



# **MARRI LAXMAN REDDY** **INSTITUTE OF TECHNOLOGY AND MANAGEMENT**

(AN AUTONOMOUS INSTITUTION)

(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)

Accredited by NBA and NAAC with 'A' Grade & Recognized Under Section 2(f) & 12(B) of the UGC act, 1956

## **DEPARTMENT MECHANICAL ENGINEERING**

### **BASIC ELECTRICAL AND ELECTRONIC ENGINEERING LAB MANUAL**



<b>SUBJECT NAME</b>	<b>Basic Electrical and Electronic Engineering Lab</b>
<b>SUBJECT CODE</b>	<b>2030272</b>
<b>COURSE-BRANCH</b>	<b>B. Tech - Mechanical Engineering</b>
<b>YEAR-SEMESTER</b>	<b>II - I</b>
<b>ACADEMIC YEAR</b>	<b>2021-2022</b>
<b>REGULATION</b>	<b>MLRS-R20</b>

# **MARRI LAXAMAN REDDY**

## **INSTITUTE OF TECHNOLOGY AND MANAGEMENT**

## **MISSION AND VISION OF THE INSTITUTE:**

### **Our Vision:**

To establish as an ideal academic institutions in the service of the nation the world and the humanity by graduating talented engineers to be ethically strong globally competent by conducting high quality research, developing breakthrough technologies and disseminating and preserving technical knowledge.

### **Our Mission:**

To fulfill the promised vision through the following strategic characteristics and aspirations:

- Contemporary and rigorous educational experiences that develop the engineers and managers;
- An atmosphere that facilitates personal commitment to the educational success of students in an environment that values diversity and community;
- Prudent and accountable resource management;
- Undergraduate programs that integrate global awareness, communication skills and team building across the curriculum;
- Leadership and service to meet society's needs;
- Education and research partnerships with colleges, universities, and industries to graduate education and training that prepares students for interdisciplinary engineering research and advanced problem solving;
- Highly successful alumni who contribute to the profession in the global society.

## **Vision and Mission statements of the Department of Mechanical Engineering:**

### **Vision Statement:**

“The Mechanical Engineering Department strives immense success in the field of education, research and development by nurturing the budding minds of young engineers inventing sets of new designs and new products which may be envisaged as the modalities to bring about a green future for humanity”

### **Mission Statement:**

1. Equipping the students with manifold technical knowledge to make them efficient and independent thinkers and designers in national and international arena.
2. Encouraging students and faculties to be creative and to develop analytical abilities and efficiency in applying theories into practice, to develop and disseminate new knowledge.

3. Pursuing collaborative work in research and development organizations, industrial enterprises, Research and academic institutions of national and international, to introduce new knowledge and methods in engineering teaching and research in order to orient young minds towards industrial development.

#### **PROGRAM EDUCATIONAL OBJECTIVE**

**PEO 1:** Graduates shall have knowledge and skills to succeed as Mechanical engineer's for their career development.

**PEO 2:** Graduates will explore in research.

**PEO 3:** Mechanical Graduates shall have the ability to design products with various interdisciplinary skills

**PEO 4:** Graduates will serve the society with their professional skills

## **PROGRAM OUTCOMES**

- A.** Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization for the solution of complex engineering problems.
- B.** Problem Analysis: Identify, formulate, research, review the available literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural science and engineering sciences.
- C.** Design and development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specific needs with appropriate considerations for public health safety and cultural, societal and environmental considerations.
- D.** Conduct investigations of complex problems: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.
- E.** Modern tool usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including predictions and modeling to complex engineering activities with an understanding of the limitations.
- F.** The Engineer and society: Apply reasoning, informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practices.
- G.** Environment and sustainability: Understand the impact of the professional engineering solutions in society and environmental context and demonstrate the knowledge of and need for sustainable development.
- H.** Ethics: Apply ethical principles and commitment to professional ethics, responsibilities and norms of the engineering practice.
- I.** Individual and team work: Function effectively as an individual and as a member or leader in diverse teams and in multi disciplinary settings.
- J.** Communication: Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend, write effective reports, design documentation, make effective presentations, give and receive clear instructions.
- K.** Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- L.** Life – long learning: Recognize the need and have the preparation, ability to engage in independent and life – long learning in the broadest context of technological change.

## **PROGRAMME SPECIFIC OUTCOMES:**

**PS01:** Students acquire necessary technical skills in mechanical engineering that make them employable graduate.

**PSO2:** An ability to impart technological inputs towards development of society by becoming an entrepreneur.

**COURSE OBJECTIVES:**

1. To understand the basic principles of fluid mechanics.
2. To identify various types of flows.
3. To understand boundary layer concepts and flow through pipes.
4. To evaluate the performance of hydraulic turbines.
5. To understand the functioning and characteristic curves of pumps.

**COURSE OUTCOMES:**

- |          |   |
|----------|---|
| ME 272.1 | To analyze and solve electrical circuits using network laws and theorems. |
| ME 272.2 | To understand and analyze basic Electric and Magnetic circuits.           |
| ME 272.3 | To study the working principles of Electrical Machines.                   |
| ME 272.4 | To introduce components of Low Voltage Electrical Installations.          |
| ME 272.5 | To identify and characterize diodes.                                      |
| ME 272.6 | To identify and characterize various types of transistors.                |

## INSTRUCTIONS TO THE STUDENTS

1. Every student should obtain a copy of the laboratory manual
2. It is important that all students arrive at each session on time.
3. Dress code: Students must come to the laboratory wearing:
  - Trousers.
  - half-sleeve tops.
  - Leather shoes.
  - Half pants, loosely hanging garments and slippers are not allowed.
4. Students should come with thorough preparation for the experiment to be conducted.
5. Students will not be permitted to attend the laboratory unless they bring the practical record fully completed in all respects pertaining to the experiment conducted in the previous class.
6. Experiment should be started only after the staff-in-charge has checked the experimental setup.
7. All the calculations should be made in the observation book. Specimen calculations for one set of readings have to be shown in the practical record.
8. Wherever graphs are to be drawn, A-4 size graphs only should be used and the same should be firmly attached to the practical record.
9. Practical record and observation should be neatly maintained.
10. They should obtain the signature of the staff-in-charge in the observation book after completing each experiment.
11. Theory regarding each experiment should be written in the practical record before procedure in your own words.

## **LABORATORY SAFETY PRECAUTIONS**

1. Laboratory uniform, shoes & safety glasses are compulsory in the lab.
2. Do not touch anything with which you are not completely familiar. Carelessness may not only break the valuable equipment in the lab but may also cause serious injury to you and others in the lab.
3. Please follow instructions precisely as instructed by your supervisor. Do not start the experiment unless your setup is verified & approved by your supervisor.
4. Do not leave the experiments unattended while in progress.
5. Do not crowd around the equipment's & run inside the laboratory.
6. During experiments material may fail and disperse, please wear safety glasses and maintain a safe distance from the experiment.
7. If any part of the equipment fails while being used, report it immediately to your supervisor. Never try to fix the problem yourself because you could further damage the equipment and harm yourself and others in the lab.
8. Keep the work area clear of all materials except those needed for your work and cleanup after your work.

## **LIST OF EXPERIMENTS/DEMONSTRATIONS:**

### **PART A: ELECTRICAL**

1. Verification of KVL and KCL
2. (i) Measurement of Voltage, Current and Real Power in primary and Secondary Circuits of a Single-Phase Transformer  
  
(ii) Verification of Relationship between Voltages and Currents (Star-Delta, Delta-Delta, Delta- star, Star-Star) in a Three Phase Transformer
3. Measurement of Active and Reactive Power in a balanced Three-phase circuit
4. Performance Characteristics of a Separately Excited 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-meters (ii) Function Generator (iii) Regulated Power Supplies (iv)CRO.
2. PN Junction diode characteristics
3. Zener diode characteristics and Zener as voltage Regulator
4. Input & Output characteristics of Transistor in CB / CE configuration
5. Full Wave Rectifier with & without filters
6. Input and Output characteristics of FET in CSconfiguration



## LIST OF EXPERIMENTS/DEMONSTRATIONS:

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# Basic Electrical Engineering Lab

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## **EXPERIMENT NO: 1**

### **VERIFICATION OF KVL AND KCL**

**AIM:** To verify Kirchhoff's Voltage Law and Kirchhoff's Current Law theoretically and practically.

#### **APPARATUS:**

S.No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-20) V	Digital	4
2	Ammeter	(0-200) mA	Digital	3
3	Regulated power supply	(0-15) V	Dual	1
4	Multimeter	-----	Digital	1
5	Kit Board	-----	-----	1
6	Resistors	1k $\Omega$	Fixed	3
7	Connecting wires	As required		

#### **THEORY:**

We saw in the Resistors tutorial that a single equivalent resistance, ( $R_T$ ) can be found when two or more resistors are connected together in either series or parallel or combinations of both, and that these circuits obey Ohm's Law.

However, sometimes in complex circuits such as bridge or T networks, we cannot simply use Ohm's Law alone to find the voltages or currents circulating within the circuit. For these types of calculations we need certain rules which allow us to obtain the circuit equations and for this we can use Kirchhoff's Circuit Law.

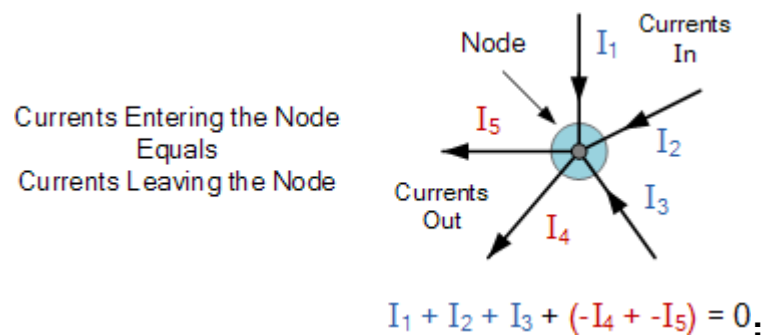
In 1845, a German physicist, Gustav Kirchhoff developed a pair or set of rules or laws which deal with the conservation of current and energy within electrical circuits. These two rules are commonly known as: Kirchhoff's Circuit Laws with one of Kirchhoff's laws dealing with the current flowing around a closed circuit, Kirchhoff's Current Law, (KCL) while the other law deals with the voltage sources present in a closed circuit, Kirchhoff's Voltage Law, (KVL).

This law is also called Kirchhoff's point rule, Kirchhoff's junction rule (or nodal rule), and Kirchhoff's first rule. It states that, "In any network of conductors, the algebraic sum of currents meeting at a point (or junction) is zero".

### 1. Kirchhoff's First Law – The Current Law, (KCL)

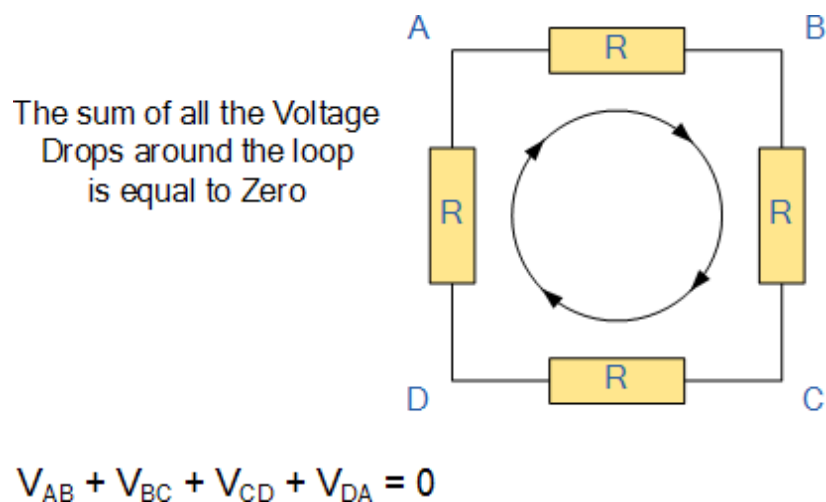
Kirchhoff's Current Law or KCL, states that the “total current or charge entering a junction or node is exactly equal to the charge leaving the node as it has no other place to go except to leave, as no charge is lost within the node”. In other words the algebraic sum of ALL the currents entering and leaving a node must be equal to zero,  $I(\text{exiting}) + I(\text{entering}) = 0$ . This idea by Kirchhoff is commonly known as the **Conservation of Charge**.

#### Kirchhoff's Current Law

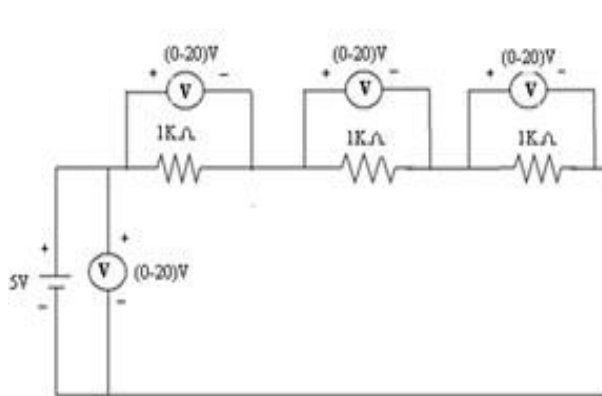


### 2. Kirchhoff's Second Law – The Voltage Law, (KVL)

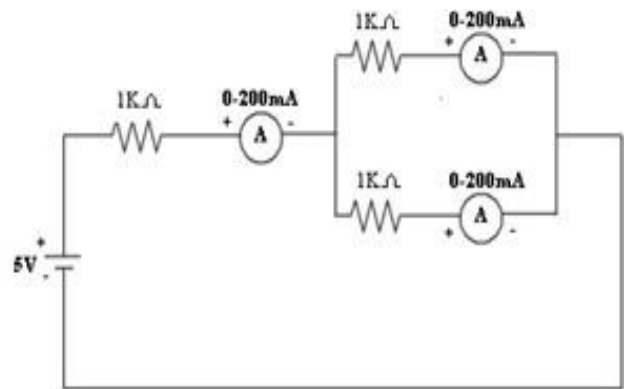
Kirchhoff's Voltage Law or KVL, states that “in any closed loop network, the total voltage around the loop is equal to the sum of all the voltage drops within the same loop” which is also equal to zero. In other words the algebraic sum of all voltages within the loop must be equal to zero. This idea by Kirchhoff is known as the **Conservation of Energy**.



## **CIRCUIT DIAGRAM:**



**(a) Circuit diagram for KVL**



**(b) Circuit diagram for KCL**

## **PROCEDURE:**

- 1) To verify KVL, Connections are made as shown in the Fig-(a)
- 2) Supply is given to the circuit and the readings of the voltmeters are noted down.
- 3) Kirchhoff's Voltage law can be verified by  $V_s = V_1 + V_2 + V_3$  (v).
- 4) To verify KCL, Connections are made as shown in the Fig-(b)
- 5) Supply is given to the circuit and the readings of the Ammeters are noted down.
- 6) Kirchhoff's Current law can be verified by  $I = I_1 + I_2$  (A).

## **OBSERVATION TABLE:**

Kirchhoff's Voltage Law						Kirchhoff's Current law			
	$V_s(V)$	$V_1(V)$	$V_2(V)$	$V_3(V)$	$V_1 + V_2 + V_3(V)$	$I(A)$	$I_1(A)$	$I_2(A)$	$I_1 + I_2(A)$
Theoretical Values									
Practical Values									

## **PRECAUTIONS:**

1. Loose connections are to be avoided.
2. Readings should be taken carefully without parallax error.

## **RESULT:**

### **APPLICATIONS:**

1. Kirchhoff's Laws are applications of two fundamental conservation laws: the Law of Conservation of Energy, and the Law of Conservation of Charge.
2. 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.
3. After that Kirchhoff Voltage law is applied, each possible loop in the circuit generates algebraic equation for every loop.

### **VIVA QUESTIONS:**

1. What is the statement of KVL?
2. What is the statement of KCL?
3. What is the statement of Ohm's law?
4. Give the limitations of Kirchhoff's laws?
5. What is the Condition of Ohm's law?
6. Please Define Ohm's Law for A.C (Alternating Current)?
7. What is Voltage Divider Rule?
8. What is Current Divider Rule (CDR)?
9. Differentiate between Kirchhoff's First law and Kirchhoff's Second law?
10. What is the function of Capacitor in Electrical Circuits?
11. Why Inductors are installed in electrical Circuits?
12. Briefly explain the purpose of Inductor in an electric circuit?
13. What do you mean by dependent and independent voltage sources?
14. Differentiate between ideal and non-ideal voltage sources?
15. What does the term "Voltage Regulation" means?
16. What is DC Current source? Differentiate between ideal and non ideal current sources?
17. What is the difference between power and energy?
18. Define steady state?
19. Initial conditions of capacitors?
20. Explain how an inductor and capacitors behaves when AC&DC are given?
21. Initial conditions of inductance?
22. What is the difference between Voltage Divider Rule and current divider rule?

23. What is the function of an inductor in electrical circuits?
24. What is dependent voltage source?
25. What is independent voltage source?
26. On what bases KCL is based on?
27. Kirchhoff's current law is applied at?
28. Kirchhoff's voltage law is based on?
29. Which law can be best suited for the analysis of circuit with more number of loops?
30. Mathematically KVL can written as?
31. What is an ideal current source?
32. How can a current source will be practically represented?
33. How can a voltage source will be practically represented?
34. What is a constant voltage source?
35. With some initial change at  $t=0+$ , a capacitor will act as?
36. Potential difference in electrical terminology is known as?
37. Why inductors are installed in electrical Circuits?
38. What is an ideal voltage soure?
39. What is a non ideal voltage source?
40. What is meant by a power?
41. What is meant by current?
42. What is meant by a energy?
43. What is the difference between power and energy?
44. What is Kirchhoff's second law?
45. How to calculate energy stored in an inductance?
46. How could you measure voltage in series?
47. What is the difference between inductor and capacitor?
48. Could you measure current in parallel?
49. What is the difference between voltages or potential difference?
50. How to calculate energy stored in capacitance?

