ACDC ground coupling switch

CALIBRATION: 15mv – 150mv dc signal depending on position selection is applied to vertical amplifier.

DC BALANCE: It is control on panel electrostatic ally in accordance with waveforms to be displayed.

VOLTS/CM: Switch adjusts sensitivity.

HORIZANTAL SECTION:

X-POSITION: This control enables movement of display along xaxis.

TRIGGERING LEVEL: It selects mode of triggering.

TIMEBASE: This controls or selects sweep speeds.

VERNUIS: This control the fine adjustments associated with time base sweep.

SIGN SELECTOR: It selects different options of INT/EXT, NORM/TO.

STAB: Present on panel

EXITCAD: It allows time base range to be extended.

HORIZANTAL INPUT: It connects external signal to horizontal amplifier.

Ext SYN: it connects external signal to trigger circuit for synchronization.

OBSERVATIONS:

Amplitude = no. of vertical divisions * Volts/div.

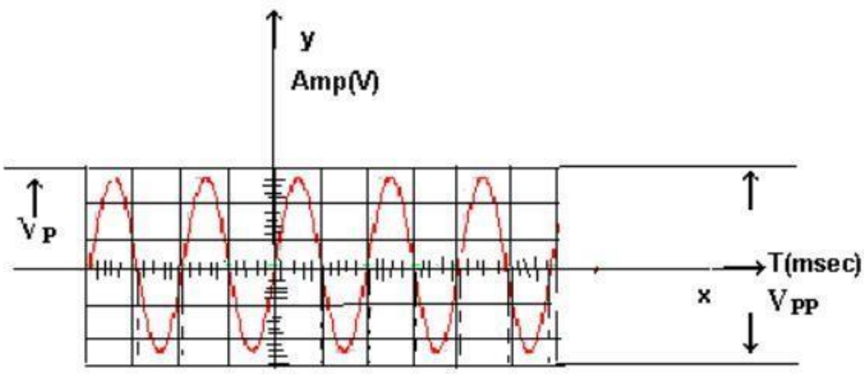
Time period = no. of horizontal divisions * Time/div.

Frequency = 1/T

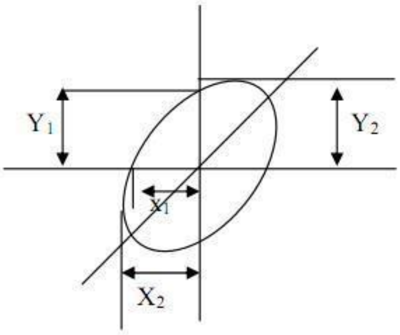
Amplitude taken on vertical section (y).

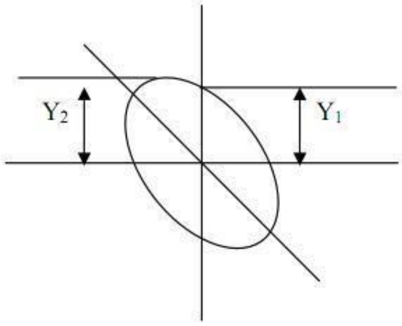
Time period taken on horizontal section(x)

Model waveforms



Measurement of Phase:





$$\phi = \sin^{-1}\frac{Y_1}{Y_2} = \sin^{-1}\frac{X_1}{X_2}$$

$$\phi = 180 - \sin^{-1}\frac{Y_1}{Y_2}$$

2.P-N JUNCTION DIODE CHARACTERISTICS

AIM: 1. To observe and draw the Forward and Reverse bias V-I Characteristics of a P-N Junction diode.

2. To calculate static and dynamic resistance in both forward and Reverse Bias conditions.

APPARATUS:

S.No	Description	Range	Quantity
1	P-N Diode IN4007	-	1No
2	Regulated Power supply	(0-20)V	1No
3	Resistor 1KΩ		1No
4	Ammeter	(0-20 mA)	1No
5	Ammeter	(0-200μA)	1No
6	Voltmeter	(0-20V)	2No.
7	Bread board	-	-
8	Connecting wires	-	As required

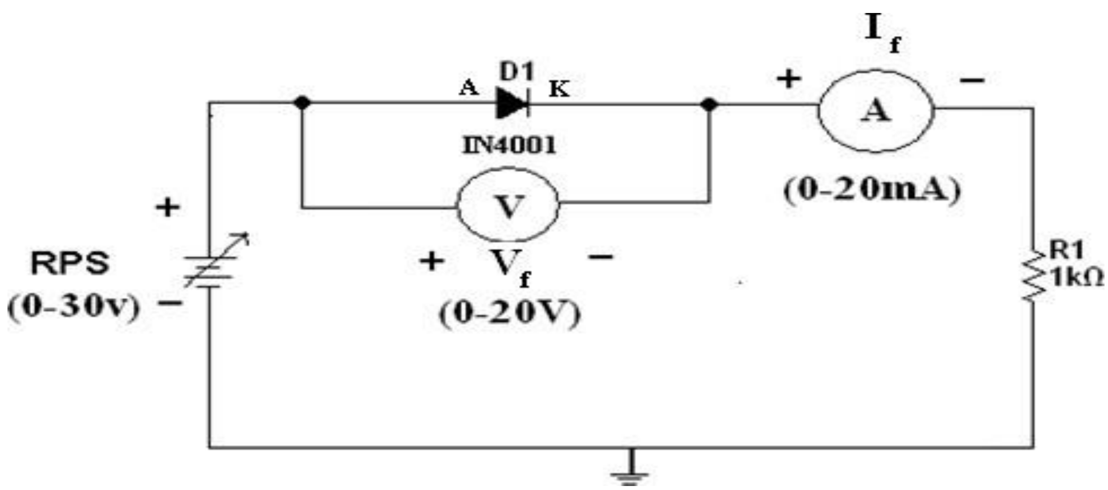
THEORY:

A p-n junction diode conducts only in one direction. The V-I characteristics of the diode are curve between voltage across the diode and current flowing through the diode. When external voltage is zero, circuit is open and the potential barrier does not allow the current to flow. Therefore, the circuit current is zero. When P-type (Anode) is connected to +ve terminal and n- type (cathode) is connected to −ve terminal of the supply voltage is known as forward bias. The potential barrier is reduced when diode is in the forward biased condition. At some forward voltage, the potential barrier altogether eliminated and current starts flowing through the diode and also in the circuit. Then diode is said to be in ON state. The current increases with increasing forward voltage.

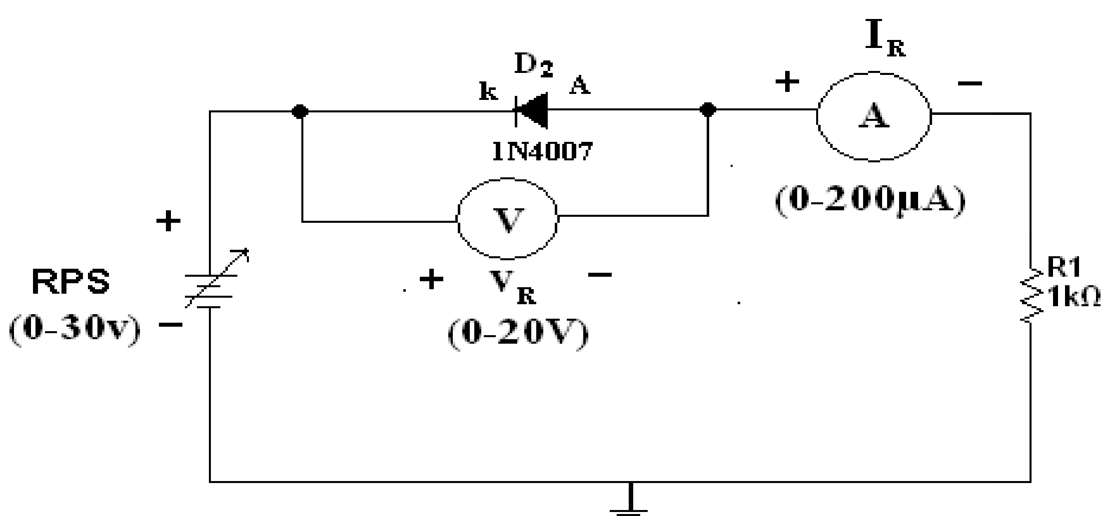
When N-type (cathode) is connected to +ve terminal and P-type (Anode) is connected −ve terminal of the supply voltage is known as reverse bias and the potential barrier across the junction increases. Therefore, the junction resistance becomes very high and a very small current (reverse saturation current) flows in the circuit. Then diode is said to be in OFF state. The reverse bias current is due to minority charge carriers.

