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 Section2(f) & 12(B)of the UGC act,1956

DEPARTMENT MECHANICAL ENGINEERING

BASIC ELECTRICAL AND ELECTRONIC ENGINEERING
LAB MANUAL

SUBJECT NAME	**Basic Electrical and Electronic Engineering Lab**
SUBJECT CODE	**1940272**
COURSE-BRANCH	**B. Tech - Mechanical Engineering**
YEAR-SEMESTER	**II - II**
ACADEMIC YEAR	**2020-2021**
REGULATION	**MLRS-R19**

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:

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

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	1kΩ	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.

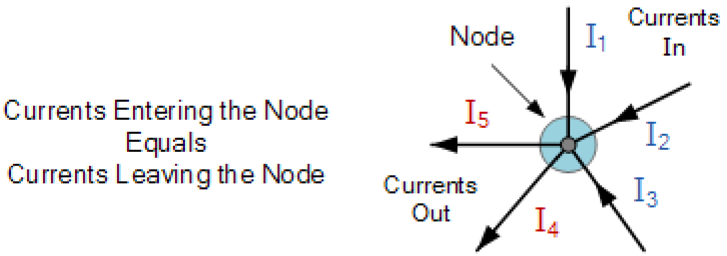
In 1845, a German physicist, Gustav Kirchhoff developed a pair or set of rules or laws which deal with the conservation of current and energy within electrical circuits. These two rules are commonly known as: Kirchhoff's Circuit Laws with one of Kirchhoff's laws dealing with the current flowing around 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(exiting) + I(entering) = 0. This idea by Kirchhoff is commonly known as the **Conservation of Charge**.

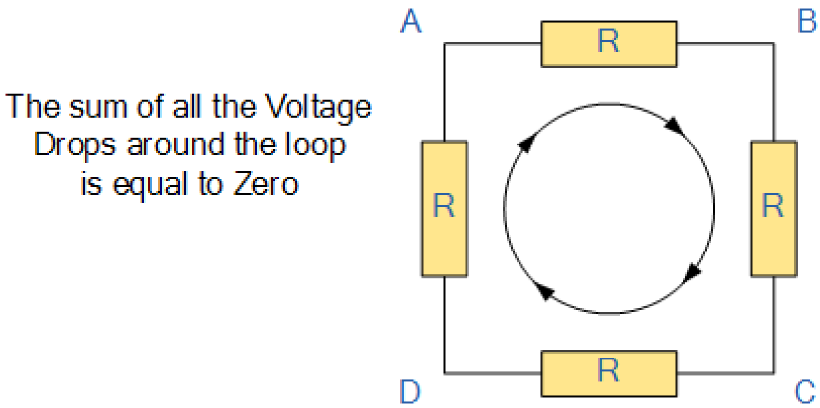
Kirchhoff's Current Law



$$I_1 + I_2 + I_3 + (-I_4 + -I_5) = 0$$

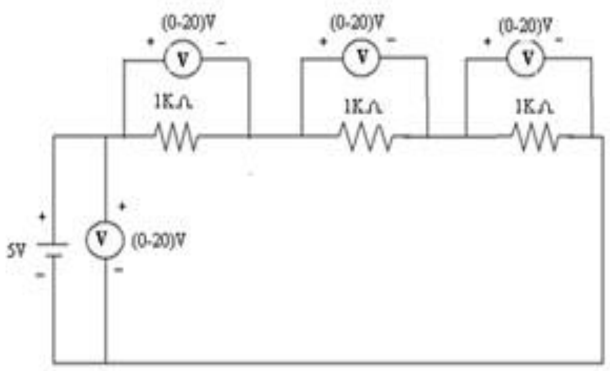
2. Kirchhoff's Second Law – The Voltage Law, (KVL)

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**.

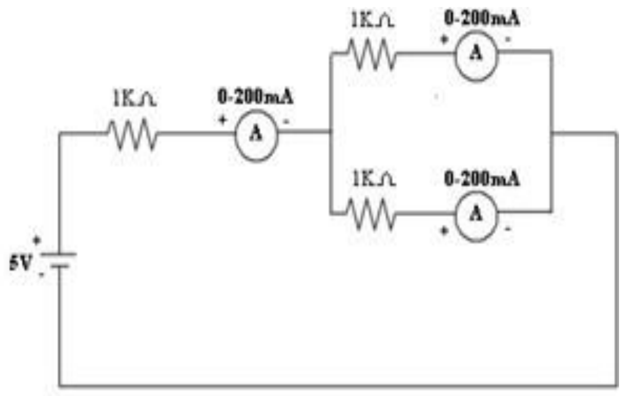


$$V_{AB} + V_{BC} + V_{CD} + V_{DA} = 0$$

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):____________________

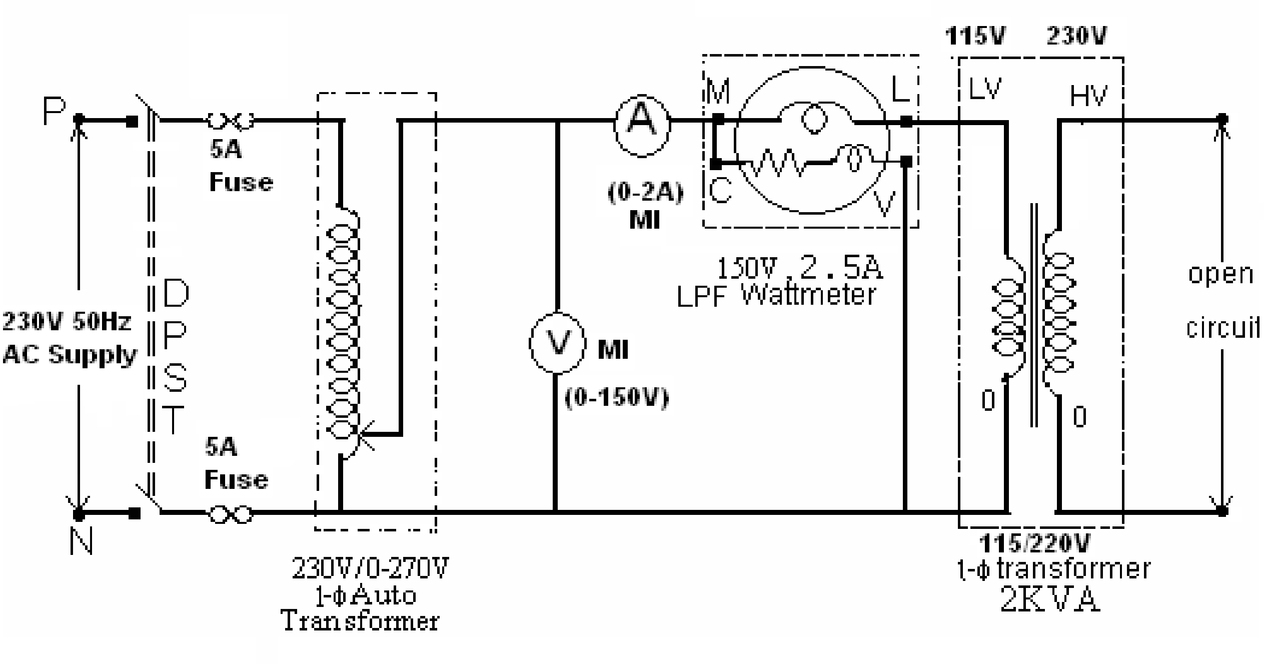
Output Voltage (in Volts): ____________________

Frequency (in Hz):____________________________

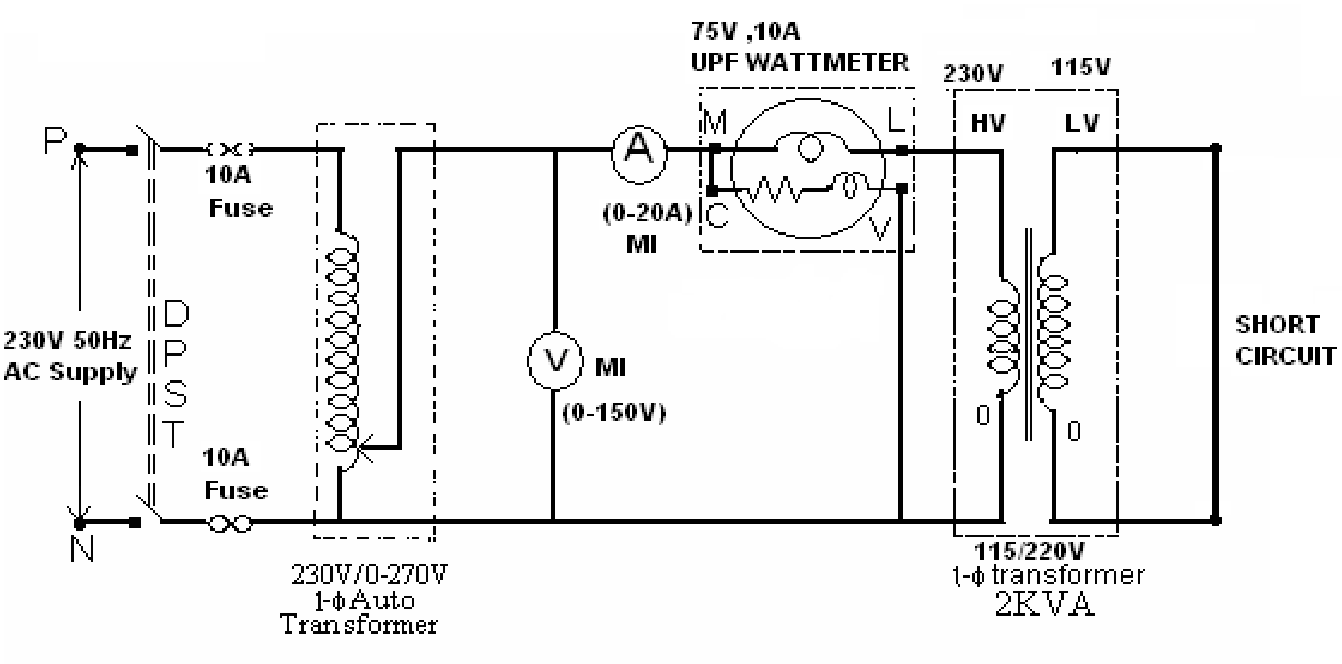
Current rating (in Amp):______________________

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 Ro and Xo 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 Ro_1 and Xo_1 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(Vsc)	Ammeter Reading(Isc)	Wattmeter Reading(Wsc)	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-Φ 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 Δ-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): _______________

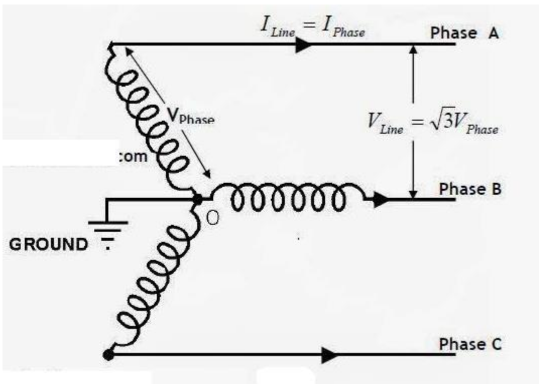
Frequency (in Hz):______________________

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.

