

BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY

LAB MANUAL

AcademicYear : 2019-2020
CourseCode : AEEB08
Regulations : IARE -R18
Semester : I
Branch : (CE)



DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)

Dundigal – 500 043, Hyderabad



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Department of Electrical and Electronics Engineering

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	Engineering knowledge: Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication..
PSO2	Broadness and diversity: Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage.
PSO3	Self-learning and service: Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.

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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 Ohm's law	PO1,PO2	PSO2
3	Magnetization Characteristics of DC Shunt Generator	PO1,PO2	PSO2
4	Swinburne's test on DC Shunt Machine	PO1,PO2, PO3	PSO2
5	Open Circuit and Short Circuit test on Single Phase Transformer	PO1,PO2,PO4	PSO1
6	Brake test on Three Phase Squirrel Cage Induction Motor	PO1,PO2	PSO2
7	Regulation of an Alternator using Synchronous Impedance Method	PO1,PO2	PSO1
8	Volt Ampere Characteristics of P-N Junction Diode	PO1,PO2	PSO2
9	Zener Diode Characteristics	PO1,PO2,PO4	PSO1
10	Half Wave Rectifier With/Without Filter	PO1,PO2,PO4	PSO1
11	Full Wave Rectifier With/Without Filter	PO1,PO2	PSO2
12	Transistor Common Base Characteristics	PO1,PO2,PO4	PSO2
13	Transistor Common Emitter Characteristics	PO1,PO2,PO4	PSO2
14	Study of CRO	PO1,PO2	PSO1

BASIC ELECTRICAL AND ELECTRONICS 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 electro mechanical energy conversion devices.
2. **Understand** the 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:

To verify KVL:

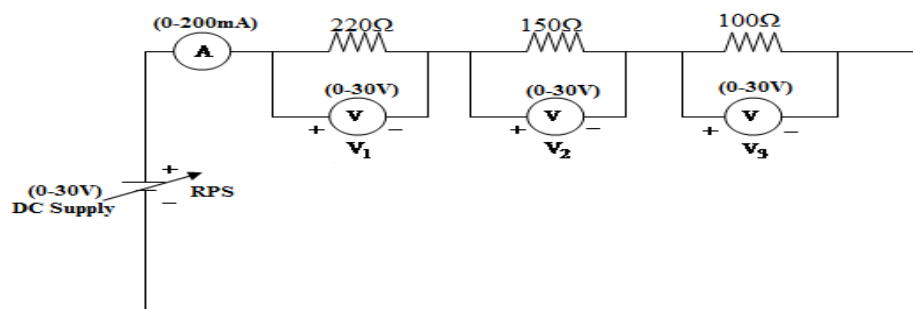


Fig. - 1.1KVL

To Verify KCL:

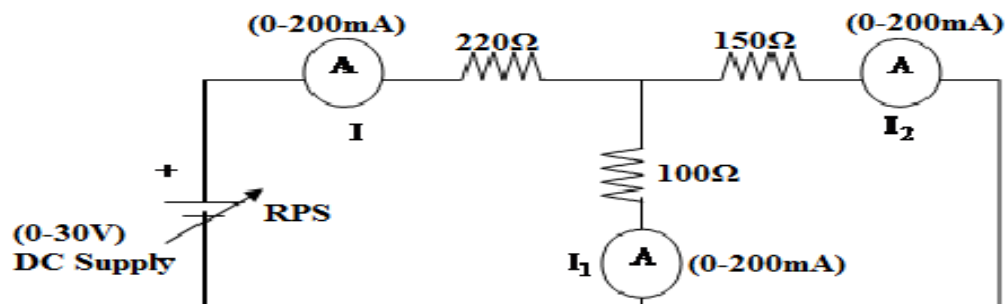


Fig.– 1.2KCL

1.4 PROCEDURE:

To Verify KVL

1. Connect the circuit diagram as shown in Fig. 1.1.
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 Fig.1.2.
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?