CIRCUIT DIAGRAM:

A) Forward bias:



B) Reverse Bias:



PROCEDURE:

A) FORWARD BIAS:

1. Connections are made as per the circuit diagram.
2. For forward bias, the RPS +ve is connected to the anode of the diode and RPS −ve is connected to the cathode of the diode
3. Switch on the power supply and increases the input voltage (supply voltage) in Steps of 0.1V
4. Note down the corresponding current flowing through the diode and voltage across the diode for each and every step of the input voltage.
5. The reading of voltage and current are tabulated.
6. Graph is plotted between voltage (V_f) on X-axis and current (I_f) on Y-axis.

B) REVERSE BIAS:

1. Connections are made as per the circuit diagram
2. For reverse bias, the RPS +ve is connected to the cathode of the diode and RPS −ve is connected to the anode of the diode.
3. Switch on the power supply and increase the input voltage (supply voltage) in Steps of 1V.
4. Note down the corresponding current flowing through the diode voltage across the diode for each and every step of the input voltage.
5. The readings of voltage and current are tabulated
6. Graph is plotted between voltage (V_R) on X-axis and current (I_R) on Y-axis.

OBSERVATIONS:

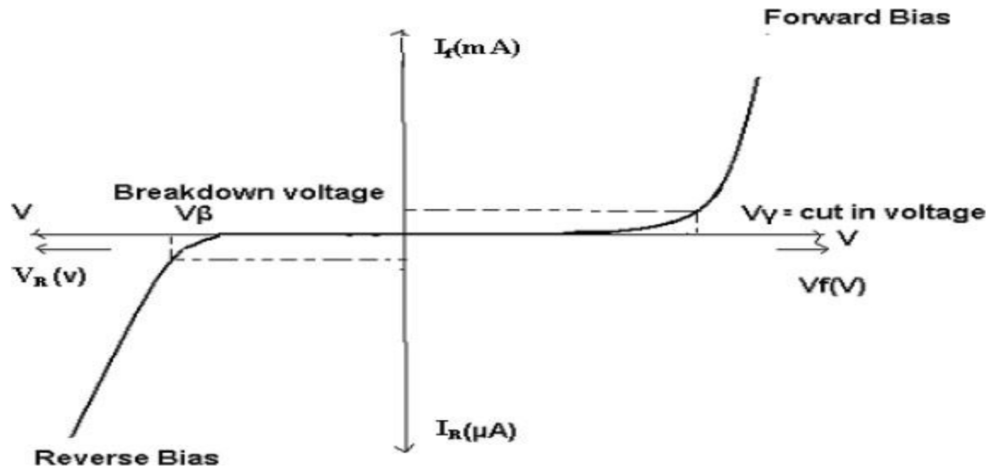
A) FORWARD BIAS:

S.NO	Applied Voltage(V)	Forward Voltage(V_f)	Forward Current(I_f(mA))

B) REVERSE BIAS:

S.NO	Applied Voltage(V)	Reverse Voltage(V_R)	Reverse Current(I_R(µA))

MODEL GRAPH:



RESULT:

Calculating Static and Dynamic Resistance of given diode.

In forward bias condition:

Static Resistance , $R_s = Vf/I_f =$

Dynamic Resistance, $R_D = \Delta V_f / \Delta I_f =$

In Reverse bias condition:

Static Resistance , $R_s = V_R/I_R =$

Dynamic Resistance, $R_D = \Delta V_R / \Delta I_R =$

PRECAUT IONS:

1. All the connections should be correct.
2. Parallax error should be avoided while taking the readings from the Analog meters.

VIVA QUESTIONS:

1. Define depletion region of a diode?
2. Is the V-I relationship of a diode Linear or Exponential?
3. Define cut-in voltage of a diode and specify the values for Si and Ge diodes?
4. What are the applications of a p-n diode?
5. Draw the ideal characteristics of P-N junction diode?
6. What is the break down voltage?

3.

AIM:

3.ZENER DIODE CHARACTERISTICS

AIM:

1.To observe and draw the static characteristics of a zener diode
2.To find the voltage regulation of a given zener diode

APPARATUS:

1. Zener diode -1No.
2. Regulated Power Supply (0-30v) -1No.
3. Voltmeter (0-20v) -1No.
4. Ammeter (0-20mA) -1No.
5. Resistor (1K ohm)
6. Bread Board
7. Connecting wires

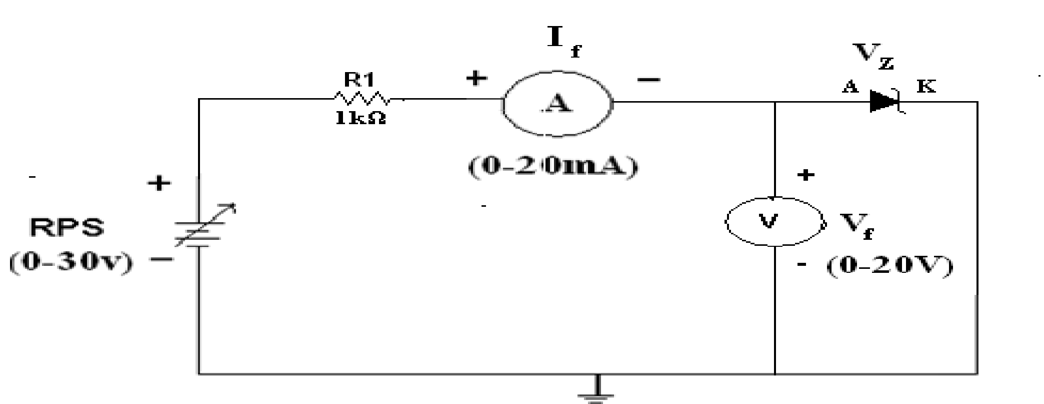
THEORY:

A zener diode is heavily doped p-n junction diode, specially made to operate in the break down region. A p-n junction diode normally does not conduct when reverse biased. But if the reverse bias is increased, at a particular voltage it starts conducting heavily. This voltage is called Break down Voltage. High current through the diode can permanently damage the device

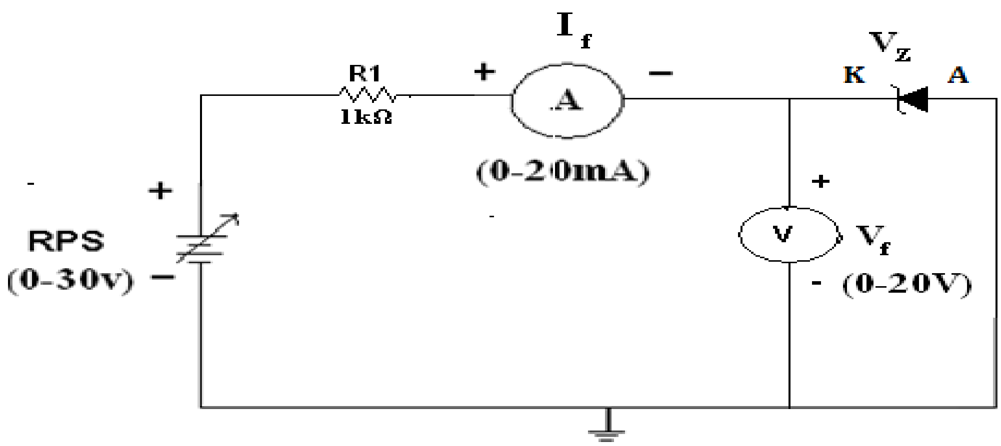
To avoid high current, we connect a resistor in series with zener diode. Once the diode starts conducting it maintains almost constant voltage across the terminals whatever may be the current through it, i.e., it has very low dynamic resistance. It is used in voltage regulators.

CIRCUIT DIAGRAM

A) **Forward bias:**



B) **Reverse bias:**



PROCEDURE:

A) FORWARD BIAS:

1. Connections are made as per the circuit diagram.
2. For forward bias, the RPS +ve is connected to the anode of the Zener diode and RPS −ve is connected to the cathode of the Zener diode
3. Switch on the power supply and increases the input voltage (supply voltage) in Steps of 0.5V
4. Note down the corresponding current flowing through the Zener diode and voltage across the diode for each and every step of the input voltage.
5. The reading of voltage and current are tabulated.
6. Graph is plotted between voltage (V_f) on X-axis and current (I_f) on Y-axis.