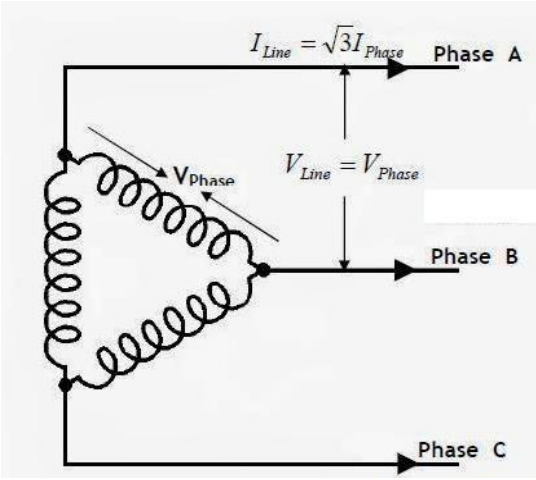
In Star (also denoted by Y) system of interconnection, the starting ends or finishing ends (similar ends) of three coils are connected together to form the neutral point. or Star Connection is obtained by connecting together similar ends of the three coils, either “Starting” or “Finishing”. The other 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 (Δ) 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 Δ) 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.



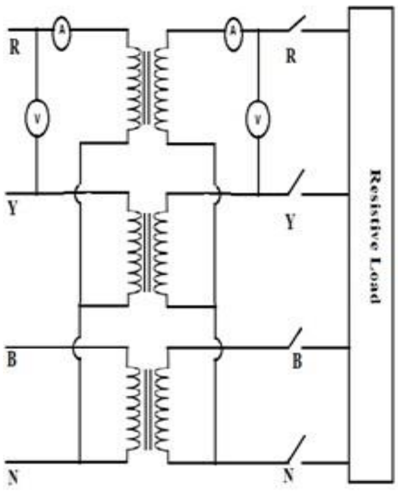
In more clear words, all three coils are connected in series to form a close mesh or circuit. Three wires are taken out from three junctions and the all outgoing currents from junction assumed to be positive.

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.

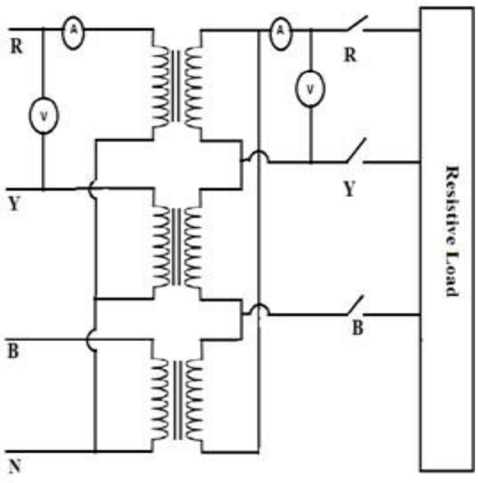
When a terminal is open in Δ, then there is no chance of flowing currents with basic frequency around the closed mesh.

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

ROCEDURE:

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	$\boldsymbol{Y} - \boldsymbol{Y}$										
2	$\boldsymbol{Y} - \Delta$										
3	$\Delta - \boldsymbol{Y}$										
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° 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°. 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 Δ - 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°. In recent years, this arrangement has become very popular for distribution system as it provides 3- Ø, 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 Δ-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 Δ-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:

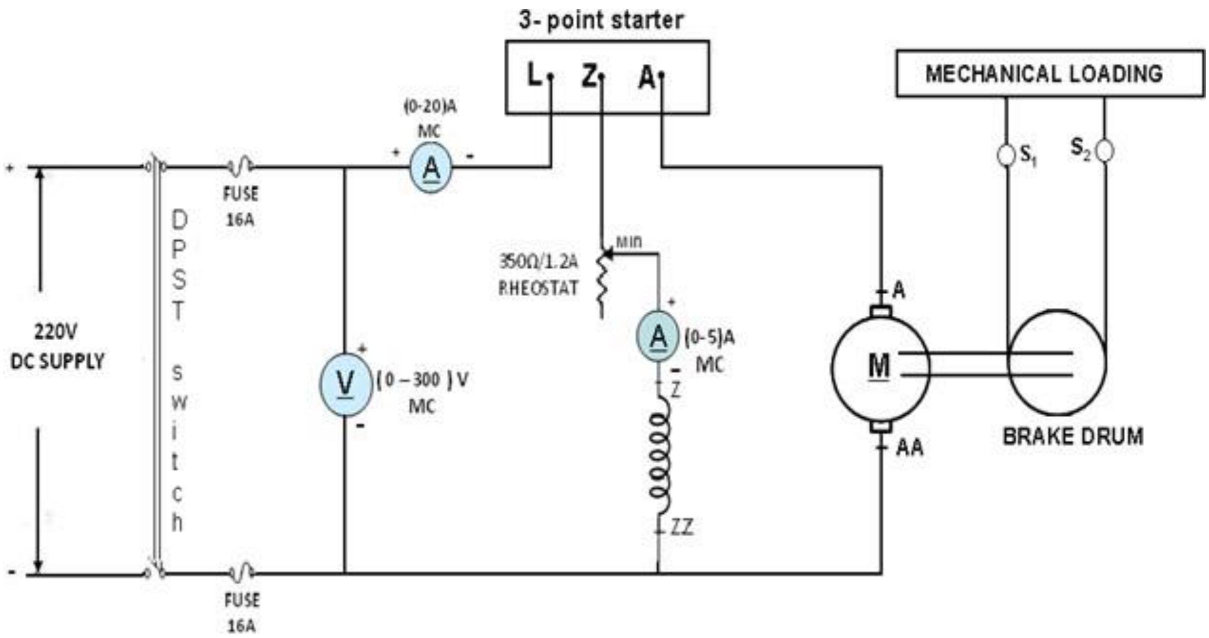
S.No.	Name of the Equipment	Range	Type	Quantity
1	Ammeter	(0 -20) A	MC	1
2	Ammeter	(0 -5) A	MC	1
3	Voltmeter	(0 -300) V	MC	1
4	Rheostat	350Ω/ 1.2A	WW	2
5	Tachometer	(0 -9999)rpm	Digital	1
8	Connecting wires	As required		

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 S1 and S2 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 current

   are plotted.

OBSERVATION TABLE:

S. No	V_L (V)	I_L (A)	I_F (A)	I_A (A)	Speed (rpm)	S_1 (Kg)	S_2 (Kg)	Torque (N-m)	Input (W) V x I	Output (W)= $2MNT/60$	Efficiency Output/Input

MODEL CALCULATION:

FORMULAE:

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

Output = $2MNT / 60$

Input = $V*I_L$

Efficiency = Output /Input

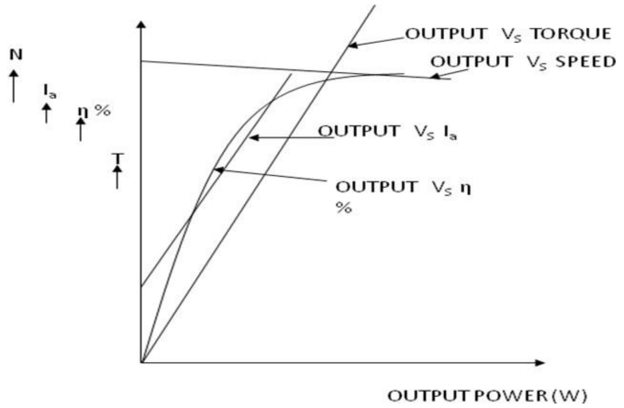
Radius of the brake drum = R in mts

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-Φ INDUCTION MOTOR

AIM:

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

NAME PLATE DETAILS:

S. No	Parameter	3-Φ 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:

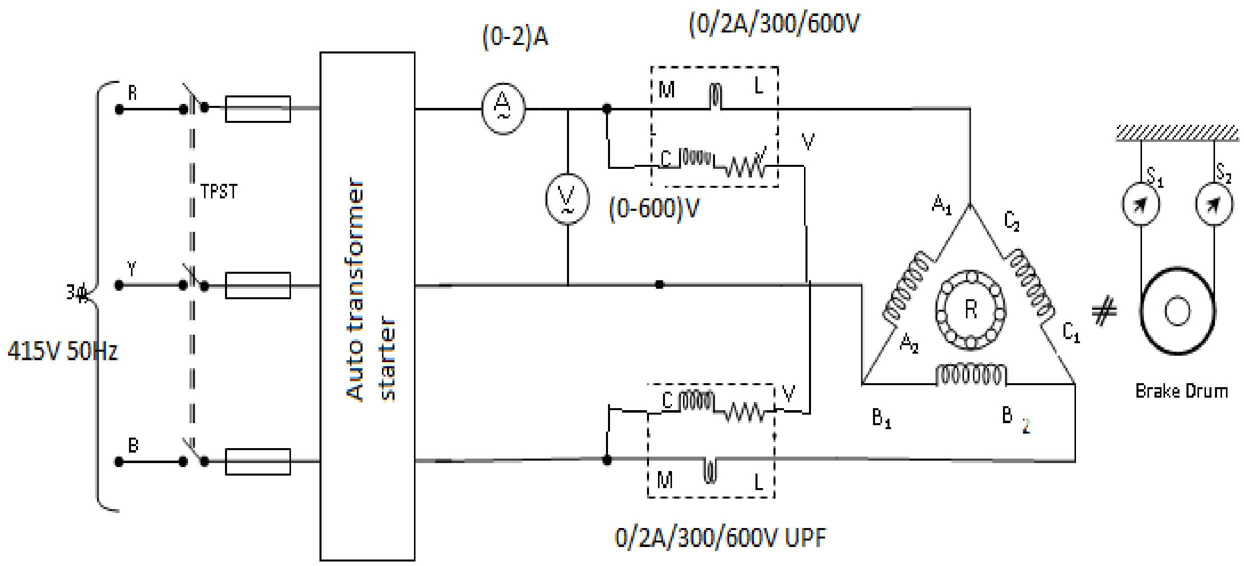
As a general rule, conversion of electrical energy to mechanical energy takes place in to the rotating part on electrical motor. In DC motors, electrical power is conduct directly to the armature, i.e, rotating part through brushes and commutator. Hence, in this sense, a DC motor can be called as 'conduction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

OBSERVATION TABLE:

S. No	V_L (V)	I_L (A)	Speed (rpm)	S_1 (Kg)	S_2 (Kg)	Torque (N-m)	Input (W) W_1+W_2	Output (W)= $2MNT/60$	Efficiency Output/Input

MODEL CALCULATION:

FORMULAE:

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

Output = $2MNT / 60$

Input = W_1+W_2

Efficiency = Output /Input

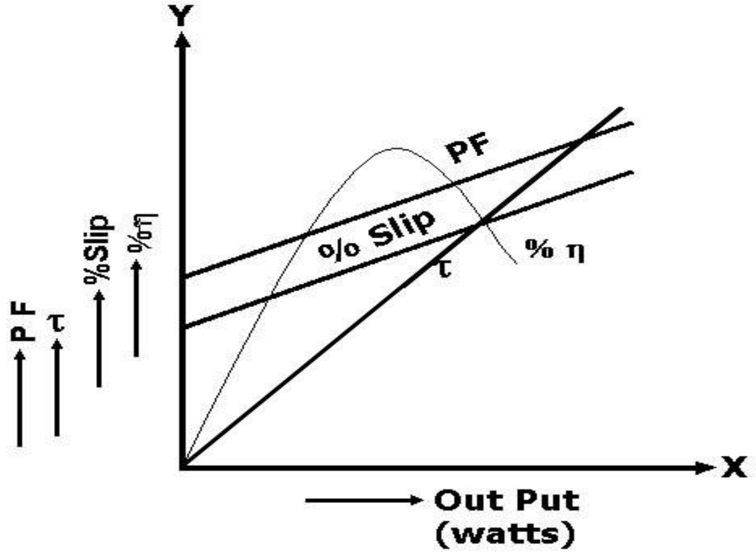
Radius of the brake drum = R in mts

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:

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	400Ω/1.7A	WW	1
5	Rheostat	145Ω/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 (Ra).

