BASIC ELECTRICAL AND ELCTRONICS ENGINEERING LABORATORY

LAB MANUAL

Academic Year	:	**2019-2020**
Course Code	:	**AEEB08**
Regulations	:	**IARE - R18**
Semester	:	**II**
Branch	:	**ME**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal – 500 043, Hyderabad

Department of Electrical and Electronics Engineering

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	Program Outcomes
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**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.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**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 practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PO12	**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.

Program Specific Outcomes	
PSO1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.
PSO2	**Modeling and Simulation Practices**: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.
PSO3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become Technocrats.

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ATTAINMENT OF PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

Exp. No	Experiment	Program Outcomes Attained	Program Specific Outcomes Attained
1	Verification of Kirchhoff's current and voltage laws.	PO1,PO2	PSO2
2	Verification of ohms law.	PO1,PO2	PSO2
3	Magnetization characteristics of DC shunt generator.	PO1,PO2	PSO2
4	Predetermination of efficiency (Swinburne's test) of DC shunt machine.	PO1,PO2, PO3	PSO2
5	Open circuit and short circuit test on single phase transformer.	PO1,PO2,PO4	PSO2
6	Study the performance characteristics of three phase induction motor by brake test.	PO1,PO2	PSO2
7	Determine the regulation of alternator using synchronous impedance method.	PO1,PO2	PSO2
8	PN junction diode characteristics.	PO1,PO2	PSO2
9	Zener diode characteristics.	PO1,PO2,PO4	PSO2
10	Half wave rectifier circuit.	PO1,PO2,PO4	PSO2
11	Full wave rectifier circuit.	PO1,PO2	PSO2
12	Transistor common emitter characteristics.	PO1,PO2,PO4	PSO2
13	Transistor common base characteristics.	PO1,PO2,PO4	PSO2
14	Study of CRO.	PO1,PO2	PSO2

BASIC ELECTRICAL AND ELCTRONICS ENGINEERING LABORATORY

OBJECTIVE:

The objective of Basic electrical and electronics engineering laboratory is to learn the practical experience with operation and applications electromechanical energy conversion devices such as DC machines, transformers, three phase induction motors and alternators. It also aims to get the knowledge of the different electronic devices like diodes, rectifiers, transistors and how these devices are used in real time applications. It also makes the students to learn how to measure the electrical quantities with different measuring devices and with CRO.

OUTCOMES:

Upon the completion of electrical and electronics practical course, the student will be able to:

1. **Understand** the operation and applications of electromechanical energy conversion devices.

2. **Understand** identification and selection of various electrical and electronic components.

3. **Analyze** the characteristics of various electronics components.

EXPERIMENT – 1

VERIFICATION OF KIRCHHOFF'S CURRENT AND VOLTAGE LAWS

1.1 AIM:

To verify Kirchhoff's voltage law (KVL) and Kirchhoff's current law (KCL) in a passive resistive network

1.2 APPARATUS REQUIRED:

S. No	Apparatus Name	Range	Type	Quantity
1	RPS			
2	Ammeter			
3	Voltmeter			
4	Resistors			
5	Bread Board			
6	Connecting Wires			

1.3 CIRCUIT DIAGRAMS:

Circuit to verify KVL:
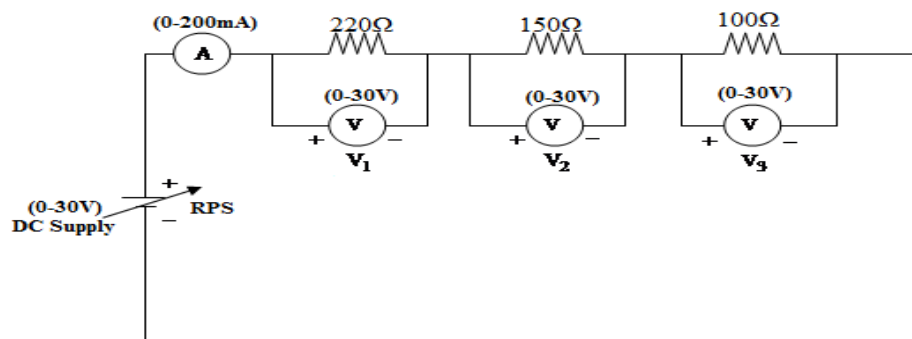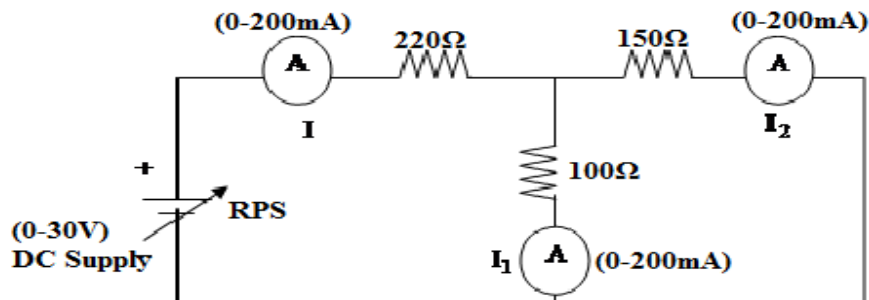

Fig - 1 KVL

To Verify KCL:

Fig - 1 KCL

1.4 PROCEDURE:

To Verify KVL

1. Connect the circuit diagram as shown in Figure 1.
2. Switch ON the supply to RPS.
3. Apply the voltage (say 5v) and note the voltmeter readings.
4. Sum up the voltmeter readings (voltage drops), that should be equal to applied voltage.
5. Thus KVL is verified practically.

To Verify KCL

1. Connect the circuit diagram as shown in Figure 2.
2. Switch ON the supply to RPS.
3. Apply the voltage (say 5v) and note the ammeter readings.
4. Sum up the Ammeter readings (I_1 and I_2), that should be equal to total current (I).
5. Thus KCL is verified practically.

1.5 OBSERVATIONS:

For KVL

Applied Voltage V (volts)	V_1 (volts)		V_2 (volts)		V_3 (volts)		$V_1+V_2+V_3$ (volts)	
	Theoretical	Practical	Theoretical	practical	Theoretical	practical	Theoretical	practical

For KCL

Applied Voltage V (volts)	I (A)		I_1 (A)		I_2 (A)		I_1+I_2 (A)	
	Theoretical	Practical	Theoretical	practical	Theoretical	practical	Theoretical	practical

1.6 PRECAUTIONS:

1. Check for proper connections before switching ON the supply.
2. Make sure of proper color coding of resistors.
3. The terminal of the resistance should be properly connected.

1.7 RESULT:

1.8   PRE LAB VIVA QUESTIONS:

1. What is current?
2. What is voltage?
3. What is resistance?
4. What is ohm's law?
5. What is KCL and KVL?

1.9   POST LAB VIVA QUESTIONS:

1. What do you mean by junction?
2. What directions should be assumed for KCL?
3. What are the positive and negative signs in KVL?
4. What is the colour coding of resistors?
5. What are the precautions to be taken while doing the experiment?
6. What is the range of ammeters and voltmeters you used in this experiment?

<h1 style="text-align:center">EXPERIMENT – 2</h1>
<h2 style="text-align:center">VERIFICATION OF OHM'S LAW</h2>

2.1   AIM:

To verify Ohm's law for a given resistive network.

2.2   APPARATUS REQUIRED:

S. No	Apparatus Name	Range	Type	Quantity
1	RPS			
2	Ammeter			
3	Voltmeter			
4	Resistor			
5	Rheostat			
6	Bread Board			
7	Connecting Wires			

2.3   CIRCUIT DIAGRAM:

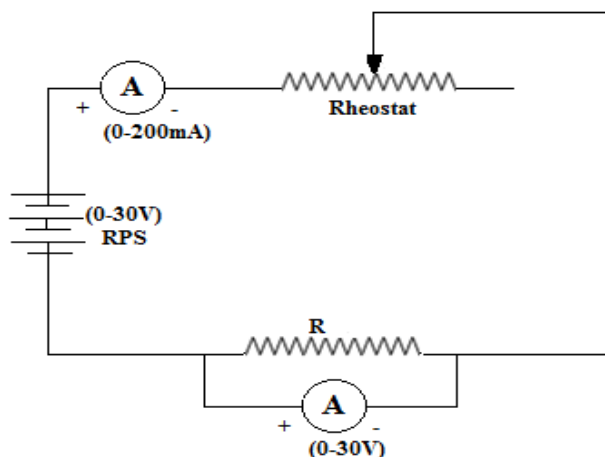<p style="text-align:center">Fig – 2.1 Circuit Diagram</p>

2.4   PROCEDURE:

1. Make the connections as per circuit diagram.
2. Switch ON the power supply to RPS and apply a voltage (say 10V) and take the reading of voltmeter and ammeter.
3. Adjust the rheostat in steps and take down the readings of ammeter and voltmeter.
4. Plot a graph with **V** along x-axis and **I** along y-axis.
5. The graph will be a straight line which verifies Ohm's law.
6. Determine the slope of the V-I graph. The reciprocal of the slope gives resistance of the wire.

2.5   OBSERVATIONS:

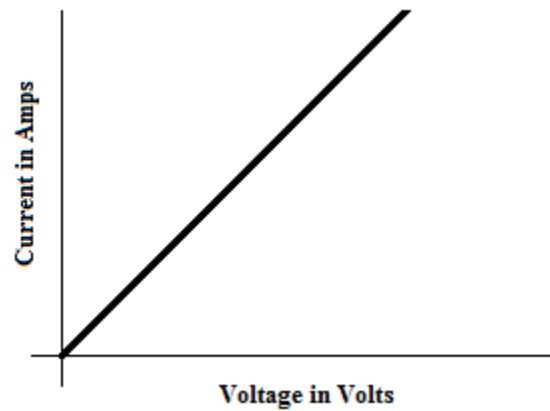| S. No.	Voltage (V)	Current (mA)

2.6   MODEL GRAPH:

Fig: 2.2 Voltage and Current Characteristics

2.7   PRECAUTIONS:

1. Take care to connect the ammeter and voltmeter with their correct polarity.
2. Make sure of proper color coding of resistors.
3. The terminal of the resistance should be properly connected.

2.8   RESULT:

2.9   PRE LAB QUESTIONS:

1. What is current?
2. What is voltage?
3. Define charge.
4. Define power.
5. What is the resistance?
6. What is ohm's law?

2.10   POST LAB QUESTIONS:

1. What do you mean by junction?
2. What is the colour coding of resistors?
3. What are the precautions to be taken while doing the experiment?
4. What is the range of ammeters and voltmeters you used in this experiment?
5. What are the limitations of ohm's law?
6. What is the condition of ohm's law?

MAGNETIZATION CHARACTERISTICS OF DC SHUNT GENERATOR

3.1   AIM:

To determine experimentally the Magnetization (or) Open Circuit Characteristics of a D.C. Shunt Generator and also to determine the critical field resistance.