B) REVERSE BIAS:

1. Connections are made as per the circuit diagram
2. For reverse bias, the RPS +ve is connected to the cathode of the Zener diode and RPS −ve is connected to the anode of the Zener diode.
3. Switch on the power supply and increase the input voltage (supply voltage) in Steps of 0.5 V .
4. Note down the corresponding current flowing through the diode voltage across the diode for each and every step of the input voltage.
5. The readings of voltage and current are tabulated
6. Graph is plotted between voltage (V_R) on X-axis and current (I_R) on Y-axis.

OBSERVATION TABLE:

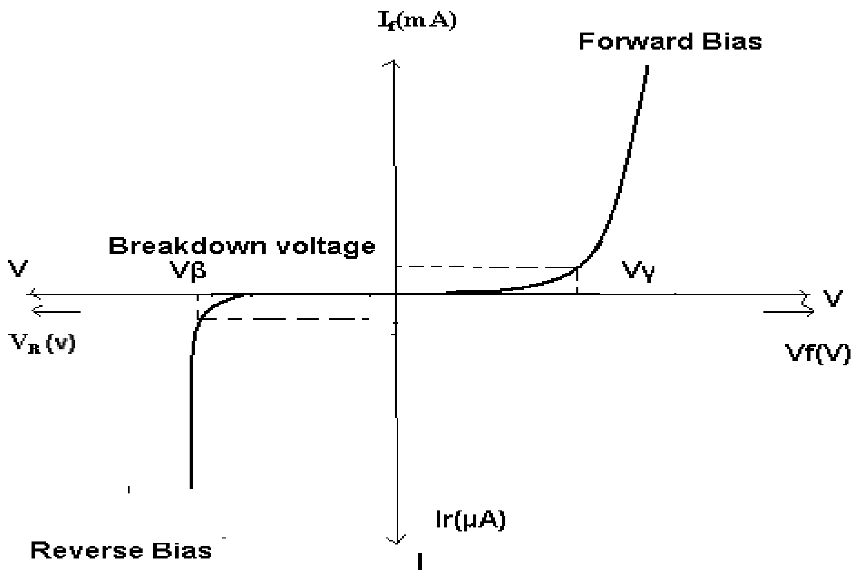
A) FORWARD BIAS:

S.NO	Applied Voltage(V)	Forward Voltage(V_f)	Forward Current(I_f(mA))

B) REVERSE BIAS:

S.NO	Applied Voltage(V)	Reverse Voltage(V_R)	Reverse Current(I_R(mA))

Model Graph:



RESULT:

Calculating Static and Dynamic Resistance of given Zener diode.

In forward bias condition:

Static Resistance , $R_s = Vf/I_f =$

Dynamic Resistance, $R_D = \Delta V_f / \Delta I_f =$

In Reverse bias condition:

Static Resistance , $R_s = V_R/I_R =$

Dynamic Resistance, $R_D = \Delta V_R / \Delta I_R =$

PRECAUTIONS:

2. All the connections should be correct.
3. Parallax error should be avoided while taking the readings from the Analog meters

VIVAQUESTIONS:

1.If the impurity concentration is increased, how the depletion width effected?
2.Explain briefly about avalanche and zener breakdowns?
3.By what type of charge carriers the current flows in zener and avalanche breakdown diodes?

4.INPUT AND OUTPUT CHARACTERISTICS OFTRANSISTOR in CE CONFIGURATION

AIM:

1. To draw the input and output characteristics of transistor connected in CE configuration
2. To find β of the given transistor and also its input and output Resistances

APPARATUS:

S.No	Description	Quantity
1	Transistor, 100S	1
2	Regulated power supply (0-30V)	1
3	Voltmeter (0-20V)	2
4	Ammeters (0-20mA)	1
5	Ammeters (0-200μA)	1
6	Resistor- 100Ω	1
7	Resistor-1KΩ	1
8	Bread board	1
9	Connecting wires	As per requirement

THEORY:

In common emitter configuration, input voltage is applied between base and emitter terminals and output is taken across the collector and emitter terminals. Therefore the emitter terminal is common to both input and output.

The input characteristics resemble that of a forward biased diode curve. This is expected since the Base-Emitter junction of the transistor is forward biased. As compared to CB arrangement I_B increases less rapidly with $V_{BE.}$ Therefore input resistance of CE circuit is higher than that of CB circuit.

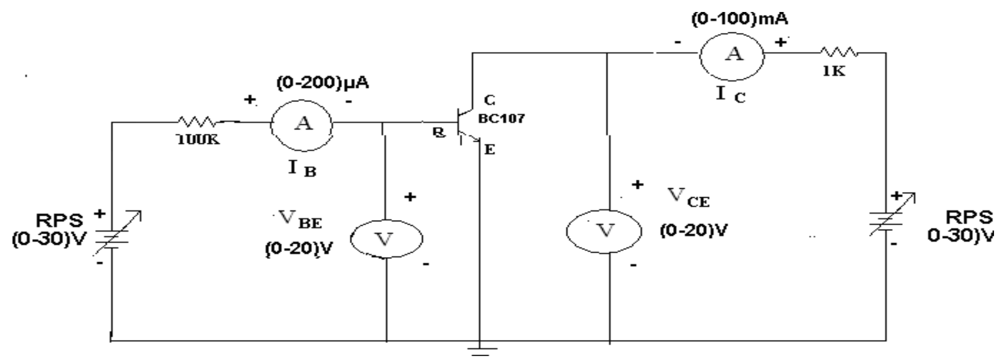
The output characteristics are drawn between I_c and V_{CE} at constant $I_{B.}$ the collector current varies with V_{CE} upto few volts only. After this the collector current becomes almost constant, and independent of $V_{CE.}$ The value of V_{CE} up to which the collector current changes with V_{CE} is known as Knee voltage. The transistor always operated in the region above Knee voltage, I_C is always constant and is approximately equal to $I_{B.}$The current amplification factor of CE configuration is given by

$$\beta = \Delta I_C/\Delta I_B$$

Input Resistance, $r_i = \Delta V_{BE} / \Delta I_B$ (μA) at Constant V_{CE}

Output Résistance, $r_o = \Delta V_{CE} / \Delta I_C$ at Constant I_B (μA)

CIRCUIT DIAGRAM:



PROCEDURE:

A) INPUT CHARECTERSTICS:

1. Connect the circuit as per the circuit diagram.
2. For plotting the input characteristics the output voltage V_{CE} is kept constant at 1V and for different values of V_{BB} , note down the values of I_B and V_{BE}
3. Repeat the above step by keeping V_{CE} at 0V, 5V & 10V and tabulate all the readings.
4. plot the graph between V_{BE} and I_B for constant V_{CE}

B) OUTPUT CHARACTERSTICS:

1. Connect the circuit as per the circuit diagram
2. for plotting the output characteristics the input current I_B is kept constant at 50μA and for different values of V_{CC} note down the values of I_C and V_{CE}
3. Repeat the above step by keeping I_B at 25 μA, 50 μA & 75 μA and tabulate the all the readings
4. plot the graph between V_{CE} and I_C for constant I_B

OBSERVATION TABLE

INPUT CHARACTERISTICS:

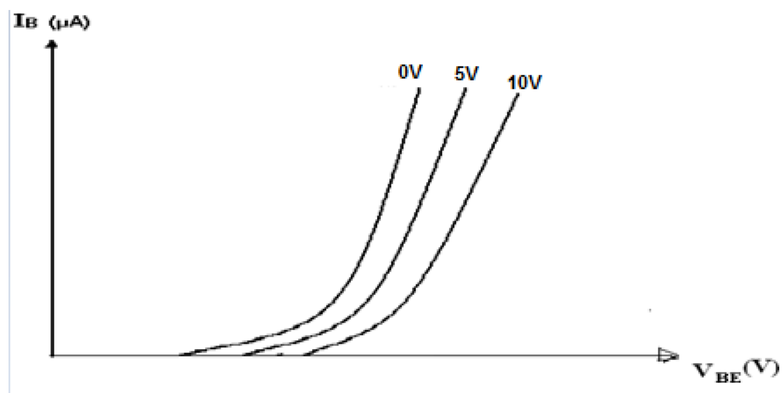
V_{BB}	V_{CE} = 0V		V_{CE} = 5V		V_{CE} = 10V	
	V_{BE}(V)	I_B(μA)	V_{BE}(V)	I_B(μA)	V_{BE}(V)	I_B(μA)