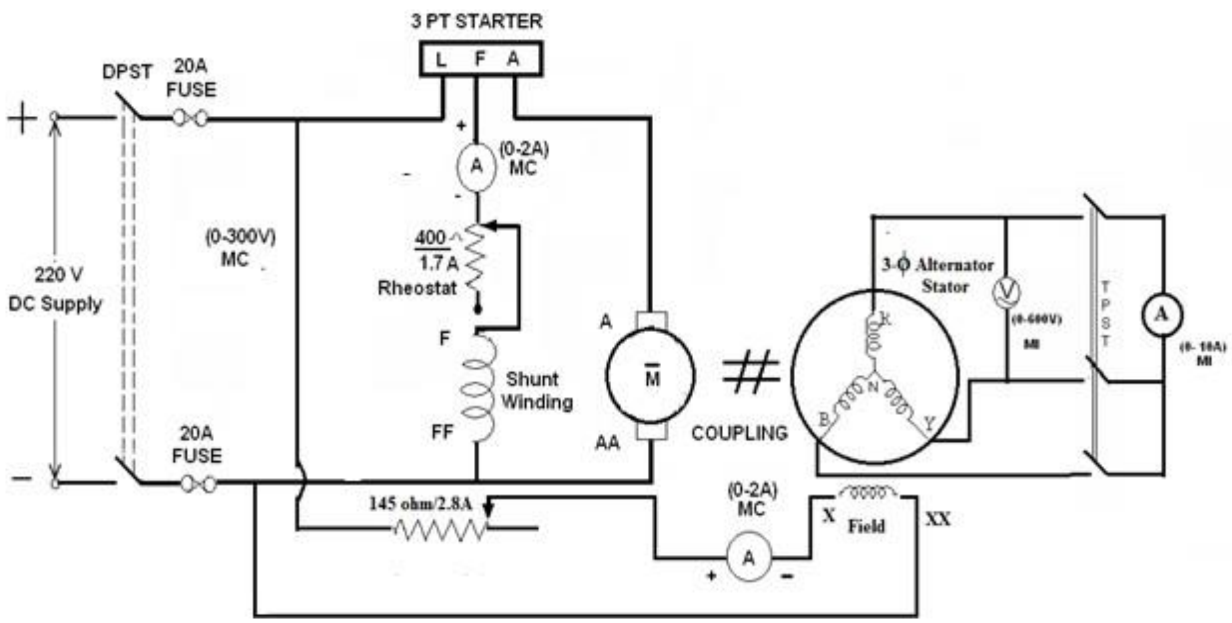
The open circuit and short circuit characteristics of a 3-Φ alternator is plotted on Per phase basis. To find out the synchronous impedance from these characteristics, open circuit voltage, (E_0) and short circuit current (I_{sc},) corresponding to a particular value of field current is obtained. Then, synchronous impedance per phase (Zs) 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 'Zs' calculated for the unsaturated region of the O.C.C is called the unsaturated value of the synchronous impedance. If 'Ra' is the effective resistance of the armature per phase, the synchronous reactance 'Xs' 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 (Φ)then the corresponding magnitude of the open circuit voltage 'E_0' is given byE_0=V+IZs

Percentage of regulation = $\frac{(E_0 - V)}{V} X100.$

CIRCUIT DIAGRAM:



PROCEDURE:

OPEN CIRCUIT TEST:

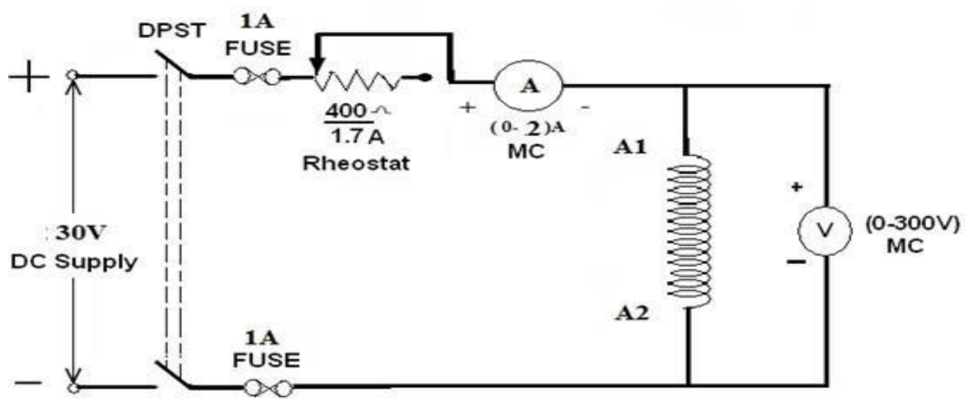
1. Make the connections as per the circuit diagram.
2. Before starting the experiment, the potential divider network in the alternator field circuit is maximum and field regulator rheostat of motor circuit is set minimum resistance position.

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_0 vs I_f. and I_a vs I_f.

CONNECTION DIAGRAM TO FIND Ra:



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 Ra of armature is found out.

OBSERVATION TABLE

Sl no.	Armature current I(amp)	Armature voltage Va (volts)	Rdc=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:

Zs = Voc/Isc for the same If and speed $X_s = \sqrt{Z_s^2 - R_s^2}$

Generated emf of alternator = $\sqrt{(V_{ph}cos\Phi + I_aR_a)^2 + (V_{ph}sin\Phi \pm I_ax_s)^2}$

+ Sign for lagging power factor loads

- Sign for leading power factor loads

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

% 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(Voc)	Field current (I_f)	SC current per phase(I_{SC})

PRECAUTIONS:

1. Loose connections are to be avoided.

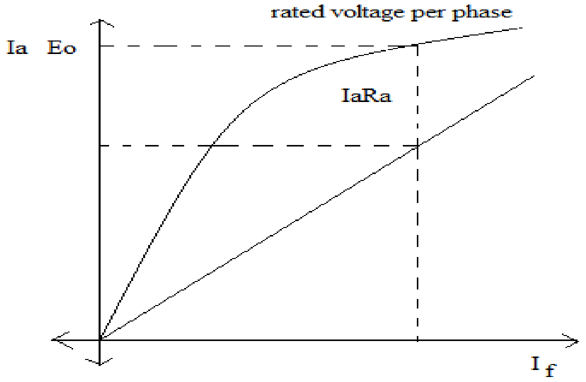
2.The rheostat in the motor field circuit is kept in minimum position.

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 β?
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 isproduced.

Oscilloscopescontainavacuumtubewithacathode(negativeelectrode)atoneendtoemit 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 andleft/right.

Theelectronsarecalledcathoderaysbecausetheyareemittedbythecathodeandthisgives the oscilloscope its full name of cathode ray oscilloscope orCRO.

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.

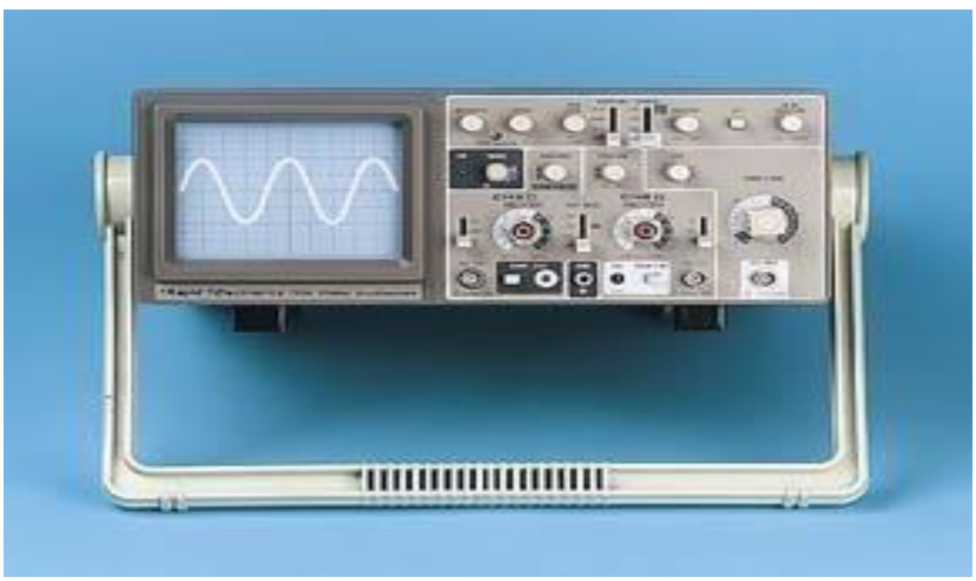


Figure1: Front Panel of CRO

- **BASIC OPERATION:**

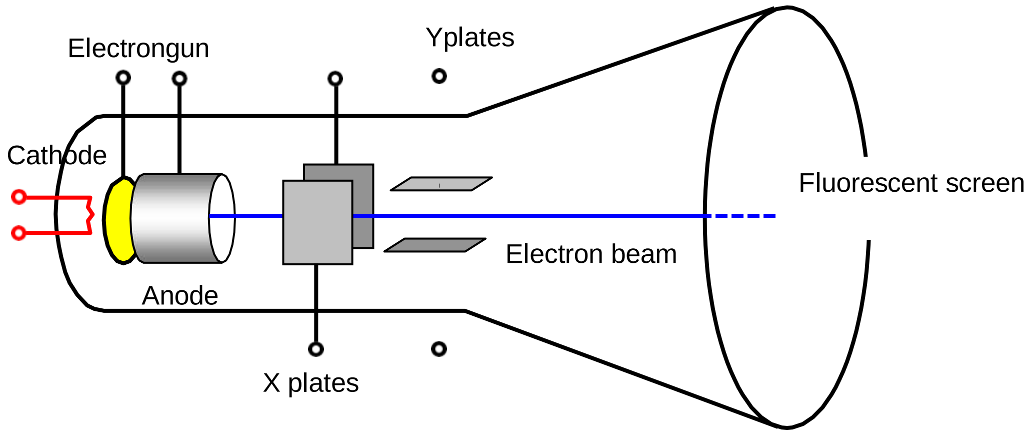


Figure2: Internal Blocks of CRO

- **Setting up an oscilloscope:**

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

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 ortwo).
2. Do not connect the input lead at thisstage.
3. Set the AC/GND/DC switch (by the Y INPUT) toDC.
4. Set the SWP/X-Y switch to SWP(sweep).
5. Set Trigger Level toAUTO.
6. Set Trigger Source to INT (internal, the yinput).
7. Set the Y AMPLIFIER to 5V/cm (a moderatevalue).
8. Set the TIMEBASE to 10ms/cm (a moderatespeed).
9. Turn the time base VARIABLE control to 1 orCAL.
10. Adjust Y SHIFT (up/down) and X SHIFT (left/right) to give a trace acrossthe middle of the screen, like thepicture.
11. Adjust INTENSITY (brightness) and FOCUS to give a bright, sharptrace.

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

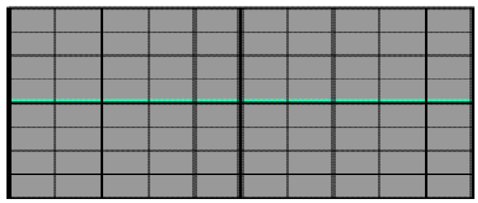


Figure 3: Absence of input signal

- **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).