3.2   APPARATUS REQUIRED:

S. No.	Apparatus Name	Range	Type	Quantity
1	Ammeter			
2	Voltmeter			
3	Rheostat			
4	Tachometer			
5	Connecting Wires			

3.3   NAME PLATE DETAILS:

MOTOR

Voltage (V)	
Current (A)	
Output (KW/HP)	
Speed (RPM)	
Excitation type	Shunt
Excitation voltage (V)	
Excitation current (A)	

GENERATOR

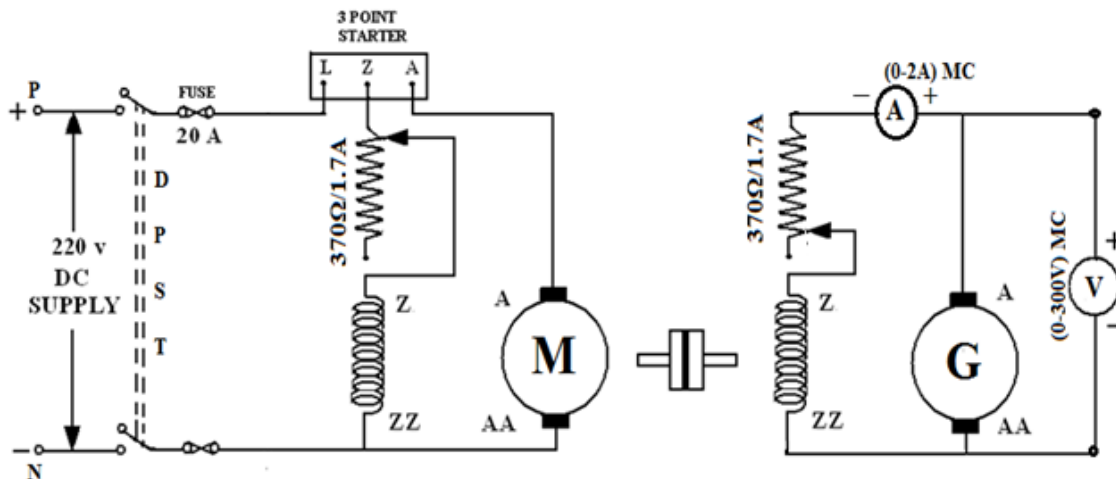|	
Voltage (V)	
Current (A)	
Output (KW/HP)	
Speed (RPM)	
Excitation type	Shunt
Excitation voltage (V)	
Excitation current (A)	

3.4   CIRCUIT DIAGRAM:

Fig – 3.1 Magnetization characteristics (or) open circuit characteristics of a DC shunt generator

3.5   PROCEDURE:

1. Choose the proper ranges of meters after noting the name plate details of the given machine and make the connections as per the circuit diagram.

2. Keep the field rheostat of motor in minimum position and field rheostat of generator in maximum position.

3. Switch ON the power supply and start the M-G set by slowly moving the handle of three point starter.

4. Observe the speed of the generator using a tachometer and adjust the speed to rated value by varying the motor field rheostat. Keep the same speed throughout the experiment.

5. Note down the terminal voltage of the generator at zero field current. This is the E.M.F. due to residual magnetism.

6. Increase the generator field current I_f (ammeter) by gradually moving the jockey of generator field rheostat. For every value of I_f, note down the corresponding voltmeter reading. Increase the field current till induced E.M.F. is about 120% of rated value.

7. Repeat the same procedure for decreasing values of the same field currents (I_f) and finally note down the E.M.F. generated due to residual magnetism.

8. Draw the characteristics of generated E.M.F. (E_g) versus field current (I_f) for both increasing and decreasing values of field current.

9. Draw a tangent line to the initial portion of Characteristics from the origin. The slope of this straight line gives the critical field resistance.

3.6   OBSERVAIONS:

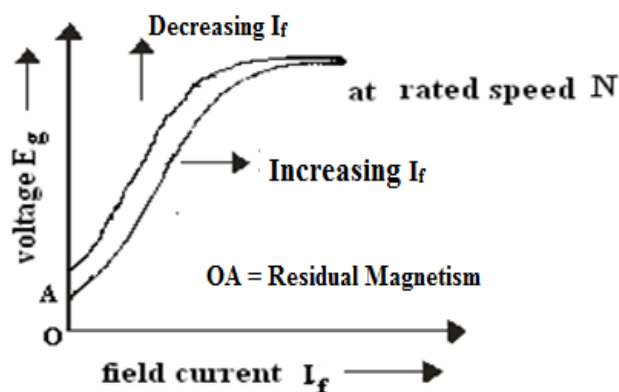| S. No.	ASCENDING		DESCENDING	
	Field Current If (amp)	Generated Voltage Eg (volts)	Field Current If (amp)	Generated Voltage Eg (volts)

3.7 MODEL GRAGH:

Fig – 3.2 Open Circuit Characteristics of DC shunt generator

3.8 PRECAUTIONS:

1. The experiment should be done at constant speed.
2. The jockey should be moved only in one direction. It should not be moved back and forth for obtaining a particular field current.
3. At zero field there would be some EMF due to residual magnetism
4. Avoid parallax errors and loose connections

3.9 RESULT:

3.10 PRE LAB QUESTIONS:

1. What is a generator?
2. What is the principle of operation of generator?
3. What are the different types of generators?
4. What is residual magnetism?
5. What is the Flemings right hand rule?
6. What is the EMF equation of generator?

3.11 POST LAB QUESTIONS:

1. What is the rating of generator used?
2. What is the motor rating used?
3. What is meant by starter?
4. What type of starter is used in your experiment?
5. How you can vary the speed of generator?

EXPERIMENT – 4

SWINBURNE'S TEST ON DC SHUNT MACHINE

4.1   AIM:

To pre-determine the efficiency of a DC shunt machine when run both as generator and motor.

4.2   APPARATUS REQUIRED:

S. No.	Name of the Apparatus	Range	Type	Quantity
1	Voltmeter			
2	Ammeter			
3	Ammeter			
4	Rheostat			
5	Tachometer			

4.3   NAME PLATE DETAILS

MOTOR

Voltage (V)	
Current (A)	
Output (KW/HP)	
Speed (RPM)	
Excitation Type	Shunt
Excitation Voltage	
Excitation current	

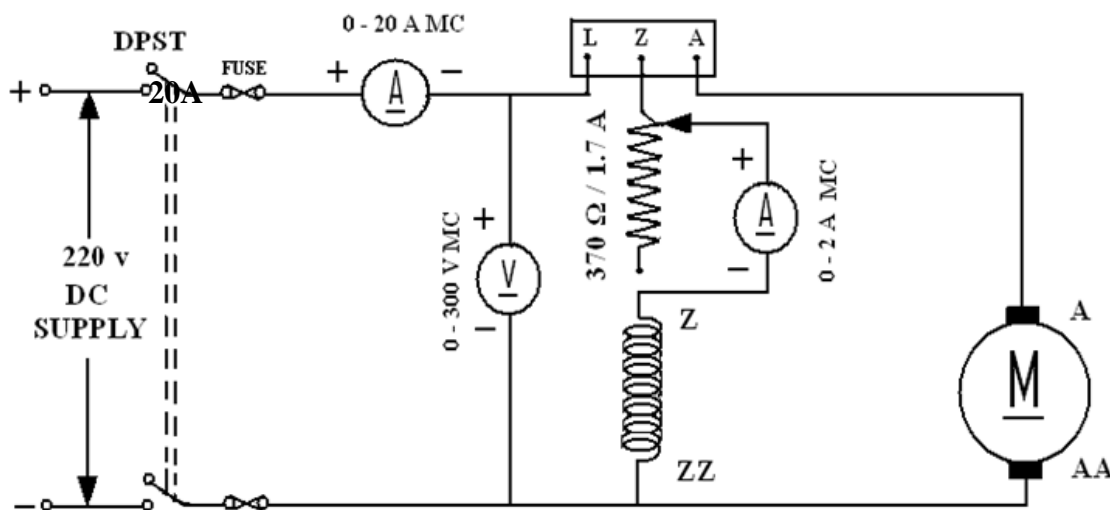**4.4   CIRCUIT DIAGRAM:**

Fig – 4.1 Swinburne's test on a D.C. Shunt Machine

4.5 PROCEDURE:

1. Choose the proper ranges of meters after noting the name plate details of the given machine and make the connections as per the circuit diagram.
2. Keep the motor field rheostat the minimum position, and start the motor by closing the switch and operating the starter slowly.
3. Run the motor at rated speed by adjusting the motor field rheostat.
4. Note down the voltage, no load current and field current.

4.6 OBSERVATIONS:

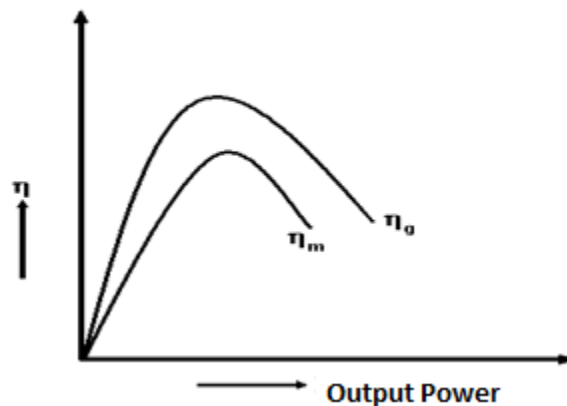| S. No.	V_L (V)	I_{Lo} (A)	I_f (A)

4.7 MODEL GRAPH:

Fig - 4.2 Performance characteristics of DC shunt machine

4.8 CALCULATIONS FOR SWINBURNE'S TEST:

From the no load test results,
Supply voltage = V_L Volts.
No load line current = I_{Lo} Amperes.
Field current= I_f Amperes.
Therefore No load Armature Current = I_{ao} = I_L-I_f Amperes.
No load copper losses are =$I_{ao}^2 R_a$
        Where R_a is the armature resistance
No load power input=$V_L I_L$
Constant losses = (No load power input - No load copper losses). ------------ (1)

Efficiency as motor:

Efficiency=output/input = (input – total losses)/ input.
Where total losses = constant losses + variable losses.
Constant losses are known value from the equation   (1)
Variable loss = $I_a^2 R_a$, where I_a= I_L-I_f

Input = $V_L I_L$, V_L is rated voltage of the machine

Assume line currents (I_L) as 2A, 4A,6A,----and find corresponding efficiency

Efficiency as generator:

Efficiency=output/input = output / (output + total losses).

Where losses = constant losses + variable losses

Constant losses are same for both motor and Generator

Armature Current = $I_a = I_L + I_f$

Variable loss = $I_a^2 R_a$

Output power = $V_L I_L$. V_L is rated voltage of the machine

Assume load currents (I_L) as 2A, 4A,6A,---- and find corresponding efficiencies

4.9   OBSERVATIONS:

As a Motor: **Rated voltage V_L =**   **Rated speed   N =**

S. No.	I_L	Input Power $P_i = V_L I_L$	Constant losses $W_{const.}$	Copper losses $W_{cu} = I_a^2 R_a$	Total losses = $(W_{cons.} + W_{cu})$	Output power = $(P_i -$ Total losses)	η

As a Generator:

Rated voltage VL =   **Rated speed   N =**

S. No.	I_L	Output Power $P_o = V_L I_L$	Constant losses $W_{const.}$	Copper losses $W_{cu} = I_a^2 R_a$	Total losses = $(W_{cons.} + W_{cu})$	Input power = $(P_o +$ Total losses)	η

4.10   PRECAUTIONS:

1. Run the motor at rated speed and rated voltage.
2. Avoid loose connections and parallax errors.

4.11   RESULTS:

4.12   PRE LAB QUESTIONS:

1. What is the principle of alternator?
2. What is meant by regulation?
3. What is meant by synchronous impedance?
4. What is meant by mmf?
5. How the alternators be rated?

4.13   POST LAB QUESTIONS:

1. How you determine the synchronous impedance in this method?
2. How the input to an alternator be given in your experiment?
3. Why DC supply only given to Field winding of an alternator?
4. How the frequency of an alternator is changes?
5. What is the effect of excitation on Current and Power factor?

EXPERIMENT – 5
OPEN CIRCUIT AND SHORT CIRCUIT TESTS ON SINGLE PHASE TRANSFORMER

5.1   AIM:

To perform open circuit and short circuit tests on a single phase transformer and to pre-determine the efficiency, regulation and equivalent circuit of the transformer.