### **EXPERIMENT NO: 2(i)**

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

**AIM:** To determine the parameters of Voltage, current and power on primary and secondary of a given single phase transformer

### **APPARATUS:**

S.No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-300)V	M.I	1
2	Voltmeter	(0-150)V	M.I	1
3	Ammeter	(0-2)A	M.I	1
4	Ammeter	(0-20)A	M.I	1
5	Wattmeter	(0-150)V/(0-2.5)A	LPF	1
6	Wattmeter	(0-150)V/(0-10)A	UPF	1
7	Connecting wires	As required		

### **TRANSFORMER SPECIFICATIONS:**

Transformer Rating :(inKVA) \_\_\_\_\_

### **Winding Details:**

LV (inVolts): \_\_\_\_\_

L.V.side current:\_\_\_\_\_

HV (in Volts): \_\_\_\_\_

HV side Current: \_\_\_\_\_

Type (Shell/Core):\_\_\_\_\_

### **AUTO TRANSFORMER SPECIFICATIONS:**

Input Voltage (in Volts):\_\_\_\_\_

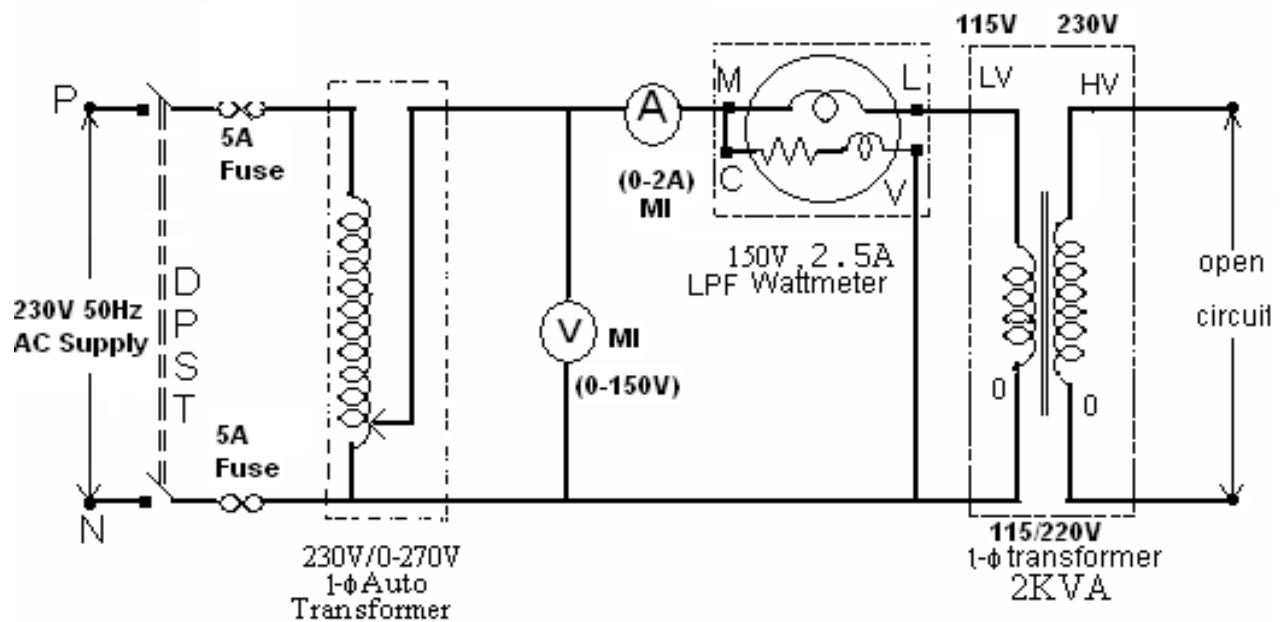
Output Voltage (in Volts): \_\_\_\_\_

Frequency (in Hz):\_\_\_\_\_

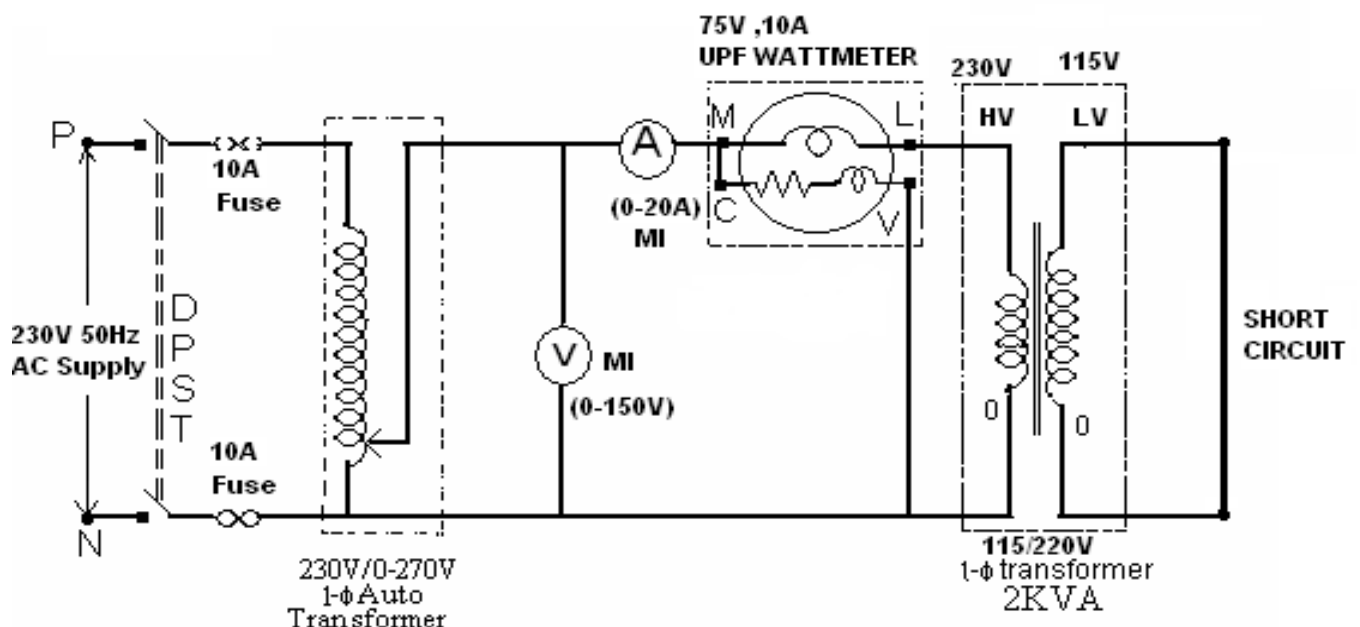
Current rating (in Amp):\_\_\_\_\_

## CIRCUIT DIAGRAM:

### OPEN CIRCUIT:



### SHORT CIRCUIT:





### **PROCEDURE:**

#### **OPEN CIRCUIT TEST:**

1. Connections are made as per the circuit diagram.
2. Ensure that variac is set to zero output voltage position before starting the experiment
3. Switch ON the supply. Now apply the rated voltage to the Primary winding by using Variac
4. The readings of the Voltmeter, ammeter and wattmeter are noted down in Tabular form.
5. Then Variac is set to zero output position and switch OFF the supply.
6. Calculate  $R_0$  and  $X_0$  from the readings.

#### **SHORT CIRCUIT TEST:**

1. Connections are made as per the circuit diagram.
2. Ensure that variac is set to zero output voltage position before starting the experiment.
3. Switch ON the supply. Now apply the rated Current to the Primary winding by using Variac
4. The readings of the Voltmeter, ammeter and wattmeter are noted down in Tabular form.
5. Then Variac is set to zero output position and switch OFF the supply.
6. Calculate  $R_{01}$  and  $X_{01}$  from the readings.

### **OBSERVATION TABLE:**

#### **For O.C.TEST**

S.No	Voltmeter Reading( $V_{oc}$ )	Ammeter Reading( $I_o$ )	Wattmeter Reading( $W_{oc}$ )	$R_0$	$X_0$

#### **For S.C.TEST**

S.No	Voltmeter Reading( $V_{sc}$ )	Ammeter Reading( $I_{sc}$ )	Wattmeter Reading( $W_{sc}$ )	$R_{01}$	$X_{01}$	$Z_{01}$

### **PRECAUTIONS:**

1. Connections must be made tight.
2. Before making or breaking the circuit, supply must be switched off.

### **RESULT:**

### **APPLICATIONS:**

1. Step-down localized power distribution.
2. Television sets to regulate voltage.
3. Low voltage electronic devices.
4. Step-up power in home inverters.
5. Non-urban areas where electrical demand is lower.
6. Commercial and residential lighting and heating equipment.

### **VIVA QUESTIONS:**

1. Explain the regulation of a transformer.
2. What is the condition for maximum efficiency of a transformer?
3. Explain all day efficiency and commercial efficiency of a transformer.
4. What are the various losses of a transformer?
5. What is oil immersed type transformer?
6. What are step up transformers?
7. What are step down transformers?
8. What are isolation transformers?
9. Why stepped cores are used?
10. What is yoke section of transformers?
11. What is the purpose of laminating the core in a transformer?
12. What is the purpose of laminating the core in a transformer?
13. Why the cross-section of iron is less than total cross section area of Core?
14. What is stack factor?
15. What are the properties of ideal transformer?
16. What are the functions of no-load current of a transformer?

17. What is the condition for zero voltage regulation?
18. What is the condition for maximum voltage regulation?
19. What are the factors affecting voltage regulation?
20. What is eddy current loss in transformer?
21. The main purpose of using core in transformer is to
22. Transformer works on the principle of?
23. If dc voltage is applied to the primary of a transformer it may?
24. Which of the following will improve the mutual coupling between primary and secondary of a transformer?
25. Which type of core is used for a high-frequency transformer?
26. Transformer oil used in transformer provides
27. Enamel layer is coated over the lamination of a transformer core to
28. In a transformer, the oil must be free from
29. In a transformer, the magnetic coupling between the primary and secondary circuit can be increased by
30. If the density in the core of a transformer is increased
31. The power factor in a transformer
32. which of the following transformer will be largest is size?
33. A transformer transforms
34. A transformer does not change the following
35. In a transformer, the magnitude of the mutual flux is?
36. Thickness of laminations of trans-former core is usually of the order of
37. The size of transformer core depends on
38. In power transformers, breather is used to
39. In a transformer, conservator consists of
40. In a transformer, the resistance between its primary and secondary should be
41. Which is minimized by laminating the core of a transformer?
42. Transformer windings are tapped in the middle because?
43. Which of the following materials is used to absorb moisture from air entering the transformer?
44. Which of the following acts as a protection against high voltage surges due to lightening and switching?
45. A tap changer is used on a transformer for?

- 46. Over currents in a transformer affect?
- 47. Highest rating transformers are likely to find application in?
- 48. Transformer ratings are usually expressed in terms of
- 49. The noise in transformer due to vibration of laminations set by magnetic forces, is called?
- 50. The maximum load that a power transformer can carry is limited by its

### **EXPERIMENT NO: 2(ii)**

### **THREE PHASE TRANSFORMER: VERIFICATION OF RELATIONSHIP BETWEEN VOLTAGES AND CURRENTS (STAR-DELTA, DELTA-DELTA, DELTA-STAR, STAR-STAR)**

#### **AIM:**

To study the balanced three phase system for star & delta connected load.

#### **APPARATUS:**

S.No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-600)V	M.I	1
2	Ammeter	(0-10)A	M.I	1
3	Wattmeter	(0-600)V/(0-10)A	LPF	1
4	3- $\Phi$ Autotransformer	415V/(0-470)V	Core	1
5	Resistive Load	415V,10A	Resistive	1
6	Connecting wires	As required		

#### **TRANSFORMER SPECIFICATIONS:**

Transformer Rating :( inKVA) \_\_\_\_\_

#### **Winding Details (For Y-connected Transformer):**

LV (inVolts): \_ \_ \_ \_ \_

L.V.side current:\_ \_ \_ \_ \_

HV (in Volts): \_ \_ \_ \_ \_

HV side Current: \_ \_ \_ \_ \_

Type (Shell/Core):\_ \_ \_ \_ \_

#### **Winding Details (For $\Delta$ -connected Transformer):**

LV (inVolts): \_ \_ \_ \_ \_

L.V.side current:\_ \_ \_ \_ \_

HV (in Volts): \_ \_ \_ \_ \_

HV side Current: \_ \_ \_ \_ \_

Type (Shell/Core):\_ \_ \_ \_ \_

### **AUTO TRANSFORMER SPECIFICATIONS:**

Input Voltage (in Volts):\_\_\_\_\_

Output Voltage (in Volts): \_\_\_\_\_

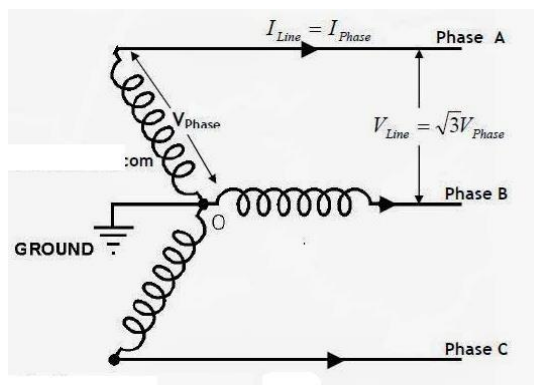
Frequency (in Hz):\_\_\_\_\_

Current rating (in Amp):\_\_\_ \_\_\_\_\_

### **THEORY:**

1. Star Connection (Y) System is also known as Three Phase Four Wire System (3-Phase 4 Wire) and it is the most preferred system for AC power distribution while for transmission, Delta connection is generally used.

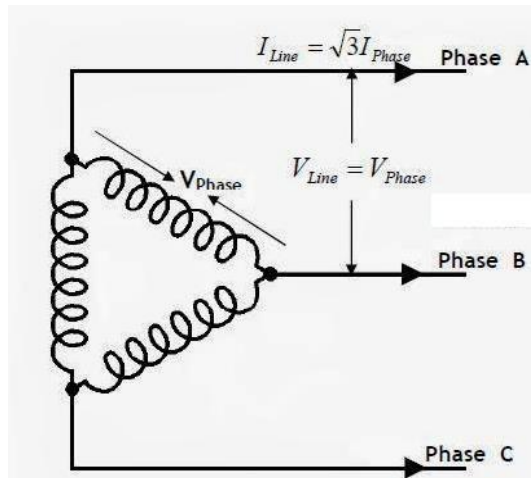
In Star (also denoted by Y) system of interconnection, the starting ends or finishing ends (similar ends) of three coils are connected together to form the neutral point. or Star Connection is obtained by connecting together similar ends of the three coils, either “Starting” or “Finishing”. The other ends are joined to the line wires. The common point is called the neutral or Star Point, which is represented by N. (As shown in fig 1)



In Star Connection  $V_L = \sqrt{3} V_{Ph}$  and  $I_L = I_{Ph}$

2. Delta or Mesh Connection ( $\Delta$ ) System is also known as Three Phase Three Wire System (3-Phase 3 Wire) and it is the most preferred system for AC power transmission while for distribution, Star connection is generally used.

In Delta (also denoted by  $\Delta$ ) system of interconnection, the starting ends of the three phases or coils are connected to the finishing ends of the coil. Or the starting end of the first coil is connected to the finishing end of the second coil and so on (for all three coils) and it looks like a closed mesh or circuit as shown in fig.



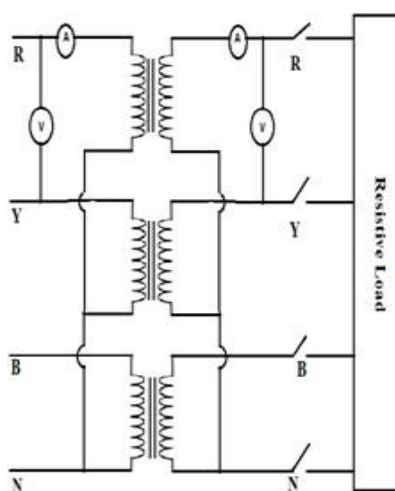
In more clear words, all three coils are connected in series to form a close mesh or circuit. Three wires are taken out from three junctions and the all outgoing currents from junction assumed to be positive.

In Delta connection, the three windings interconnection looks like a short circuit, but this is not true, if the system is balanced, then the value of the algebraic sum of all voltages around the mesh is zero in Delta connection.

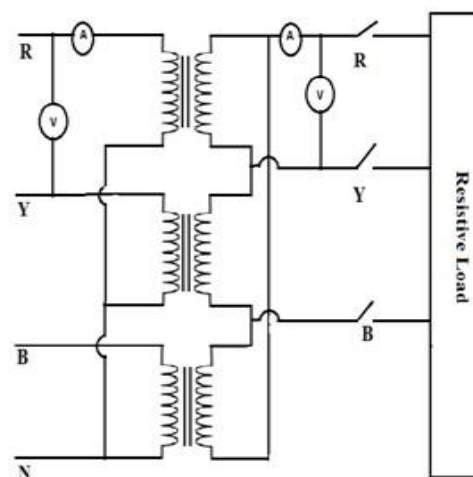
When a terminal is open in  $\Delta$ , then there is no chance of flowing currents with basic frequency around the closed mesh.

In Delta connection, the Line Voltage is equal to the Phase Voltage, i.e  $V_L = V_{ph}$  and  $I_L = \sqrt{3}I_{ph}$

### **CIRCUIT DIAGRAM:**



Star-Star Connection of Transformer



Star-Delta Connection of Transformer

**PROCEDURE:**

1. Connect circuit as shown in the circuit diagram.
2. Set Variac to minimum position.
3. Switch on the main supply.
4. Note the readings of ammeter, voltmeter.
5. Note more readings by changing supply voltage.

**OBSERVATION TABLE:**

S.No	Connection	Star Connection					Delta Connection				
		$V_L$	$V_{ph}$	$I_L$	$I_{ph}$	Real Power $\sqrt{3}V_L I_L \cos\Phi$	$V_L$	$V_{ph}$	$I_L$	$I_{ph}$	Real Power $\sqrt{3}V_L I_L \cos\Phi$
1	$Y - Y$										
2	$Y - \Delta$										
3	$\Delta - Y$										
4	$\Delta - \Delta$										

**MODEL CALCULATION:****FORMULAE:**

Line voltage  $V_L =$

Line current  $I_L =$

Phase voltage  $V_{ph} =$

Phase current  $I_{ph}$

Real power (P) =  $\sqrt{3}V_L I_L \cos\Phi$

**PRECAUTIONS:**

1. Ensure the minimum position of three phase autotransformer during power on and off.
2. Set the ammeter pointer at zero position.
3. Take the readings without parallax error.
4. Avoid loose connections.

**RESULT:**



### **APPLICATIONS:**

#### **1. Star-Star Connection of three phase transformer:**

1. This Type of Transformer is rarely used due to problems with unbalanced loads.
2. It is economical for small high voltage transformers as the number of turns per phase and the amount of insulation required is less.

#### **2. Star-Delta Connection of three phase transformer:**

1. It is commonly employed for power supply transformers.
2. This type of connection is commonly employed at the substation end of the transmission line. The main use with this connection is to step down the voltage. The neutral available on the primary side is grounded. It can be seen that there is phase difference of  $30^\circ$  between primary and secondary line voltages.
3. Commonly used in a step-down transformer, Y connection on the HV side reduces insulation costs the neutral point on the HV side can be grounded, stable with respect to unbalanced loads. As for example, at the end of a transmission line. The neutral of the primary winding is earthed. In this system, line voltage ratio is  $1/\sqrt{3}$  Times of transformer turn-ratio and secondary voltage lags behind primary voltage by  $30^\circ$ . Also third harmonic currents flow in the to give a sinusoidal flux.

#### **3. Delta - Star Connection of three phase transformer:**

1. Commonly used in a step-up transformer: As for example, at the beginning of a HT transmission line. In this case neutral point is stable and will not float in case of unbalanced loading. There is no distortion of flux because existence of a  $\Delta$  - connection allows a path for the third-harmonic components. The line voltage ratio is  $\sqrt{3}$  times of transformer turn-ratio and the secondary voltage leads the primary one by  $30^\circ$ . In recent years, this arrangement has become very popular for distribution system as it provides 3-  $\emptyset$ , 4-wire system.
2. Commonly used in commercial, industrial, and high-density residential locations: To supply three-phase distribution systems. An example would be a distribution transformer with a delta primary, running on three 11kV phases with no neutral or earth required, and a star (or wye) secondary providing a 3-

phase supply at 400 V, with the domestic voltage of 230 available between each phase and an earthed neutral point.

3. Used as Generator Transformer: The  $\Delta$ -Y transformer connection is used universally for connecting generators to transmission systems because of two very important reasons. First of all, generators are usually equipped with sensitive ground fault relay protection. The  $\Delta$ -Y transformer is a source of ground currents for loads and faults on the transmission system, yet the generator ground fault protection is completely isolated from ground currents on the primary side of the transformer. Second, rotating machines can literally be.