OUTPUT CHAREACTARISTICS:

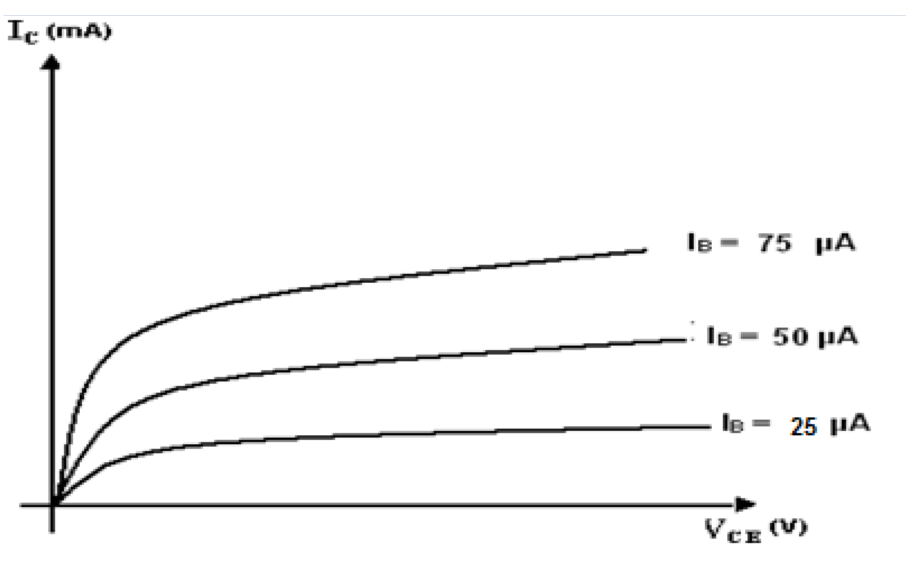
S.NO	I_B = 25 µA		I_B = 50 µA		I_B = 75 µA	
	V_{CE}(V)	I_C(mA)	V_{CE}(V)	I_C(mA)	V_{CE}(V)	I_C(mA)

MODEL GRAPHS:

INPUT CHARACTERISTICS:



OUTPUT CHARACTERSITICS:



PRECAUTIONS:

1. The supply voltage should not exceed the rating of the transistor
2. Meters should be connected properly according to their polarities

RESULT:

VIVA QUESTIONS:

1. What is the range of β for the transistor?
2. What are the input and output impedances of CE configuration?
3. What is the relation between α and β?
4. Define current gain in CE configuration?
5. Why CE configuration is preferred for amplification?
6. Draw diagram of CE configuration for PNP transistor?
7. What is the power gain of CE configuration?
8. What are the applications of CE configuration?

5. FULL WAVE RECTIFIER WITH AND WITHOUTFILTERS

AIM: To Examine the input and output waveforms of Full Wave Rectifier and alsocalculate its load regulation and ripple factor.

1. with Filter
2. without Filter

APPARATUS:

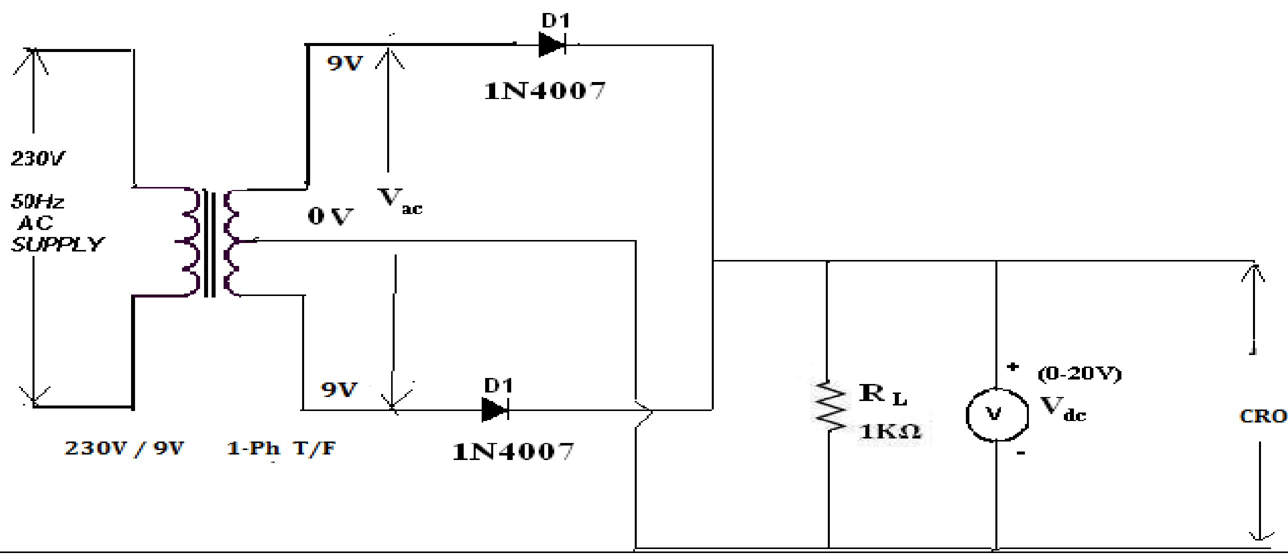
S.No	Description	Quantity
1	General Purpose Trainer Kit	1
2	Resistor 1K ohm	1
	Capacitor, 47 & 1000µF	
3	Diodes IN4007	2
4	DSO/CRO	1
5	DSO/CRO Probes	1
6	Connecting Wires	As per requirement

THEORY:

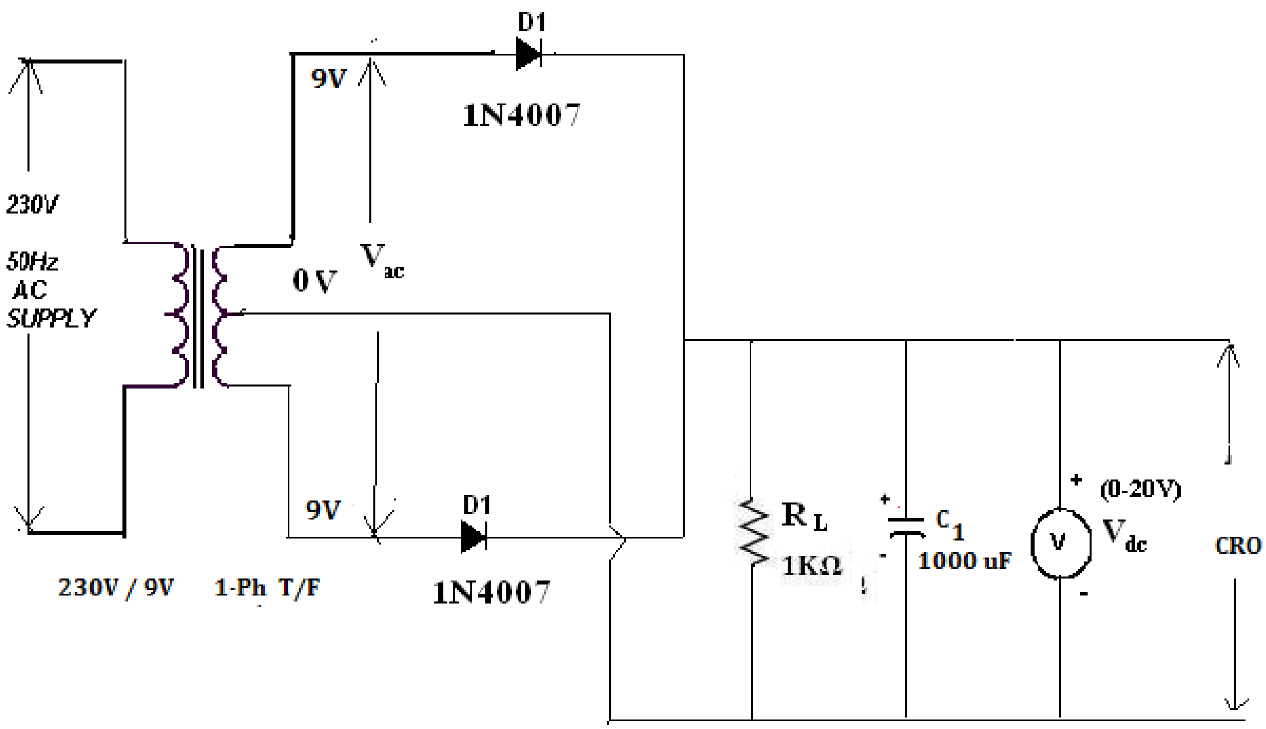
During positive half cycle of secondary voltage (input voltage), the diode D1 is forward biased and D2is reverse biased. So the diode D1 conducts and current flows through load resistor R_L.During negative half cycle, diode D2 becomes forward biased and D1 reverse biased. Now, D2 conducts and current flows through the load resistor R_L in the same direction. There is a continuous current flow through the load resistor R_L, during boththe half cycles and will get unidirectional current as show in the model graph. The difference between full wave and half wave rectification is that a full wave rectifier allows unidirectional (one way) current to the load during the entire 360 degrees of the input signal and half-wave rectifier allows this only during one half cycle (180 degree).