5.2   APPARATUS REQUIRED:

S. No.	Apparatus Name	Range	Type	Quantity
1	Voltmeter			
2	Voltmeter			
3	Ammeter			
4	Ammeter			
3	Wattmeter			
4	Wattmeter			
5	Connecting Wires			

5.3   NAME PLATE DETAILS:

Transformer Specifications

Capacity (KVA)	
Primary Voltage (V)	
Secondary Voltage (V)	
Phase	
Frequency (Hz)	

Autotransformer Specifications

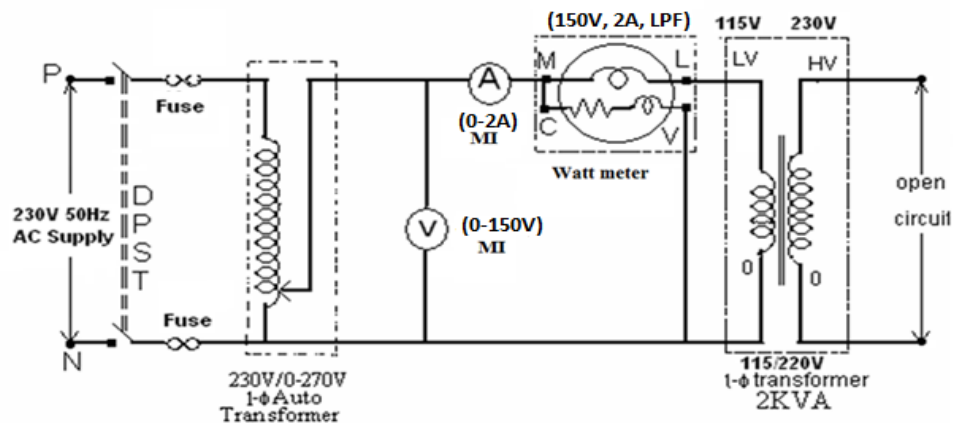|	
Capacity (KVA)	
Input Voltage (V)	
Output Voltage (V)	
Phase	
Frequency (Hz)	

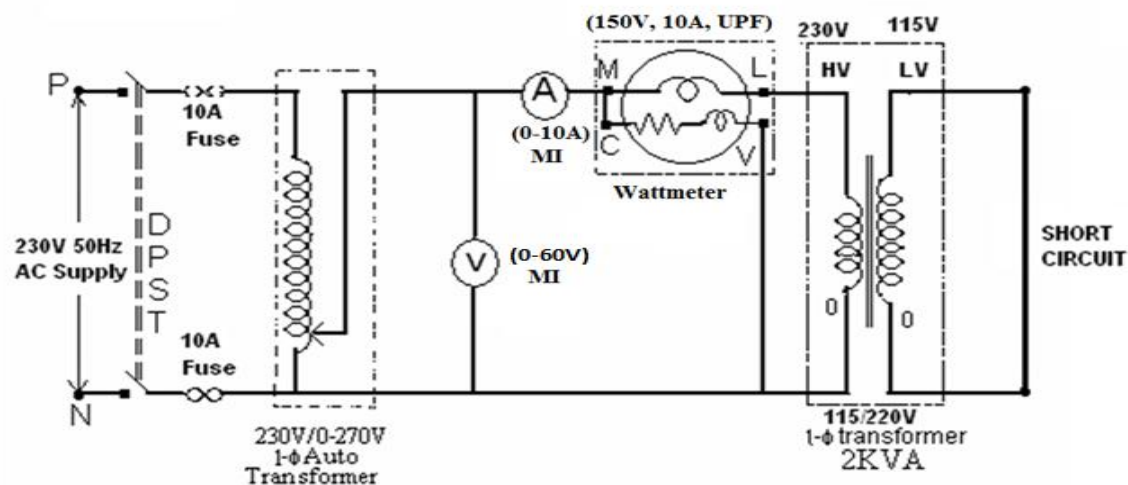**5.4   CIRCUIT DIAGRAMS:**

Fig -5.1 Open Circuit Test

Fig - 5.2 Short Circuit Test

5.5 PROCEDURE:

Open Circuit Test:

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

Short Circuit Test:

1. Connections are made as per the circuit diagram.
2. Ensure that variac is set to zero output voltage position before starting the experiment.
3. Switch ON the supply. Now apply the rated Current to the Primary winding by using variac.
4. The readings of the Voltmeter, ammeter and wattmeter are noted down in Tabular form.
5. Then Variac is set to zero output position and switch OFF the supply.
6. Calculate R_{o1} and X_{o1} from the readings.

5.6 OBSERVATIONS:

Open Circuit Test			Short Circuit Test		
Voltage (V_o)	Current (I_o)	Power (W_o)	Voltage (V_{SC})	Current (I_{SC})	Power (W_{SC})

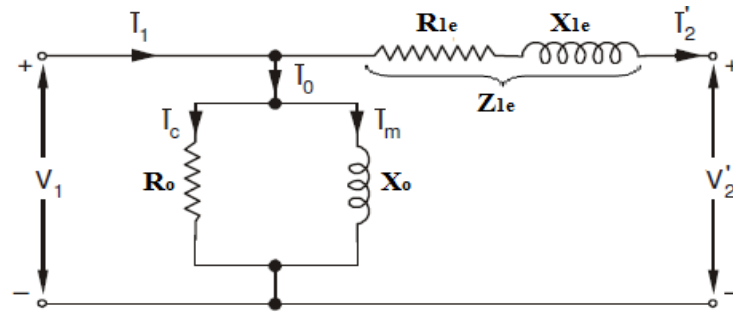## 5.7   EQUIVALENT CIRCUIT OF TRANSFORMER:

Fig – 5.3 Equivalent circuit of single phase transformer

5.8   MODEL CALCULATIONS:

Find the equivalent circuit parameters R_0, X_0, R_{1e}, R_{2e}, X_{1e} and X_{2e} from the O. C. and S. C. test results and draw the equivalent circuit referred to primary side.

Let the transformer be the step-up transformer (115/230V), then

Primary is H. V. side.

Secondary is L. V. side

From OC test:

$$\cos \emptyset_o = \frac{W_o}{V_o * I_o}$$

Working component of current $I_c = I_o * \cos \phi_0$
Magnetizing component of current $I_m = I_o * \sin \phi_0$

$$R_0 = \frac{V_0}{I_c} \quad \text{Where } I_c = I_0 \cos\phi_0$$

$$X_0 = \frac{V_0}{I_m} \quad \text{Where } I_m = I_0 \sin \phi_0$$

From SC Test:

$$R_{2e} = \frac{W_{SC}}{I_{SC}^2}$$

$$Z_{2e} = \frac{V_{SC}}{I_{SC}} = \sqrt{R_{2e}^2 + X_{2e}^2}$$

$$\therefore \qquad X_{2e} = \sqrt{Z_{2e}^2 - R_{2e}^2}$$

Thus we will get the equivalent circuit parameters referred to primary side of the transformer. The secondary side parameters also calculated by using the transformation ratio K.

$$R_{1e} = R_{1e}/K^2$$
$$X_{1e} = X_{1e}/K^2$$

Where K $= \dfrac{V_2}{V_1} =$ Transformation ratio.

Calculations to find efficiency and regulation from OC and SC tests

The efficiency and Regulation can be Predetermined at any load (n) and any power factor using the formulas given below

$$\% \text{ } \eta \text{ at any load} = \frac{n*(VA)*\cos \emptyset}{n*(VA)*\cos \emptyset + W_o + n^2 * W_{sc}}$$

Where n = Fraction of full load

        n = 1 (at full load)

        n = ½ (at half load)

        n = ¼ (at quarter load)

$$\% \operatorname{Re}gulation\ (\%R) = \frac{I_1 R_{1e}\ \cos\phi \pm I_1 X_{1e}\ \sin\phi}{V_1}\ x\ 100$$

Where V_1 is the rated Voltage and

I_1 is the rated current for full load, and for any load $I_1 = n * I_{rated}$

'+' for lagging power factors

'-' for leading power factor

Cosϕ = 1.0

Load n	Pcu (W) = n²* Wsc	P_i (W) = Wo	O/P (W) = n* (VA)*Cosϕ	I/P (W) = O/P + Pcu + Pi	η (%)	%R Lag	%R Lead

Cosϕ = 0.8

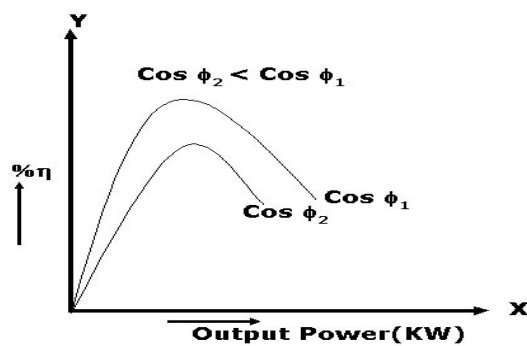| Load n	Pcu (W) = n²* Wsc	P_i (W) = Wo	O/P (W) = n* (VA)*Cosϕ	I/P (W) = O/P + Pcu + Pi	η (%)	%R Lag	%R Lead

5.9   MODEL GRAPH:

Fig – 5.4 Load vs Efficiency characteristics

5.10   PRECAUTIONS:

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

5.11   RESULT:

5.12   PRE LAB QUESTIONS:

1. What is a transformer?
2. What is the principle of transformer?
3. What happens when a DC supply is given to a transformer?
4. What are the types of transformer?
5. What is transformation ratio?

5.13   POST LAB QUESTIONS:

1. How the transformer is rated?
2. Why OC and SC tests are conducted on transformers?
3. On which side of the transformer OC test is conducted? Why?
4. On which side of the transformer SC test is conducted? Why?
5. What is the condition for maximum efficiency of transformer?

EXPERIMENT – 6

BRAKE TEST ON 3- ϕ SQUIRREL CAGE INDUCTION MOTOR

6.1 AIM:

To determine the efficiency of 3- ϕ induction motor by performing load test and to obtain the performance curves for the same.

6.2 APPARATUS REQUIRED:

S. No.	Equipment	Range	Type	Quantity
1	Voltmeter			
2	Ammeter			
3	Wattmeter			
4	Tachometer			
5	Connecting Wires			

6.3 NAME PLATE DETAILS:

3- ϕ Squirrel Cage Induction Motor

Voltage (V)	
Current (A)	
Power (KW/HP)	
Speed (RPM)	
Frequency (Hz)	

3- ϕ Auto Transformer

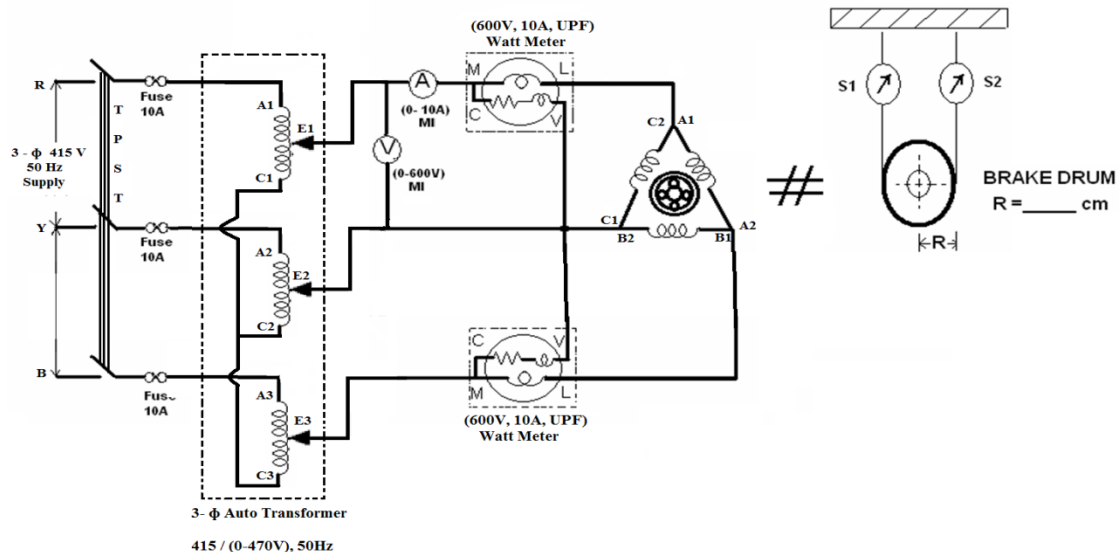|	
Capacity (KVA)	
Input Voltage (V)	
Output Voltage (V)	
Phase	
Frequency (Hz)	

6.4 CIRCUIT DIAGRAM:

Fig – 6.1 Brake test on three – phase squirrel cage induction motor

6.5   PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Ensure that the 3-ϕ variac is kept at minimum output voltage position and belt is freely suspended.
3. Switch ON the supply, Increase the variac output voltage gradually until rated voltage is observed in voltmeter. Note that the induction motor takes large current initially, so keep an eye on the ammeter such that the starting current should exceed the rated current.
4. By the time speed gains rated value, note down the readings of voltmeter, ammeter, and wattmeter at no-load.
5. Now the increase the mechanical load by tightening the belt around the brake drum gradually in steps.
6. Note down the various meters readings at different values of load till the ammeter shows the rated current.
7. Reduce the load on the motor and also bring the variac to minimum position, then switch OFF the supply.