#### **4. Delta - Delta Connection of three phase transformer:**

1. Suitable for large, low voltage transformers.
2. This Type of Connection is normally uncommon but used in some industrial facilities to reduce impact of SLG faults on the primary system
3. It is generally used in systems where it need to be carry large currents on low voltages and especially when continuity of service is to be maintained even though one of the phases develops fault.

#### **VIVA QUESTIONS:**

1. What is the power factor of a transformer at no load?
2. What is the normal phase difference between the voltage and the no-load current in a transformer?
3. What are the essential parts of a transformer?
4. What is the name of the winding to which supply is given?
5. What is the name of the winding from which the supply is taken for load connections?
6. Which material is used for the core of a transformer and why?
7. What is the use of iron core in a transformer?
8. How is magnetic leakage reduced?
9. Why iron cores of transformers are laminated?
10. What determines the thickness of the lamination or stamping?
11. Why are the laminations insulated from each other?
12. What is stacking factor? What is its approximate value?
13. What is called grain-oriented laminations?
14. What is the permissible maximum flux density in transformer core?

15. What is the phase relationship between the primary and secondary voltages of a transformer?
16. What is turn ratio of a transformer?
17. What is voltage ratio of a transformer?
18. What current flows in the transformer primary when it's secondary is open?
19. What is the formula for calculating no-load current?
20. Why is the frequency not changed during transformation of electrical energy in a transformer?
21. What is the emf equation of a transformer?
22. What are the two basic types of transformers?
23. What are the types of transformers according to the arrangement of iron cores?
24. What magnetic circuit is formed in Berry-type constructions and why?
25. What is called limb of a transformer?
26. Why are LT windings placed near the core?
27. What are the types of windings according to the construction?
28. What is the difference between cylindrical-type and sandwich-type winding?
29. What are the types of transformers?
30. What do you mean by step-up transformers?
31. What is an ideal transformer?
32. What do you mean by power transformer?
33. What do you mean by distribution transformers?
34. What do you mean by lighting transformer?
35. How does a transformer contribute towards the widespread popularity of AC system over DC?
36. The required thickness of lamination in a transformer decreases when
37. Oil in transformers is used to -
38. What is the principle of operation of a Transformer?
39. What is the function of a Transformer?
40. What are the different types of a Transformer?
41. What are the different parts of a Transformer?
42. What are the different types of measuring instruments?
43. What is the principle of operation of a Transformer?

- 44. What is meant by efficiency?
- 45. What is the purpose of Auto transformer (or Dimmer stat)?
- 46. Define regulation?
- 47. What do you mean by step-down transformers?

### **EXPERIMENT NO: 4**

#### **BRAKE TEST ON DC SHUNT MOTOR**

#### **AIM:**

To determine the efficiency of a DC shunt motor by conducting brake test.

#### **NAME PLATE DETAILS:**

S. No	Parameter	DC Motor
1	Voltage	
2	Current	
3	Speed	
4	Power rating	
5	Exciting Voltage	
6	Exciting Current	
7	Winding	

#### **APPARATUS:**

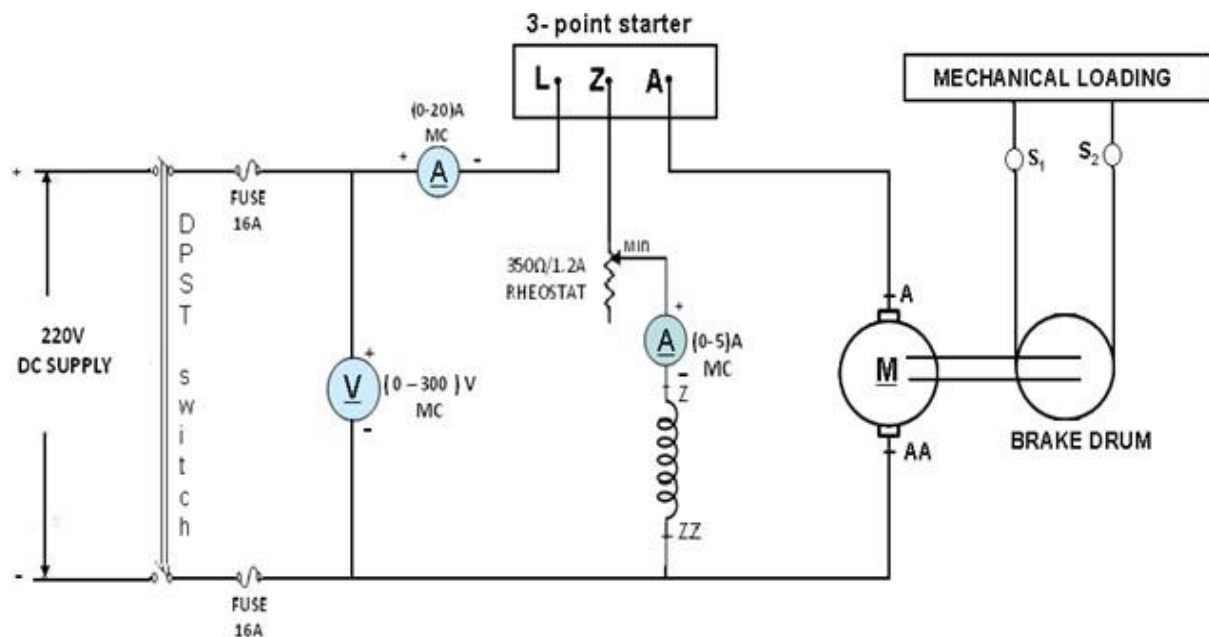
S.No.	Name of the Equipment	Range	Type	Quantity
1	Ammeter	(0 -20 ) A	MC	1
2	Ammeter	(0 -5 ) A	MC	1
3	Voltmeter	(0 -300 ) V	MC	1
4	Rheostat	350Ω/ 1.2A	WW	2
5	Tachometer	(0 -9999 )rpm	Digital	1
8	Connecting wires	As required		

#### **THEORY:**

It is a direct method and consists of applying a brake to a water cooled pulley mounted on the motor shaft. The brake band is fixed with the help of wooden blocks gripping the pulley. One end of the band is fixed to earth via a spring balance S and the other is connected to a suspended weight W. The motor is running and the load on the motor is adjusted till it carries its full load current.

The simple brake test can be used for small motors only, because in the case of large motors, it is difficult to dissipate the large amount of heat generated at the brake.

### CIRCUIT DIAGRAM:



### PROCEDURE:

1. Connections are made as shown in Fig.
2. The rheostat in the motor field is kept in the minimum position and the tensions  $S_1$  and  $S_2$  are in zero position.
3. Rated voltage is applied by closing the DPST switch and the motor is started with the help of 3-point starter and brought to rated speed by adjusting its field rheostat.
4. No - load readings of voltmeter and ammeters are noted down.
5. By gradually applying the load using the brake drum, the readings of voltmeter, ammeters, Speed, tensions  $S_1$  and  $S_2$  of spring balances are noted down at every load.
6. The graph between
  - (a) Output & Speed
  - (b) Output & Efficiency
  - (c) Output & Torque
  - (d) Output & Armature currentare plotted.

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### **OBSERVATION TABLE:**

S. No	V <sub>L</sub> (V)	I <sub>L</sub> (A)	I <sub>F</sub> (A)	I <sub>A</sub> (A)	Speed (rpm)	S <sub>1</sub> (Kg)	S <sub>2</sub> (Kg)	Torque (N-m)	Input (W) V x I	Output (W)= 2MNT/60	Efficiency Output/Input

### **MODEL CALCULATION:**

#### **FORMULAE:**

Torque  $T = 9.81 \cdot (S_1 - S_2) \cdot R$  N-m

Output  $= 2MNT / 60$

Input  $= V \cdot I_L$

Efficiency  $= \text{Output} / \text{Input}$

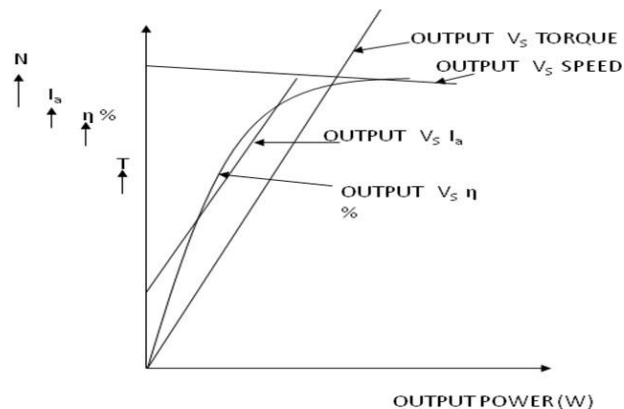
Radius of the brake drum  $= R$  in mts

Spring balance readings  $= S_1$  and  $S_2$  in kgs

#### **PRECAUTIONS:**

1. Loose connections are to be avoided.
2. The rheostat in the motor field circuit is kept in minimum position.
3. Tensions are checked for zero position.
4. Readings should be taken without any parallax errors.

### **MODEL GRAPH:**



### **RESULT:**

### **APPLICATIONS:**

DC shunt motor is also called as constant speed motor.

In other words, if we assume that the supply voltage is constant then flux also becomes constant. At the rated speed the back emf also becomes nearly constant if the load is same.

The various applications of DC shunt motor are in

1. Lathe Machines,
2. Centrifugal Pumps,
3. Fans,
4. Blowers,
5. Conveyors,
6. Lifts,
7. Weaving Machine,
8. Spinning machines, etc.

### **VIVA QUESTIONS:**

1. What are the methods for finding the efficiency?
2. What are the basic requirements to conduct the load test?
3. Compare the load characteristics for different types of DC motors.
4. If two motors are required to drive a common load, how will they share the total load?



- 5.What are the different types of a DC Motor?
- 6.What is the purpose of a three point starter?
- 7.What is field flashing?
8. Why do we use starter for dc machine?
9. What are the different losses in dc machine?
10. Drawbacks of Brake test?
- 11.What is meant by torque? or Define torque.
12. How can we reduce the eddy current loss in the electrical machine?
- 13.In DC generators, the series field winding has low resistance while the shunt field winding has high resistance. Why?
- 14.Why series motor cannot be started on no-load?
- 15.Which type of motor is used in trains, what is the rating of supply used?
- 16.What is magnetic circuit?
- 17.Define magnetic flux?
- 18.Define magnetic flux density?
- 19.Define magneto motive force?
- 20.Define reluctance?
- 21.What is retentivity?
- 22.Define permeance?
- 23.Define magnetic flux intensity?
- 24.Define permeability?
- 25.Define relative permeability?
- 26.What is mean by leakage flux?
- 27.What is leakage coefficient?
- 28.State faradays law of electromagnetic induction
- 29.State Lenz law?
- 30.Define self inductance?
- 31.Define mutual inductance?
- 32.Define coefficient coupling?
- 33.Give the expression for hysteresis loss and eddy current loss?
- 34.What is dynamically induced emf?
- 35.What is fringing effect?
- 36.What is statically induced emf?

- 37. How eddy current losses are minimized?
- 38. What are the magnetic losses?
- 39. Types of induced emf?
- 40. What is the significance of winding factor?
- 41. Write the energy balance equation for motor?

### **EXPERIMENT NO: 5**

#### **BRAKE TEST ON 3- $\Phi$ INDUCTION MOTOR**

##### **AIM:**

To conduct a brake test on the given 3- $\Phi$  Slip ring Induction motor and to draw its performance characteristics.

##### **NAME PLATE DETAILS:**

S. No	Parameter	3- $\Phi$ INDUCTION MOTOR
1	Voltage	
2	Current	
3	Speed	
4	Power rating	

##### **APPARATUS:**

S.No.	Name of the Equipment	Range	Type	Quantity
1	Ammeter	(0 -20 ) A	MI	1
2	Voltmeter	(0 -600 ) V	MI	1
3	Wattmeter	600V/10A	UPF	2
4	Tachometer	(0 -9999 )rpm	Digital	1
5	Connecting wires	As required		

##### **THEORY:**

As a general rule, conversion of electrical energy to mechanical energy takes place in to the rotating part on electrical motor. In DC motors, electrical power is conduct directly to the armature, i.e, rotating part through brushes and commutator. Hence, in this sense, a DC motor can be called as 'conduction motor'.

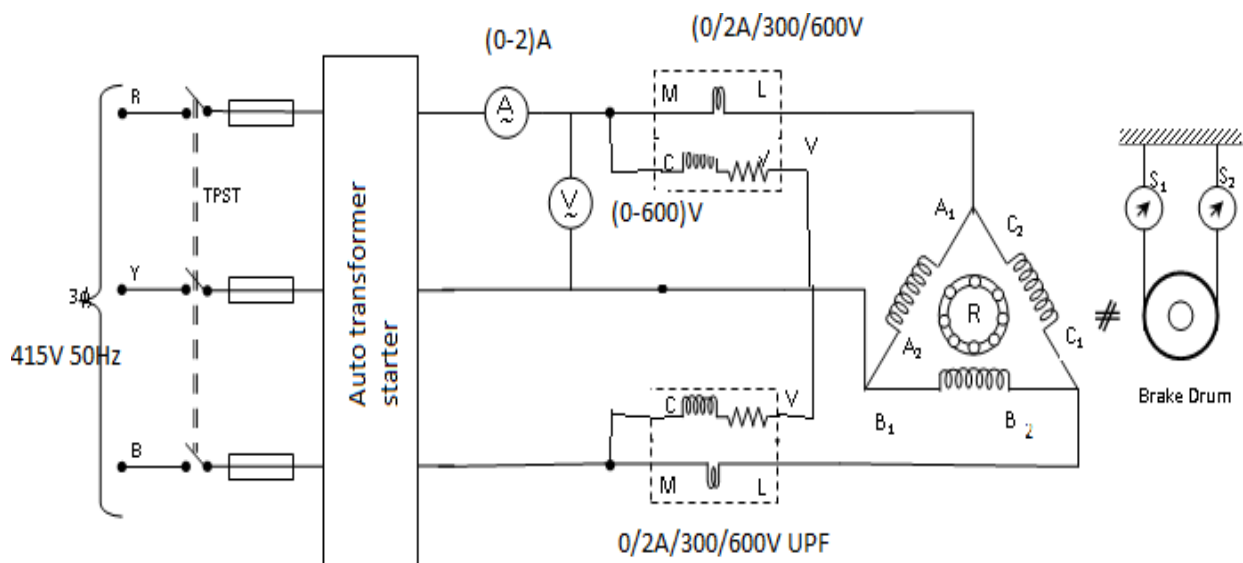
However, in AC motors, rotor does not receive power by conduction but by induction in exactly the same way as secondary of a two winding T/F receives its power from the primary. So, these motors are known as Induction motors. In fact an induction motor can be taken as rotating T/F, i.e, one in which primary winding is stationary and but the secondary is free. The starting torque of the Induction motor can be increase by improving its p.f by adding external resistance in the rotor circuit from the stator connected rheostat, the rheostat resistance being progressively cut out as the motor gathers speed.

Addition of external resistance increases the rotor impedance and so reduces the rotor current. At first, the effect of improved p.f pre dominates the

current-decreasing effect of impedance. So, starting torque is increased. At time of starting, external resistance is kept at maximum resistance position and after a certain time, the effect of increased impedance pre dominates the effect of improved p.f and so the torque starts decreasing.

By this during running period the rotor resistance being progressively cut-out as the motor attains its speed. In this way, it is possible to get good starting torque as well as good running torque.

### **CIRCUIT DIAGRAM:**



### **PROCEDURE:**

1. Connections are made as per the circuit diagram.
2. The TPST switch is closed and the motor is started using auto transformer starter to run at rated voltage
3. At no load the speed, current, voltage and power are noted.
4. By applying the load, for various values of current the above-mentioned readings are noted.
5. The load is later released and the motor is switched off and the graph is drawn.

## Basic Electrical Engineering Lab

### **OBSERVATION TABLE:**

S. No	V <sub>L</sub> (V)	I <sub>L</sub> (A)	Speed (rpm)	S <sub>1</sub> (Kg)	S <sub>2</sub> (Kg)	Torque (N-m)	Input (W) W <sub>1</sub> +W <sub>2</sub>	Output (W)= 2MNT/60	Efficiency Output/Input

### **MODEL CALCULATION:**

#### **FORMULAE:**

Torque                      T    =   9.81\*(S<sub>1</sub>-S<sub>2</sub>)\*R      N-m

Output                                = 2MNT / 60

Input                                    = W<sub>1</sub>+W<sub>2</sub>

Efficiency                            = Output /Input

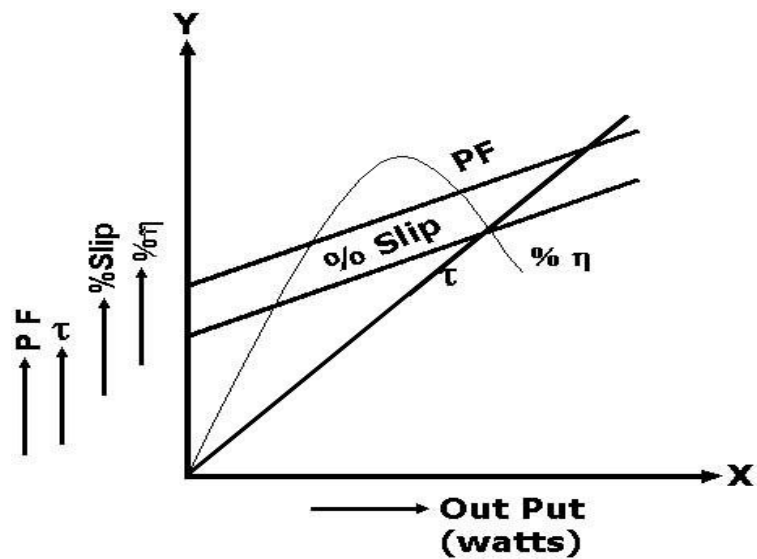
Radius of the brake drum        = R in mts

Spring balance readings         = S<sub>1</sub> and S<sub>2</sub> in kgs

#### **PRECAUTIONS:**

1. Loose connections are to be avoided.
- 2.The rheostat in the motor field circuit is kept in minimum position.
- 3.Tensions are checked for zero position.
4. Readings should be taken without any parallax errors.

### MODEL GRAPH:



### RESULT:

### APPLICATIONS:

#### 1. Applications of Polyphase Wound Rotor Induction Motors

1. Wound rotor motors are suitable for loads requiring high starting torque and where a lower starting current is required.
2. The Wound rotor induction motors are also used for loads having high inertia, which results in higher energy losses.
3. Used for the loads which require a gradual buildup of torque.
4. Used for the loads that require speed control.
5. The wound rotor induction motors are used in conveyors, cranes, pumps, elevators and compressors.
6. The maximum torque is above 200 percent of the full load value while the full load slip may be as low as 3 percent. The efficiency is about 90 %.

### 2. Applications of Polyphase Cage Rotor Induction Motors

Many polyphase cage induction motors are available in the market to meet the demand of the several industrial applications and various starting and running condition requirement. They are classified according to the Class.

#### **Class A Motors**

Class A motors have normal starting torque, high starting current and low operating slip (0.005-0.015). The design has low resistance single cage rotor. The efficiency of the motor is high at full load. Applications of Class A motors are fans, blowers, centrifugal pumps, etc.

#### **Class B Motors**

Class B motors have normal starting torque, low starting current and low starting current and low operating slip. The motor is designed, in such a way to withstand the high leakage reactance; as a result, the starting current is reduced. The starting torque is maintained by use of a double cage or deep bar rotor.

The Class B motors are most commonly used motor and used for full voltage starting. The applications and the starting torque are same as that of Class A motors.