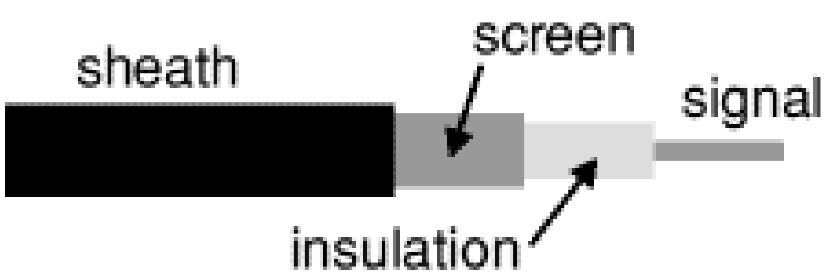


Figure 4: Construction of a co-axial lead

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.

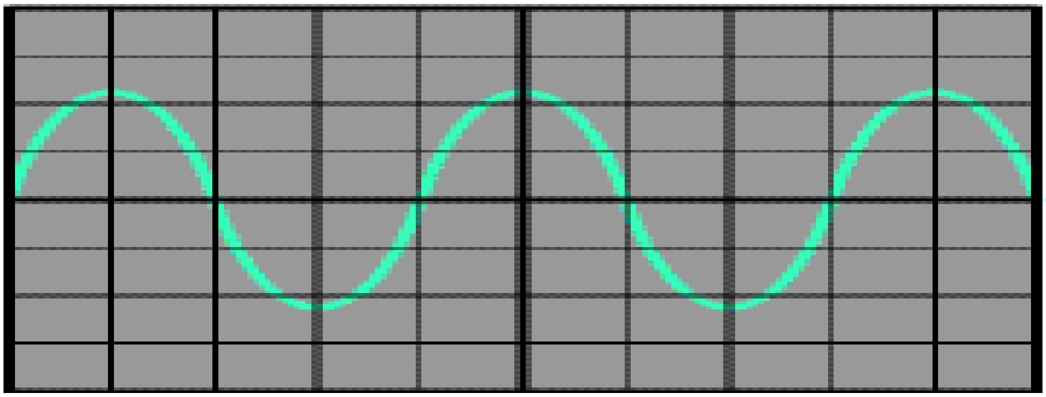


Figure 6 : Stable waveform

- **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

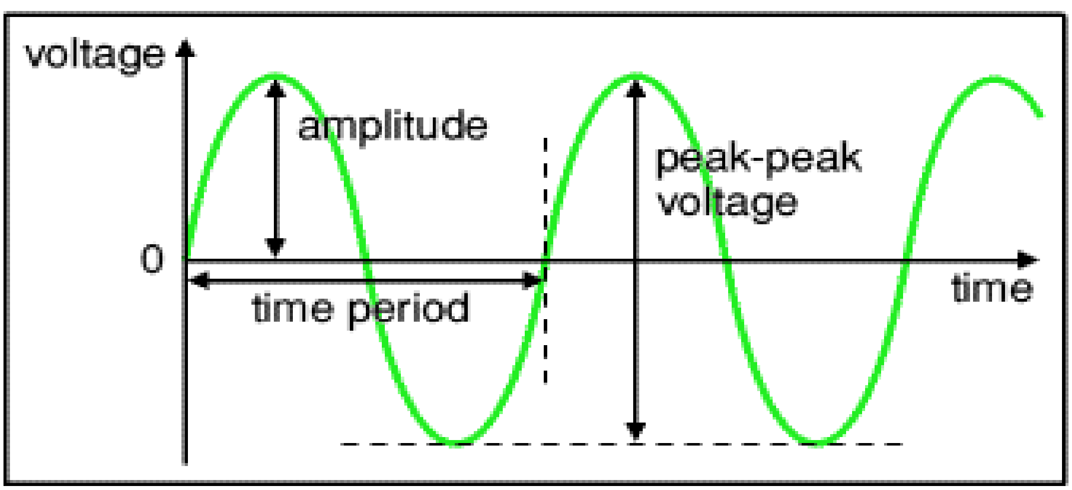


Figure7: Properties of trace

- **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 (µs) are often used. 1ms = 0.001s and 1µs = 0.000001s.
- **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. 1kHz = 1000Hz and 1MHz = 1000000Hz.

$$\text{Frequency} = \frac{1}{\text{Time period}}$$

$$\text{Time period} = \frac{1}{\text{Frequency}}$$

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-peakvoltage.

Voltage = distance in cm × 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 thetimefor one cycle of the signal. The frequency is the number of cycles per second, frequency = 1/timeperiod.

Time = distance in cm × 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.

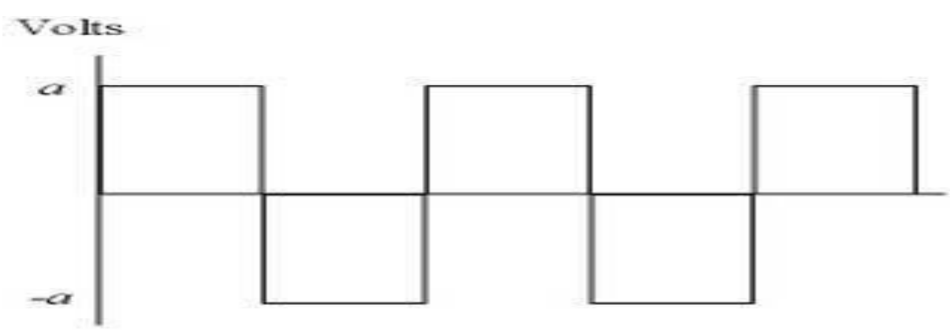


Figure 2: Square wave

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.

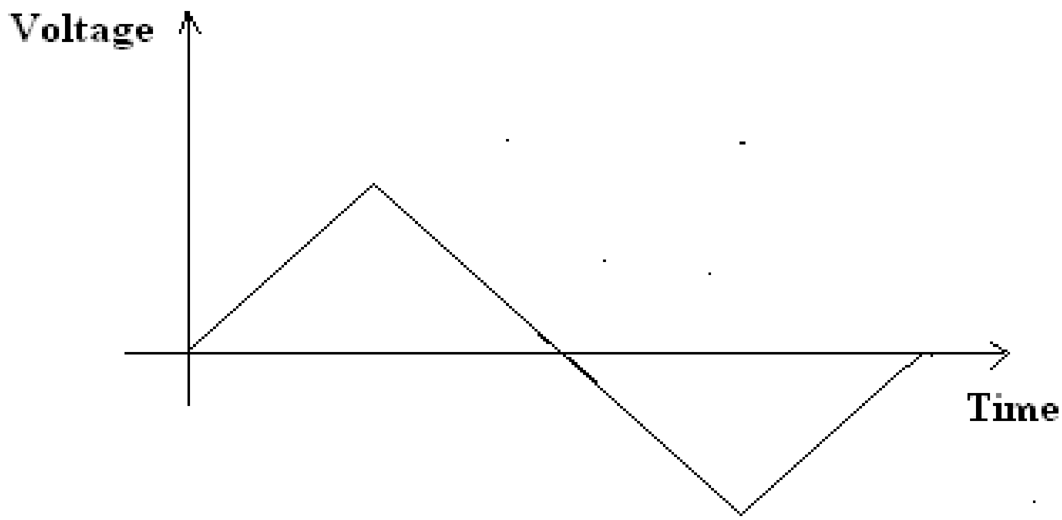


Figure 4: Triangular Wave

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.Onsomefunctiongenerators,thefrequencycontrolisacombinationofdifferent 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 forsignals.

- **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,thenattachthesignalandgroundleadsfromthefunctiongeneratortotheinputand ground of the device under test. For some applications, the negative lead of the function generatorshouldattachtoanegativeinputofthedevice,but usuallyattachingtogroundis 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 by broken down into a series of blocks, each of which performs a particular function. For example a 5V regulated supply:

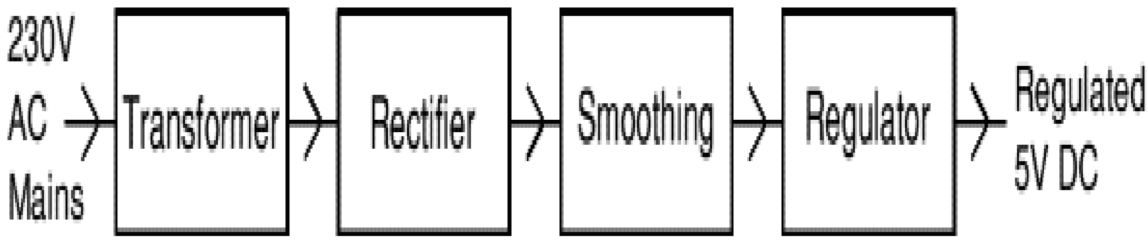


Figure1: Block Diagram Of Regulated Power Supply

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 ±9V supply has +9V, 0V and -9V outputs.

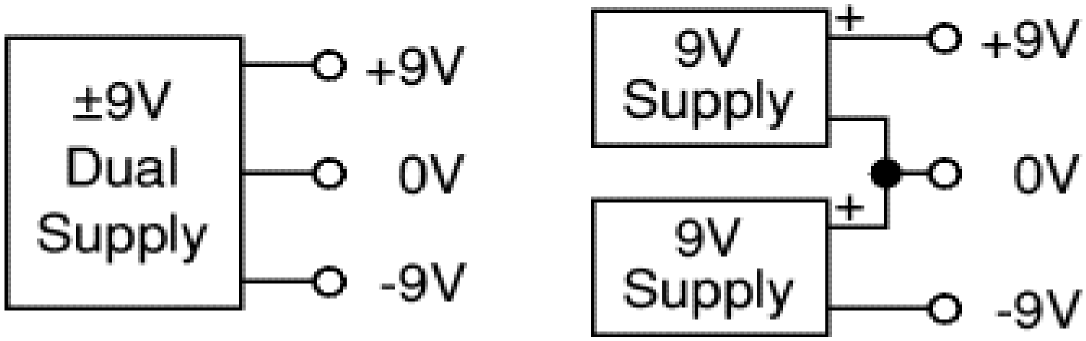


Figure 2: Dual Supply

EXP NO: 2
PN JUNCTION DIODE CHARACTERSTICS A)FORWARD BIAS B) REVERSEBIAS

AIM: -

1. To study the characteristics of PN junction diodeunder
   a) Forwardbias. b) Reversebias.
2. To find the cut-in voltage (Knee voltages) static & dynamic resistance in forward & reversedirection.