6.6   MODEL CALCULATIONS:

Input power drawn by the motor $W = (W_1 + W_2)$ watts
Shaft Torque, $T_{sh} = 9.81 * R * (S_1 \sim S_2)$ N-m
Where R is the Radius of drum in meters.

Output power $P_o = \dfrac{2 \pi N T_{sh}}{60}$ watts

$\% \ Efficiency \ = \dfrac{Output \ Power \ in \ watts}{Input \ Power \ in \ watts} \ x \ 100$

$\% \ slip \ = \dfrac{N_s - N}{N_s} \ x \ 100 \qquad \left[where \ N_s \ = \dfrac{120 \ x \ f}{p} \right]$

Power factor of the induction motor $\cos \phi \ = \dfrac{P_i}{\sqrt{3} \ V \ I}$

6.7   **OBSERVATIONS:**

| S. No. | V (V) | I (A) | Power W (Watts) | | Speed N (RPM) | Spring balance (Kg) | | | Torque T (N-m) | Input Power $P_i = W_1 + W_2$ (Watts) | Output Power $P_o = \dfrac{2\pi NT}{60}$ (Watts) | %η |
			W_1	W_2		S_1	S_2	$S_1 \sim S_2$				

6.8   **MODEL GRAPHS:**
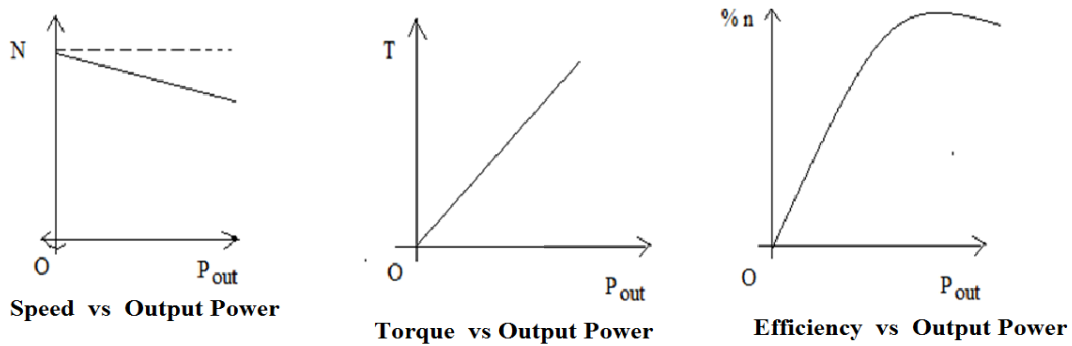
Fig – 6.2 Performance characteristics of three phase induction motor

6.9   **PRECAUTIONS:**

1. Connections must be made tight.
2. Parallax errors must be avoided while taking the readings.
3. Pour the water in the brake drum for cooling purpose.

6.10   RESULT:

6.11   PRE LAB QUESTIONS:

1.   What is the principle of operation of induction motor?
2.   What is meant by slip of induction motor?
3.   What are the types of 3-phase induction motors?
4.   What is Lenz's law?
5.   What is the difference between slip ring and squirrel cage induction motors?

6.12   POST LAB QUESTIONS:

1.   How induction motor speed can be reversed?
2.   What you do if the wattmeter shows the reading in reverse direction?
3.   What is the slip at standstill?
4.   How long the load on the motor be increased?
5.   What is the rating of induction motor you used?

REGULATION OF AN ALTERNATOR USING SYNCHRONOUS IMPEDANCE METHOD

7.1   AIM:

To find the regulation of a three-phase alternator by using synchronous impedance method.

7.2   APPARATUS REQUIRED:

S. No.	Equipment	Type	Range	Quantity
1	Voltmeter			
2	Ammeter			
3	Ammeter			
4	Rheostat			
5	Tachometer			
6	Connecting Wires			

7.3   NAME PLATE DETAILS:

DC Motor

Voltage (V)	
Current (A)	
Output (KW/HP)	
Speed (RPM)	
Excitation Type	Shunt
Excitation Voltage	
Excitation current	

3- φ Alternator

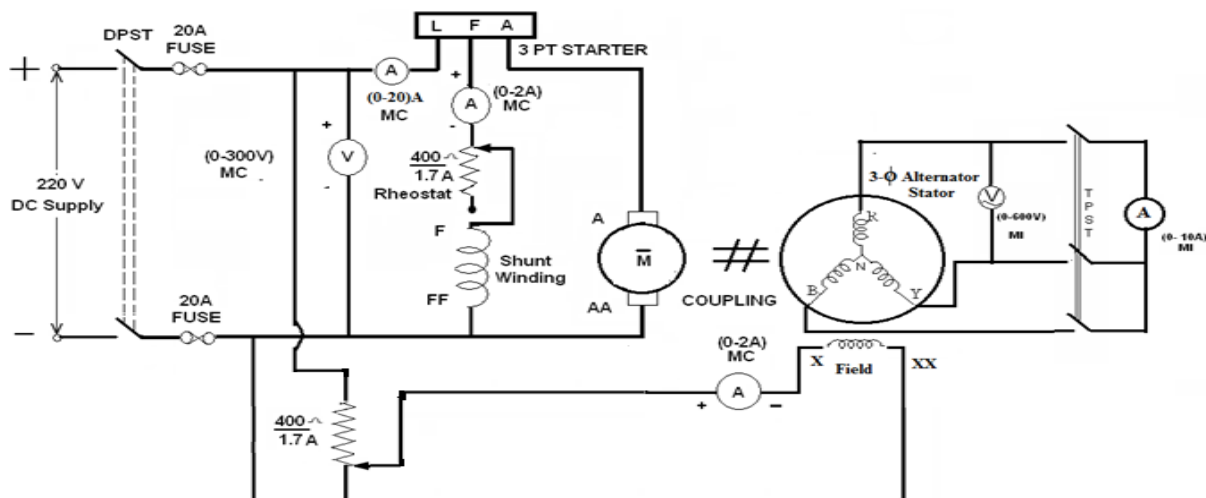|	
KVA rating	
Voltage (V)	
Current (A)	
Speed	
Power factor	
Excitation Voltage	
Rated Current	

7.4   CIRCUIT DIAGRAM:

Fig – 7.1 Regulation of Alternator Using Synchronous Impedance Method

7.5   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 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 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. For Short circuit test, before starting the experiment the potential divider is brought back to zero output position, i.e., resistance should be zero in value.

2. Now close the TPST switch.

3. The excitation of alternator is gradually increased in steps until rated current flows in the machine and note down the readings of excitation current and load current (short circuit current)

4. Switch OFF the supply.

7.6   OBSERVATIONS:

S. No.	OC test	
	Field current I_f (Amp.)	OC voltage per phase Vo (volts)

S. No.	S.C. test	
	Field current I_f (Amp.)	SC current I_{sc} Amp.

7.7 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 a armature is found out.
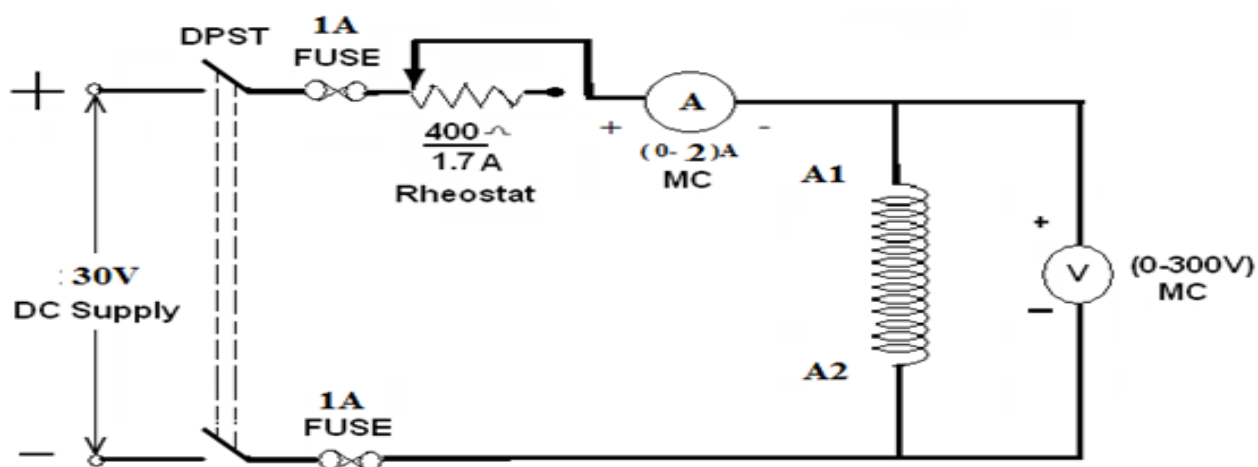
7.7.1 CONNECTION DIAGRAM TO FIND Ra:

Fig - 7.2 Circuit diagram for calculation of Resistance of armature winding of alternator

7.7.2 OBSERVATIONS:

S. No.	Armature current I(amp)	Armature voltage Va (volts)	$R_{dc}=V / I$

7.8   PROCEDURE:

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.

7.9   MODEL CALCULATIONS:

$$Z_S = \frac{V_{OC}}{I_{SC}} \text{ for the same } I_f \text{ and speed}$$

$$X_S = \sqrt{Z_S^2 - R_a^2} \qquad [\because R_a = R_{dC}]$$

Generated emf of alternator on no load is

$$E_0 = \sqrt{(v\cos\phi + I_a\,R_a)^2 + (v\sin\phi \pm I_a\,X_S)^2}$$

+ For lagging p. f.
- For leading p. f.

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

$$\% \text{ Re}\,g = \frac{E_0 - V}{V}\ x\ 100$$

Where

E_0– Generated emf of alternator (or excitation voltage per phase)
V – Full load, rated terminal voltage per phase.

7.10   MODEL GRAPHS:

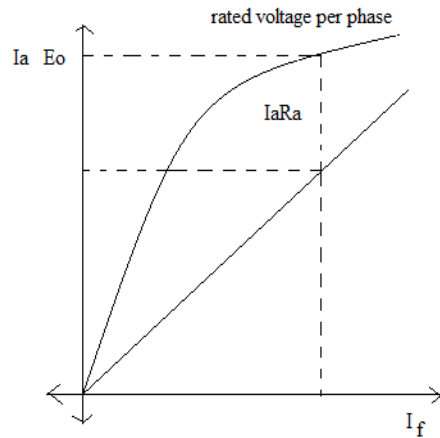Draw the graph between I_f V_S E_0 per phase and I_f V_S I_{SC}

Fig – 7.3 OCC and SC characteristics of Alternator

7.11   PRECAUTIONS:

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

7.12   RESULT:

7.13   PRE LAB QUESTIONS:

1. What is the principle of alternator?
2. What is meant by regulation?
3. What is meant by synchronous impedance?
4. What is meant by mmf?
5. How the alternators be rated?

7.14   POST LAB QUESTIONS:

1. How you determine the synchronous impedance in this method?
2. How the input to an alternator be given in your experiment?
3. Why DC supply only given to Field winding of an alternator?
4. How the frequency of an alternator is changes?
5. What is the effect of excitation on Current and Power factor?

EXPERIMENT – 8

VOLT AMPERE CHARACTERISTICS OF P-N JUNCTION DIODE

8.1   AIM:

To plot the V-I characteristics of a P-N junction diode in both forward and reverse directions, determine Cut in voltage (knee voltage), static and dynamic resistance in forward direction at forward current of 2mA & 8mA respectively and find static and dynamic resistance at 10V in reverse bias condition.