#### **Class C Motors**

The class C motors have high starting torque and low starting current. Such motors are of the double cage and deep bar and has higher rotor resistance. The loads are compressors, conveyors, reciprocating pumps, crushers, etc.

#### **Class D Motors**

Class D motors have the highest starting torque as compared to all the other class of motors. The bars of the rotor cage are made up of brass. These types of motors have low starting current and high operating slip. The value of full load operating slip varies between 8 to 15%. Thus, the efficiency of the motor is low.

These motors are suitable for driving intermittent loads which require frequent acceleration and high loads. For example – punch presses, bulldozers and die stamping machines. When the motor is driving the high impact loads, it is coupled to a flywheel to provide kinetic energy.

### **VIVA QUESTIONS:**

1. What is a cogging torque?
2. What is an armature?
3. What is commutator?
4. What is a rotor?
5. How an induction motor is started? why the starter is used?
6. What is the difference between dc motors and the induction motors?
7. What techniques is used to produce a desired speed?
8. How many types of rotor are there?
9. How many types of induction motor?
10. What is the slip?
11. Why the speed of the physical rotor and the speed of the rotating magnetic field in the stator must be different?
12. Why stator windings are arranged around the rotor?
13. What is the basic difference between synchronous motor and an induction motor?
14. Why an induction motor sometimes called rotating transformer?
15. How to supply power to rotor?
16. Name the two windings of a single-phase induction motor.
17. What is the use of shading ring in a pole motor?
18. Why is the efficiency of a 3-phase induction motor less than of a transformer?
19. What are the types of starters?
20. State the advantages of capacitor start run motor over capacitor start motor.
21. Explain why single-phase induction motor is not self-starting one.
22. What kind of motor is used in mixie?
23. State the application of an induction generator?
24. How can varying supply frequency control speed?
25. How is speed control achieved by changing the number of stator poles?
26. Define-Slip frequency
27. What is the application of shaded pole induction motor?
28. What is Universal motor?
29. What are types of 3- phase induction motor?
30. Why the rotor slots of a 3-phase induction motor are skewed?



31. Why the induction motor is called asynchronous motor?
32. What are slip rings?
33. What is the general working principle of Induction motor?
34. What are the various methods of measuring slip?
35. What is the general working principle of Induction motor?
36. What is the advantage of skewed stator slots in the rotor of Induction motors?
37. What are the various methods of speed control in three phase induction motors?
38. What is meant by crawling in the induction motor?
39. Why an Induction Motor sometimes called Rotating transformer?
40. What is the basic difference between Synchronous motor and an Induction Motor?
41. What is the slip?
42. What is a Rotor Speed?
43. What is a Stator?
44. Give the conditions for maximum torque for 3-phase induction motor?
45. What is reason for inserting additional resistance in rotor circuit of a slip ring induction motor?
46. List out the methods of speed control of cage type 3-phase induction motor?
47. Mention different types of speed control of slip ring induction motor?
48. What are the advantages of 3-phase induction motor?
49. What does crawling of induction motor mean?

### **EXPERIMENT NO: 6**

#### **NO LOAD TEST ON 3-PHASE ALTERNATOR**

#### **AIM:**

To find no-load parameters of 3-phase alternator Voltage and Current.

#### **NAME PLATE DETAILS:**

S. No	Parameter	DC Motor	3-phase alternator
1	Voltage		
2	Current		
3	Speed		
4	Power rating		
5	Exciting Voltage		
6	Exciting Current		
7	Winding		

#### **APPARATUS:**

S.No.	Name of the Equipment	Range	Type	Quantity
1	Ammeter	(0 -10 ) A	MI	1
2	Ammeter	(0-5)A	MC	1
3	Voltmeter	(0 -600 ) V	MI	1
4	Rheostat	400 $\Omega$ /1.7A	WW	1
5	Rheostat	145 $\Omega$ /1.7A	WW	1
6	Tachometer	(0 -9999 )rpm	Digital	1
7	Connecting wires	As required		

#### **THEORY:**

The regulation of Alternator is defined as “the rise in terminal voltage” when full load is removed divided by rated terminal voltage with speed and excitation of alternator remaining unchanged. The experiment involves the determination of the following characteristics and parameters:

1. The open -circuit characteristic (the O.C.C).
2. The short-circuit characteristic (the S.C.C).
3. The effective resistance of the armature winding ( $R_a$ ).

The open circuit and short circuit characteristics of a 3- $\Phi$  alternator is plotted on Per phase basis. To find out the synchronous impedance from these characteristics, open circuit voltage, ( $E_0$ ) and short circuit current ( $I_{sc}$ )

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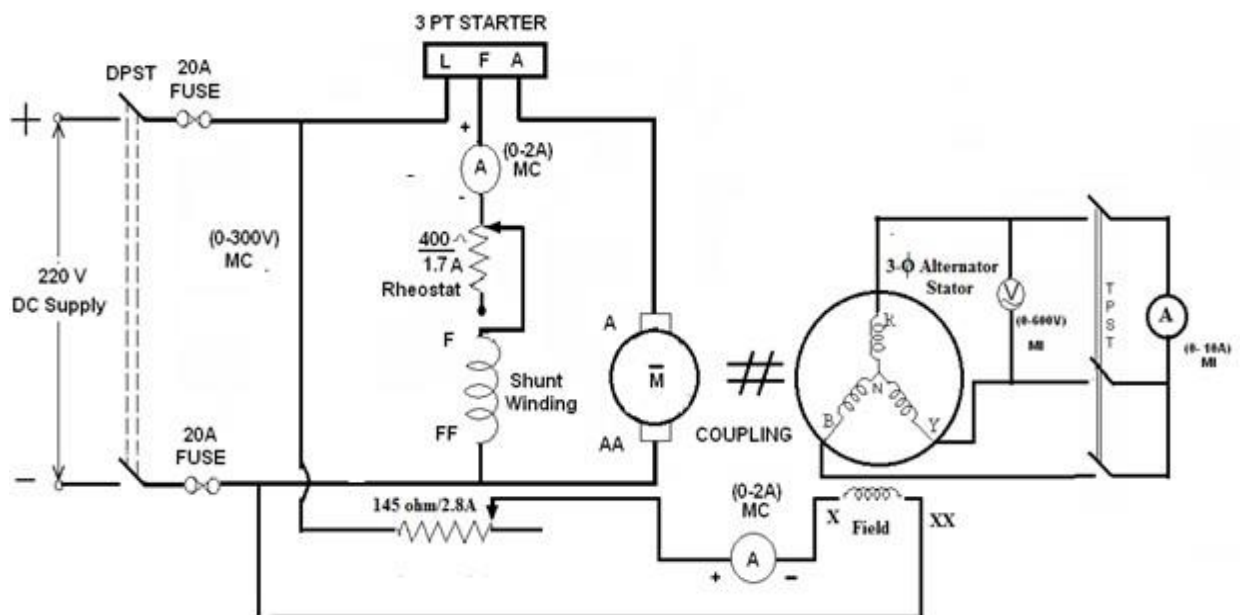
corresponding to a particular value of field current is obtained. Then, synchronous impedance per phase ( $Z_s$ ) is given by  $-Z_s = \frac{E_0}{I_{sc}}$

At higher values of field current, saturation occurs and the synchronous Impedance of the machine decreases. The value of ' $Z_s$ ' calculated for the unsaturated region of the O.C.C is called the unsaturated value of the synchronous impedance. If ' $R_a$ ' is the effective resistance of the armature per phase, the synchronous reactance ' $X_s$ ' is given by  $-X_s = \sqrt{Z_a^2 - R_a^2}$

If ' $V$ ' is the magnitude of the rated voltage of the machine whose regulation is to be calculated for a load current ' $I$ ' at a power factor angle ( $\Phi$ ) then the corresponding magnitude of the open circuit voltage ' $E_0$ ' is given by  $E_0 = V + IZ_s$

Percentage of regulation =  $\frac{(E_0 - V)}{V} \times 100$ .

### CIRCUIT DIAGRAM:



### PROCEDURE:

#### OPEN CIRCUIT TEST:

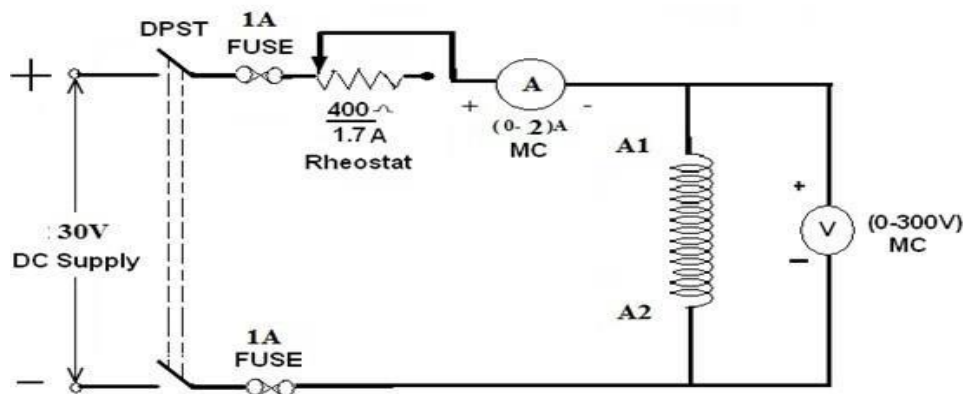
1. Make the connections as per the circuit diagram.
2. Before starting the experiment, the potential divider network in the alternator field circuit is maximum and field regulator rheostat of motor circuit is set minimum resistance position.

3. Switch ON the supply and close the DPST switch. The DC motor is started by moving starter handle.
4. Adjust the field rheostat of DC motor to attain rated speed (equal to synchronous speed of an alternator)
5. By decreasing the field resistance of Alternator, the excitation current of alternator is increased gradually in steps.
6. Note the readings of field current, and its corresponding armature voltage in a tabular column
7. The voltage readings are taken upto and 10% beyond the rated voltage of the machine.

### **SHORT CIRCUIT TEST:**

1. Make the connections as per the circuit diagram.
2. Before starting the experiment, the potential divider network in the alternator field circuit is maximum and field regulator rheostat of motor circuit is set minimum resistance position.
3. Switch ON the supply and close the DPST switch. The DC motor is started by moving starter handle.
4. Close the TPST Switch in the circuit diagram.
5. Adjust the field rheostat of DC motor to attain rated speed (1500 rpm).
6. By decreasing the field resistance of Alternator, the excitation current of alternator is increased gradually in steps.
7. Note the readings of field current, and its corresponding short circuit current in a tabular column.
8. The readings are taken within the limits of alternator current rating.
9. Draw the graph between  $E_o$  vs  $I_f$  and  $I_a$  vs  $I_f$ .

### CONNECTION DIAGRAM TO FIND $R_a$ :



### PROCEDURE TO FIND ARMATURE RESISTANCE OF ALTERNATOR:

1. Connections are made as per the circuit diagram.
2. Switch ON the supply. By varying the rheostat, take different readings of ammeter and voltmeter in a tabular column.
3. From the above readings, average resistance  $R_a$  of armature is found out.

### OBSERVATION TABLE

Sl no.	Armature current I(amp)	Armature voltage $V_a$ (volts)	$R_{dc} = V / I$

### PROCEDURE TO FIND SYNCHRONOUS IMPEDANCE FROM OC AND SC

#### TESTS:

1. Plot open circuit voltage, short circuit current verses field current on a graph sheet.
2. From the graph, the synchronous impedance for the rated value of excitation is calculated.
3. The excitation emf is calculated at full load current which is equal to the terminal voltage at No-load.
4. The voltage regulation is calculated at rated terminal voltage.

### MODEL CALCULATION:

#### FORMULAE:

$$Z_s = V_{oc}/I_{sc} \text{ for the same } I_f \text{ and speed} \quad X_s = \sqrt{Z_s^2 - R_s^2}$$

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$$\text{Generated emf of alternator} = \sqrt{(V_{ph}\cos\Phi + I_a R_a)^2 + (V_{ph}\sin\Phi \pm I_a X_s)^2}$$

+ Sign for lagging power factor loads

- Sign for leading power factor loads

The percentage regulation of alternator for a given p.f. is

$$\% \text{ Reg} = E_0 - V/V$$

Where

$E_0$  – Generated emf of alternator (or excitation voltage per phase)

$V$  – Full load, rated terminal voltage per phase

### **OBSERVATION TABLE:**

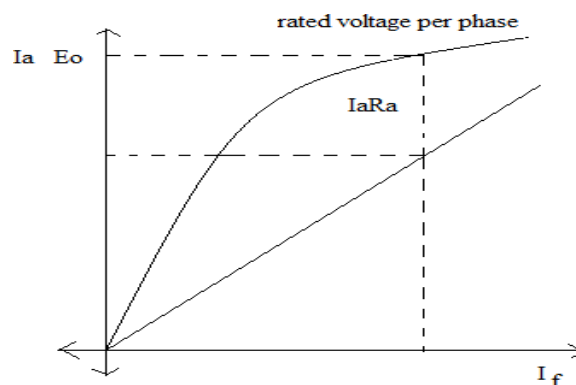
S.No.	OC Test		SC Test	
	Field current ( $I_f$ )	OC voltage per phase( $V_{oc}$ )	Field current ( $I_f$ )	SC current per phase( $I_{sc}$ )

### **PRECAUTIONS:**

1. Loose connections are to be avoided.
2. The rheostat in the motor field circuit is kept in minimum position.
3. Tensions are checked for zero position.
4. Readings should be taken without any parallax errors.

### **MODEL GRAPH:**

Draw the graph between  $I_f$   $V_s$   $E_0$  per phase



### **RESULT:**

### **APPLICATIONS:**

1. Salient pole synchronous generators are mostly used in hydro power plants.
2. Non-salient pole rotors are used in nuclear, gas and thermal power plants.

### **VIVA QUESTIONS:**

- 1.What is meant by voltage regulation?
- 2.What is meant by Synchronous Impedance?
- 3.What is OC test?
- 4.What is SC test?
- 5.What is meant by mmf or field ampere turns?
- 6.What is basic the principle of operation of an alternator
- 7.Why an alternator is called synchronous generator
- 8.List the different types of alternators
- 9.List the advantages of rotating field system in alternators
- 10.Why the pole shoes of salient pole machines are chamfered
- 11.Which type of alternators are used in hydro electric power plants
- 12.Differentiate between full pitched and short pitched winding.
- 13.List the advantages of short pitched winding.
- 14.What is meant by armature reaction?
- 15.What is meant by predetermination of regulation?
- 16.Why almost all large size Synchronous machines are constructed with rotating field system type?
- 17.Name the types of Alternator based on their rotor construction.
- 18.Why do cylindrical Alternators operate with steam turbines?
- 19.What are the advantages of salient pole type construction used for Synchronous machines?
- 20.How does electrical degree differ from mechanical degree?
21. Frequency generated in an 8-pole alternator that rotates at 750 r.p.m is?
- 22.Define pole pitch?
- 23.What is short pitch winding?

24. Define pitch factor or coil span factor?
25. Why is short pitch winding preferred over full-pitch winding ?
26. What is distributed winding?
27. What is slot angle  $\beta$ ?
28. Why are Alternators rated in kVA and not in kW?
29. What is meant by armature reaction in Alternators?
30. Alternator operates on the principle of?
31. In modern alternators, the rotating part is?
32. Salient pole field structure has the advantages of?
33. What are the two types of turbo-alternators?
34. How do you compare the two?
35. What is direct-connected alternator?
36. What is the difference between direct-connected and direct-coupled units?
37. Why Alternator is called Synchronous generator?
38. Why a 3-phase synchronous machine will always run at synchronous speed?
39. What are the essential features of synchronous machine?
40. Why almost all large size Synchronous machines are constructed with rotating field system type?
41. Write down the equation for frequency of emf induced in an Alternator?
42. How are alternators classified?
43. Why do cylindrical Alternators operate with steam turbines?
44. Which type of pole generators are used in Hydro-electric plants and why?
45. State three important features of turbo alternator rotors?
46. What are the advantages of salient pole type of construction used for synchronous machines?
47. Mention the uses of damper windings in a synchronous machine?
48. Why is the stator core of Alternator laminated?
49. How does electrical degree differ from mechanical degree?
50. What is the relation between electrical degree and mechanical degree?



## **LIST OF EXPERIMENTS/DEMONSTRATIONS:**

### **PART B: ELECTRONICS**

1. Study and operation of  
(i) Multi-meters (ii) Function Generator (iii) Regulated Power Supplies (iv)CRO.
2. PN Junction diode characteristics
3. Zener diode characteristics and Zener as voltage Regulator
4. Input & Output characteristics of Transistor in CB / CE configuration
5. Full Wave Rectifier with & without filters
6. Input and Output characteristics of FET in CSconfiguration

### **EXP NO: 1**

## **STUDY AND OPERATION OF (i)CRO (ii)FUNCTION GENERATOR (iii)REGULATED POWER SUPPLIES (iv)MULTIMETER**

An oscilloscope is a test instrument which allows us to look at the 'shape' of electrical signals by displaying a graph of voltage against time on its screen. It is like a voltmeter with the valuable extra function of showing how the voltage varies with time. A graticule with a 1cm grid enables us to take measurements of voltage and time from the screen.

The graph, usually called the trace, is drawn by a beam of electrons striking the phosphor coating of the screen making it emit light, usually green or blue. This is similar to the way a television picture is produced.

Oscilloscopes contain a vacuum tube with a cathode (negative electrode) at one end to emit electrons and an anode (positive electrode) to accelerate them so they move rapidly down the tube to the screen. This arrangement is called an electron gun. The tube also contains electrodes to deflect the electron beam up/down and left/right.

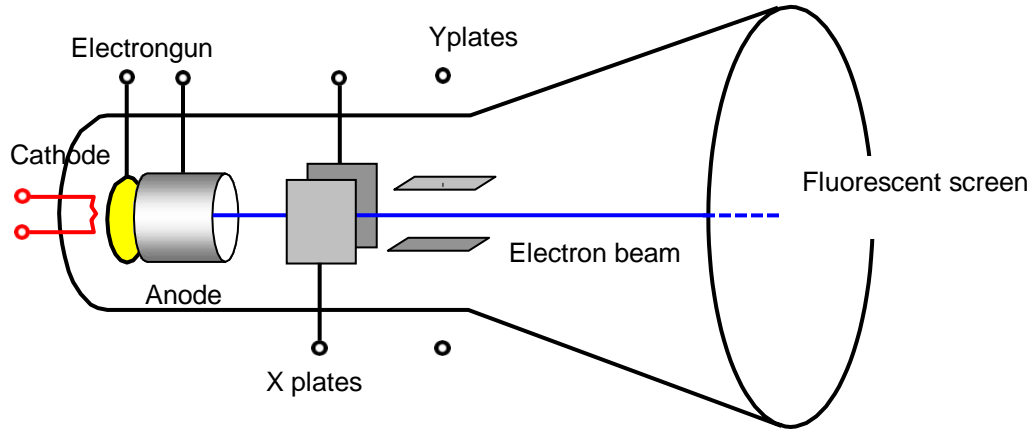
The electrons are called cathode rays because they are emitted by the cathode and this gives the oscilloscope its full name of cathode ray oscilloscope or CRO.

A dual trace oscilloscope can display two traces on the screen, allowing us to easily compare the input and output of an amplifier for example. It is well worth paying the modest extra cost to have this facility.