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	1kΩ,10kΩ	

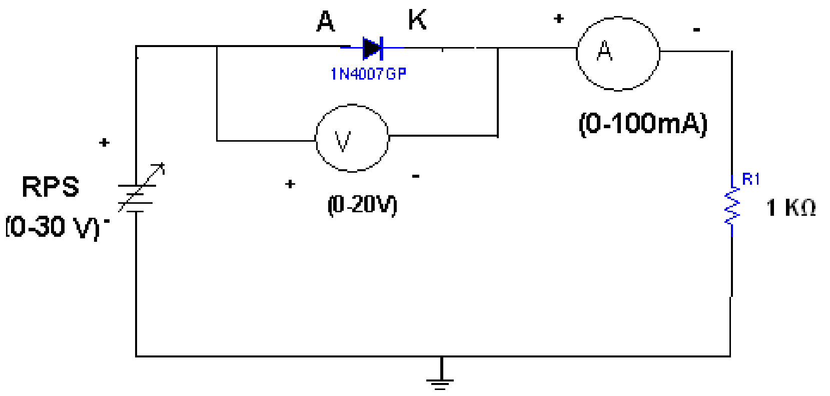
THEORY:

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 andcurrent

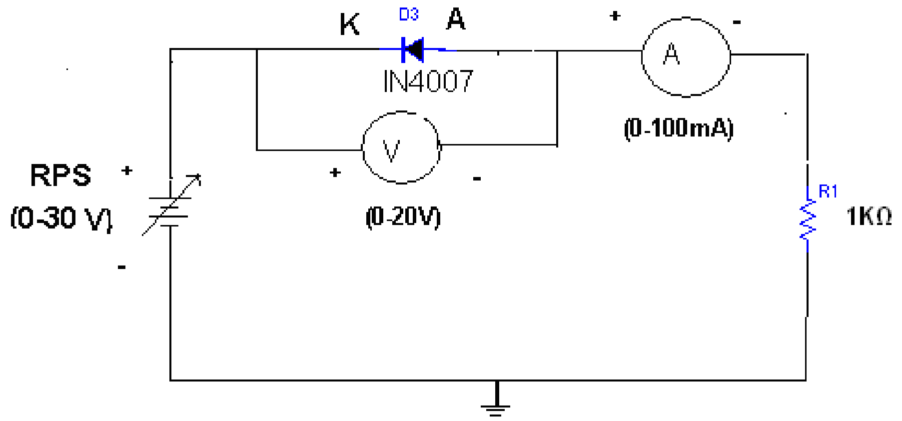
starts flowing through the diode and also in the circuit. The diode is said to be in ON state. The current increases with increasing forward voltage. When N-type (cathode) is connected to +ve terminal and P-type (Anode) is connected –ve terminal of the supply voltage is known as reverse

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.

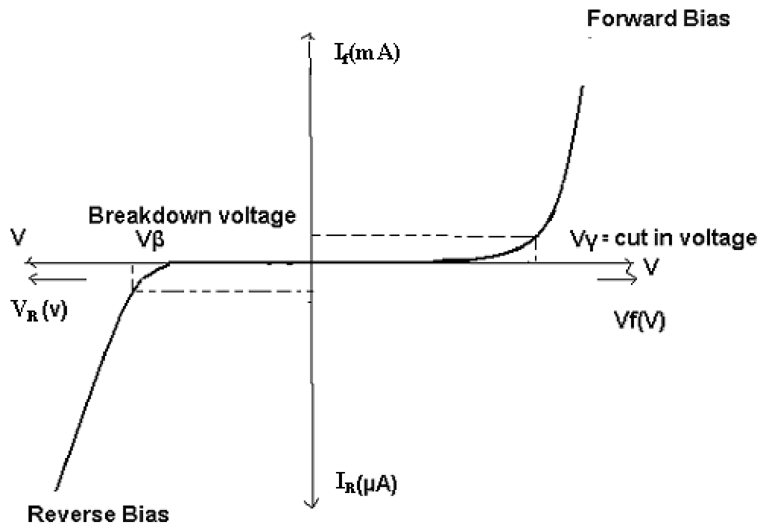
CIRCUIT DIAGRAM:
FORWARD BIAS:-



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 Vsin steps from 0V onwards (0.1V,0.2V……1V) note down the forward current (If) through the diode for different Forwardvoltages (Vf) across the diode without exceeding the rated value (IfMax=20mA)
3. Tabulate the results in the tabularform.
4. Plot the graph between Vf&If.
5. Repeat the above steps 4 steps by using Germaniumdiode.

Reverse bias characteristics

1. Connect the circuit diagram as shown in figure for Reverse bias using silicondiode.
2. Now vary RPS supply voltage Vsin steps from 0V onwards (1V,2V……10V) note down the forward current (Ir) through the diode for different Reverse voltages (Vr) across the diode without exceeding the rated value (VrMax=15V)
3. Tabulate the results in the tabularform.
4. Plot the graph between Vr&Ir.
5. Repeat the above steps 4 steps by using Germaniumdiode.

PRECAUTIONS:

1. Check the wires for continuity beforeuse.
2. Keep the power supply at Zero volts beforeStart.
3. All the contacts must beintact.

TABULAR COLUMN:ForwardBias

SL. No	Forward voltage (Vf)	Forward current (If)
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 (Vf)	Forward current (If)
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 junctiondiode?
2. What is doping why doping isnecessary?
3. Difference between P-type and N-type semiconductormaterials?
4. What is diodeequation?
5. What is an idealdiode?
6. Define depletion region of adiode?
7. What is meant by transition & space charge capacitance of adiode?
8. Is the V-I relationship of a diode Linear orExponential?
9. Define cut-in voltage of a diode and specify the values for Si and Gediodes?
10. What are the applications of a p-ndiode?
11. Draw the ideal characteristics of P-N junctiondiode?
12. What is the diodeequation?
13. What is the break downvoltage?
14. What is the effect of temperature on PN junctiondiodes?
15. What isPIV?
16. What is Forwardbias?
17. What is Reversebias?
18. What is Forwardvoltage?
19. What is Reversecurrent?
20. What is an idealdiode?
21. What is Break downvoltage?
22. What is cut-involatge?
23. Is the V-I relationship of a diode Linear orExponential?
24. Definediode?
25. What are the characterstics ofdiode?
26. Draw the ideal characteristics of P-N junctiondiode?
27. What is the diodecharacterstics?
28. What is the break down voltage indiode?
29. What is the effect of PN junctiondiodes?
30. What isPVI?
31. Prove that P-N junction Diode acts as aisolator?
32. Prove that P-N junction diode acts as on Switch when it is in forwardbias?
33. Prove that P-N junction diode acts as off Switch, when it is in Reversebias?
34. Find the change in cut-in voltage when input resistance is varied from 1k to1M?
35. Prove that Ohms law is verified for P-N junction diode in forward biasedcondition?
36. Find the static resistance of P-N junctionDiode?
37. Find the Dynamic resistance of P-N junctionDiode?
38. Find the cut in voltage for the given diode in forwardbias?
39. Explain what does the arrow heads represents in the schematic symbol ofPN junctiondiode.
40. Why silicon is preferred over Germanium in the manufacture of semiconductor devices
41. Name the breakdown mechanism in a lightly doped PN junction underreverse biasedcondition.
42. Is reverse saturation current of diode is independent of reverse biasvoltage.
43. Why germanium is more temperature dependent thansilicon
44. Define Dynamic resistance of PN junctionDiode
45. Define Zero bias PN junctiondiod

46. Define barriervoltage
47. Define depletionregion
48. Define biasing of thediode
49. Define electronemission.
50. If the voltage of the potential barrier is V_0. A voltage V is applied to the input, atwhat moment will the barrierdisappear?

Design Problems

1. Forward and reverse bias characteristics of Si diode with1N4007.
2. Forward and reverse bias characteristics of Gediode.
3. Forward and reverse bias characteristics of Si diode with V_D = 10 V and I_D = 10mA
4. Forward and reverse bias characteristics of Ge diode with V_D = 5 V and I_D = 10mA
5. Forward and reverse bias characteristics of Si diode with R = 500Ohms
6. Forward and reverse bias characteristics of Si diode with R =1.5K
7. Forward and reverse bias characteristics of Si diode with R =2K
8. Forward and reverse bias characteristics of Si diode with V_{RPS} = 0 –10V
9. Forward and reverse bias characteristics of Si diode with V_{RPS} = 0 –5V
10. Forward and reverse bias characteristics of Si diode with V_D = 20 V and I_D = 10mA
11. Forward and reverse bias characteristics of Si diode with R =2.5K?
12. Forward and reverse bias characteristics of Si diode with R =5K?
13. Forward and reverse bias characteristics of Si diode with1N4008?
14. Find the cut in voltage for the given diode in forward bias when the input resistance is 1K?
15. Find the cut in voltage for the given diode in forward bias when the input resistanceis 1K?
16. Forward and reverse bias characteristics of Ge diode with1N4007?
17. Reverse and Forward bias characteristics of Gediode?
18. Forward and reverse bias characteristics of Ge diode with V_D = 10 V and I_D = 10mA?
19. Forward and reverse bias characteristics of Si diode with R = 50Ohms?
20. Forward and reverse bias characteristics of Si diode with V_{RPS} = 0–210V?
21. Forward and reverse bias characteristics of Si diode with V_{RPS} = 0 –1V?
22. Forward and reverse bias characteristics of Ge diode with1N4008?

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 junctiondiode.
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 diodeunder
   a) Forwardbias. b) Reversebias.
2. To find the Zener breakdown voltage in reversed biasedcondition.

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 1kΩ,10kΩ	1 12 1
2.	Voltmeter	0-1V,0-20V	1
3.	Ammeter	0-10mA,200mA	1
4.	Connecting wires & bread board		

Theory:-

Azenerdiodeisheavilydopedp-njunctiondiode,speciallymadetooperateinthebreak down region. A p-n junction diode normally does not conduct when reverse biased. But if the reversebiasisincreased,ataparticularvoltageitstartsconductingheavily.Thisvoltageiscalled 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 conductingitmaintainsalmostconstantvoltageacrosstheterminalswhatevermaybethecurrent throughit,i.e.,ithasverylowdynamicresistance.Itisusedinvoltageregulators.Itisalsocalled as stabilizer diode or stabilitrons or constant voltagedevice.

Zener diodes are more heavily doped (around 1 x10^5) as compared to ordinary diodes (1 x10^8) and they have a narrow depletion layer.

The breaks down mechanisms are of two types.

(i) avalanchebreakdown

(ii) Zener breakdown

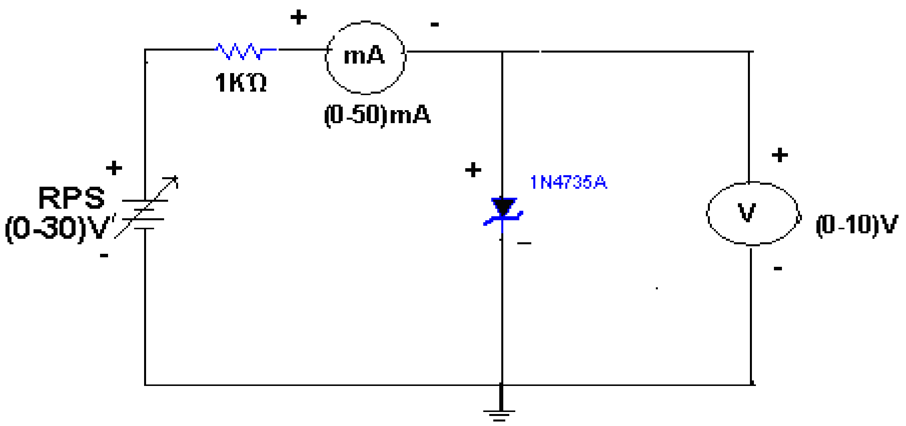
In avalanche breakdown mechanism, thermally generated electrons & holes acquire sufficient energy from the applied potential to produce new carriers by removing valance electrons from their bonds. These new carriers, in turn produce new carriers (called avalanche multiplication).