8.2 APPARATUS:

S.No	Device	Range/Rating	Quantity (in No.s)
1.	Semiconductor diode trainer Board Containing DC Power Supply. Diode (Silicon) Diode (Germanium) Carbon Film Resistor	(0-15) V 1N 4007 OA79 1 KΩ, 1/2 W	1 1 1 1
2.	DC Voltmeter DC Voltmeter	(0-1) V (0-20) V	1 1
3.	DC Ammeter DC Ammeter	(0-200) μA (0-20) mA	1 1
4.	Connecting wires	5A	10

8.3 CIRCUIT DIAGRAMS:

8.3.1 Forward Bias
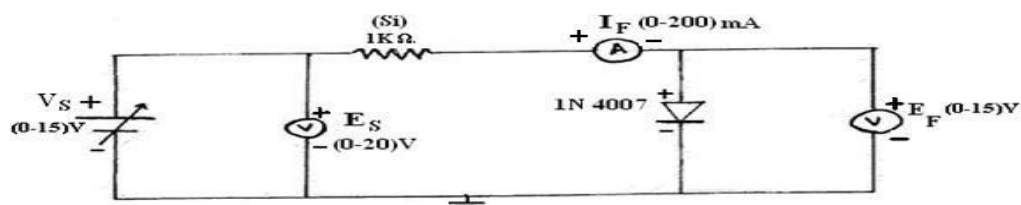
Figure – 8.3.1. Forward Bias Circuit
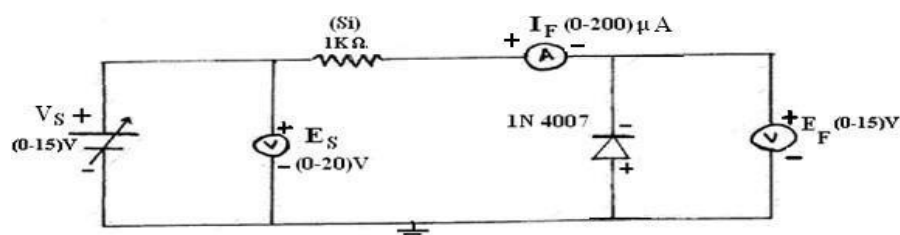
8.3.2 Reverse Bias

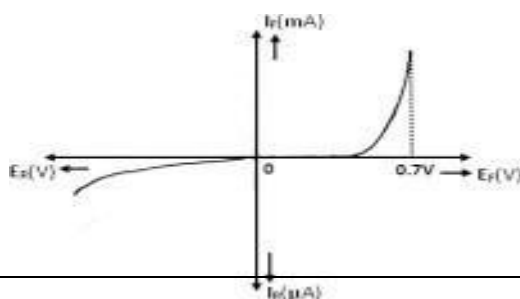**Figure – 8.3.2. Reverse Bias Circuit**

8.4 EXPECTED GRAPHS:

Figure – 8.4.1. Volt Ampere Characteristics of P-N Junction Diode

8.5 TABULAR COLUMN:

FORWARD BIAS

E_s (volts)	E_f (volts)	I_f (mA)
0.1		
0.2		
0.3		
0.4		
0.5		
0.6		
0.7		
0.8		
0.9		
1		
2		
4		
6		
8		
10		
12		
14		

REVERSE BIAS

E_s (volts)	E_r (volts)	I_r (µA)
0.1		
0.2		
0.3		
0.4		
0.5		
0.6		
0.7		
0.8		
0.9		
1		
2		
4		
6		
8		
10		
12		
14		

8.6 PRECAUTIONS:

1. Ensure that the polarities of the power supply and the meters as per the circuit diagram.
2. Keep the input voltage knob of the regulated power supply in minimum position both when switching ON or switching OFF the power supply.
3. No loose contacts at the junctions.
4. Ensure that the ratings of the meters are as per the circuit design for precision.

8.7 CALCULATIONS:

Forward Bias

Static Resistance at 8mA = E_f / I_f =
Static resistance at 2mA = E_f / I_f =
Dynamic resistance at 8mA = $\Delta E_f / \Delta I_f$ =
Dynamic resistance at 8mA = $\Delta E_f / \Delta I_f$ =

Reverse Bias

Static Resistance at (10V) = E_r / I_r =
Dynamic resistance at (10V) = $\Delta E_r / \Delta I_r$ =

8.8 RESULT:

8.9 PRE LAB QUESTIONS:

1. Define depletion region of a diode.
2. What is meant by transition and space charge capacitance of a diode?
3. Is the V-I relationship of a diode Linear or Exponential?
4. Draw the ideal characteristics of P-N junction diode.
5. What is the diode equation?

8.10 POST LAB QUESTIONS:

1. Define cut-in voltage of a diode and specify the values for Si and Ge diodes.
2. What are the applications of a p-n diode?
3. What is PIV?
4. Define break down voltage.
5. What is the effect of temperature on PN junction diodes?

ZENER DIODE CHARACTERISTICS AND VOLTAGE REGULATOR

9.1 AIM:

Plot the V-I characteristics of a Zener diode, find Zener breakdown voltage in reverse bias condition, find static and dynamic resistance in both forward and reverse bias conditions and perform Zener diode voltage regulator.

9.2 APPARATUS:

S.NO	DEVICES	RANGE /RATING	QUANTITY (in No.s)
1.	Zener diode trainer Board Containing		
	a) DC Power Supply.	(0-15) V	1
	b) Zener Diode	4.7 V	1
	c) Zener Diode	6.2 V	1
	d) Carbon Film Resistor	1 KΩ, 1/2 W	1
2.	DC Voltmeter	(0-1) V	1
	DC Voltmeter	(0-20) V	1
3.	a) DC Ammeter	(0-200) µA	1
	b) DC Ammeter	(0-20) mA	1
4.	Connecting wires	5A	10

9.3 CIRCUIT DIAGRAMS:
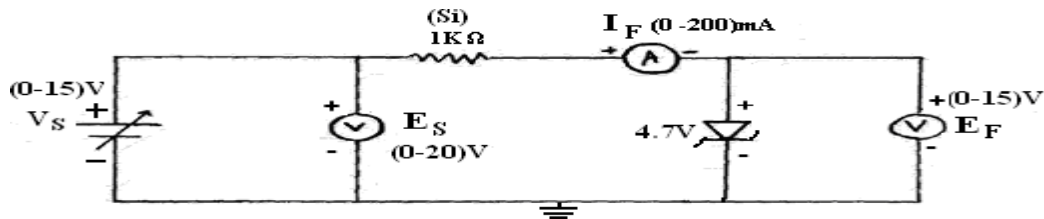
Forward Bias

Figure – 9.1. Forward Bias Circuit
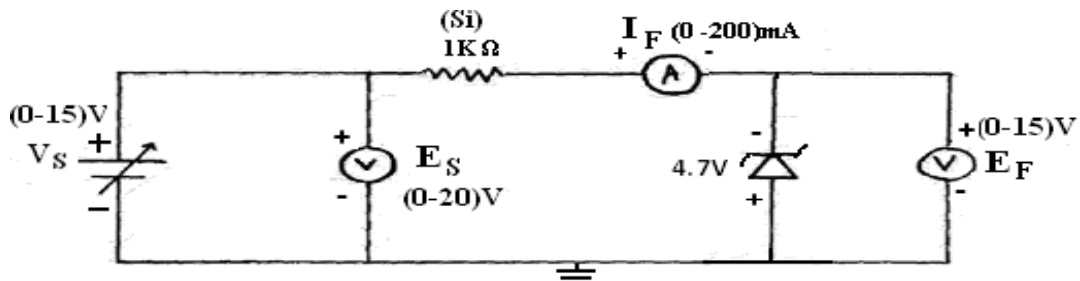
Reverse Bias

Figure – 9.2. Reverse Bias Circuit
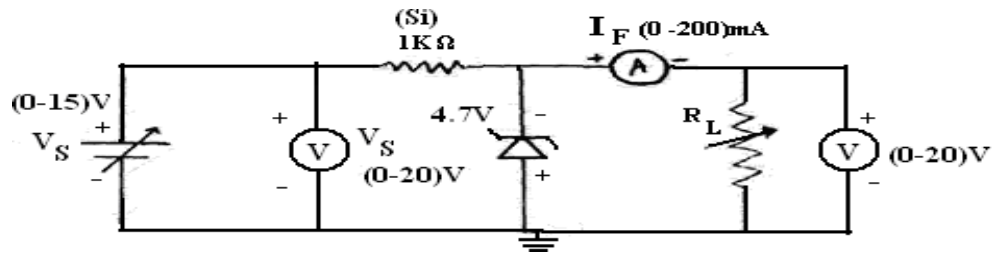
Zener Diode as Voltage Regulator

Figure – 9.3. Zener Diode as Voltage Regulator

9.3 PROCEDURE:

Forward Bias

1. Connect the circuit as shown in figure 10.4.1.

2. Vary the supply voltage E_s in steps and note down the corresponding values of E_f and I_f as shown in the tabular column.

Reverse Bias

1. Connect the circuit as shown in figure 10.4.2.

2. Repeat the procedure as in forward bias and note down the

   corresponding Values of E_r and I_r as shown in the tabular column
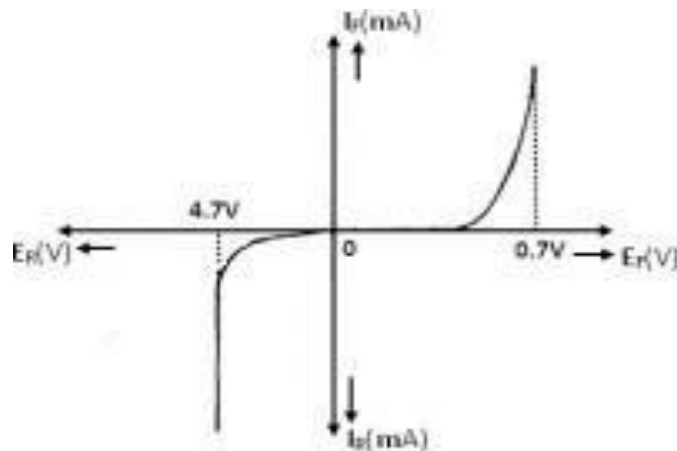
9.4 EXPECTED GRAPH:

Figure – 9.4. Zener Diode as Voltage Regulator

9.5 TABULAR COLUMN:

Forward Bias

E_s (volts)	E_f (volts)	I_f (mA)
0.1		
0.2		
0.3		
0.4		
0.5		
0.6		
0.7		
0.8		
0.9		
1		
2		
4		
6		
8		
10		
12		
14		

Reverse Bias

E_s (volts)	E_r (volts)	I_r (mA)
0.1		
0.2		
0.3		
0.4		
0.5		
0.6		
0.7		
0.8		
0.9		
1		
2		
4		
6		
8		
10		
12		
14		

Zener Diode as Voltage Regulator:

V_{in}=15V, V_{NL}=____ R_L=15K

$R_L(\Omega)$	V_{FL}(volts)	I_L (mA)	%Regulation
100			
200			
500			
1K			
2K			
5K			
10K			
20K			

E_s (volts)	E_{FL} (volts)	I_L (mA)
1		
2		
4		
6		
8		
10		
12		
14		

9.6 PRECAUTIONS:

1. Ensure that the polarities of the power supply and the meters as per the circuit diagram.
2. Keep the input voltage knob of the regulated power supply in minimum position both when switching ON or switching OFF the power supply.
3. No loose contacts at the junctions.
4. Ensure that the ratings of the meters are as per the circuit design for precision.

9.7 CALCULATIONS:

Forward Static resistance at 6 mA= E_f/ I_f Forward

Dynamic resistance at 6mA=ΔE_f / ΔI_f Reverse

Static resistance at 6 mA= E_f/ I_f Reverse Dynamic

resistance at 6mA=ΔE_f / ΔI

9.8 RESULT:

1. V-I characteristics of Zener diode are plotted and verified in both forward and reverse directions.
2. Zener breakdown voltage for 4.7V zener diode = 4.7V.
3. (i) Forward Bias:
   a) Static resistance at 6 mA =
   b) Dynamic resistance at 6 mA=

   (ii) Reverse Bias:

   Static resistance at 6 mA=

   Dynamic resistance at 6 mA=

9.9 PRE LAB QUESTIONS:

1. What type of temperature Coefficient does the zener diode have?
2. If the impurity concentration is increased, how the depletion width effected?
3. How the breakdown voltage of a particular diode can be controlled?
4. What type of temperature coefficient does the Avalanche breakdown has?