**Figure1: Front Panel of CRO**

▪ **BASIC OPERATION:**



**Figure2: Internal Blocks of CRO**

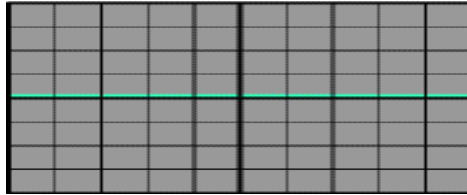
□ **Setting up an oscilloscope:**

Oscilloscopes are complex instruments with many controls and they require some care to set up and use successfully. It is quite easy to 'lose' the trace off the screen if controls are set wrongly.

There is some variation in the arrangement and labeling of the many controls so the following instructions may need to be adapted for this instrument.

1. Switch on the oscilloscope to warm up (it takes a minute or two).
2. Do not connect the input lead at this stage.
3. Set the AC/GND/DC switch (by the Y INPUT) to DC.
4. Set the SWP/X-Y switch to SWP (sweep).
5. Set Trigger Level to AUTO.
6. Set Trigger Source to INT (internal, the y input).
7. Set the Y AMPLIFIER to 5V/cm (a moderate value).
8. Set the TIMEBASE to 10ms/cm (a moderate speed).
9. Turn the time base VARIABLE control to 1 or CAL.
10. Adjust Y SHIFT (up/down) and X SHIFT (left/right) to give a trace across the middle of the screen, like the picture.
11. Adjust INTENSITY (brightness) and FOCUS to give a bright, sharp trace.

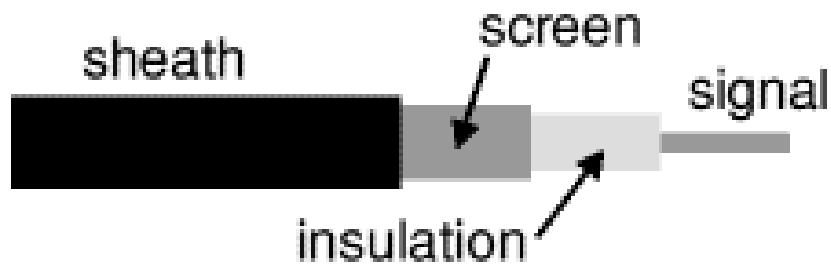
The following type of trace is observed on CRO after setting up, when there is no input signal connected.



**Figure 3: Absence of input signal**

#### □ **Connecting an oscilloscope:**

The Y INPUT lead to an oscilloscope should be a co-axial lead and the figure 4 shows its construction. The central wire carries the signal and the screen is connected to earth (0V) to shield the signal from electrical interference (usually called noise).



**Figure 4: Construction of a co-axial lead**

Most oscilloscopes have a BNC socket for the y input and the lead is connected with a push and twist action, to disconnect we need to twist and pull. Professionals use a specially designed lead and probes kit for best results with high frequency signals and when testing high resistance circuits, but this is not essential for simpler work at audio frequencies (up to 20 kHz).



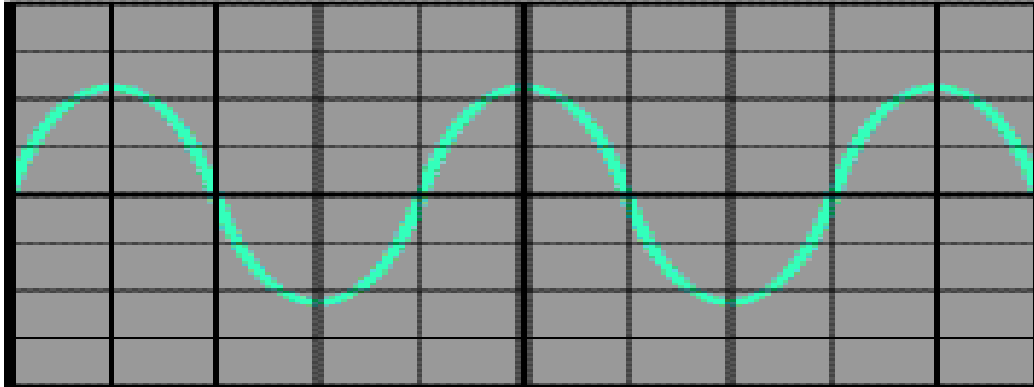
**Figure 5: Oscilloscope lead and probes kit**

☐ **Obtaining a clear and stable trace:**

Once if we connect the oscilloscope to the circuit, it is necessary to adjust the controls to obtain a clear and stable trace on the screen in order to test it.

- ☐ The Y AMPLIFIER (VOLTS/CM) control determines the height of the trace. Choose a setting so the trace occupies at least half the screen height, but does not disappear off the screen.
- ☐ The TIMEBASE (TIME/CM) control determines the rate at which the dot sweeps across the screen. Choose a setting so the trace shows at least one cycle of the signal across the screen. Note that a steady DC input signal gives a horizontal line trace for which the time base setting is not critical.
- ☐ The TRIGGER control is usually best left set to AUTO.

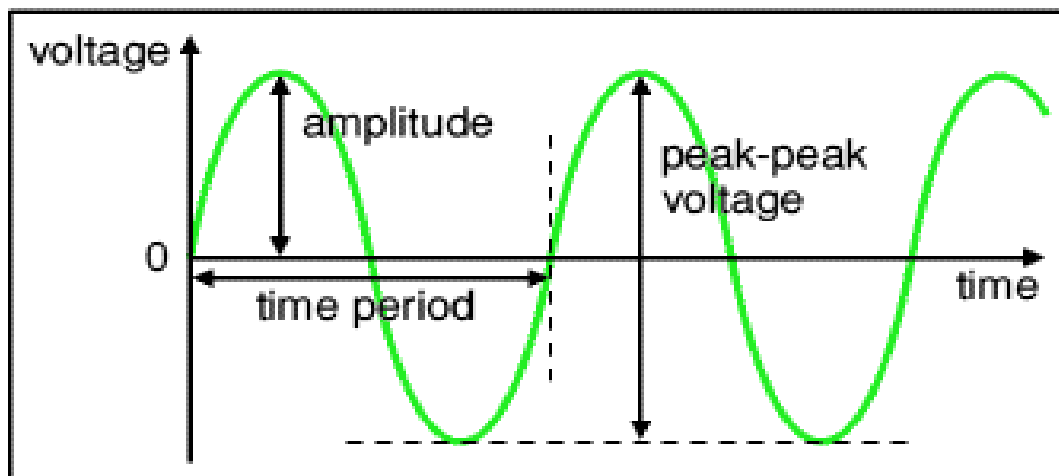
The trace of an AC signal with the oscilloscope controls correctly set is as shown in Figure 6.



**Figure 6 : Stable waveform**

#### ☐ Measuring voltage and time period

The trace on an oscilloscope screen is a graph of voltage against time. The shape of this graph is determined by the nature of the input signal. In addition to the properties labeled on the graph, there is frequency which is the number of cycles per second. The diagram shows a sine wave but these properties apply to any signal with a constant shape



## Figure7: Properties of trace

- ☐ **Amplitude** is the maximum voltage reached by the signal. It is measured in volts.
- ☐ **Peak voltage** is another name for amplitude.
- ☐ **Peak-peak voltage** is twice the peak voltage (amplitude). When reading an oscilloscope trace it is usual to measure peak-peak voltage.
- ☐ **Time period** is the time taken for the signal to complete one cycle. It is measured in seconds (s), but time periods tend to be short so milliseconds (ms) and microseconds ( $\mu$ s) are often used.  $1\text{ms} = 0.001\text{s}$  and  $1\mu\text{s} = 0.000001\text{s}$ .
- ☐ **Frequency** is the number of cycles per second. It is measured in hertz (Hz), but frequencies tend to be high so kilohertz (kHz) and megahertz (MHz) are often used.  $1\text{kHz} = 1000\text{Hz}$  and  $1\text{MHz} = 1000000\text{Hz}$ .

$$\begin{aligned}\text{Frequency} &= \frac{1}{\text{Time period}} \\ \text{Time period} &= \frac{1}{\text{Frequency}}\end{aligned}$$

**A) Voltage:** Voltage is shown on the vertical y-axis and the scale is determined by the Y AMPLIFIER (VOLTS/CM) control. Usually peak-peak voltage is measured because it can be read correctly even if the position of 0V is not known. The amplitude is half the peak-peak voltage.

$$\text{Voltage} = \text{distance in cm} \times \text{volts/cm}$$

**B) Time period:** Time is shown on the horizontal x-axis and the scale is determined by the TIMEBASE (TIME/CM) control. The time period (often just called period) is the time for one cycle of the signal. The frequency is the number of cycles per second,  $\text{frequency} = 1/\text{time period}$ .

$$\text{Time} = \text{distance in cm} \times \text{time/cm}$$



## STUDY OF FUNCTION GENERATOR

A function generator is a device that can produce various patterns of voltage at a variety of frequencies and amplitudes. It is used to test the response of circuits to common input signals. The electrical leads from the device are attached to the ground and signal input terminals of the device under test.

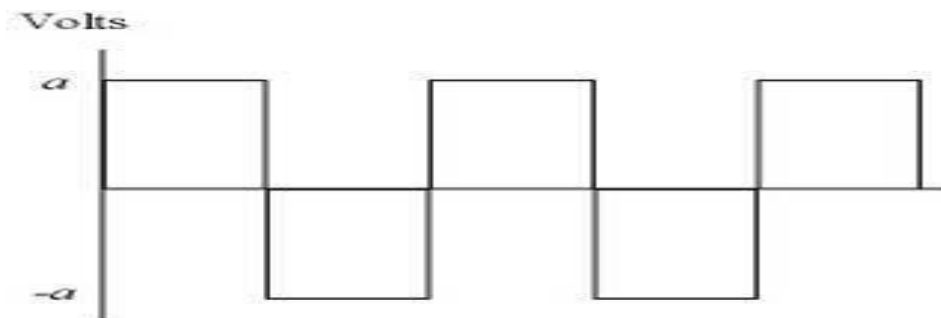


**Figure 1: A typical low-cost function generator.**

### ☐ Features and controls :

Most function generators allow the user to choose the shape of the output from a small number of options.

- ☐ Square wave - The signal goes directly from high to low voltage.



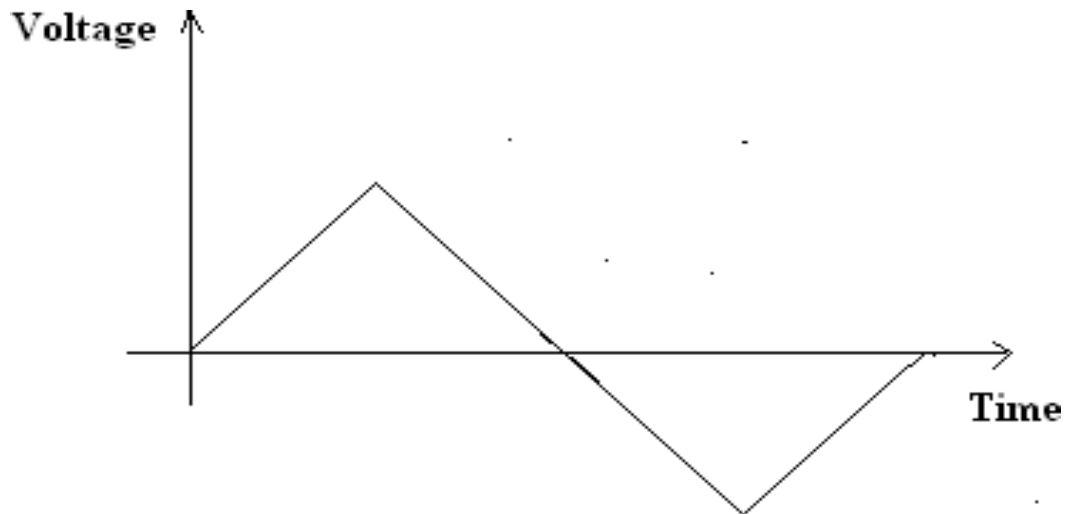
**Figure 2: Square wave**

The duty cycle of a signal refers to the ratio of high voltage to low voltage time in a square wave signal.

- Sine wave - The signal curves like a sinusoid from high to low voltage.

**Figure3: Sine Wave**

- Triangle wave - The signal goes from high to low voltage at a fixed rate.



**Figure 4: Triangular Wave**

The amplitude control on a function generator varies the voltage difference between the high and low voltage of the output signal. The direct current (DC) offset control on a function generator varies the average voltage of a signal relative to the ground.

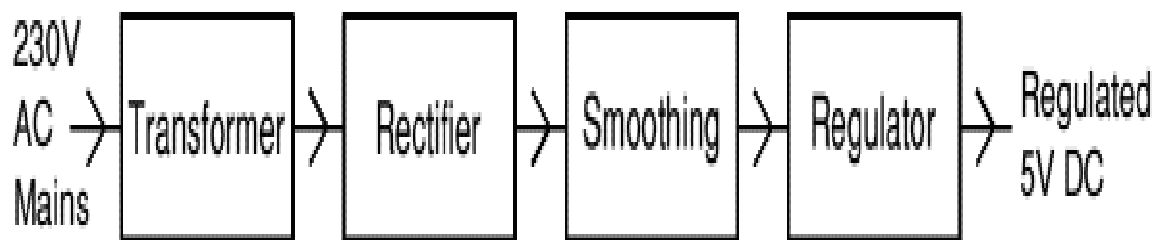
The frequency control of a function generator controls the rate at which output signal oscillates. On some function generators, the frequency control is a combination of different controls. One set of controls chooses the broad frequency range (order of magnitude) and the other selects the precise frequency. This allows the function generator to handle the enormous variation in frequency scale needed for signals.

#### □ **How to use a function generator**

After powering on the function generator, the output signal needs to be configured to the desired shape. Typically, this means connecting the signal and ground leads to an oscilloscope to check the controls. Adjust the function generator until the output signal is correct, then attach the signal and ground leads from the function generator to the input and ground of the device under test. For some applications, the negative lead of the function generator should attach to a negative input of the device, but usually attaching to ground is sufficient.

## STUDY OF REGULATED POWER SUPPLY

There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can be broken down into a series of blocks, each of which performs a particular function. For example a 5V regulated supply:



**Figure1: Block Diagram Of Regulated Power Supply**

Each of the blocks is described in more detail below:

- ☐ Transformer: Steps down high voltage AC mains to low voltage AC.
  - ☐ Rectifier: Converts AC to DC, but the DC output is varying.
  - ☐ Smoothing: Smooths the DC from varying greatly to a small ripple.
  - ☐ Regulator: Eliminates ripple by setting DC output to a fixed voltage.
- 
- ☐ **Dual Supplies:** Some electronic circuits require a power supply with positive and negative outputs as well as zero volts (0V). This is called a 'dual supply' because it is like two ordinary supplies connected together as shown in the diagram. Dual supplies have three outputs, for example a  $\pm 9V$  supply has +9V, 0V and -9V outputs.

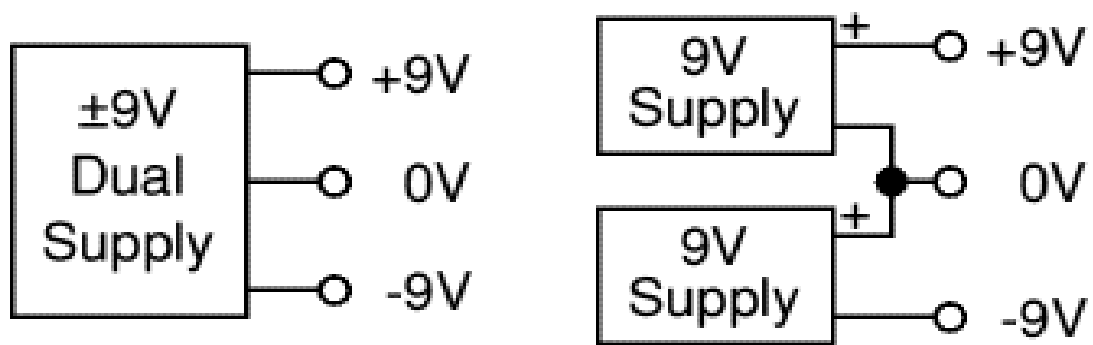


Figure 2: Dual Supply



**EXP NO: 2**  
**PN JUNCTION DIODE CHARACTERISTICS A) FORWARD BIAS B)**  
**REVERSE BIAS**

**AIM: -**

1. To study the characteristics of PN junction diode under  
a) Forward bias. b) Reverse bias.
2. To find the cut-in voltage (Knee voltages) static & dynamic resistance in forward & reverse direction.

**COMPONENTS & EQUIPMENTS REQUIRED: -**

S.No	Device	Range/Rating	Qty
1.	Regulated power supply voltage	0-30V	1
2.	Voltmeter	0-1V or 0-20V	1
3.	Ammeter	0-10mA, 200mA	1
4.	Connecting wires & bread board		
5	Diode	In4007, OA79	
6	Resistors	1k $\Omega$ , 10k $\Omega$	

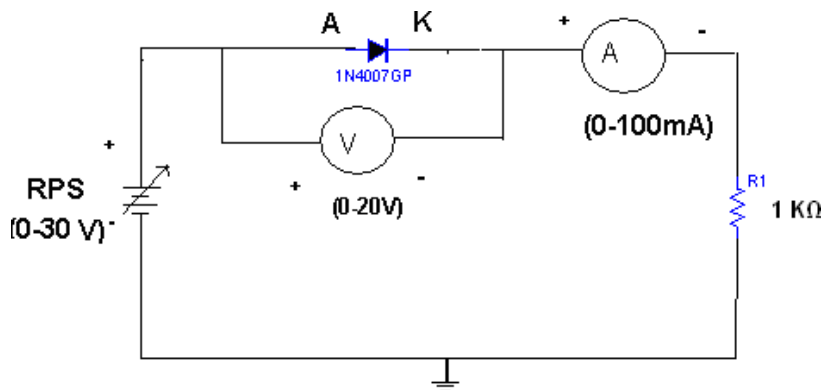
**THEORY:**

The V-I characteristics of the diode are curve between voltage across the diode and current 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

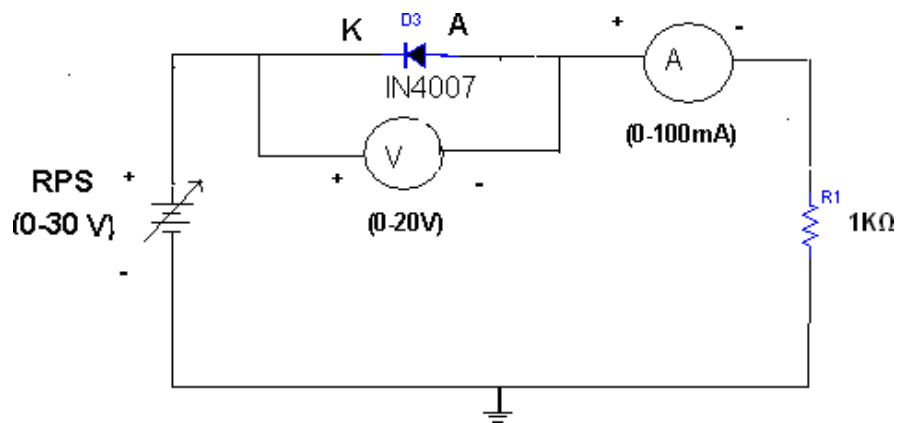
starts flowing through the diode and also in the circuit. The diode is said to be in ON state. The current increases with increasing forward voltage. When N-type (cathode) is connected to +ve terminal and P-type (Anode) is connected -ve terminal of the supply voltage is known as reverse

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. The diode is said to be in OFF state. The reverse bias current is due to minority charge carriers. The p-n junction diode conducts only in one direction.