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

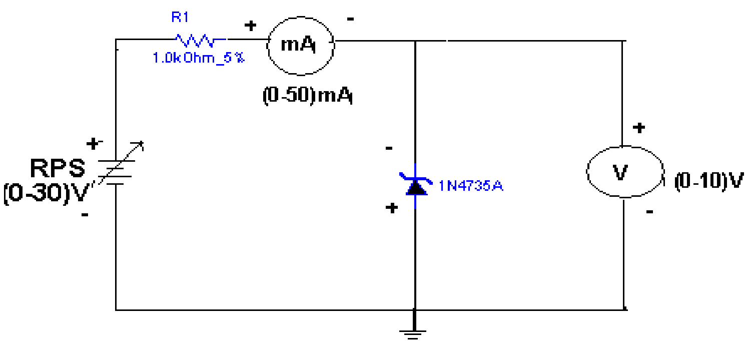
Duringbreakdownthevoltageacrossthedioderemainsconstant,independenttothecurrentthat flows through it. Because of this property a Zener diode serves as Voltage Stabilizer or voltage reference and break down occurs by avalanching in Zener diodes having break down voltages greater than 8V. It occurs by a combination of both mechanisms when breakdown voltage is between 5V & 8V. Zener effect play a very important role only in the diodes with breakdown voltagesbelowabout5V.Zenerbreakdownvoltagesdecreaseswithincreasedtemperaturewhere as avalanche breakdown voltage increases with increased temperature. Zener diode operates in either a 'ON' state or 'OFF' state

CIRCUIT DIAGRAM:

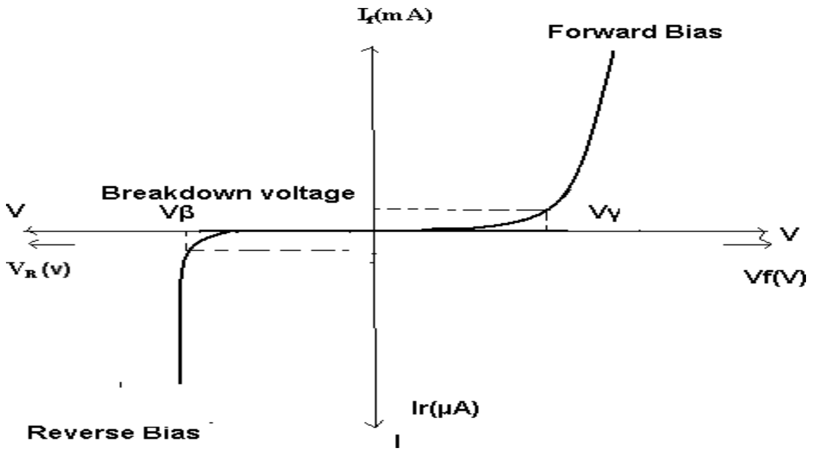
STATIC CHARACTERISTICS:-



REGULATION CHARACTERISTICS:-



EXPECTED WAVEFORMS:-



PROCEDURE: -

Forward bias characteristics

1. Connect the circuit diagram as shown in figure for Forward bias using zenerdiode
2. Switch on the RPS supply voltage Vs and vary in steps from 0V onwards (0.1V, 0.2V……1V) note down the forward current (If) through the diode fordifferent forward
   Voltages (Vf) across the diode without exceeding the rated value (Vs=10V)
3. Tabulate the results in the tabularform.
4. Plot the graph between Vf&If.

Reverse bias characteristics

1. Connect the circuit diagram as shown in figure for Reverse bias using Zenerdiode.
2. Now vary RPS supply voltage Vsin steps from 0V onwards (1V, 2V……10V) note down the Reverse current (Ir) through the diode for different Reverse voltages (Vr) across the diode without exceeding the rated value (VrMax=15V)
3. Tabulate the results in the tabularform.
4. Plot the graph between Vr&Ir.

TABULAR COLUMN: Forward Bias

SL. No	Forward voltage (Vf)	Forward current (If)
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 (Vf)	Forward current (If)
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 beforeuse.
2. Keep the power supply at Zero volts beforeStart.
3. All the contacts must beintact.

RESULT: -

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

ZenerBreakdownVoltage= Volts.
ForwardBiasResistance = Ohms
ReverseBiasResistance = Ohms

VIVA QUESTIONS:-

1. What is Zenerdiode?
2. Can Zenerbe used as arectifier?
3. What are the voltage ratings of zenerdiode?
4. Give advantages of zenerdiode?
5. How zener diode behaves in foreardbias?
6. What type of temp? Coefficient does the zener diodehave?
7. If the impurity concentration is increased, how the depletion widtheffected?
8. Does the dynamic impendence of a zener diodevary?
9. Explain briefly about avalanche and zenerbreakdowns?
10. Draw the zener equivalentcircuit?
11. Differentiate between line regulation & loadregulation?
12. In which region zener diode can be used as aregulator?
13. How the breakdown voltage of a particular diode can be controlled?
14. What type of temperature coefficient does the Avalanche breakdown has?
15. By what type of charge carriers the current flows in zener and avalanchebreakdown diodes?
16. What is static characterstics ofdiode?
17. Can Zenerbe used as aintegrator?
18. What are the rating voltages of zenerdiode?
19. Give disadvantages of zenerdiode?
20. How zener diode behaves in forwardbias?
21. What type of temp Coefficient does the zener diodehave?
22. If the impurity concentration is decreased, how the depletion widtheffected?
23. Does the dynamic impendence of a diodevary?
24. Explain briefly about avalanchebreakdown?
25. Draw the zener equalcircuit?
26. Differentiate between line & loadregulation?
27. In which region zener diode can be used as aintegratorr?
28. How the cut in voltage of a particular diode can becontrolled?
29. What type of temperature coefficient does the zener breakdownhas?
30. what type of charge carriers the voltage flows in zener and avalanchebreakdown 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 Reversebias condition?
33. Find the Break down voltage for given ZenerDiode?
34. Define what happens to a series current,load current and zener current when the dc input voltage of zener regulatorincreases.
35. How does the Zener breakdown voltage varies withtemperature.
36. How does the avalanche breakdown voltage varies withtemperature.
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 Ω. Find VZ0 of the Zenermodel.
38. Zener diodescanbeeffectivelyusedinvoltageregulator.However,theyarethesedays being replaced by moreefficient
39. The other name for Zener diodeis.
40. Why zener diode is used as voltageregulator.
41. Explain what is meant by the temperaturecoefficient?
42. Why zener diode is always reversebiased
43. How the width of depletion region in the reverse biased diode varies with theimpurity concentration

44. Under what condition zener diode behaves like pn junctiondiode.
45. How the value of potential barrier depends on the amount of doping ofthe semiconductor.
46. Difference between intrinsic and extrinsicsemiconductor
47. Why is a zener diode generally not connected to forwarddiode.
48. What is the temperature effect on reverse saturation current and barriervoltage.
49. How the name of the zener came.
50. Is the breakdown region in zeneris reallydestructible.

Design Problems

1. Reverse bias characteristics of ZenerSi diode with5.6V.
2. Reverse bias characteristics of ZenerSi diode with6.2V.
3. Reverse bias characteristics of ZenerSi diode with 5.6V with R =2K.
4. Reverse bias characteristics of ZenerSi diode with 5.6V with R =2.5K.
5. Verify the operation of Zener acts as voltageregulator.
6. Verify the operation of Zener acts as voltage regulator with R = 2K and R_L =5K
7. Reverse bias characteristics of ZenerSi diode with 5.6V with V_{RPS} = 0 –15V
8. Reverse bias characteristics of ZenerSi diode with 5.6V with V_{RPS} = 0 –20V
9. Reverse bias characteristics of ZenerSi diode with 6.2V with V_D = 10 V and I_D = 10mA
10. Reverse bias characteristics of ZenerSi diode with 6.2V with V_D = 20 V and I_D = 15mA
11. Plot the Reverse Bias characteristics for the Zener diode when I/P resistance is10k?
12. Find the effect of change in characteristics of Zener diode connected in ReverseBias condition when input resistance is changed from 10k to20K?
13. Find the effect of change in characteristics ofZener diode connected in Reverse Bias condition when input resistance is changed from 20k to10K?
14. Reverse bias characteristics of ZenerSi diode with 6.2V with V_D = 12 V?
15. Find output voltage of ZenerSi diode with 6.2V with V_D =10V?
16. Find output voltage of ZenerSi diode with 6.2V with V_D=5V?
17. Find output voltage of ZenerSi diode with 6.2V with V_D=6.2V?
18. Reverse bias characteristics of ZenerSi diode with6.5V?
19. Reverse bias characteristics of ZenerSi diode with2.6V?
20. Reverse bias characteristics of ZenerSi diode with 2.6V with R =1K?
21. Reverse bias characteristics of ZenerSi diode with 2.6V with R =2.0K?
22. Verify the operation of Zener acts as voltageintegrator?
23. Verify the operation of Zener acts as voltage regulator with R = 1K and R_L =2K?
24. Reverse bias characteristics of ZenerSi diode with 2.6V with V_{RPS} = 0 –10V?
25. Reverse bias characteristics of ZenerSi diode with 2.6V with V_{RPS} = 0 –10V?
26. Reverse bias characteristics of ZenerSi diode with 2.2V with V_D = 20 V and I_D = 5mA?
27. Reverse bias characteristics of ZenerSidiode with 6.2V with V_D = 10 V and I_D = 10 mA?

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 voltageregulator. HeretheACvoltage isrectifiedbythediodeD1andfilteredbythecapacitor. ThisfilteredDCvoltageisregulatedbythediodetoprovideaconstantreferencevoltageof15V. This regulated DC voltage is used to drive the control circuit, used to control the switching of light, as in an automated lighting controlsystem.

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 incommon Emitterconfiguration.
2. To calculate current gainβ.
3. To calculate input resistance Ri& output resistanceRo.

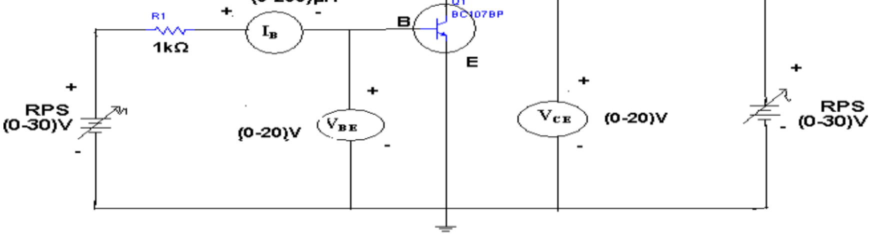
EQUIPMENTS & COMPONENTS REQUIRED:

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 IB increases less rapidly with VBE . Therefore input resistance of CE circuit is higher than that of CB circuit. The output characteristics are drawn between Ic and VCE at constant IB. the collector current varies with VCE unto few volts only. After this the collector
current becomes almost constant, and independent of VCE. The value of VCE 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, IC is always constant and is approximately equal to IB.
The current amplification factor of CE configuration is given byB = ΔIC/ΔIB.

CIRCUIT DIAGRAM:



PROCEDURE: -

Input characteristics:

1. Connect the circuit according to the circuit diagram of inputcharacteristics
2. Keep (Collector to Emitter Voltage) VCE=0V) by varying VCC (collector supply voltage). Increasing VBB (Base supply Voltage from 0 onwards (0.1V,0.2V….0.75V) observe IB (Base current) for different values of VBE (Base to Emittervoltage).
3. Repeat the Step 2 for Different (collector to Emitter voltage) VCE i.e. 3V &6V.
4. Tabulate the results in the tabular form and plot thegraph.

Outputcharacteristics:

1. Connect the circuit according to the circuit diagram of outputcharacteristic.
2. Keep (collector supply voltage) VCC=0V. Increase (Base supply Voltage) VBB toget Base current IB=3µA.
3. Now increase (Collector supply voltage) VCC from 0 onwards and observe the Collector current IC for different Values of (Collector to Emitter voltage) VCEWithout exeding the rated value(IC=15mA)
4. Tabulate the results in the tabular coloum and plot thegraph.