9.10 LAB ASSIGNMENT:

1. To plot the V-I characteristics of a Zener diode (6.1V) in both forward and reverse directions by using multisim.

9.11 POST LAB QUESTIONS:

1. Explain briefly about avalanche and Zener breakdowns.
2. Draw the Zener equivalent circuit.
3. Differentiate between line regulation & load regulation.
4. In which region Zener diode can be used as a regulator?

EXPERIMENT – 10

HALF WAVE RECTIFIERS WITH / WITHOUT FILTER

10.1 AIM:

Examine the input and output waveforms of a half wave rectifier without and with filters. Calculate the ripple factor with load resistance of 500Ω, 1 KΩ and 10 KΩ respectively. Calculate ripple factor with a filter capacitor of 100□ F and the load of 1K□ , 2K□ and 10KΩ respectively.

10.2 APPARATUS:

S.No	Device	Range/Rating	Quantity in No.
1	Rectifier and Filter trainer Board Containing a) AC Supply. b) Silicon Diodes c) Capacitor	(9-0-9) V 1N 4007 0.47µF	1 7 1
2	a) DC Voltmeter b) AC Voltmeter	(0-20) V (0-20) V	1 1
3	DC Ammeter	(0-50) mA	1
4	Cathode Ray Oscilloscope	(0-20) MHz	1
5	Decade Resistance Box	10Ω-100KΩ	1
6	Connecting wires	5A	12

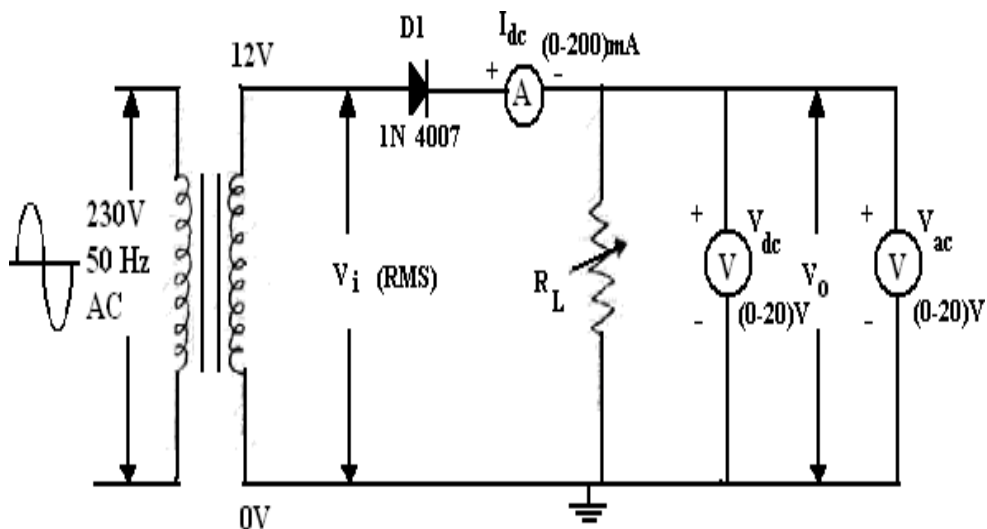### 10.3 CIRCUIT DIAGRAMS:

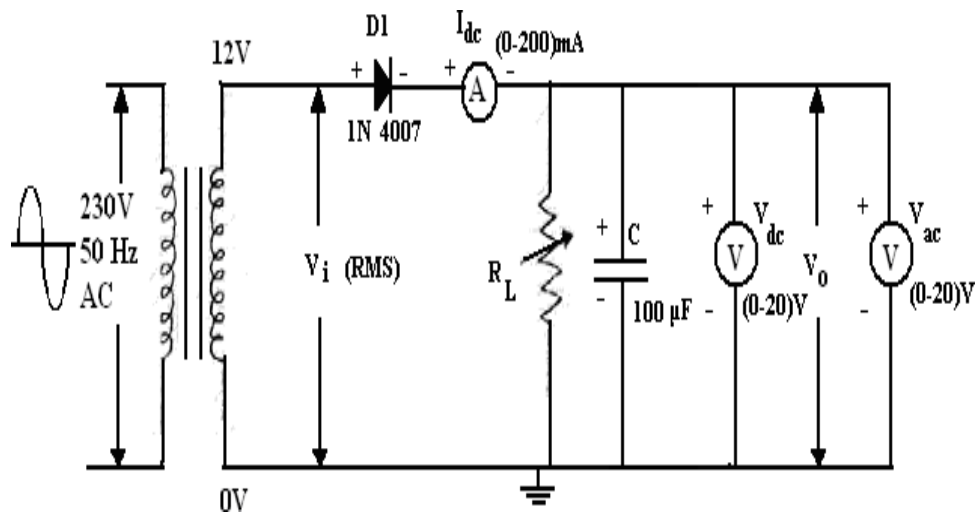**Figure – 10.1. Half Wave Rectifier without Filter**

Figure – 10.2. Half Wave Rectifier with Filter

10.4 PROCEDURE:

Half Wave Rectifier without filter

1. Connect the circuit as shown in figure 11.4.1.
2. Adjust the load resistance, R_L to 500Ω, and note down the readings of input and output voltages through oscilloscope.
3. Note the readings of dc current, dc voltage and ac voltage.
4. Now, change the resistance the load resistance, RL to 1 KΩ and repeat the procedure as above. Also repeat for 10 KΩ.
5. Readings are tabulated as per the tabular column.

Half Wave Rectifier with filter

1. Connect the circuit as shown in figure 11.4.2 and repeat the procedure as for half Wave rectifier without filter.

10.5 EXPECTED GRAPHS:
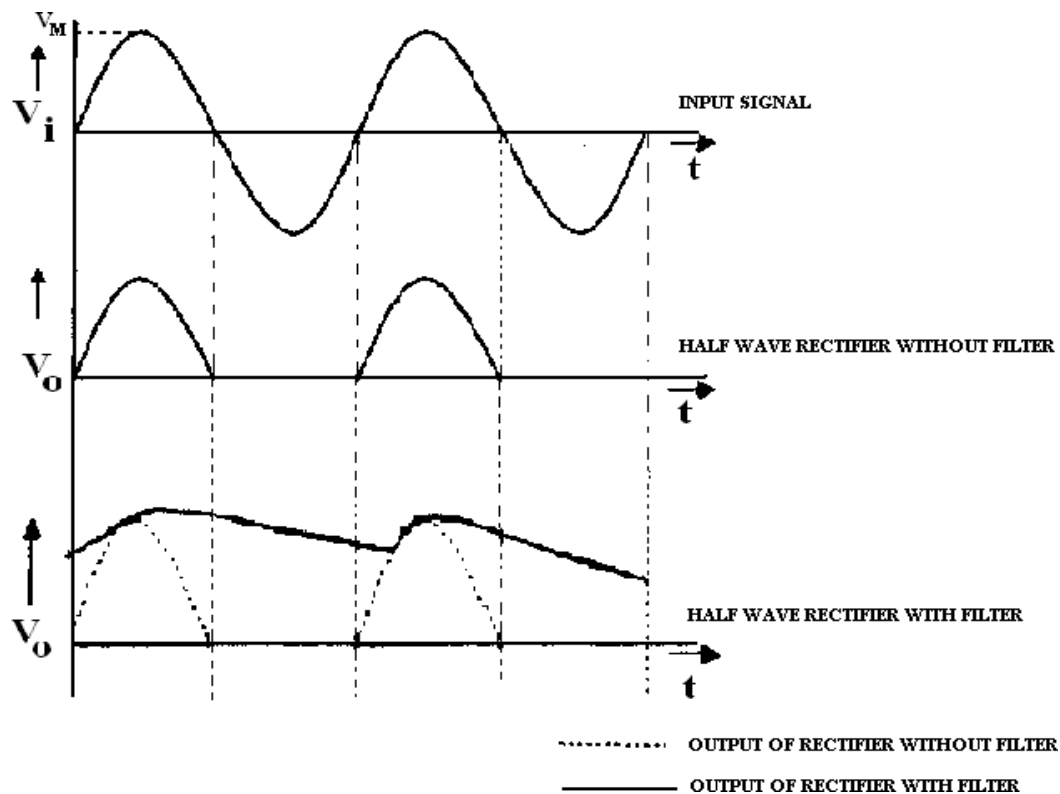
10.6 PRECAUTIONS:

1. No loose contacts at the junctions.
2. Meters of correct ranges must be used for precision

10.7 TABULAR COLUMNS:

Half Wave Rectifier without Filter

S.No	Load Resistance (R_L)	Input Voltage Peak (V_m)	Output Voltage Peak (V_o)	Average dc current (I_{dc})	Average Dc voltage (V_{dc})	RMS Voltage (V_{ac})	Ripple Factor $\gamma = \dfrac{V_{ac}}{V_{dc}}$
1.	500Ω						
2.	1KΩ						
3.	10KΩ						

Half Wave Rectifier with Filter C=10μF

S.No	Load Resistance (R_L)	Input Voltage Peak (V_m)	Output Voltage Peak (V_o)	Average dc current (I_{dc})	Average Dc voltage (V_{dc})	RMS Voltage (V_{ac})	Ripple Factor $\gamma = \dfrac{V_{ac}}{V_{dc}}$
1.	1KΩ						
2.	2KΩ						
3.	10KΩ						

10.8 PRE LAB QUESTIONS:

1. What is a rectifier?
2. How Diode acts as a rectifier?
3. What is the significance of PIV? What is the condition imposed on PIV?
4. Define regulation.
5. Define time constant.

10.9 LAB ASSIGNMENT:

1. Plot the wave forms of Half wave rectifier with R=5000 ohms, C = 680μF.

10.10 POST LAB QUESTIONS:

1. Draw the o/p wave form without filter.
2. Draw the o/p wave form with filter.
3. What is meant by ripple factor? For a good filter whether ripple factor should be high or low?
4. What happens to the o/p wave form if we increase the capacitor value?
5. What happens if we increase the capacitor value?

10.11 RESULT:

1. Input and Output waveforms of a half-wave with /without filter are observed and plotted.
2. For Half-wave rectifier without
   filter- γ, Ripple factor at
   500Ω=

                        1KΩ=

                      10 KΩ=

3. For Half-wave rectifier with
   filter:- γ, Ripple factor at
   1KΩ, 100μF =

                    2KΩ, 100μF =

                 10 KΩ, 100μF =

FULLWAVE RECTIFIERS WITH/WITHOUT FILTER

11.1 AIM:

Examine the input and output waveforms of a full wave (center tapped) rectifier without and with filters.
Calculate the ripple factor with load resistance of 500Ω, 1 KΩ and 10 KΩ respectively.
Calculate ripple factor with a filter capacitor of 100 F and the load of 1KΩ , 2KΩ and 10KΩ respectively.