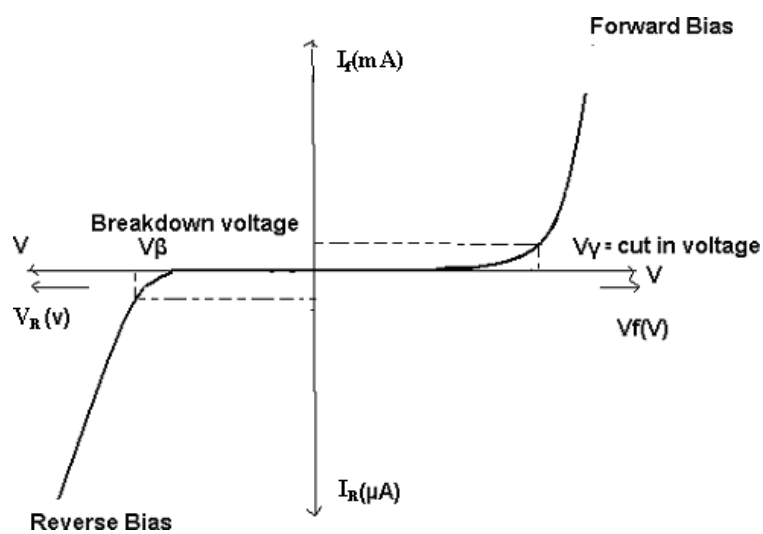
**CIRCUIT DIAGRAM:  
FORWARD BIAS:-**



**REVERSE BIAS:-**



**EXPECTED WAVEFORM:-**





**PROCEDURE: -****Forward bias characteristics**

1. Connect the circuit diagram as shown in figure for Forward bias using silicon diode.
2. Now vary RPS supply voltage  $V_{sin}$  steps from 0V onwards (0.1V, 0.2V, ..... 1V) note down the forward current ( $I_f$ ) through the diode for different Forward voltages ( $V_f$ ) across the diode without exceeding the rated value ( $I_{fMax}=20mA$ )
3. Tabulate the results in the tabular form.
4. Plot the graph between  $V_f$  &  $I_f$ .
5. Repeat the above steps 4 steps by using Germanium diode.

**Reverse bias characteristics**

1. Connect the circuit diagram as shown in figure for Reverse bias using silicon diode.
2. Now vary RPS supply voltage  $V_{sin}$  steps from 0V onwards (1V, 2V, ..... 10V) note down the forward current ( $I_r$ ) through the diode for different Reverse voltages ( $V_r$ ) across the diode without exceeding the rated value ( $V_{rMax}=15V$ )
3. Tabulate the results in the tabular form.
4. Plot the graph between  $V_r$  &  $I_r$ .
5. Repeat the above steps 4 steps by using Germanium diode.

**PRECAUTIONS:**

1. Check the wires for continuity before use.
2. Keep the power supply at Zero volts before Start.
3. All the contacts must be intact.

**TABULAR COLUMN: Forward Bias**

SL. No	Forward voltage ( $V_f$ )	Forward current ( $I_f$ )
1	0	
2	0.15	
3	0.25	
4	0.3	
5	0.4	
6	0.5	
7	0.6	
8	0.7	
9	0.72	
10	0.75	

**TABULAR COLUMN: Reverse**

SL. No	Forward voltage ( $V_f$ )	Forward current ( $I_f$ )
1	1	
2	2	
3	3	
4	4	
5	5	
6	6	
7	7	
8	8	
9	9	
10	10	

Specifications		Si	Ge
Cut in Voltage			
Static Resistance	F.Bias R.Bias		
Dynamic Resistance	F.Bias R.Bias		

RESULT: - Forward and Reverse Bias characteristics for a p-n diode is observed

**VIVA QUESTIONS:**

1. What is P-N junction diode?
2. What is doping why doping is necessary?
3. Difference between P-type and N-type semiconductor materials?
4. What is diode equation?
5. What is an ideal diode?
6. Define depletion region of a diode?
7. What is meant by transition & space charge capacitance of a diode?
8. Is the V-I relationship of a diode Linear or Exponential?
9. Define cut-in voltage of a diode and specify the values for Si and Ge diodes?
10. What are the applications of a p-n diode?
11. Draw the ideal characteristics of P-N junction diode?
12. What is the diode equation?
13. What is the break down voltage?
14. What is the effect of temperature on PN junction diodes?
15. What is PIV?
16. What is Forward bias?
17. What is Reverse bias?
18. What is Forward voltage?
19. What is Reverse current?
20. What is an ideal diode?
21. What is Break down voltage?
22. What is cut-in voltage?
23. Is the V-I relationship of a diode Linear or Exponential?
24. Define diode?
25. What are the characteristics of diode?
26. Draw the ideal characteristics of P-N junction diode?
27. What is the diode characteristics?
28. What is the break down voltage in diode?
29. What is the effect of PN junction diodes?
30. What is PVI?
31. Prove that P-N junction Diode acts as an isolator?
32. Prove that P-N junction diode acts as on Switch when it is in forward bias?
33. Prove that P-N junction diode acts as off Switch, when it is in Reverse bias?
34. Find the change in cut-in voltage when input resistance is varied from 1k to 1M?
35. Prove that Ohm's law is verified for P-N junction diode in forward biased condition?
36. Find the static resistance of P-N junction Diode?
37. Find the Dynamic resistance of P-N junction Diode?
38. Find the cut in voltage for the given diode in forward bias?
39. Explain what does the arrow heads represent in the schematic symbol of PN junction diode.
40. Why silicon is preferred over Germanium in the manufacture of semiconductor devices?
41. Name the breakdown mechanism in a lightly doped PN junction under reverse biased condition.
42. Is reverse saturation current of diode independent of reverse bias voltage?
43. Why germanium is more temperature dependent than silicon?
44. Define Dynamic resistance of PN junction Diode?
45. Define Zero bias PN junction diode?

46. Define barrier voltage
47. Define depletion region
48. Define biasing of the diode
49. Define electron emission.
50. If the voltage of the potential barrier is  $V_0$ . A voltage  $V$  is applied to the input, at what moment will the barrier disappear?

### Design Problems

1. Forward and reverse bias characteristics of Si diode with 1N4007.
2. Forward and reverse bias characteristics of Ge diode.
3. Forward and reverse bias characteristics of Si diode with  $V_D = 10\text{ V}$  and  $I_D = 10\text{ mA}$
4. Forward and reverse bias characteristics of Ge diode with  $V_D = 5\text{ V}$  and  $I_D = 10\text{ mA}$
5. Forward and reverse bias characteristics of Si diode with  $R = 500\text{ Ohms}$
6. Forward and reverse bias characteristics of Si diode with  $R = 1.5\text{ K}$
7. Forward and reverse bias characteristics of Si diode with  $R = 2\text{ K}$
8. Forward and reverse bias characteristics of Si diode with  $V_{RPS} = 0 - 10\text{ V}$
9. Forward and reverse bias characteristics of Si diode with  $V_{RPS} = 0 - 5\text{ V}$
10. Forward and reverse bias characteristics of Si diode with  $V_D = 20\text{ V}$  and  $I_D = 10\text{ mA}$
11. Forward and reverse bias characteristics of Si diode with  $R = 2.5\text{ K}$ ?
12. Forward and reverse bias characteristics of Si diode with  $R = 5\text{ K}$ ?
13. Forward and reverse bias characteristics of Si diode with 1N4008?
14. Find the cut in voltage for the given diode in forward bias when the input resistance is  $1\text{ K}$ ?
15. Find the cut in voltage for the given diode in forward bias when the input resistance is  $1\text{ K}$ ?
16. Forward and reverse bias characteristics of Ge diode with 1N4007?
17. Reverse and Forward bias characteristics of Ge diode?
18. Forward and reverse bias characteristics of Ge diode with  $V_D = 10\text{ V}$  and  $I_D = 10\text{ mA}$ ?
19. Forward and reverse bias characteristics of Si diode with  $R = 50\text{ Ohms}$ ?
20. Forward and reverse bias characteristics of Si diode with  $V_{RPS} = 0 - 210\text{ V}$ ?
21. Forward and reverse bias characteristics of Si diode with  $V_{RPS} = 0 - 1\text{ V}$ ?
22. Forward and reverse bias characteristics of Ge diode with 1N4008?

### REALTIME APPLICATIONS:

1. PN junction (which has direct energy band gap) in forward biased condition produces light when biased with a current. All LED lighting uses a PN junction diode.
2. Voltage across PN junction biased at a constant current has a negative temperature coefficient. Difference between the PN junction voltages of two differently biased diodes has a positive temperature coefficient. These properties are used to create Temperature Sensors, Reference voltages (Bandgap).
3. Various circuits like Rectifiers, Varactors for Voltage Controlled Oscillators (VCO) etc.

### EXPT NO: 3

## **ZENER DIODE CHARACTERISTICS AND ZENER AS VOLTAGE REGULATOR**

### **AIM: -**

1. To study the volt-Ampere characteristics of a given Zener diode under  
a) Forward bias. b) Reverse bias.
2. To find the Zener breakdown voltage in reversed biased condition.

### **EQUIPMENTS & COMPONENTS REQUIRED: -**

S.No	Device	Range/Rating	Qty
1.	(a) Regulated DC supply voltage b) Diode (d) Resistors	0-30V 1N4735A or BZ6.2v, 5.6v or 3.9V 1k $\Omega$ , 10k $\Omega$	1 12 1
2.	Voltmeter	0-1V, 0-20V	1
3.	Ammeter	0-10mA, 200mA	1
4.	Connecting wires & bread board		

### **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. It is also called as stabilizer diode or stabilitrons or constant voltage device.

Zener diodes are more heavily doped (around  $1 \times 10^5$ ) as compared to ordinary diodes ( $1 \times 10^8$ ) and they have a narrow depletion layer.

The breakdown mechanisms are of two types.

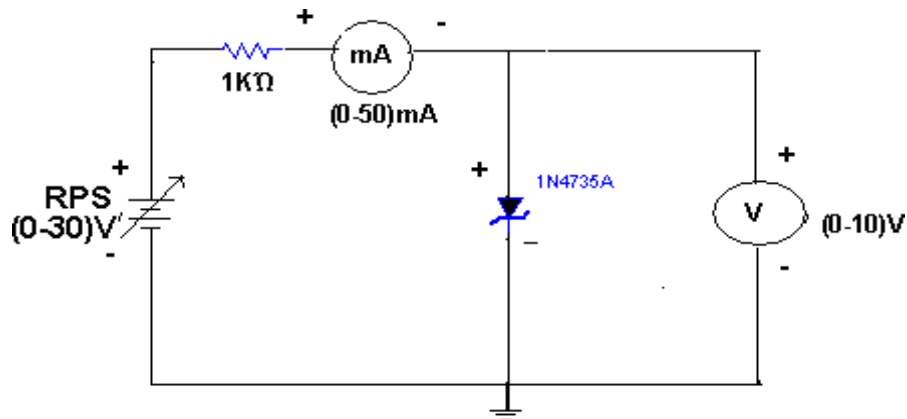
- (i) avalanche breakdown
- (ii) Zener breakdown

In avalanche breakdown mechanism, thermally generated electrons & holes acquire sufficient energy from the applied potential to produce new carriers by removing valance electrons from their bonds. These new carriers, in turn produce new carriers (called avalanche multiplication).

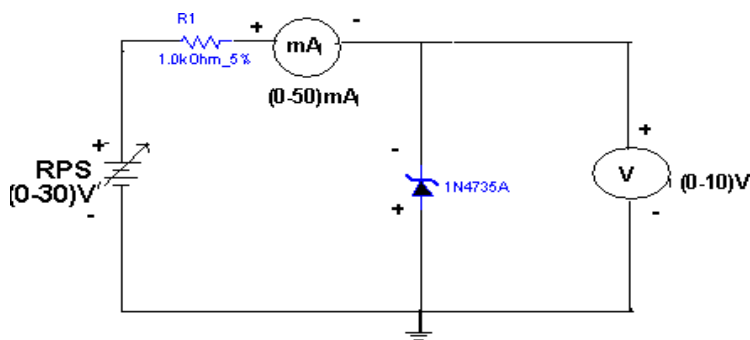
In Zener breakdown mechanism, very high electric field intensity across the narrow depletion region directly forces carriers out of their bonds.

During breakdown the voltage across the diode remains constant, independent of the current that flows through it. Because of this property a Zener diode serves as Voltage Stabilizer or voltage reference and breakdown occurs by avalanching in Zener diodes having breakdown voltages greater than 8V. It occurs by a combination of both mechanisms when breakdown voltage is between 5V & 8V. Zener effect plays a very important role only in the diodes with breakdown voltages below about 5V. Zener breakdown voltages decrease with increased temperature where as avalanche breakdown voltage increases with increased temperature. Zener diode operates in either a 'ON' state or 'OFF' state

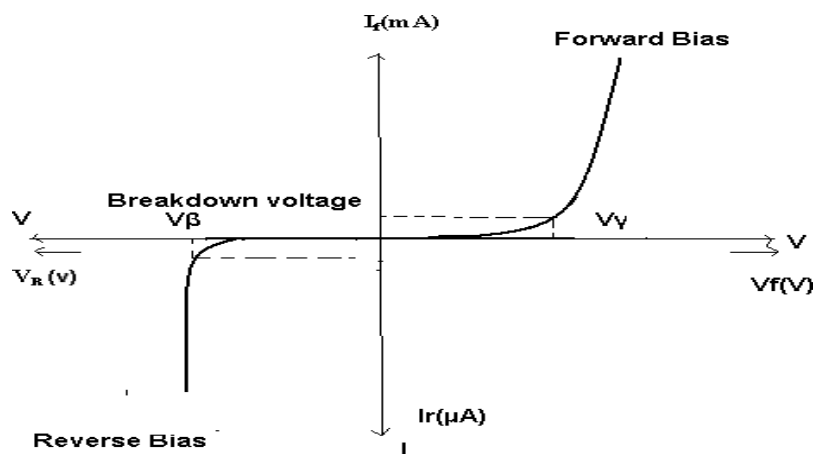
**CIRCUIT DIAGRAM:  
STATIC CHARACTERISTICS:-**



**REGULATION CHARACTERISTICS:-**



**EXPECTED WAVEFORMS:-**



**PROCEDURE: -**

**Forward bias characteristics**

1. Connect the circuit diagram as shown in figure for Forward bias using zener diode
2. Switch on the RPS supply voltage  $V_s$  and vary in steps from 0V onwards (0.1V, 0.2V.....1V) note down the forward current ( $I_f$ ) through the diode for different forward voltages ( $V_f$ ) across the diode without exceeding the rated value ( $V_s=10V$ )
3. Tabulate the results in the tabular form.
4. Plot the graph between  $V_f$  &  $I_f$ .

**Reverse bias characteristics**

1. Connect the circuit diagram as shown in figure for Reverse bias using Zener diode.
2. Now vary RPS supply voltage  $V_{sin}$  steps from 0V onwards (1V, 2V.....10V) note down the Reverse current ( $I_r$ ) through the diode for different Reverse voltages ( $V_r$ ) across the diode without exceeding the rated value ( $V_{rMax}=15V$ )
3. Tabulate the results in the tabular form.
4. Plot the graph between  $V_r$  &  $I_r$ .

**TABULAR COLUMN: Forward Bias**

SL. No	Forward voltage ( $V_f$ )	Forward current ( $I_f$ )
1	0	
2	0.15	
3	0.25	
4	0.3	
5	0.4	
6	0.5	
7	0.6	
8	0.7	
9	0.72	
10	0.75	

**TABULAR COLUMN: Reverse Bias**

SL. No	Forward voltage ( $V_f$ )	Forward current ( $I_f$ )
1	1	
2	2	
3	3	
4	4	
5	5	
6	6	
7	7	
8	8	
9	9	
10	10	

**PRECAUTIONS:**

1. Check the wires for continuity before use.
2. Keep the power supply at Zero volts before Start.
3. All the contacts must be intact.

**RESULT: -**

The Characteristics of the Forward and Reverse biased Zener Diode and the Zener Break Down Voltage from the Characteristics are Observed.

Zener Breakdown Voltage =                      Volts.  
 Forward Bias Resistance                      =              Ohms  
 Reverse Bias Resistance                      =              Ohms

### VIVA QUESTIONS:-

1. What is Zener diode?
2. Can Zener be used as a rectifier?
3. What are the voltage ratings of zener diode?
4. Give advantages of zener diode?
5. How zener diode behaves in forward bias?
6. What type of temp? Coefficient does the zener diode have?
7. If the impurity concentration is increased, how the depletion width is affected?
8. Does the dynamic impedance of a zener diode vary?
9. Explain briefly about avalanche and zener breakdowns?
10. Draw the zener equivalent circuit?
11. Differentiate between line regulation & load regulation?
12. In which region zener diode can be used as a regulator?
13. How the breakdown voltage of a particular diode can be controlled?
14. What type of temperature coefficient does the Avalanche breakdown have?
15. By what type of charge carriers the current flows in zener and avalanche breakdown diodes?
16. What are the static characteristics of diode?
17. Can Zener be used as an integrator?
18. What are the rating voltages of zener diode?
19. Give disadvantages of zener diode?
20. How zener diode behaves in forward bias?
21. What type of temp Coefficient does the zener diode have?
22. If the impurity concentration is decreased, how the depletion width is affected?
23. Does the dynamic impedance of a diode vary?
24. Explain briefly about avalanche breakdown?
25. Draw the zener equivalent circuit?
26. Differentiate between line & load regulation?
27. In which region zener diode can be used as an integrator?
28. How the cut-in voltage of a particular diode can be controlled?
29. What type of temperature coefficient does the zener breakdown have?
30. What type of charge carriers the voltage flows in zener and avalanche breakdown diodes?
31. Find the difference between P-N junction Diode and Zener diode in forward bias condition?
32. Find the difference between P-N junction Diode and Zener diode in Reverse bias condition?
33. Find the Break down voltage for given Zener Diode?
34. Define what happens to a series current, load current and zener current when the dc input voltage of zener regulator increases.
35. How does the Zener breakdown voltage vary with temperature.
36. How does the avalanche breakdown voltage vary with temperature.
37. A 9.1-V zener diode exhibits its nominal voltage at a test current of 28 mA. At this current the incremental resistance is specified as  $5\ \Omega$ . Find  $V_{Z0}$  of the Zener model.
38. Zener diodes can be effectively used in voltage regulator. However, they are these days being replaced by more efficient
39. The other name for Zener diode is.
40. Why zener diode is used as voltage regulator.
41. Explain what is meant by the temperature coefficient?
42. Why zener diode is always reverse biased
43. How the width of depletion region in the reverse biased diode varies with the impurity concentration

44. Under what condition zener diode behaves like pn junction diode.
45. How the value of potential barrier depends on the amount of doping of the semiconductor.
46. Difference between intrinsic and extrinsic semiconductor.
47. Why is a zener diode generally not connected to forward bias?
48. What is the temperature effect on reverse saturation current and barrier voltage.
49. How the name of the zener came.
50. Is the breakdown region in zener really destructible.