CIRCUIT DIAGRAM:

A)FULL WAVE RECTIFIER WITHOUT FILTER:



B)FULL WAVE RECTIFIER WITH FILTER:



PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Connect the ac mains to the primary side of the transformer and the secondaryside to the rectifier.
3. Measure the ac voltage at the input side of the rectifier.
4. Measure both ac and dc voltages at the output side the rectifier.
5. Find the theoretical value of the dc voltage by using the formula Vdc=2Vm/Π
6. Connect the filter capacitor across the load resistor and measure the values of Vac and Vdc at the output.
7. The theoretical values of Ripple factors with and without capacitor arecalculated.
8. From the values of Vac and Vdc practical values of Ripple factors arecalculated. The practical values are compared with theoretical values.

THEORITICAL CALCULATIONS:

$V_{rms} = V_m/\sqrt{2}$

$V_m = \sqrt{2}\,V_{rms}$

$V_{dc} = 2V_m/\Pi$

(i) **Without filter**: Ripple factor, $r = \sqrt{(V_{rms}/V_{dc})^2 - 1} = 0.812$

(ii) **With filter**:

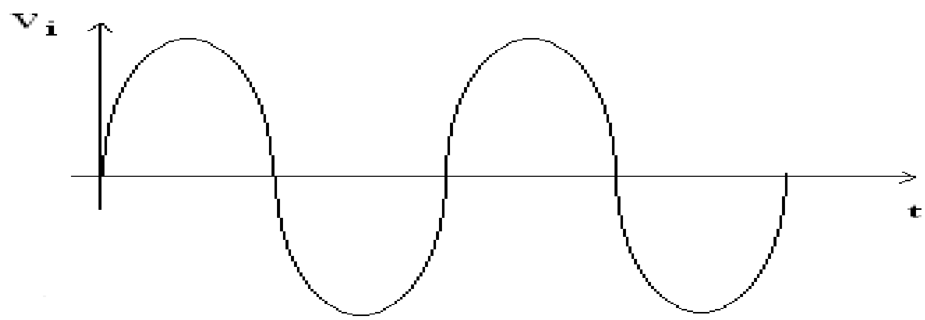
Ripple factor, $r = 1/(4\sqrt{3}\, f C R_L)$

OBSERVATION TABLE

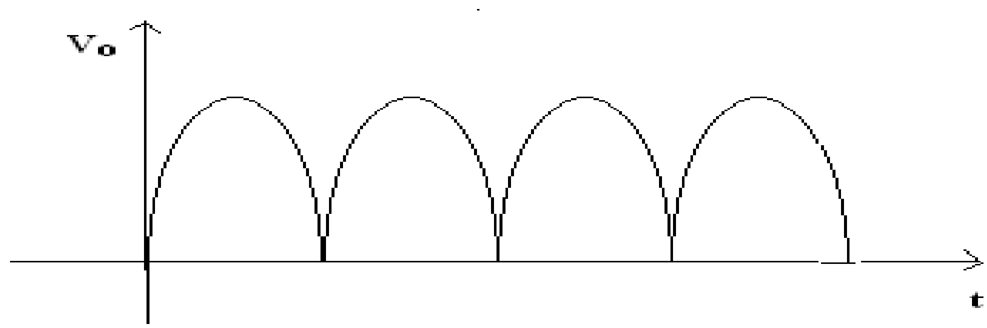
	Vrms	Vdc	Ripple Factor = Vrms/ Vdc
Without Filter			
With Filter C=47µF			
With Filter C=1000µF			

MODEL WAVEFORMS:

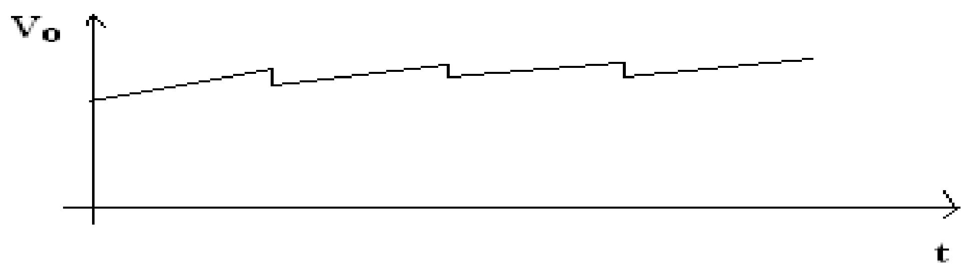
INPUT WAVEFORM



A) OUTPUT WAVEFORM WITHOUT FILTER:



B) OUTPUT WAVEFORM WITHOUT FILTER:



RESULTS:

PRECAUTIONS:

1. The primary and secondary side of the transformer should be carefully identified.
2. The polarities of all the diodes should be carefully identified.

VIVA QUESTIONS:

1. Define peak inverse voltage (PIV)? And write its value for Full-wave rectifier?
2. If one of the diode is changed in its polarities what wave form would you get?
3. Does the process of rectification alter the frequency of the waveform?
4. What is ripple factor of the Full-wave rectifier?

6.Input and Output characteristics of FET in CS Configuration

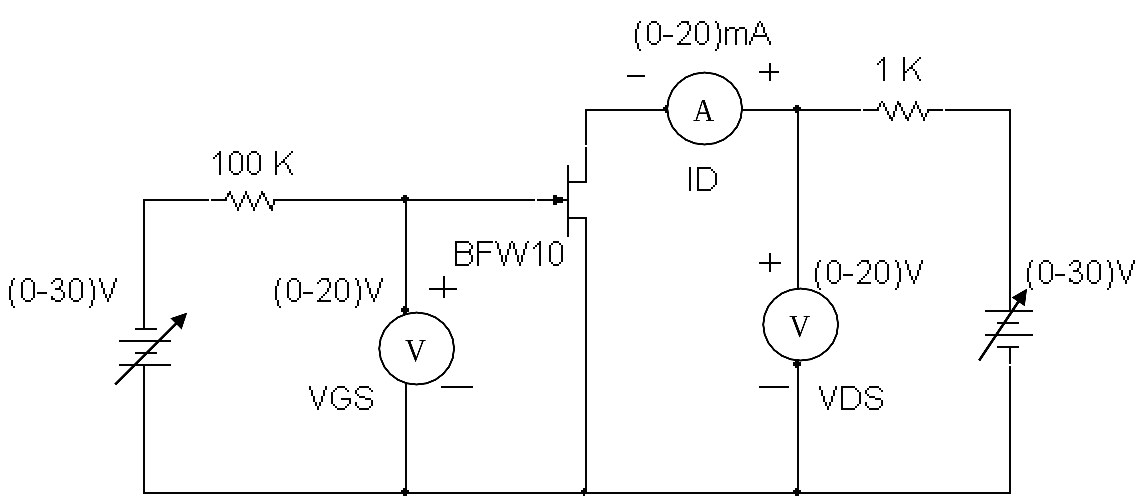
AIM: To plot the Drain and Transfer characteristics of an n-channel FET in CS configuration and determine from the characteristics:

(i) Drain resistance (r_d)
(ii) Amplification Factor (μ)
(iii)Trans Conductance (g_m)