11.2 APPARATUS:

| S.No	Device	Range /Rating	Quantity (in No.s)
1	Rectifier and Filter trainer Board Containing a) AC Supply. b) Silicon Diodes c) Capacitor	(9-0-9) V 1N 4007 0.47µF	1 7 1
2	a) DC Voltmeter b) AC Voltmeter	(0-20) V (0-20) V	1 1
3	DC Ammeter	(0-50) mA	1
4	Cathode Ray Oscilloscope	(0-20) MHz	1
5	Decade Resistance Box	10Ω-100KΩ	1
6	Electrolytic Capacitor	100µF	1
7	Connecting wires	5A	12

11.3 CIRCUIT DIAGRAMS:
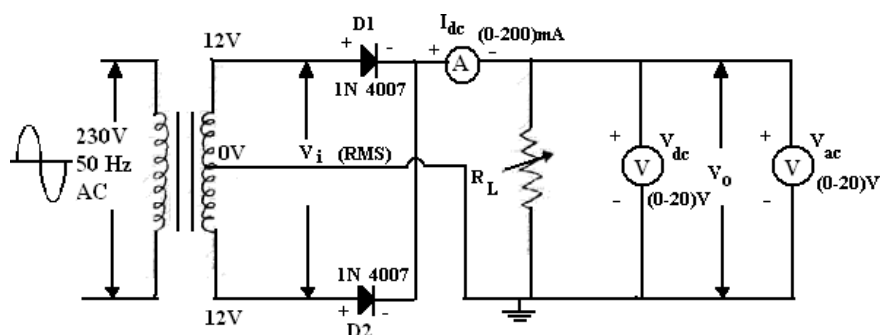
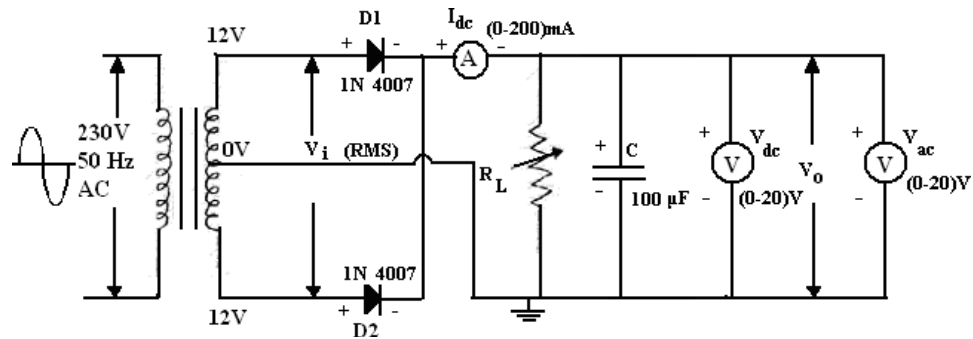**Figure – 11.1. Full Wave Rectifier (Center-tap) Without Filter**

Figure – 11.2. Full Wave Rectifier (Center-tap) With Filter

11.4 PROCEDURE:

Full-wave Rectifier without filter

1. Connect the circuit as shown in the figure (a).
2. Adjust the load resistance R_L to 500☐ and connect a capacitorof 100☐ F value in parallel with the load and note the readings of input and output voltages through Oscilloscope.
3. Note the readings of DC current, DC voltage and AC voltage.
4. Now change the load resistance RL to 2000☐ and repeat the procedure astheabove.
5. Readings are tabulate as per the tabular column.

Full-wave Rectifier with filter

1. Connect the circuit as shown in the figure (b).
2. Adjust the load resistance R_L to 1K☐ and connect a capacitorof 100☐ F values in parallel with the load and note the readings of input and output voltages through Oscilloscope.
3. Note the readings of DC current, DC voltage and AC voltage.
4. Now change the load resistance R_L to 2K☐ and repeat the procedure as the above. Also repeat for 10K, 100µF values
5. Readings are tabulate as per the tabular column.

11.5 EXPECTED GRAPHS:
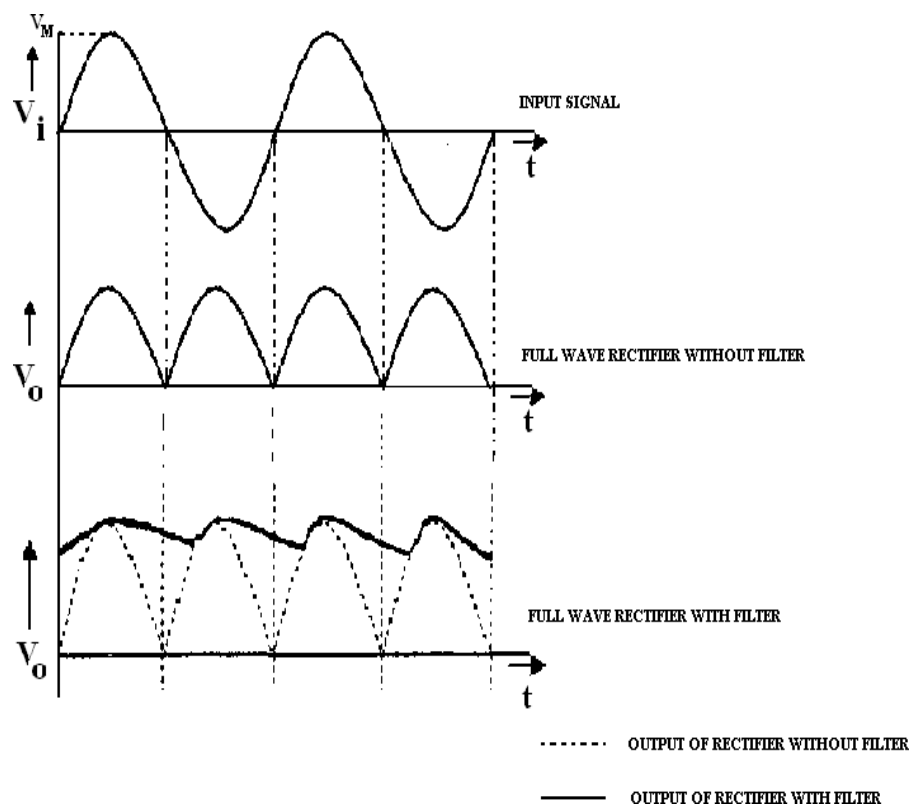
11.6 PRECAUTIONS:

1.   No loose contacts at the junctions.

2.   Meters of correct range must be used for precision.

11.7 TABULAR COLUMNS:

Full wave Rectifier (Center-tap) Without Filter

S.No	Load Resistance (R_L)	Input Voltage Peak (V_m)	Output Voltage Peak (V_o)	Average dc current (I_{dc})	Average Dc voltage (V_{dc})	RMS Voltage (V_{ac})	Ripple Factor $\gamma = \dfrac{V_{ac}}{V_{dc}}$
1	500Ω						
2	1KΩ						
3	10KΩ						

Full wave Rectifier (Center-tap) With Filter C = --- µF

S.No	Load Resistance (R_L)	Input Voltage Peak (V_m)	Output Voltage Peak (V_o)	Average dc current (I_{dc})	Average Dc voltage (V_{dc})	RMS Voltage (V_{ac})	Ripple Factor $\gamma=\dfrac{V_{ac}}{V_{dc}}$
1	500Ω						
2	1KΩ						
3	10K						

11.8 PRE LAB QUESTIONS:

1. What is a full wave rectifier?
2. How Diode acts as a rectifier?
3. What is the significance of PIV requirement of Diode in full-wave rectifier?
4. Compare capacitor filter with an inductor filter.
5. What is the theoretical maximum value of ripple factor for a full wave rectifier?

11.9 LAB ASSIGNMENT:

Plot the wave forms of full wave rectifier with R=500 ohms, C = 470µF.

11.10 POST LAB QUESTIONS:

1. Draw the o/p wave form without filter? Draw the O/P? What is wave formwith Filter.

2. Define ripple factor. For a good filter whether ripple factor should be high or low? What happens to the ripple factor if we insert the filter?

3. Define regulation. Why regulation is poor in the case of inductor filter?

4. Define time constant.

5. What happens to the o/p wave form if we increase the capacitor value? What happens if we increase the capacitor value?

11.11 RESULT:

1. Input and Output waveforms of a full-wave (center tapped) and bridge rectifier with /without filters are observed and plotted.

2. For Full-wave rectifier(center tapped) without filter-

      i. γ, Ripple factor at 500Ω, 100μF =

         a. 2KΩ, 100μF =

3. For full-wave rectifier (Center tapped) with filter-

      i. γ, Ripple factor at 500Ω, 100μF =

         a. 2KΩ, 100μF =

EXPERIMENT – 12

TRANSISTOR CB CHARACTERISTICS

12.1 AIM:

Plot the input and output characteristics of a transistor connected in Common Base configuration. Calculate the input resistance R_i at I_e= 12 mA, output resistance R_o at V_{CB}=8V and current gain at V_{CB}=6V.

12.2 APPARATUS:

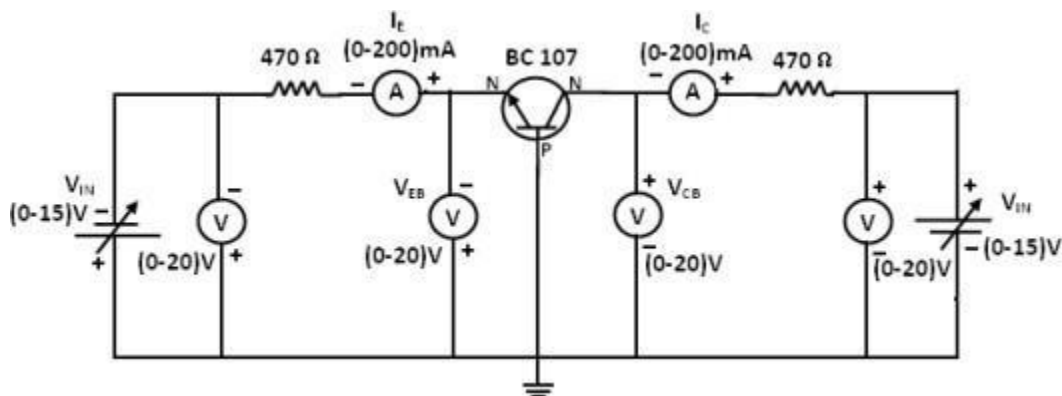| S.No.	Device	Range /Rating	Quantity (in No.s)
1.	Transistor CB trainer Board Containing a) DC Power Supply. b) PNP Transistor c) Carbon Film Resistor	(0-12) V CK100 470Ω, 1/2 W	2 1 2
2.	a) DC Voltmeter b) DC Voltmeter	(0-1) V (0-20) V	1 1
3.	DC Ammeter	(0-50) mA	2
4.	Connecting wires	5A	12

12.3 CIRCUIT DIAGRAM:

Figure – 12.1. Transistor CB Characteristics

12.4 PROCEDURE:

12.4.1 Input Characteristics:

1. Connect the transistor as shown in figure12.3.1
2. Keep the V_{CB} constant at 4V and 8V. Vary the V_{EB} in steps and note corresponding I_E values asper tabular form.

Output Characteristics:

1. Keep the I_E constant at 4mA and 8mA.Vary the V_{CB} in steps and note
   Corresponding I_C values.
2. Readings are tabulated as shown in tabular column
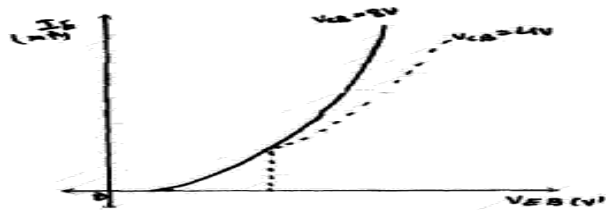
12.5 EXPECTED GRAPHS:

Input Characteristics:

Figure – 12.2. Transistor CB Input Characteristics
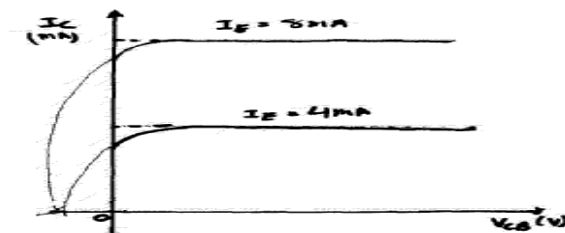
Output characteristics:

Figure – 12.3. Transistor CB output Characteristics

12.6 PRECAUTIONS:

1. Keep the knobs of supply voltages V_{EB} & V_{CB} at minimum positions when switching ON or switching OFF the power supply.
2. No loose contacts at the junctions.
3. Do not overload the meters above its rated ranges.

12.7 TABULAR COLUMN:

Input Characteristics

V_{CB} = -4V		V_{CB} = -8V	
V_{EB} (Volts)	I_E (mA)	V_{EB} (Volts)	I_E (mA)

Output Characteristics

I_E = 8mA		I_E = 4mA	
V_{CB} (Volts)	I_C (mA)	V_{CB}(Volts)	I_C(mA)

12.8 CALCULATIONS:

Input Resistance (I_E =12 mA) = $\Delta V_{EB}/\Delta I_E$ =At V_{EB} = 4V

Input Resistance (I_E =12 mA) = $\Delta V_{EB}/\Delta I_E$ = At V_{EB} = 8V

Output resistance (I_E =8mA) = $\Delta V_{CB}/\Delta I_C$ = At V_{CB} = -8V.

Output resistance (I_E =4mA) = $\Delta V_{CB}/\Delta I_C$ = At V_{CB} = -8V.