OBSERVATIONS:

INPUT CHARACTERISTICS:

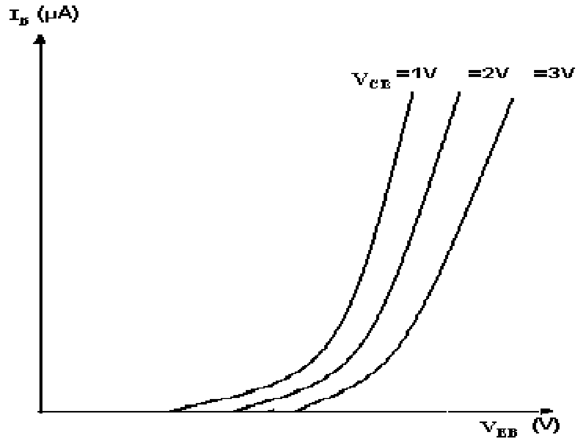
S.NO	V_{CE} = 1V		V_{CE} = 2V		V_{CE} = 4V	
	V_{BE}(V)	I_B(µA)	V_{BE}(V)	I_B(µA)	V_{BE}(V)	I_B(µA)

OUT PUT CHAREACTARISTICS:

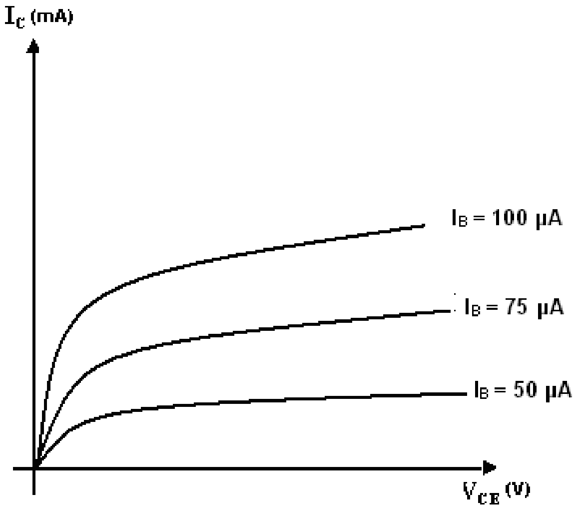
S.NO	I_B = 5µA		I_B = 10µA		I_B = 15 µA	
	V_{CE}(V)	I_C(mA)	V_{CE}(V)	I_CmA)	V_{CE}(V)	I_C(mA)

EXPECTED GRAPHS:

INPUT CHARACTERSTICS:



OUTPUT CHARECTERSTICS:



Preacutions:

1. Always keep the supply Voltage Knobs i.e. VCE, VBE positions at minimum positionwhen switching on &off.
2. Never load the meters above its ratedrange.
3. Avoid loose connections at thejunction.

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 β for thetransistor?
2. What are the input and output impedances of CEconfiguration?
3. Identify various regions in the outputcharacteristics?
4. What is the relation between α andβ?
5. Define current gain in CEconfiguration?
6. Why CE configuration is preferred foramplification?
7. What is the phase relation between input andoutput?
8. Draw diagram of CE configuration for PNPtransistor?
9. What is the power gain of CEconfiguration?
10. What are the applications of CE configuration? . What is the range of β for thetransistor?
2. What are the input and output impedances of CEconfiguration?
3. Identify various regions in the outputcharacteristics?
4. What is the relation between α andβ?
5. Define current gain in CEconfiguration?
6. Why CE configuration is preferred foramplification?
7. What is the phase relation between input andoutput?
8. Draw diagram of CE configuration for PNPtransistor?
9. What is the power gain of CEconfiguration?
10. What are the applications of CEconfiguration?
11. What is the range of β for thetransistor?
12. What are the input and output impedances of CEconfiguration?
13. Identify various regions in the outputcharacteristics?
14. What is the relation between α andβ?
15. Define current gain in CEconfiguration?
16. Why CE configuration is preferred foramplification?
17. What is the phase relation between input andoutput?
18. Draw diagram of CE configuration for PNPtransistor?
19. What is the power gain of CEconfiguration?
20. What are the applications of CEconfiguration?
21. What is EarlyEffect?
22. Why the doping of collector is less compared toemitter?
23. What do you mean by “reverseactive”?
24. What is the difference between CE and Emitter followercircuit?
25. What are the input and output impedances of CEconfiguration?
26. Identify various regions in the outputcharacteristics?
27. What is the relation between α, β andγ?
28. Define current gain in CEconfiguration?
29. Why CE configuration is preferred foramplification?
30. What is the phase relation between input and output?

31 Definedopping?

32. Why CE configuration is usedmostly?
33. A germanium transistor with α=0.98 gives a reverse saturation current I_{CBO}=10μA in a CB configuration. When it is used in CE configuration with a base current of 0.22μA, calculate the collectorcurrent.
34. In I_{CEO}, wtdoes the subscript ‘CEO’ mean? 35. The range of βis
36. Define the point on the DC load line which is represented by ‘Q’ iscalled __________
37. The input resistance is givenby

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 iscalled

42. The small amount of current which flows even when base current I_B=0iscalled _________

43. Which of the points locates the quiescentpoint?

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

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

- List the different configurations used

47.Definebiasing

- What are the different biasingmethods?

48. List the applications of common emitterconfiguration

49. which biasing techniques are used mostly for CEConfiguration?

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 amplifyfaint signalsreceivedbyanantenna.Inthiscaseit iscommontoreplacetheloadresistor with a tuned circuit. This may be done to limit the bandwidth to a narrow band centered around theintendedoperatingfrequency.Moreimportantlyitalsoallowsthecircuittooperateathigher 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-noiseamplifiers.

EXPT NO: 5

FULL WAVE RECTIFIR WITH & WITHOUT FILTER.

AIM: -

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

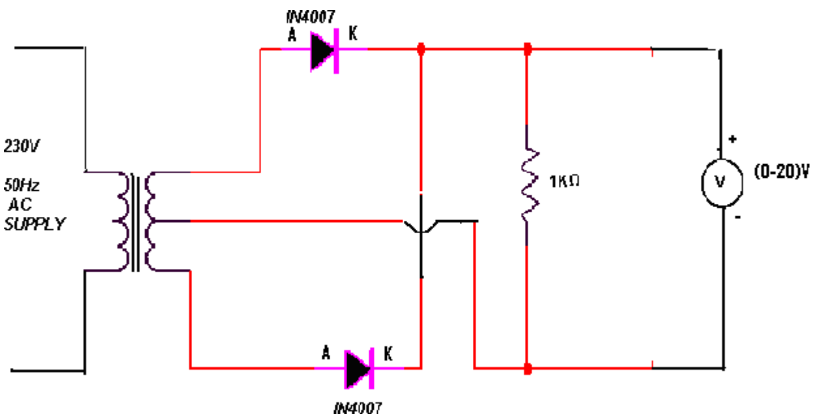
EQUIPMENTS & COMPONENTS REQUIRED:

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

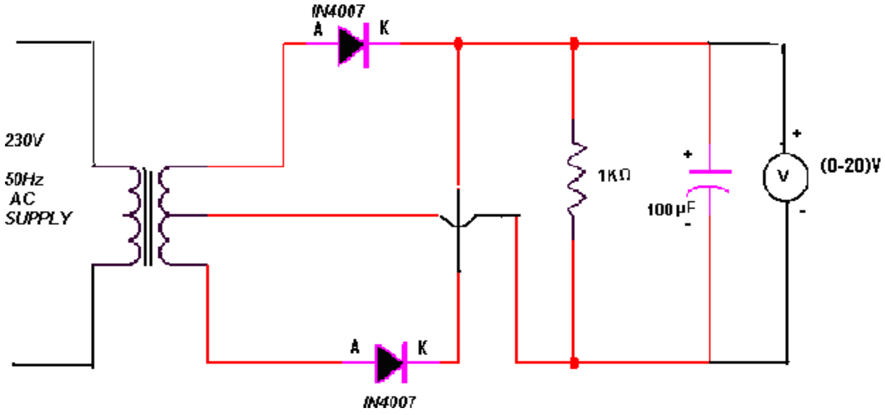
THEORY:-
The circuit of a center-tapped full wave rectifier uses two diodes D1&D2. During positive half cycle of secondary voltage (input voltage), the diode D1 is forward biased and D2is reverse biased. The diode D1 conducts and current flows through load resistor RL.
During negative half cycle, diode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



WITHFILTER:



PROCEDURE:-

Without filter:

1. Connect the circuit as shown in the circuitdiagram.
2. Note down the voltage across the secondary of transformer and across theoutput terminals (Vo) i.e. across load resistor RL (with 1K, 4.7K, 10K, 100k) useDRB Decade resistance box or discrete component.
3. Vary the RL load resistor for different values note down AC and DC voltages across theRL using DMM orCRO.
4. Now Disconnect the RL and note the No Load voltageVNL.
5. Calculate the ripple factor & regulation using formula for different loads andtabulate.

With filter:

1. Connect a capacitor (100µf/35V) across the load resistanceRL..
2. Note down the voltage across the secondary of transformer and across theoutput terminals (Vo) i.e. across load resistor RL (with 1K, 4.7K, 10K, 100k) use DRB Decade resistance box or discretecomponent.
3. Vary the RL load resistor for different values note down AC and DC voltages across the RL using DMM orCRO.
4. Now Disconnect the RL and note the No Load voltageVNL.
5. Calculate the ripple factor & regulation using formula for different loads andtabulate.

OBSERVATIONS:

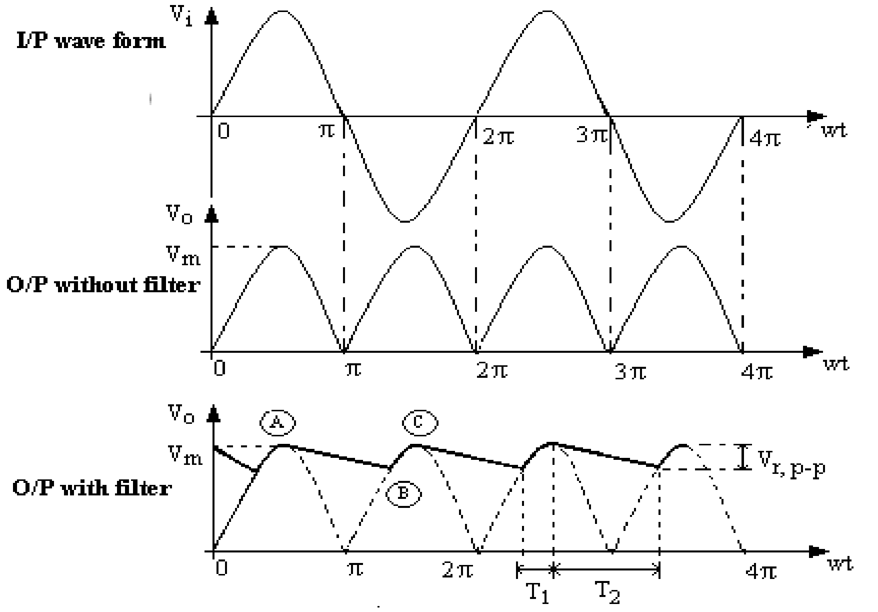
VNL= ----------volts

SL No	RL (Ohm)	VFL=Vdc	Vac	Ripple factorr=Vac/Vdc		% Regulation	
				With filter	Without filter	With filter	Without filter

Were % of regulation =VNL-VFL/VFL*100
[VNL= No load voltage

VFL= Full load voltage]

waveforms :



Full-wave Rectifier with capacitor filter wave form

THEORITICAL CALCULATIONS:-

$$Vrms = Vm/ \sqrt{2}$$

$$Vm = Vrms\sqrt{2}$$

$$Vdc = 2Vm/\Pi$$

(i) **Withoutfilter**:

Ripple factor, $r = \sqrt{(Vrms/ Vdc)^2 - 1} = 0.482$

(ii) **Withfilter**:

Ripple factor, $r = 1/ (4\sqrt{3}\ fCR_L)$ where f=50Hz

C =100µF

R_L=1KΩ

PRECAUTIONS:

1. Check the wires for continuity beforeuse.
2. Keep the power supply at Zero volts beforeStart.
3. All the contacts must beintact.