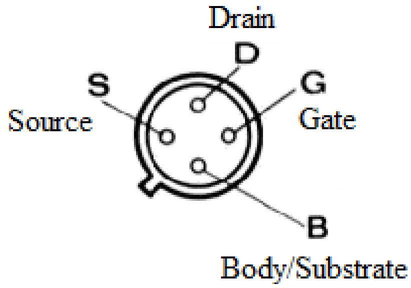
COMPONENTS & EQUIPMENT:

S.No	Description	Quantity
1	D.C Regulated Power supply (0-30)V	1
2	D.C. Voltmeter (0-20) V	2
	D.C. Ammeter (0-20) mA	1
3	Resistor 1 k□.	1
4	Resistor 100K□.	1
5	N-channel JFET BFW10	1
6	Connecting wires	As per requirement

CIRCUIT DIAGRAM:



FET Terminal Identification:



PROCEDURE:

1. Connect the circuit as shown in fig.
2. Keep $V_{GS} = 0V$. Vary the drain voltage (V_{DS}) in step of 0.5v and note the corresponding drain current (I_D)
3. Repeat step 2 for V_{GS}= -1V, -2V.
4. Plot the drain characteristics V_{DS} Vs I_D.
5. To obtain the transfer characteristics, adjust $V_{DS} = 8V$, vary V_{GS} in convenient steps and note the corresponding drain current (I_D).
6. Plot the transfer characteristics V_{GS} Vs I_D for different values of V_{DS}. Indicate the various regions on the graph.

OBSERVATIONS:

Drain characteristics

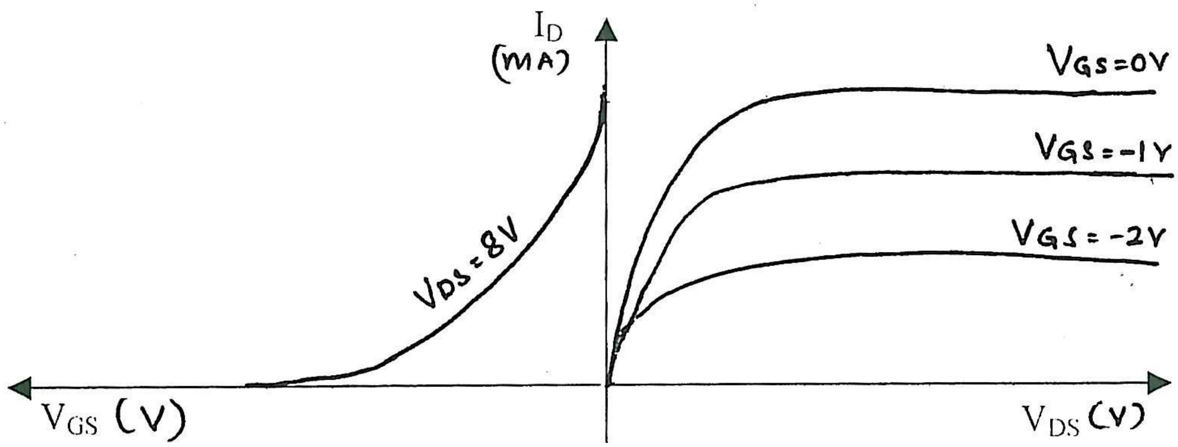
V_{GS} = 0V, -1V, -2V		
S.NO	V_{DS} (v)	I_D (mA)

Transfer characteristics

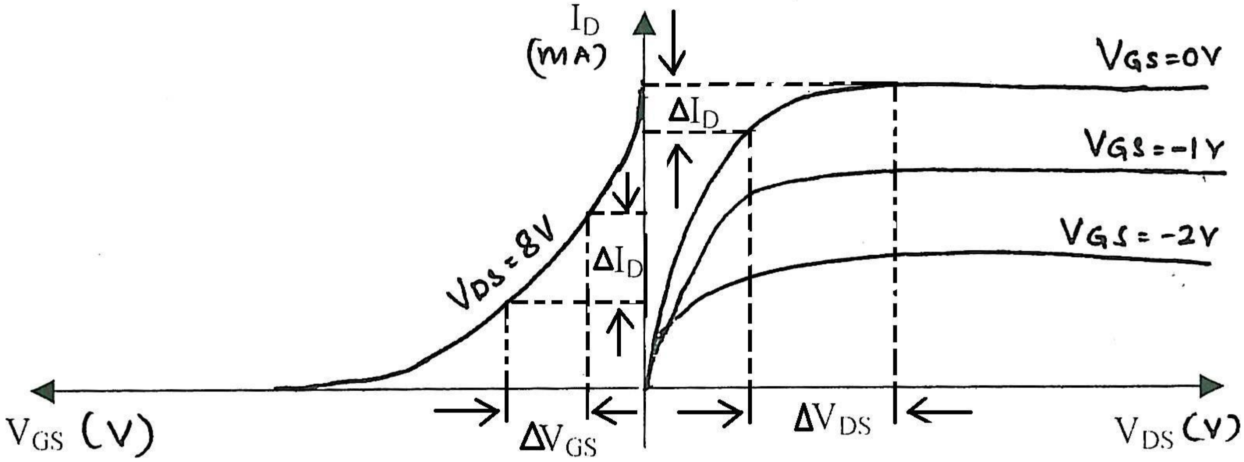
V_{DS} = 8V		
S.NO	V_{GS} (v)	I_D (mA)

EXPECTED GRAPH:

Transfer characteristics **Drain Characteristics**



CALCULATIONS:



From Drain characteristics:

$$\text{Drain resistance } r_d = \frac{\Delta V_{DS}}{\Delta I_D}\bigg|_{V_{GS}} = \text{constant}$$

From Transfer characteristics:

$$\text{Trans Conductance } g_m = \frac{\Delta I_D}{\Delta V_{GS}}\bigg|_{V_{DS}} = \text{constant}$$

Amplification Factor $\mu = \dfrac{\Delta V_{DS}}{\Delta V_{GS}}\bigg|_{I_D} = \text{constant}$ (or) $\mu = r_d \times g_m$

RESULT:

1. Drain resistance (r_d) =
2. Amplification Factor (μ) =
3. Trans Conductance (g_m) =

Precautions:

1. The three terminals of the FET must be carefully identified.
2. Practically FET contains four terminals, which are called Source, Drain, Gate and Substrate
3. Voltage exceeding the ratings of the FET should not be applied.

VIVA QUESTIONS:

1. What is the difference between a JFET and a bipolar transistor?
2. What are the advantages of a FET?
3. Why a FET is called as a unipolar device?
4. What are the applications of JFET?
5. Define Shockley equation.
6. Define Pinch – off voltage?
7. What is a FET?
8. Draw the output characteristics of a JFET and indicate the Pinch- off level?

BEYOND SYLLABUS

VERIFICATION OF OHM'S LAW

Aim:-

To verify the Ohm's law for the given circuit

Theory:-

Ohm's law is the fundamental law of Electrical Engineering. It relates the current flowing through any resistor to the voltage applied to its ends. According to the Law: "The current flowing through a resistor is directly proportional to the voltage applied across its terminals under constant temperature".

Resistance can be calculated by using the formula V = I × R

Where, V = voltage measured in volts (V)

I = current measured in amps (A)

R = resistance measured in ohms (Ω)

Ohms law gives the relationship between voltage, current and resistance. For a metal conductor at a constant temperature the current is directly proportional to the voltage. This means that if the current increases the voltage will also increase in the same proportion. For example: If a cell provides a voltage of 1 volt and the circuit has a resistor of 1 ohm connected to it an ammeter would read 1 amp. If the cell was replaced with a 2 Volt cell the ammeter will read 2 Amps.

The standard metric unit for resistance is the ohm, represented by the Greek letter omega - Ω. An electrical device having a resistance of 5 ohms would be represented as **R = 5 Ω**. The equation representing the dependency of the resistance (**R**) of a cylindrically shaped conductor (e.g., a wire) upon the variables that affect it is

$$R = \rho \frac{L}{A}$$

Where, '**L**' represents the length of the wire (in meters), '**A**' represents the cross-sectional area of the wire (in meters^2), and 'ρ' represents the resistivity of the material (ohm-meter)

Temperature coefficient of resistance is the measure of change in electrical resistance of any material per **degreeCelsius** of temperature change.

$$R = R_{ref}[1 + \alpha(T - T_{ref})]$$

Where

R = the resistance at temperature, T R_{ref} =
the resistance at temperature T_{ref}
α = the temperature coefficient of resistance for the material
T = the material temperature in ° Celsius
T_{ref} = is the reference temperature for which the temperature coefficient is specified.