Current Amplification Factor 'α'= $\Delta I_C/\Delta I_E$ =

12.9 PRE LAB QUESTIONS:

1. What is the range of α for the transistor?
2. Draw the input and output characteristics of the transistor in CB configuration?
3. Identify various regions in output characteristics?
4. What is the relation between α and β?

12.10 LAB ASSIGNMENT:

Plot the I/O characteristics of CB configuration for Vcc = 12V, VEE = 6V, RE= 100K ohms, Rc = 1K ohms, α =0.98, Vbe = 0.7V.

12.11 POST LAB QUESTIONS:

1. Discuss the applications of CB configuration?
2. What are the input and output impedances of CB configuration?
3. Define α (alpha)?
4. What is EARLY effect?
5. Discuss the power gain of CB configuration

12.12 RESULT:

1. Input and output curves are plotted.
2. R_i Input Resistance:
   - (i) V_{EB} = 4V and I_E =12 mA, R_i =
   - (ii) V_{EB} = 8V and I_E =12 mA, R_i =
3. R_o Output Resistance:
   - (i) V_{CB} = 8V and I_E = 8 mA, R_o =
   - (ii) V_{CB} = 8V and I_E = 4 mA, R_o =
4. Current Amplification factor

   'α' =

   (at V_{CB} =6V)

EXPERIMENT NO: 13

TRANSISTOR CE CHARACTERISTICS

13.1 AIM:

Plot the input and output characteristics of a transistor connected in Common Emitter configuration. Calculate the input resistance R_i at I_B= 20 µA, output resistance R_O at V_{CE}=10V and current gain at V_{CE} =10V.

13.2 APPARATUS:

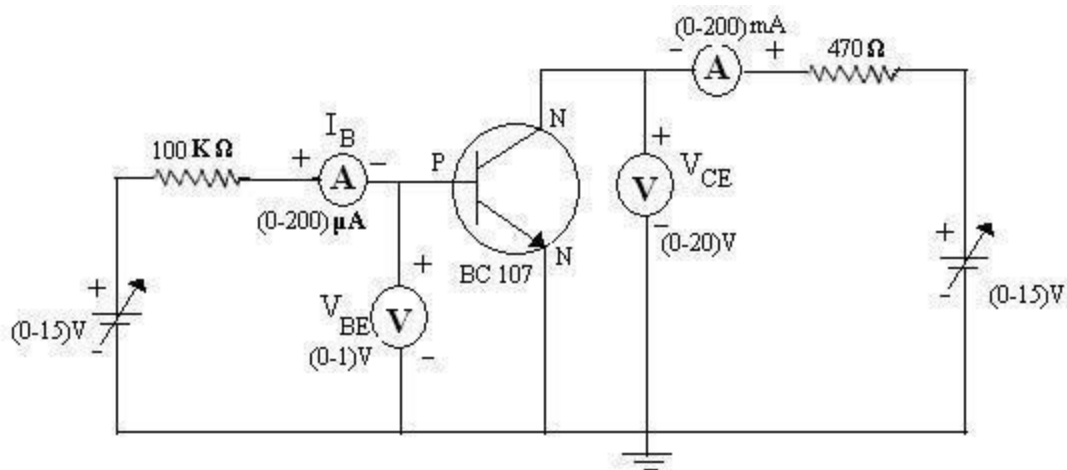| S. No	Devices	Range / Rating	Quantity (in No's)
1.	Transistor CE trainer Board Containing a) DC Power Supply. b) NPN Transistor c) Carbon Film Resistor	(0-12) V BC 107 470Ω, 1/2 W 100KΩ, 1/2 W	2 1 1 1
2.	a) DC Voltmeter b) DC Voltmeter	(0-1) V (0-20) V	1 1
3.	DC Ammeter	(0-50) mA (0-200) µA	1 1
4.	Connecting wires	5A	12

13.3 CIRCUIT DIAGRAM:

Figure – 13.1. Transistor CE Characteristics

13.4 PROCEDURE:

Input Characteristics:

1. Connect the transistor as shown in figure 13.3.1
2. Keep the V_{CE} constant at 2V and 6V.
3. Vary the I_B in steps and note down the corresponding V_{EB} values as per tabular column.

Output Characteristics:

1. Keep the I_B constant at 20 μA and 40 μA.
2. Vary the V_{CE} in steps and note corresponding I_C values.
3. Readings are tabulated as shown in tabular column.

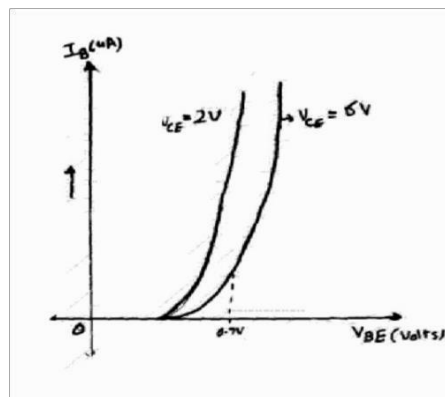## 13.5 EXPECTED GRAPHS:

Input Characteristics:

Figure – 13.5.1. Transistor CE Input characteristics
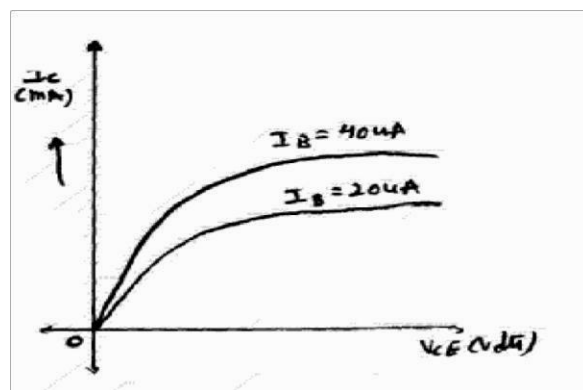
Output characteristics:

Figure – 13.5.2. Transistor CE Output Characteristics

13.6 PRECAUTIONS:

1. Keep the knobs of supply voltages V_{BE}& V_{CE} at minimum positions when switching ON or switching OFF the power supply.
2. No loose contacts at the junctions.
3. Do not overload the meters above its rated ranges.

13.7 TABULAR COLUMNS:

Input Characteristics:

V_{CB} = 2V		V_{CB} = 6V	
V_{BE} (Volts)	I_B (μA)	V_{BE} (Volts)	I_B (μA)
	0		0
	0.2		0.2
	0.4		0.4
	0.6		0.6
	0.8		0.8
	1		1
	2		2
	4		4
	6		6
	8		8
	10		10
	20		20
	30		30
	40		40
	50		50
	60		60

Output characteristics:

$I_B = 20\mu A$		$I_B = 40\mu A$	
V_{CE} (Volts)	I_C (mA)	V_{CE} (Volts)	I_C (mA)
0		0	
0.5		0.5	
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
11		11	
12		12	

13.8 CALCULATIONS:

Input Resistance (I_B=20μA) = $\Delta V_{BE}/\Delta I_B$ = At V_{CE} = 2V

Input Resistance (I_B =20μA) = $\Delta V_{BE}/\Delta I_B$ = At V_{CE}= 6V

Output resistance (V_{CE}=10V) = $\Delta V_{CE}/\Delta I_C$= At I_B=20μA

Output resistance (V_{CE}=10V) = $\Delta V_{CE}/\Delta I_C$ = At I_B=20μA

Current Amplification Factor 'β'= $\Delta I_C/\Delta I_B$ =

13.9 RESULT:

1. Input and Output curves are plotted.

2. R_i, Input Resistance:
a. $V_{CE} = 2V$ and $I_B = 20\ \mu A$, $R_i =$
b. $V_{CE} = 6V$ and $I_B = 20\ \mu A$, $R_i =$

3. R_O, Output Resistance:
a. $V_{CE} = 10V$ and $I_B = 20\mu A$, $R_O =$
b. $V_{CE} = 10V$ and $I_B = 40\mu A$, $R_O =$

4. Current Amplification factor 'β' =
     (at $V_{CE} = 10V$)

13.10 PRE LAB QUESTIONS:

1. What is the range of 'β' for the transistor?

2. What are the input and output impedances of CE configuration?

3. Identify various regions in the output characteristics?

4. What is the relation between 'α' and 'β'?

13.11 POST LAB QUESTIONS:

1. Define current gain in CE configuration.

2. Why CE configuration is preferred for amplification?

3. What is the phase relation between input and output?

4. Draw diagram of CE configuration for PNP transistor.

5. What is the power gain of CE configuration?

Study of CRO

14.1 AIM:

To study about cathode ray oscilloscope (CRO).

14.2 APPARATUS:

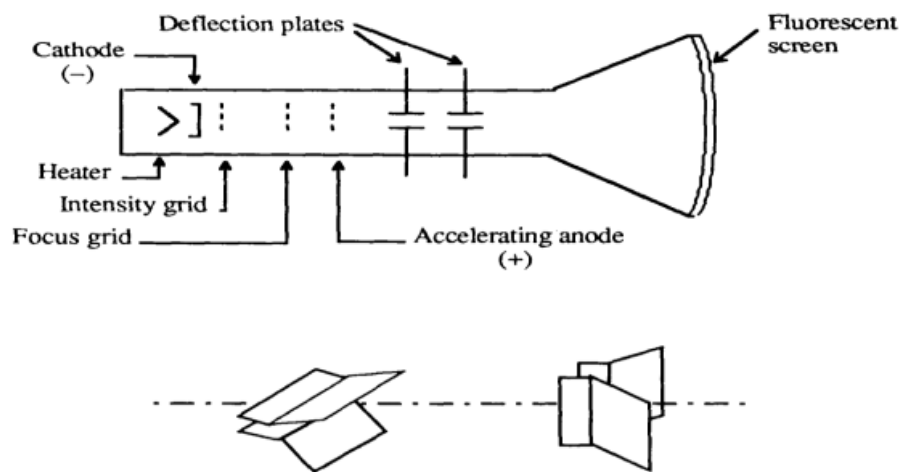CRO, CONNECTING LEADS, POWER SUPPLY.

14.3 CIRCUIT DIAGRAM:

Figure – 13.1. Schematic Of Cathode Ray Tube

14.4 PROCEDURE:

Oscilloscopes are complex instruments with many controls and they require some care to set up and use successfully.
It is quite easy to 'lose' the trace off the screen if controls are set wrongly.
There is some variation in the arrangement and labeling of the many controls.
So, the following instructions may be adapted for this instrument.

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

14.5 EXPECTED GRAPHS:

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.
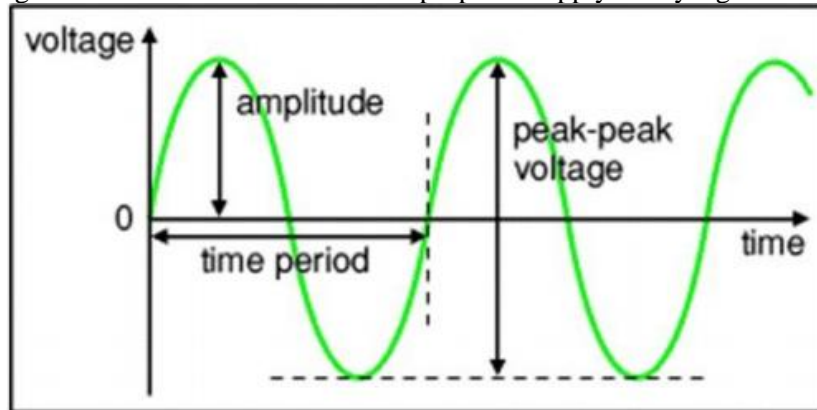

Figure – 13.5.1. Trace in CRO

14.6 CALCULATIONS:

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

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 the time for one cycle of the signal.
 The frequency is the number of cycles per second,

frequency = 1/time period. Time = distance in cm × time/cm.

14.7 RESULT:

14.8 PRE LAB QUESTIONS:
1. What is cathode ray oscilloscope?
2. What are essential components of CRO?
3. Explain electron gun assembly in CRO?
4. What is meant by defection sensitivity in CRO?

14.9 POST LAB QUESTIONS:

1. How is CRO superior to other ordinary instruments?
2. How are vertical and horizontal plates useful in CRO?
3. For what a triggering circuit provided in CRO?
4. What is meant by defection factor in CRO?