### Design Problems

1. Reverse bias characteristics of Zener Si diode with 5.6V.
2. Reverse bias characteristics of Zener Si diode with 6.2V.
3. Reverse bias characteristics of Zener Si diode with 5.6V with  $R = 2K$ .
4. Reverse bias characteristics of Zener Si diode with 5.6V with  $R = 2.5K$ .
5. Verify the operation of Zener acts as voltage regulator.
6. Verify the operation of Zener acts as voltage regulator with  $R = 2K$  and  $R_L = 5K$ .
7. Reverse bias characteristics of Zener Si diode with 5.6V with  $V_{RPS} = 0 - 15V$ .
8. Reverse bias characteristics of Zener Si diode with 5.6V with  $V_{RPS} = 0 - 20V$ .
9. Reverse bias characteristics of Zener Si diode with 6.2V with  $V_D = 10V$  and  $I_D = 10mA$ .
10. Reverse bias characteristics of Zener Si diode with 6.2V with  $V_D = 20V$  and  $I_D = 15mA$ .
11. Plot the Reverse Bias characteristics for the Zener diode when I/P resistance is  $10k$ ?
12. Find the effect of change in characteristics of Zener diode connected in Reverse Bias condition when input resistance is changed from  $10k$  to  $20K$ ?
13. Find the effect of change in characteristics of Zener diode connected in Reverse Bias condition when input resistance is changed from  $20k$  to  $10K$ ?
14. Reverse bias characteristics of Zener Si diode with 6.2V with  $V_D = 12V$ ?
15. Find output voltage of Zener Si diode with 6.2V with  $V_D = 10V$ ?
16. Find output voltage of Zener Si diode with 6.2V with  $V_D = 5V$ ?
17. Find output voltage of Zener Si diode with 6.2V with  $V_D = 6.2V$ ?
18. Reverse bias characteristics of Zener Si diode with 6.5V?
19. Reverse bias characteristics of Zener Si diode with 2.6V?
20. Reverse bias characteristics of Zener Si diode with 2.6V with  $R = 1K$ ?
21. Reverse bias characteristics of Zener Si diode with 2.6V with  $R = 2.0K$ ?
22. Verify the operation of Zener acts as voltage integrator?
23. Verify the operation of Zener acts as voltage regulator with  $R = 1K$  and  $R_L = 2K$ ?
24. Reverse bias characteristics of Zener Si diode with 2.6V with  $V_{RPS} = 0 - 10V$ ?
25. Reverse bias characteristics of Zener Si diode with 2.6V with  $V_{RPS} = 0 - 10V$ ?
26. Reverse bias characteristics of Zener Si diode with 2.2V with  $V_D = 20V$  and  $I_D = 5mA$ ?
27. Reverse bias characteristics of Zener Si diode with 6.2V with  $V_D = 10V$  and  $I_D = 10mA$ ?

### REALTIME APPLICATIONS:

With growing popularity of smart phones, android based projects are being preferred these days. These projects involve use of Bluetooth technology based device. These Bluetooth devices require about 3V voltage for operation. In such cases, a zener diode is used to provide a 3V reference to the Bluetooth device. Another application involves use of Zener diode as a voltage regulator. Here the AC voltage is rectified by the diode D1 and filtered by the capacitor. This filtered DC voltage is regulated by the diode to provide a constant reference voltage of 15V. This regulated DC voltage is used to drive the control circuit, used to control the switching of light, as in an automated lighting control system.



#### EXPT NO: 4.

### **INPUT & OUTPUT CHARACTERISTICS OF A BJT IN COMMON EMITTER (CE) CONFIGURATION**

#### **AIM: -**

1. To study the input and output characteristics of transistor (BJT) connected in common emitter configuration.
2. To calculate current gain  $\beta$ .
3. To calculate input resistance  $R_i$  & output resistance  $R_o$ .

#### **EQUIPMENTS & COMPONENTS REQUIRED:**

S.No	Device	Range/Rating	Qty
1.	Regulated DC supply voltage(RPS)	0-30V	1
2.	Voltmeter	0-1V or 0-10V, 0-20V	1
3.	Ammeter	0-10mA, 200mA	1
4.	Connecting wires & bread board		
5.	Transistor BC 107 or 2N2222 or BC547	NPN	1
6.	Resistor	1K, 100K	1

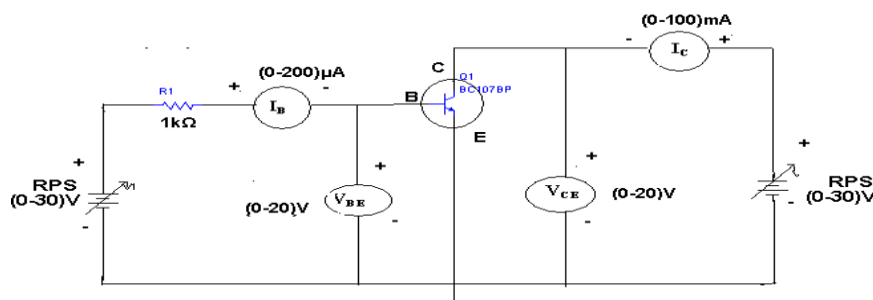
#### **THEORY:**

A transistor is a three terminal device. The terminals are emitter, base, collector. 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  $\beta = \Delta I_C / \Delta I_B$ .

#### **CIRCUIT DIAGRAM:**



**PROCEDURE: -**

Input characteristics:

1. Connect the circuit according to the circuit diagram of input characteristics
2. Keep (Collector to Emitter Voltage)  $V_{CE}=0V$  by varying  $V_{CC}$  (collector supply voltage). Increasing  $V_{BB}$  (Base supply Voltage from 0 onwards (0.1V,0.2V....0.75V) observe  $I_B$  (Base current) for different values of  $V_{BE}$  (Base to Emitter voltage).
3. Repeat the Step 2 for Different (collector to Emitter voltage)  $V_{CE}$  i.e. 3V & 6V.
4. Tabulate the results in the tabular form and plot the graph.

Output characteristics:

1. Connect the circuit according to the circuit diagram of output characteristic.
2. Keep (collector supply voltage)  $V_{CC}=0V$ . Increase (Base supply Voltage)  $V_{BB}$  to get Base current  $I_B=3\mu A$ .
3. Now increase (Collector supply voltage)  $V_{CC}$  from 0 onwards and observe the Collector current  $I_C$  for different Values of (Collector to Emitter voltage)  $V_{CE}$  Without exceeding the rated value ( $I_C=15mA$ )
4. Tabulate the results in the tabular column and plot the graph.

**OBSERVATIONS:****INPUT CHARACTERISTICS:**

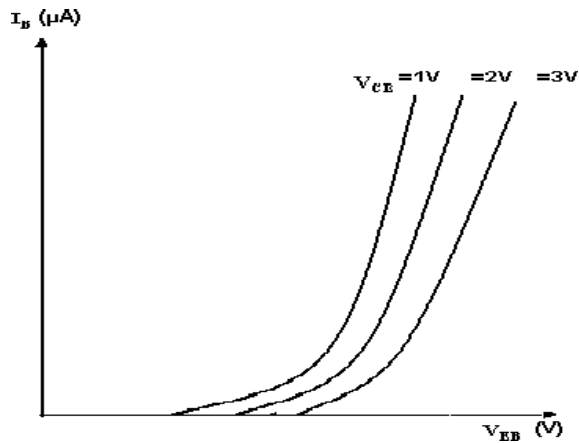
S.NO	$V_{CE} = 1V$		$V_{CE} = 2V$		$V_{CE} = 4V$	
	$V_{BE}(V)$	$I_B(\mu A)$	$V_{BE}(V)$	$I_B(\mu A)$	$V_{BE}(V)$	$I_B(\mu A)$

**OUT PUT CHAREACTARISTICS:**

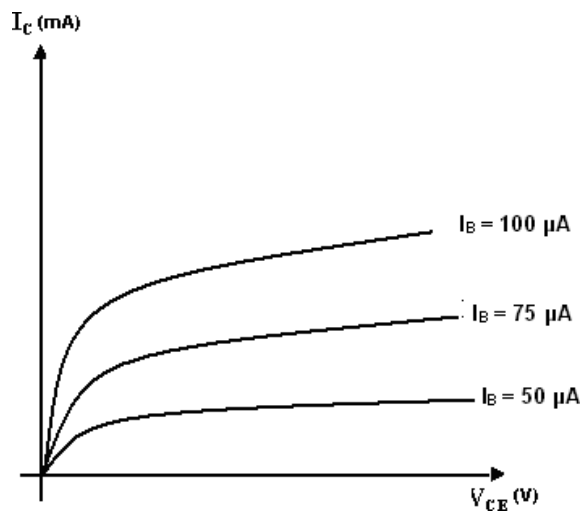
S.NO	$I_B = 5\mu A$		$I_B = 10\mu A$		$I_B = 15\mu A$	
	$V_{CE}(V)$	$I_C(mA)$	$V_{CE}(V)$	$I_C(mA)$	$V_{CE}(V)$	$I_C(mA)$

### **EXPECTED GRAPHS:**

#### **INPUT CHARACTERISTICS:**



#### **OUTPUT CHARECTERSTICS:**



Preacutions:

1. Always keep the supply Voltage Knobs i.e. VCE, VBE positions at minimum position when switching on & off.
2. Never load the meters above its rated range.
3. Avoid loose connections at the junction.

#### **RESULTS:**

The input and out put characteristics are drawn on the graphs and the h parameters are calculated

### VIVA QUESTIONS:

1. What is the range of  $\beta$  for the transistor?
2. What are the input and output impedances of CE configuration?
3. Identify various regions in the output characteristics?
4. What is the relation between  $\alpha$  and  $\beta$ ?
5. Define current gain in CE configuration?
6. Why CE configuration is preferred for amplification?
7. What is the phase relation between input and output?
8. Draw diagram of CE configuration for PNP transistor?
9. What is the power gain of CE configuration?
10. What are the applications of CE configuration? . What is the range of  $\beta$  for the transistor?
2. What are the input and output impedances of CE configuration?
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15. Define current gain in CE configuration?
16. Why CE configuration is preferred for amplification?
17. What is the phase relation between input and output?
18. Draw diagram of CE configuration for PNP transistor?
19. What is the power gain of CE configuration?
20. What are the applications of CE configuration?
21. What is Early Effect?
22. Why the doping of collector is less compared to emitter?
23. What do you mean by "reverse active"?
24. What is the difference between CE and Emitter follower circuit?
25. What are the input and output impedances of CE configuration?
26. Identify various regions in the output characteristics?
27. What is the relation between  $\alpha$ ,  $\beta$  and  $\gamma$ ?
28. Define current gain in CE configuration?
29. Why CE configuration is preferred for amplification?
30. What is the phase relation between input and output?
31. Define doping?
32. Why CE configuration is used mostly?
33. A germanium transistor with  $\alpha=0.98$  gives a reverse saturation current  $I_{CBO}=10\mu A$  in a CB configuration. When it is used in CE configuration with a base current of  $0.22\mu A$ , calculate the collector current.
34. In  $I_{CEO}$ , what does the subscript 'CEO' mean?
35. The range of  $\beta$  is \_\_\_\_\_
36. Define the point on the DC load line which is represented by 'Q' is called \_\_\_\_\_
37. The input resistance is given by \_\_\_\_\_
38. What are the output impedances of CE configuration?
39. Draw the input characteristics of CE configuration.
40. Which of the following cases damage the transistor?

41. When the collector junction is reverse biased and emitter junction is forward biased, the operating region of the transistor is called

42. The small amount of current which flows even when base current  $I_B=0$  is called \_\_\_\_\_

43. Which of the points locates the quiescent point?

44. Which of the parameters corresponds to the output circuit of a CE transistor?

45. What are DC characteristics used to prove that the transistor is indeed biased in saturation mode?

- List the different configurations used

47. Define biasing

- What are the different biasing methods?

48. List the applications of common emitter configuration

49. Which biasing techniques are used mostly for CE configuration?

### Design Problems

1. Input & output characteristics of BC 107 transistor in CE configuration with  $R_I=50K$ .
2. Input & output characteristics of BC 107 transistor in CE configuration with  $R_O=2K$ .
3. I/O characteristics of BC 107 transistor in CE configuration with  $R_I=50K$   $R_O=2K$
4. Input & output characteristics of BC 107 transistor in CE configuration with  $R_I=150K$ .
5. I/O characteristics of BC 107 transistor in CE configuration with  $R_I=150K$   $R_O=2K$
6. Input & output characteristics of SL 100 transistor in CE configuration with  $R_I=50K$ .
7. Input & output characteristics of SL 100 transistor in CE configuration with  $R_O=2K$ .
8. I/O characteristics of PNP transistor in CE configuration with  $R_I=50K$   $R_O=2K$
9. Input & output characteristics of PNP transistor in CE configuration with  $R_I=150K$ .
10. I/O characteristics of PNP transistor in CE configuration with  $R_I=150K$   $R_O=2K$
11. Input & output characteristics of BC 107 transistor in CE configuration with  $R_I=50K$ .
12. Input & output characteristics of BC 107 transistor in CE configuration with  $R_O=2K$ .
13. I/O characteristics of BC 107 transistor in CE configuration with  $R_I=50K$   $R_O=2K$
14. Input & output characteristics of BC 107 transistor in CE configuration with  $R_I=150K$ .
15. I/O characteristics of BC 107 transistor in CE configuration with  $R_I=150K$   $R_O=2K$
16. Input & output characteristics of SL 100 transistor in CE configuration with  $R_I=50K$ .
17. Input & output characteristics of SL 100 transistor in CE configuration with  $R_O=2K$ .
18. I/O characteristics of PNP transistor in CE configuration with  $R_I=50K$   $R_O=2K$
19. Input & output characteristics of PNP transistor in CE configuration with  $R_I=150K$ .
20. I/O characteristics of PNP transistor in CE configuration with  $R_I=150K$   $R_O=2K$
21. Input & output characteristics of BC 107 transistor in CE configuration with  $R_I=50K$ .
22. Input & output characteristics of BC 107 transistor in CE configuration with  $R_O=2K$ .
23. I/O characteristics of BC 107 transistor in CE configuration with  $R_I=50K$   $R_O=2K$
24. Input & output characteristics of BC 107 transistor in CE configuration with  $R_I=150K$ .
25. I/O characteristics of BC 107 transistor in CE configuration with  $R_I=150K$   $R_O=2K$
26. Input & output characteristics of SL 100 transistor in CE configuration with  $R_I=50K$ .
27. Input & output characteristics of SL 100 transistor in CE configuration with  $R_O=2K$ .
28. I/O characteristics of PNP transistor in CE configuration with  $R_I=50K$   $R_O=2K$
29. Input & output characteristics of PNP transistor in CE configuration with  $R_I=150K$ .
30. I/O characteristics of PNP transistor in CE configuration with  $R_I=150K$   $R_O=2K$

### REALTIME APPLICATIONS:

Common-emitter amplifiers are also used in radio frequency circuits, for example to amplify faint signals received by an antenna. In this case it is common to replace the load resistor with a tuned circuit. This may be done to limit the bandwidth to a narrow band centered around the intended operating frequency. More importantly it also allows the circuit to operate at higher frequencies as the tuned circuit can be used to resonate any inter-electrode and stray capacitances, which normally limit the frequency response. Common emitters are also commonly used as low-noise amplifiers.

## EXPT NO: 5

### FULL WAVE RECTIFIER WITH & WITHOUT FILTER.

#### AIM: -

1. To find ripple factor & regulation for full waverectifier.
2. To examine the input and output waveforms..

#### EQUIPMENTS & COMPONENTS REQUIRED:

S.No	Device	Range/Rating	Qty
1.	Transformer	6-0-6V or 9-0-9V	1
2.	Diode	In4007	2 or 4
3.	Resistors	1k $\Omega$ ,2.2k,3.3k $\Omega$ ,4.7K,10k	1each
4.	Connecting wires & bread board		

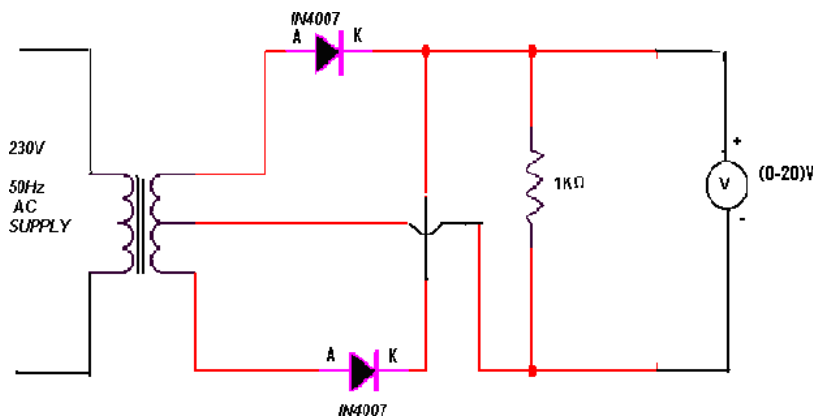
#### THEORY:-

The circuit of a center-tapped full wave rectifier uses two diodes D1&D2. During positive half cycle of secondary voltage (input voltage), the diode D1 is forward biased and D2is reverse biased. The diode D1 conducts and current flows through load resistor RL.

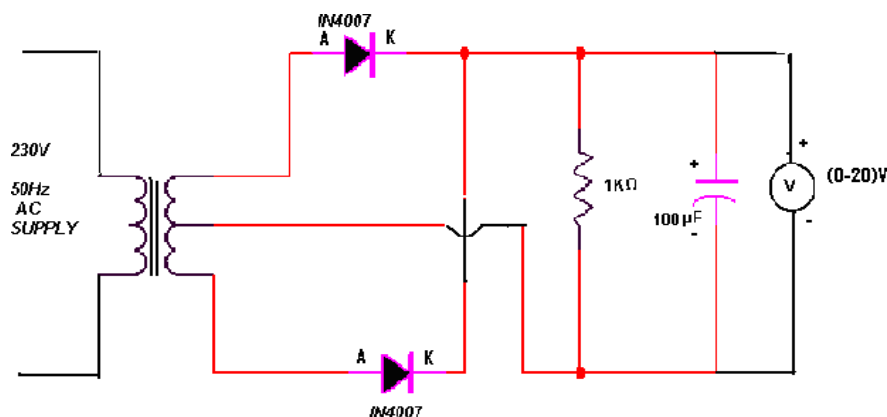
During negative half cycle, diode D2 becomes forward biased and D1 reverse biased. Now, D2 conducts and current flows through the load resistor RL in the same direction. There is a continuous current flow through the load resistor RL, during both the half cycles and will get unidirectional current as 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:

##### WITHOUT FILTER:



### WITH FILTER:



### PROCEDURE:-

Without filter:

1. Connect the circuit as shown in the circuit diagram.
2. Note down the voltage across the secondary of transformer and across the output terminals ( $V_o$ ) i.e. across load resistor  $R_L$  (with 1K, 4.7K, 10K, 100k) use DRB Decade resistance box or discrete component.
3. Vary the  $R_L$  load resistor for different values note down AC and DC voltages across the  $R_L$  using DMM or CRO.
4. Now Disconnect the  $R_L$  and note the No Load voltage  $V_{NL}$ .
5. Calculate the ripple factor & regulation using formula for different loads and tabulate.

With filter:

1. Connect a capacitor (100μf/35V) across the load resistance  $R_L$ .
2. Note down the voltage across the secondary of transformer and across the output terminals ( $V_o$ ) i.e. across load resistor  $R_L$  (with 1K, 4.7K, 10K, 100k) use DRB Decade resistance box or discrete component.
3. Vary the  $R_L$  load resistor for different values note down AC and DC voltages across the  $R_L$  using DMM or CRO.
4. Now Disconnect the  $R_L$  and note the No Load voltage  $V_{NL}$ .
5. Calculate the ripple factor & regulation using formula for different loads and tabulate.