The temperature coefficient of resistance is normally standardized in relation to a temperature of 20°C. This temperature is typically taken to be normal "room temperature."

Specifications / Technical details of Equipment and instruments:-

a. Equipment:

S.no	Name of the Equipment	Range	Quantity
1	Variable DC Power Supply	30V,2A DC Regulated Power Supply, Dual Channel	1
2	Bread Board Trainer	---	1

b. Instruments:

S.no	Name of the Instrument	Range	Type	Quantity
1	Ammeter	(0-200) mA	Digital	1
2	Resistor	1KΩ	carbon composition	1

Circuit Diagram: -

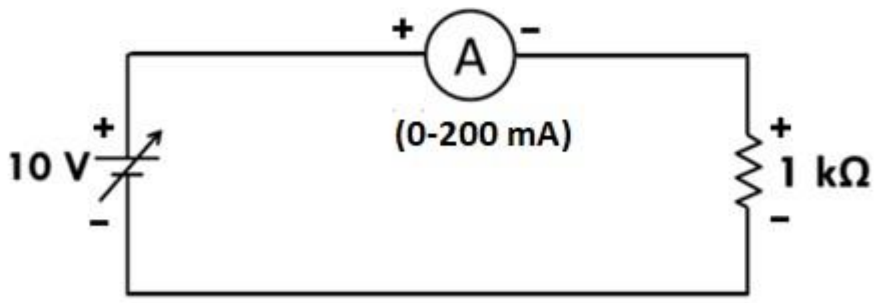


FIG.1 CIRCUIT DIAGRAM FOR VERIFICATION OF OHM'S LAW

Procedure: -

1. Implement the circuit on the breadboard as per circuit diagram.
2. Switch ON the supply and vary the output voltage of Regulated power supply in steps of 2V each (till 20V) and note down the corresponding ammeter reading.
3. Set the output voltage of the Regulated power supply to zero and switch off the supply
4. Plot a graph between voltage versus current.

Observation Tables: -

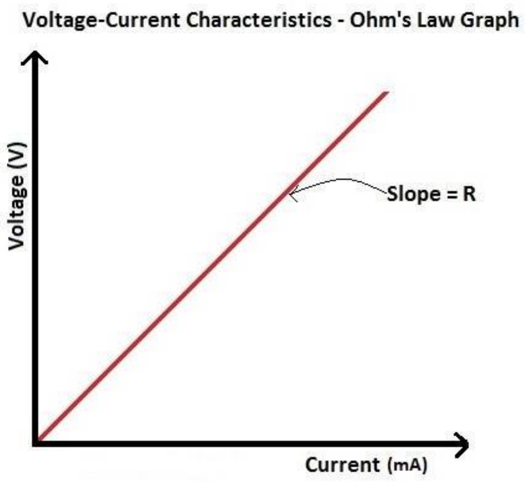
S.No	Voltage(Volts)	Current(mA)
1	2	
2	4	
3	6	
4	8	
5	10	
6	12	
7	14	
8	16	
9	18	
10	20	

Model Calculations: -

Current ‘I’ = Voltage ‘V’/Resistance ‘R’

PLOTS:-

1. Voltage Vs Current



Precautions:

General:

1. There shouldn’t be any loose connections.
2. Keep the RPS in zero volt position before starting the experiment.

Technical:

1. Don’t exceed the rated voltage and rated current while varying the DC Supply.

<u>Result</u>: -

<u>VIVA–VIOCE:</u>

1. What is Ohm' Law. What are the limitations of Ohm's law?
2. What are the linear and non linear elements?
3. How will you differentiate unilateral & bilateral elements?
4. Define temperature coefficient of resistance?
5. Resistance of a conductor is 1.72 Ω at a temperature of 20^0C. Find the resistance at100^0C. Given the coefficient of resistivityα =0.00393 per ^{0}C

BEYOND SYLLABUS

CALCULATIONS AND VERIFICATION OF IMPEDANCE AND CURRENT OF RL, RC AND RLC SERIES CIRCUITS

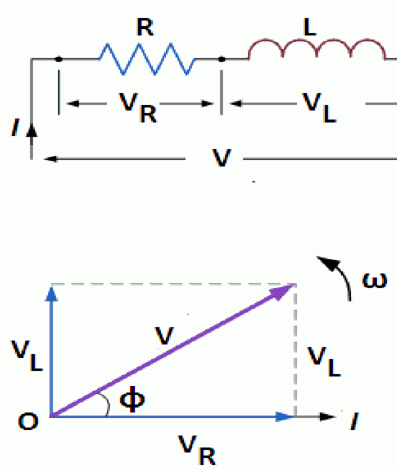
AIM: To verify the Impedance and Current in RL, RC & RLC Series Circuits

APPARATUS REQUIRED:

S.No.	Apparatus	Range	Quantity
01	Resistor	150 ohm	01
02	Inductor	320 mH	01
03	Capacitor	50 micro farad	01
04	AC Power Supply	230 Volts / 5 A	------
05	Connecting Wires	-----	As per Requirement

THEORY:

Series RL circuit



$$V = \sqrt{(IR)^2 + (IX_L)^2}$$

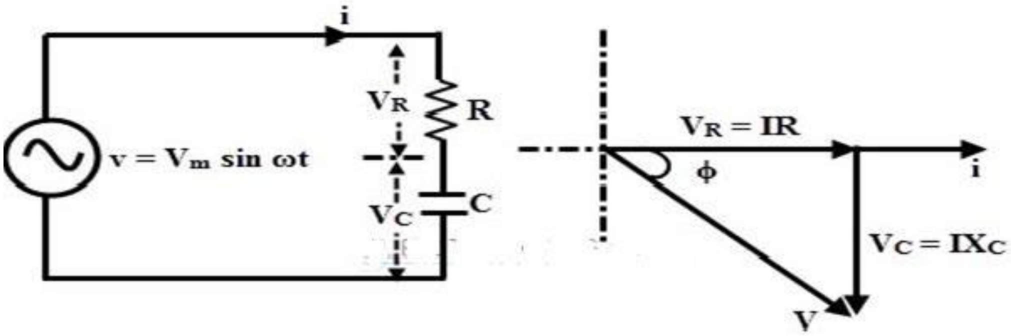
$$I = \frac{V}{\sqrt{(R)^2 + (X_L)^2}} = \frac{V}{Z}$$

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

is called impedance

$\Phi = \tan^{-1}\frac{X_L}{R}$. Power, $P = VI\cos\varphi$

Series RC circuit



$$V_{RC}^2 = V_R^2 + V_C^2$$

so, using the resistance and the capacitive reactance $1/\omega C$:

$$V_{RC}^2 = (IR)^2 + \left(\frac{I}{\omega C}\right)^2$$

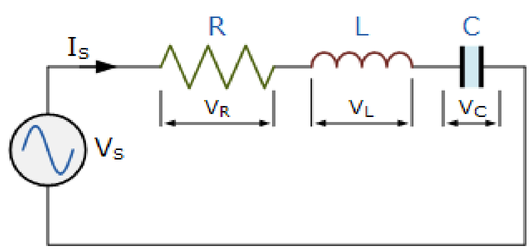
so :

$$V_{RC} = \sqrt{(IR)^2 + \left(\frac{I}{\omega C}\right)^2}$$

$$= I\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$$

Series RLC Circuits:

All three passive components in AC circuits can also be connected together in both series RLC and parallel RLC combinations as shown below.