RESULT: Observe Input and Output Wave forms and Calculate ripple factor and percentage of regulation in Full-wave rectifier with and withoutfilter.

WithoutFilter:

RippleFactor

: Regulation:

With Capacitor Filter:

RippleFactor

: 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 thewaveform?
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?
10. Define regulation of the full waverectifier?
11. Define peak inverse voltage (PIV)? And write its value forFull-wave rectifier?
12. If one of the diode is changed in its polarities what wave form would you? get?
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24. What is the necessity of the transformer in the rectifiercircuit?
25. What are the applications of arectifier?
26. What is meant by ripple and define Ripplefactor?
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 ‘γ’ 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 therectifiers?
44. DC average current of a center taped full waverectifier
    (Where $I_m$is the maxImum peak current ofinput)
45. DC power output of center taped full wave rectifier is equalto($I_m$is the peak current and R_L is the loadresistance)
46. If input frequency is 50Hz then ripple frequency of center taped full wave rectifier willbe equalto
47. Transformer utilization factor of a center taped full wave rectifier is equalto
48. If peak voltage on a center taped full wave rectifier circuit is 5V and diode cut-in voltage is 0.7, then peak inverse voltage on diode willbe
49. Inancentertapedfullwaverectifier,theinputsinewaveis20sin500πt.Theaverage output voltageis
50. Inancentertapedfullwaverectifier,theinput sinewaveis200sin50πt.Ifloadresistance is of 1k then average DC power output of half wave rectifieris

Design Problems

1. Study the performance of FWR with filter R_L = 2K, C = 0.047µF
2. StudytheperformanceofFWRwith filterR_L=15K,C=0.047µFusing Gediode.
3. Study the performance of FWR with filter R_L = 5K, C = 0.1 µF, invertdiode.
4. Study the performance of FWR with filter R_L = 5K, C = 0.94 µF, invertdiode.
5. Study the performance of FWR with R_L = 5K using GE diode, invertdiodes.
6. Study the performance of FWR with filter R_L = 10K, C = 0.1µF
7. Study the performance of FWR with filter R_L = 2K, C = 0.047µF
8. Study the performance of FWR with filter R_L = 15K, C = 0.047 µF using Gediode.
9. Study the performance of FWR with filter R_L = 5K, C = 0.1 µF, invertdiode.
10. Study the performance of FWR with filter R_L = 5K, C = 0.94 µF, invertdiode
11. Study the performance of FWR with filter R_L = 100K, C = 0.1µF?
12. Find the efficiency of the full wave rectifier designed with a CLCFilter?
13. Find the ripple factor of the FWR with Capacitorfilter?
14. Find the ripple factor of the FWR with Inductorfilter?
15. Study the performance of FWR with filter R_L = 50K, C = 0.047µF?
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 GEdiode?
19. Study the performance of FWR with R_L = 5K, invert thediodes?
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 GEdiode?
23. Study the performance of FWR with R_L = 5K, invert thediodes?
24. Study the performance of FWR with R_L = 5K using GE diode, invertdiodes?
25. Study the performance of FWR with filter R_L = 10K, C = 0.1µF

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.Whileitisalittlemorecomplicated,thisnormallyoutweighsthedisadvantages.However sometimes it may not be optimum or necessary to use a full wave rectifiercircuit

EXPT NO: 6

INPUT AND OUTPUT CHARACTERISTICS OF FET IN CS CONFIGURATION

AIM: -

1. To study the Drain and Transfer characteristics ofFET
2. To find the Drain resistance Trans-conductance and amplificationfactor

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	100Ω,560Ω	1each

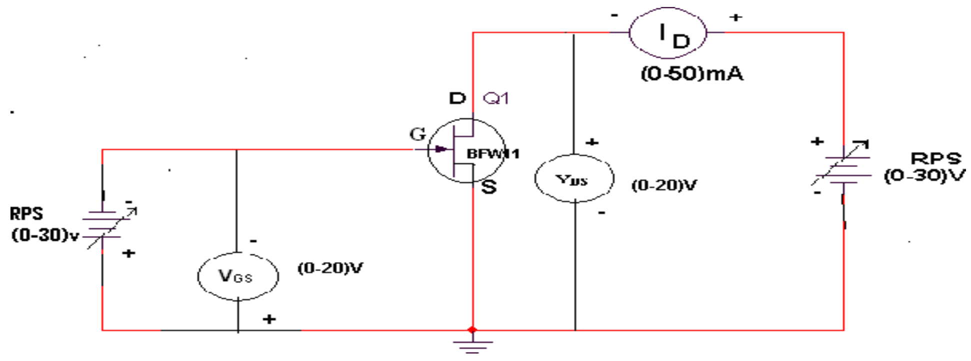
Theory:

The **field-effect transistor** (FET) is a transistor that uses an electric field to control the shape andhencetheconductivityofachannelofonetypeofchargecarrierinasemiconductormaterial. FETs are unipolar transistors as they involve single-carrier-typeoperation

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 s always reverse biased. In response to small applied voltage from drain to source, the ntype bar acts as sample resistor, and the draincurrent increaseslinearlywithVDS.WithincreaseinIDtheohmicvoltagedropbetweenthesourceand thechannelregionreversebiasesthejunctionandtheconductingpositionofthechannelbegins to remain constant. The VDS at this instant is called "pinch ofvoltage".

If the gate to source voltage (VGS) is applied in the direction to provide additional reverse bias, the pinch off voltage ill is 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 infigure.
2. Keep the power supply knob to minimumposition.
3. Switch on supply keep the gate to source voltageVGS=0V.
4. Increase the drain supply VDD from 0V onwards insteps.
5. Note down current Id and Drain to source voltage VDS without exceeding therated Value.
6. Repeat the above procedure forVGS=-1V,-0.5V
7. Tabulate the results and plot thegraph.

Transfer characteristics:

1. keeping the same circuit connections bring the Knobs of supply tminimum.
2. Now vary VDS drain to source voltage at 1V by Varying VDD Drain supplyvoltage.
3. Increasing the gate to source voltage VGS from 0V onwards in suitablesteps..
4. Note down the corresponding variation in ID until it becomes 0V.
5. Repeat the above 3 step for VDS=2V & 4Vconstant
6. Tabulate the results and plotgraph.

Tabular coloumn

Drain or Static characteristics

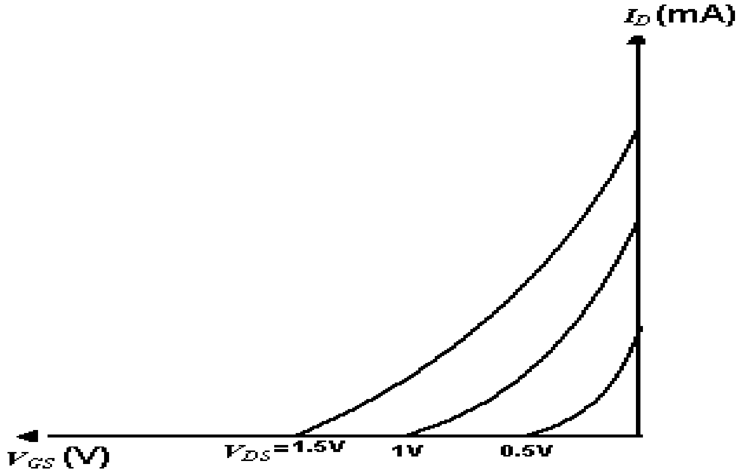
VGS=0		VGS=0.5		VGS=0.1	
VDS in volts	ID in mA	VDS in volts	ID in mA	VDS in volts	ID in mA

Transfercharacteristics

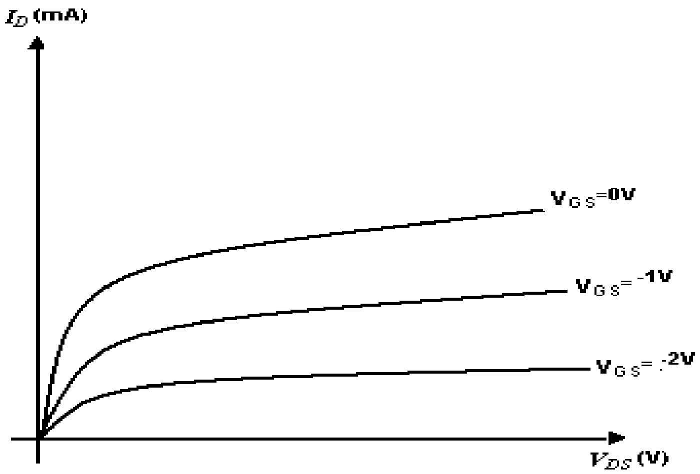
VDS=-1		VDS=-2		VDS=-3	
VGS in volts	ID in mA	VGS in volts	ID in mA	VGS in volts	ID in mA

<u>EXPECTEDGRAPH</u>:

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 ΔV_{DS} and ΔI_D

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

CALCULATION OF g_m :

Construct a Triangle on one of the Transfer characteristics for a particular V_{DS} find ΔV_{GS} and ΔI_D.

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

CALCULATION OF μ:

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

PRECAUTIONS:

1. Alwaya keep the supply voltage knobs i.eVDD, VGG position at minimumposition 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 beapplied.
5. Never load the meters above the ratedrange.
6. Avoid loose contacts at thejunction.

RESULT: -

Characteristics of CS configuration is verified.

VIVA QUESTIONS:

1. Why FET is called as a unipolardevice/
2. Name the terminals ofFET?
3. What is the difference between BJT andFET?
4. What arte the major applications ofFET?
5. What are the advantages ofFET?
6. Difference between MOSFET andFET?
7. Give the applicationsMOSFET?
8. What is the basis confurgation ofJFET?
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28. What is the basis confurgation ofJFET?
29. What is deplition mode and enhancemode?
30. What is trans-conductance and amplificationfactor?
31. Definechannel?
32. Draw the transfer characteristic for n-channel depletion typeMOSFET**?**
33. Why FET is called as "voltage operateddevice"?
34. Which MOSFET is called as Normally ON MOSFET and NORMALLY OFF MOSFET?Why?
35. Compare BJT andFET
36. Define Amplification factor inJFET?
37. What are the advantages of FET overBJT?
38. What are the important features ofFET?
39. Explain the biasing ofJFET?
40. Define Drainresistance.
41. Define Tran'sconductance?
42. Explain the term Drain inFET?
43. Write the relative disadvantages of an FET over that of aBJT?
44. List the characteristics of JFET.
45. Why MOSFET is calledIGFET?
46. Compare P channel and N channelJFET.
47. Write the advantages of JFET?
48.What are the applications ofJFET?
49.DefineJFET?
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 $R_I = 50\ \Omega$, $R_L = 280\Omega$.
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30. Study the Drain, Transfer characteristics of P channel JFET BFW 11 with $R_L =1120\Omega$.