### OBSERVATIONS:

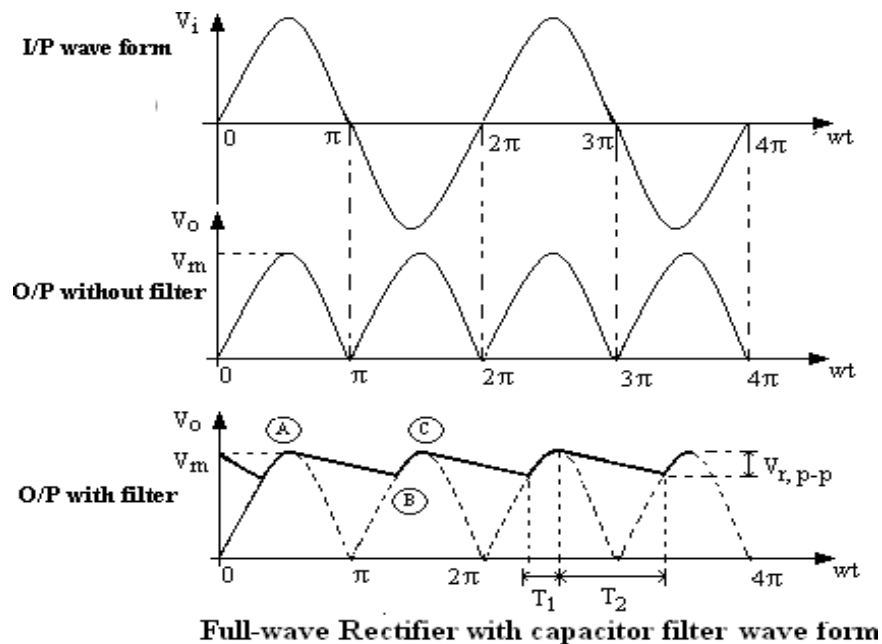
$V_{NL}$  = ----- volts

SL No	$R_L$ (Ohm)	$V_{FL} = V_{dc}$	$V_{ac}$	Ripple factor $r = V_{ac}/V_{dc}$		% Regulation	
				With filter	Without filter	With filter	Without filter

Where % of regulation =  $\frac{V_{NL} - V_{FL}}{V_{FL}} \times 100$   
 $[V_{NL}$  = No load voltage]

VFL= Full load voltage]

waveforms :



#### THEORITICAL CALCULATIONS:-

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

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

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

(i) **Without filter:**

$$\text{Ripple factor, } r = \sqrt{(V_{rms} / V_{dc})^2 - 1} = 0.482$$

(ii) **With filter:**

$$\text{Ripple factor, } r = 1 / (4\sqrt{3} f C R_L) \quad \text{where } f=50\text{Hz}$$
$$C = 100\mu\text{F}$$
$$R_L = 1\text{K}\Omega$$

#### PRECAUTIONS:

1. Check the wires for continuity before use.
2. Keep the power supply at Zero volts before Start.
3. All the contacts must be intact.

**RESULT:** Observe Input and Output Wave forms and Calculate ripple factor and percentage of regulation in Full-wave rectifier with and without filter.

**Without Filter:**

Ripple Factor  
: Regulation:

**With Capacitor Filter:**

Ripple Factor  
: Regulation:



### VIVA QUESTIONS:-

1. Define regulation of the full waverectifier?
2. Define peak inverse voltage (PIV)? And write its value forFull-wave rectifier?
3. If one of the diode is changed in its polarities what wave form would you get?
4. Does the process of rectification alter the frequency of the waveform?
5. What is ripple factor of the Full-waverectifier?
6. What is the necessity of the transformer in the rectifiercircuit?
7. What are the applications of arectifier?
8. What is meant by ripple and define Ripplefactor?
9. Explain how capacitor helps to improve the ripplefactor?
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27. Explain how capacitor helps to improve the ripplefactor?
28. What is ripple factor of the Full-waverectifier?
29. What is the necessity of the transformer in the rectifiercircuit?
30. What are the applications of arectifier?
31. Compare the efficiency of HWR you have done with the FWR circuit designedwith capacitorfilter?
32. Compare the efficiency of HWR you have done with the FWR circuit designedwith inductorfilter?
33. Compare the efficiency of FWR circuit designed with inductor filter and Capacitorfilter?
34. Compare the performance between HWR with Filter and FWR withoutfilter?
35. Compare between HWR and FWR withoutfilters?
36. Give some rectificationstechnologies?
37. In filters capacitor is always connected in parallel,why?
38. What is the value of PIV of a center tappedFWR?
39. What is the location of poles of filter inS-plane?
40. What is the output of FWR with filter? Is itunidirectional?
41. Define Ripple factor ' $\gamma$ ' and its values for the three types ofrectifiers.
42. What is the value of No load voltage for all the three types of therectifiers

43. What are the different types of filters used for the rectifiers?
44. DC average current of a center tapped full wave rectifier  
(Where  $I_m$  is the max  $I_m$  peak current of input)
45. DC power output of center tapped full wave rectifier is equal to ( $I_m$  is the peak current and  $R_L$  is the load resistance)
46. If input frequency is 50 Hz then ripple frequency of center tapped full wave rectifier will be equal to
47. Transformer utilization factor of a center tapped full wave rectifier is equal to
48. If peak voltage on a center tapped full wave rectifier circuit is 5V and diode cut-in voltage is 0.7, then peak inverse voltage on diode will be
49. In a center tapped full wave rectifier, the input sine wave is  $20 \sin 500 \pi t$ . The average output voltage is
50. In a center tapped full wave rectifier, the input sine wave is  $200 \sin 50 \pi t$ . If load resistance is of 1k then average DC power output of half wave rectifier is

### Design Problems

1. Study the performance of FWR with filter  $R_L = 2K$ ,  $C = 0.047 \mu F$
2. Study the performance of FWR with filter  $R_L = 15K$ ,  $C = 0.047 \mu F$  using GE diode.
3. Study the performance of FWR with filter  $R_L = 5K$ ,  $C = 0.1 \mu F$ , invert diode.
4. Study the performance of FWR with filter  $R_L = 5K$ ,  $C = 0.94 \mu F$ , invert diode.
5. Study the performance of FWR with  $R_L = 5K$  using GE diode, invert diodes.
6. Study the performance of FWR with filter  $R_L = 10K$ ,  $C = 0.1 \mu F$
7. Study the performance of FWR with filter  $R_L = 2K$ ,  $C = 0.047 \mu F$
8. Study the performance of FWR with filter  $R_L = 15K$ ,  $C = 0.047 \mu F$  using GE diode.
9. Study the performance of FWR with filter  $R_L = 5K$ ,  $C = 0.1 \mu F$ , invert diode.
10. Study the performance of FWR with filter  $R_L = 5K$ ,  $C = 0.94 \mu F$ , invert diode
11. Study the performance of FWR with filter  $R_L = 100K$ ,  $C = 0.1 \mu F$
12. Find the efficiency of the full wave rectifier designed with a CLC Filter?
13. Find the ripple factor of the FWR with Capacitor filter?
14. Find the ripple factor of the FWR with Inductor filter?
15. Study the performance of FWR with filter  $R_L = 50K$ ,  $C = 0.047 \mu F$
16. Study the performance of FWR with  $R_L = 2K$ ?
17. Study the performance of FWR with  $R_L = 5K$ ?
18. Study the performance of FWR with  $R_L = 5K$  using GE diode?
19. Study the performance of FWR with  $R_L = 5K$ , invert the diodes?
20. Study the performance of FWR with  $R_L = 2K$ ?
21. Study the performance of FWR with  $R_L = 5K$ ?
22. Study the performance of FWR with  $R_L = 5K$  using GE diode?
23. Study the performance of FWR with  $R_L = 5K$ , invert the diodes?
24. Study the performance of FWR with  $R_L = 5K$  using GE diode, invert diodes?
25. Study the performance of FWR with filter  $R_L = 10K$ ,  $C = 0.1 \mu F$

### REALTIME APPLICATIONS:

The full wave rectifier circuit is one that is widely used for power supplies and many other areas where a full wave rectification is required.

The full wave rectifier circuit is used in most rectifier applications because of the advantages it offers. While it is a little more complicated, this normally outweighs the disadvantages. However sometimes it may not be optimum or necessary to use a full wave rectifier circuit

## EXPT NO: 6

### **INPUT AND OUTPUT CHARACTERISTICS OF FET IN CS CONFIGURATION**

#### **AIM: -**

1. To study the Drain and Transfer characteristics of FET
2. To find the Drain resistance Trans-conductance and amplification factor

#### **EQUIPMENTS & COMPONENTS REQUIRED:**

S.No	Device	Range/Rating	Qty
1.	(a) Regulated DC supply voltage	0-30V	1
2.	Voltmeter	,0-20V	2
3.	Ammeter	0-10mA or 200mA	1
4.	Connecting wires & bread board		
5.	FET transistor	BFW10/11 or BF245A	1
6.	Resistor	100 $\Omega$ , 560 $\Omega$	1 each

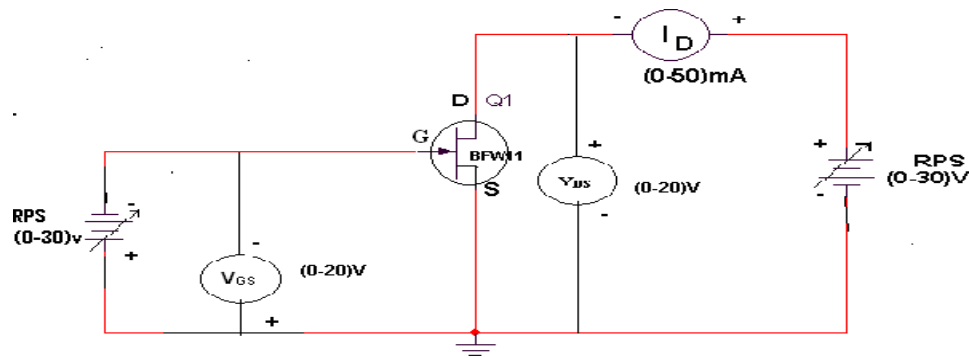
#### **Theory:**

The **field-effect transistor** (FET) is a transistor that uses an electric field to control the shape and hence the conductivity of a channel of one type of charge carrier in a semiconductor material. FETs are unipolar transistors as they involve single-carrier-type operation.

A FET is a three terminal device, having the characteristics of high input impedance and less noise, the Gate to Source junction of the FET is always reverse biased. In response to small applied voltage from drain to source, the n-type bar acts as sample resistor, and the drain current increases linearly with  $V_{DS}$ . With increase in  $I_D$  the ohmic voltage drop between the source and the channel region reverse biases the junction and the conducting position of the channel begins to remain constant. The  $V_{DS}$  at this instant is called “pinch off voltage”.

If the gate to source voltage ( $V_{GS}$ ) is applied in the direction to provide additional reverse bias, the pinch off voltage will be decreased. In amplifier application, the FET is always used in the region beyond the pinch-off.

## CIRCUIT DIAGRAM:



## PROCEDURE: -

### Drain or Static characteristics

1. Connect the circuit according to the circuit diagram as shown in figure.
2. Keep the power supply knob to minimum position.
3. Switch on supply keep the gate to source voltage  $V_{GS}=0V$ .
4. Increase the drain supply  $V_{DD}$  from  $0V$  onwards in steps.
5. Note down current  $I_D$  and Drain to source voltage  $V_{DS}$  without exceeding the rated value.
6. Repeat the above procedure for  $V_{GS}=-1V, -0.5V$
7. Tabulate the results and plot the graph.

### Transfer characteristics:

1. keeping the same circuit connections bring the Knobs of supply to minimum.
2. Now vary  $V_{DS}$  drain to source voltage at  $1V$  by Varying  $V_{DD}$  Drain supply voltage.
3. Increasing the gate to source voltage  $V_{GS}$  from  $0V$  onwards in suitable steps..
4. Note down the corresponding variation in  $I_D$  until it becomes  $0V$ .
5. Repeat the above 3 step for  $V_{DS}=2V$  &  $4V$  constant
6. Tabulate the results and plot graph.

## Tabular column

### Drain or Static characteristics

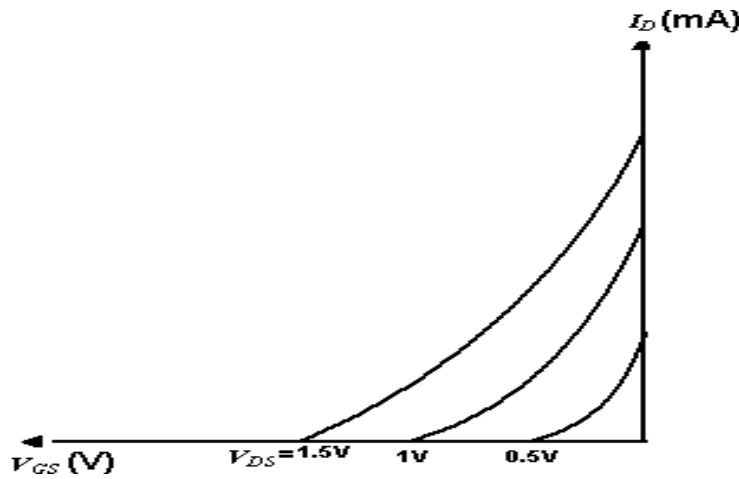
$V_{GS}=0$		$V_{GS}=0.5$		$V_{GS}=0.1$	
$V_{DS}$ in volts	$I_D$ in mA	$V_{DS}$ in volts	$I_D$ in mA	$V_{DS}$ in volts	$I_D$ in mA

**Transfer characteristics**

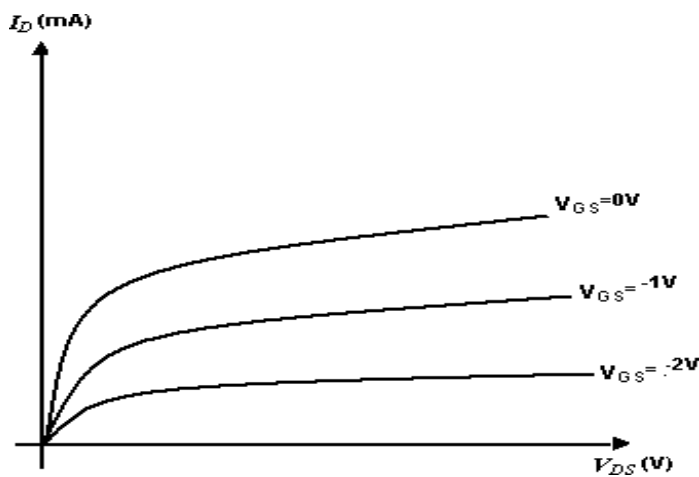
VDS=-1		VDS=-2		VDS=-3	
VGS in volts	ID in mA	VGS in volts	ID in mA	VGS in volts	ID in mA

**EXPECTEDGRAPH:**

**TRANSFER CHARACTERISTICS**



**DRAIN CHARACTERISTICS**



## **CALCULATIONS:**

### **CALCULATION OF**

**$r_d$  :**

Construct a Triangle on one of the output characteristic for a particular  $V_{GS}$  in the active region and find  $\Delta V_{DS}$  and  $\Delta I_D$

Now  $r_d = \Delta V_{DS} / \Delta I_D$  ( $V_{GS} = \text{constant}$ )

### **CALCULATION OF $g_m$ :**

Construct a Triangle on one of the Transfer characteristics for a particular  $V_{DS}$  find  $\Delta V_{GS}$  and  $\Delta I_D$ .

Now  $g_m = \Delta I_D / \Delta V_{GS}$  ( $V_{DS} = \text{constant}$ ).

### **CALCULATION OF $\mu$ :**

$$\mu = g_m \times r_d.$$

## **PRECAUTIONS:**

1. Always keep the supply voltage knobs i.e.  $V_{DD}$ ,  $V_{GG}$  position at minimum position when switching on and off
2. Practically FET contains four terminals, which are called source, drain, Gate, substrate.
3. Source and case should be shortcircuited.
4. Voltages exceeding the ratings of the FET should not be applied.
5. Never load the meters above the rated range.
6. Avoid loose contacts at the junction.

## **RESULT: -**

Characteristics of CS configuration is verified.

## **VIVA QUESTIONS:**

1. Why FET is called as a unipolar device?
2. Name the terminals of FET?
3. What is the difference between BJT and FET?
4. What are the major applications of FET?
5. What are the advantages of FET?
6. Difference between MOSFET and FET?
7. Give the applications of MOSFET?
8. What is the basic configuration of JFET?
9. What is depletion mode and enhancement mode?
10. What is trans-conductance and amplification factor?
11. Why FET is called as a unipolar device?
12. Name the terminals of FET?
13. What is the difference between BJT and FET?
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19. What is depletion mode and enhancement mode?
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21. Why FET is called as a unipolar device?

22. Name the terminals of FET?
23. What is the difference between BJT and FET?
24. What are the major applications of FET?
25. What are the advantages of FET?
26. Difference between MOSFET and FET?
27. Give the applications of MOSFET?
28. What is the basic configuration of JFET?
29. What is depletion mode and enhancement mode?
30. What is trans-conductance and amplification factor?
31. Define channel?
32. Draw the transfer characteristic for n-channel depletion type MOSFET?
33. Why FET is called as “voltage operated device”?
34. Which MOSFET is called as Normally ON MOSFET and NORMALLY OFF MOSFET? Why?
35. Compare BJT and FET
36. Define Amplification factor in JFET?
37. What are the advantages of FET over BJT?
38. What are the important features of FET?
39. Explain the biasing of JFET?
40. Define Drain resistance.
41. Define Transconductance?
42. Explain the term Drain in FET?
43. Write the relative disadvantages of an FET over that of a BJT?
44. List the characteristics of JFET.
45. Why MOSFET is called IGFET?
46. Compare P channel and N channel JFET.
47. Write the advantages of JFET?
48. What are the applications of JFET?
49. Define JFET?
50. Differences between Unipolar and Bipolar Device

### Design Problems

1. Study the Drain and Transfer characteristics of BFW 10 with  $R_I = 50\Omega$ .
2. Study the Drain and Transfer characteristics of BFW 10 with  $R_L = 280\Omega$ .
3. Study the Drain and Transfer characteristics of BFW 10 with  $R_I = 50\Omega$ ,  $R_L = 280\Omega$ .
4. Study the Drain and Transfer characteristics of BFW 10 with  $R_I = 200\Omega$ .
5. Study the Drain and Transfer characteristics of BFW 10 with  $R_L = 1120\Omega$ .
6. Study the Drain and Transfer characteristics of P channel JFET BFW 11 with  $R_I = 50\Omega$ .
7. Study the Drain, Transfer characteristics of P channel JFET BFW 11 with  $R_L = 280\Omega$ .
8. Study the Drain, Transfer characteristics of P-JFET BFW 11 with  $R_I = 50\Omega$ ,  $R_L = 280\Omega$ .
9. Study the Drain and Transfer characteristics of P channel JFET BFW 11 with  $R_I = 200\Omega$ .
10. Study the Drain, Transfer characteristics of P channel JFET BFW 11 with  $R_L = 1120\Omega$ .
11. Study the Drain and Transfer characteristics of BFW 10 with  $R_I = 50\Omega$ .
12. Study the Drain and Transfer characteristics of BFW 10 with  $R_L = 280\Omega$ .
13. Study the Drain and Transfer characteristics of BFW 10 with  $R_I = 50\Omega$ ,  $R_L = 280\Omega$ .
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20. Study the Drain, Transfer characteristics of P channel JFET BFW 11 with  $R_L = 1120\Omega$ .
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22. Study the Drain and Transfer characteristics of BFW 10 with  $R_L = 280\Omega$ .
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