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

$$Z = \angle\phi = R + jX$$

$$V_S = \sqrt{V_R^2 + (V_L - V_C)^2}$$

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

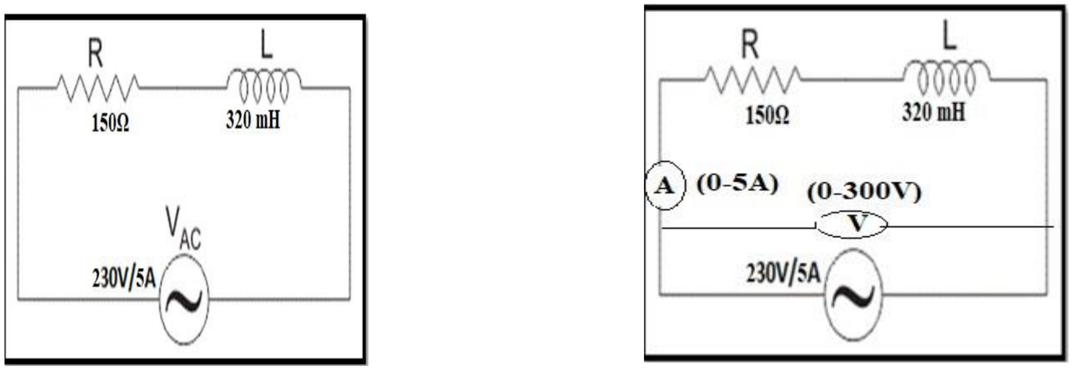
$$\phi = \tan^{-1}\left(\frac{X_L - X_C}{R}\right)$$

$$I_S = I_R = I_L = I_C$$

We have seen above that passive components in AC circuits behave very differently than when connected in a DC circuit due to the influence of frequency (f). In a purely resistive circuit, the current is in-phase with the voltage. In a purely capacitive circuit the current in the capacitor leads the voltage by 90^{o} and in a purely inductive circuit the current lags the voltage by 90^{o}. The opposition to current flow through a passive component in an AC circuit iscalled: resistance 'R' for a resistor, capacitive reactance'X_C'for a capacitor and inductive reactance'X_L'for an inductor. The combination of resistance and reactance is called

Impedance. In a series circuit, the phasor sum of the voltagesacross eachcomponentis equal to the supply voltage V_S. In a parallel circuit, the phasor sum of the currents flowing in each branch is equal to the supply current I_S. For both parallel and series connected RLC circuits, when the resultant current is "in-phase" with the supply voltage the resonance will occurs ($X_L=X_C$). A Series Resonance Circuit isknown as an *AcceptorCircuit*.

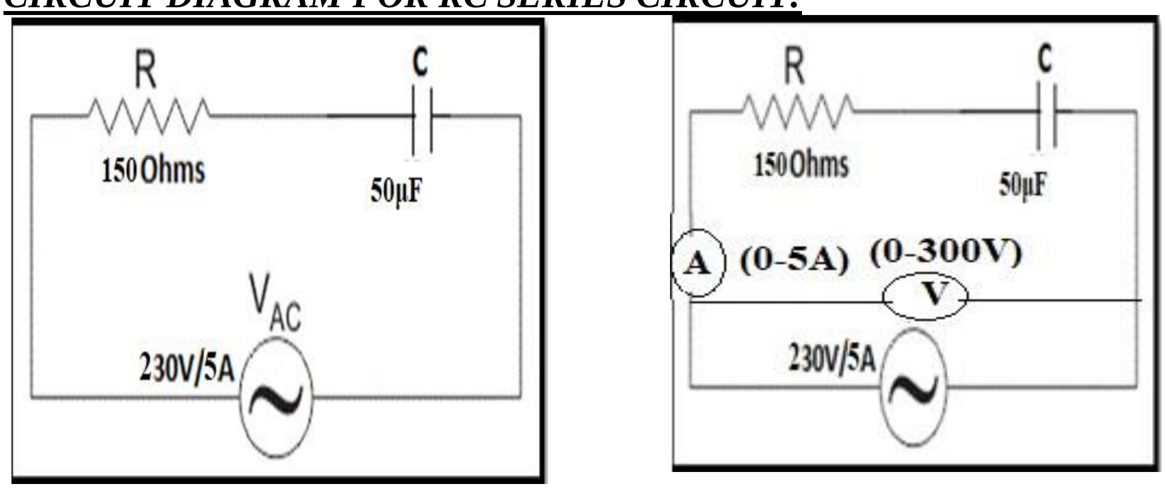
<u>CIRCUIT DIAGRAM FOR RL SERIES CIRCUIT:</u>



THEORETICAL CIRCUIT **PRACTICAL CIRCUIT**

Fig.1: RL SERIES CIRCUIT

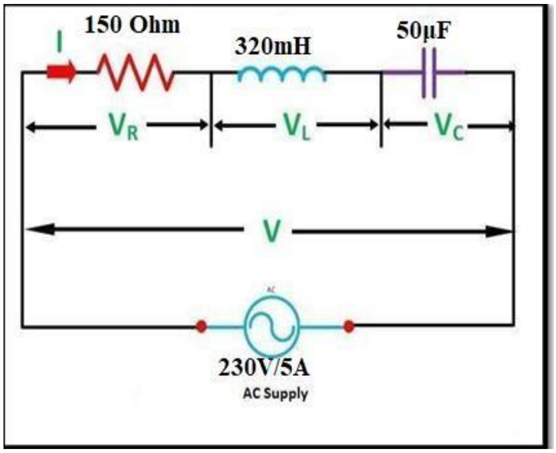
<u>CIRCUIT DIAGRAM FOR RC SERIES CIRCUIT:</u>

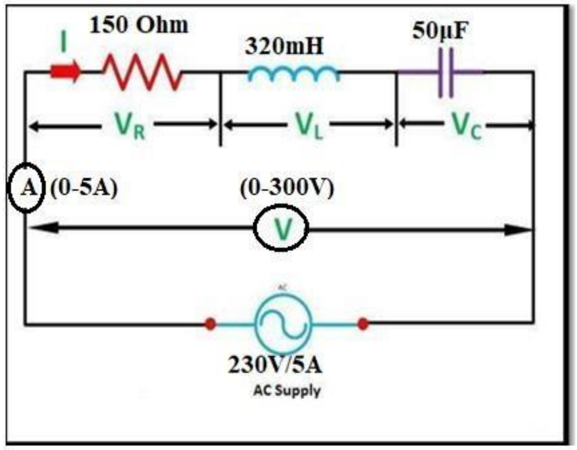


Theoretical Circui **Practical Circuit**

Fig:2 RC SERIES CIRCUIT

CIRCUIT DIAGRAM FOR RLC SERIES CIRCUIT:





Theoretical Circuit **Practical Circuit**

Fig:3 RLC SERIES CIRCUIT

PROCEDURE:

1. Connect the circuit as per the Fig1.
2. Switch on the MCB and smoothly vary the 1ph Variac to apply rated voltage of 230V.
3. Observe voltage and current readings from indicating meters & tabulate the readings.
4. Calculate the Impedance (Z) and Current(I) and compare the theoretical & Practicalvalues
5. Reduce the output voltage of the variac to zero and switch off the MCB and Disconnect the circuit.
6. Connect the circuit as per the Fig 2.
7. Switch on the MCB and smoothly vary the 1ph Variac to apply rated voltage of 230V.
8. Observe voltage and current readings from indicating meters & tabulate the readings.
9. Calculate the Impedance (Z) and Current(I) and compare the theoretical & Practicalvalues
10. Reduce the output voltage of the variac to zero and switch off the MCB and Disconnect the circuit.
11. Connect the circuit as per the Fig 3.
12. Switch on the MCB and smoothly vary the 1ph Variac to apply rated voltage of 230V.
13. Observe voltage and current readings from indicating meters & tabulate the readings.
14. Calculate the Impedance (Z) and Current(I) and compare the theoretical & Practicalvalues
15. Reduce the output voltage of the variac to zero and switch off the MCB and Disconnect the circuit.

MODEL CALCULATIONS:

- Inductive reactance : $X_L = 2\pi f L = \omega L$
- Capacitive reactance : $X_C = \dfrac{1}{2\pi f C} = \dfrac{1}{\omega C}$
- When $X_L > X_C$ the circuit is Inductive
- When $X_C > X_L$ the circuit is Capacitive
- Total circuit reactance = $X_T = X_L - X_C$ or $X_C - X_L$
- Total circuit impedance = $Z = \sqrt{R^2 + X_T^2} = R + jX$

OBSERVATION TABLE:

Series Circuit	V (Applied) In Volt	I (Theoretical) In Ampere	I (Practical) In Ampere	Z (Theoretical) In ohm	Z (Practical) In ohm
RL Circuit					
RC Circuit					
RLC Circuit					

RESULT:

VIVA–VIOCE:

1. What is meant by power factor of a circuit?
2. What do you understand by active and reactive components of current?
3. What is the effect of frequency on inductive and capacitive reactance?
4. Explain i) resistance ii) reactance iii) impedance
5. what is the phase relationship between the supply voltage and current flowing in the following circuits i) purely resistance circuit ,ii)purely inductive circuit & iii) purely capacitive circuit?