EXPERIMENT – 2

VERIFICATION OF OHM'S LAW

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:

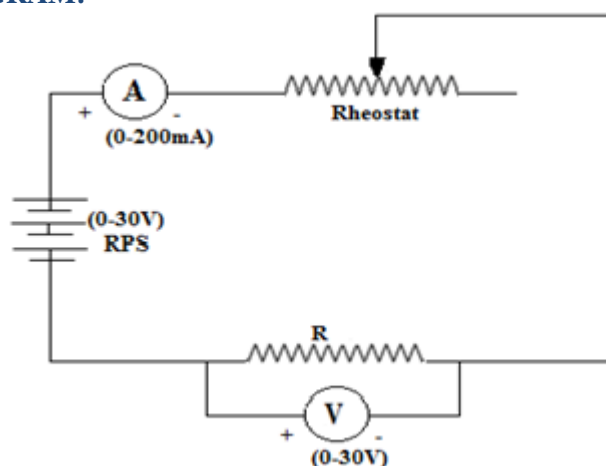


Fig. – 2.1 Circuit Diagram

2.4 PROCEDURE:

1. Make the connections as per circuit diagram shown in Fig. 2.1.
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 as shown in Fig. 2.2.
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:

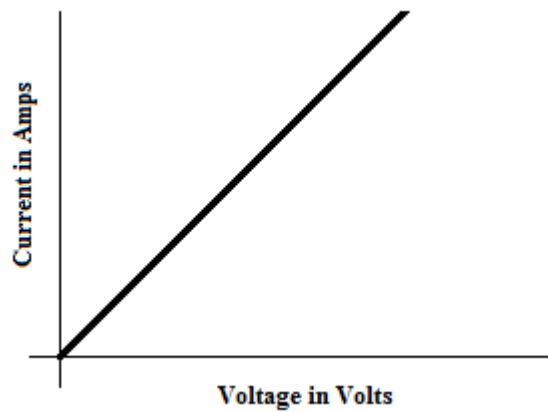


Fig.– 2.2 Voltage and Current Characteristics

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?

EXPERIMENT – 3

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:

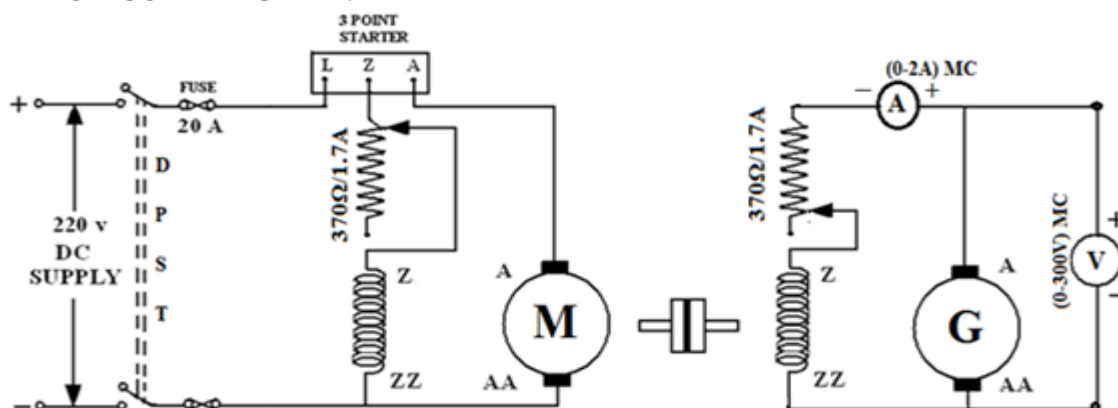


Fig. – 3.1 Magnetization characteristics (or) open circuit characteristics of a DC shunt generator

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.	INCREASING		DECREASING	
	Field Current I_f (amp)	Generated Voltage E_g (volts)	Field Current I_f (amp)	Generated Voltage E_g (volts)

3.7 MODEL GRAGH:

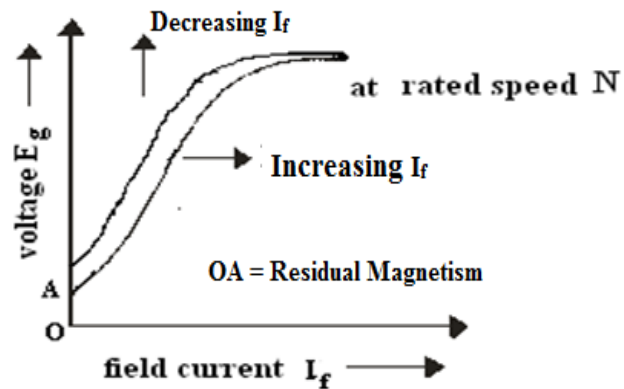


Fig. – 3.2 Open Circuit Characteristics of DC shunt generator

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:

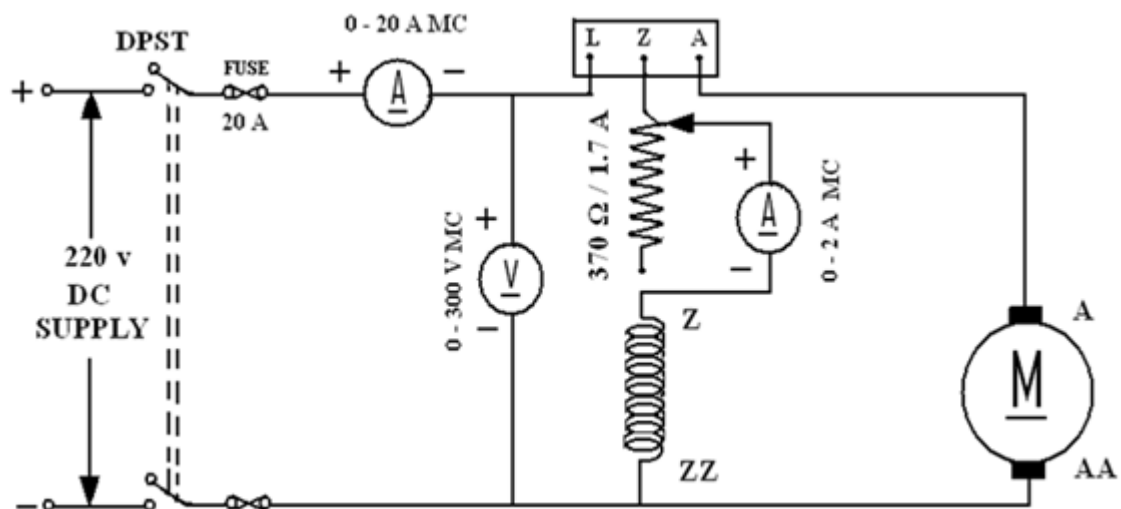


Fig. – 4.1 Swinburne's test on a D.C. Shunt Machine

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:

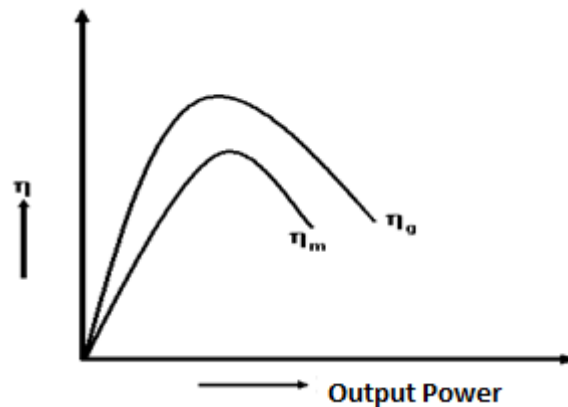


Fig. -4.2 Performance characteristics of DC shunt machine

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 $W_{\text{const.}}$	Copper losses $W_{\text{cu}} = I_a^2 R_a$	Total losses = ($W_{\text{const.}} + W_{\text{cu}}$)	Output power = ($P_i - \text{Total losses}$)	η

As a Generator:

Rated voltage $V_L =$ Rated speed $N =$

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

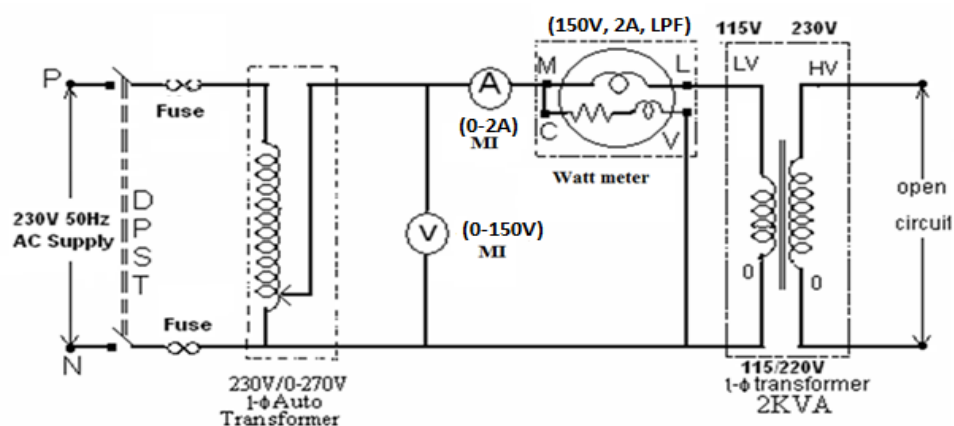


Fig. -5.1 Open Circuit Test

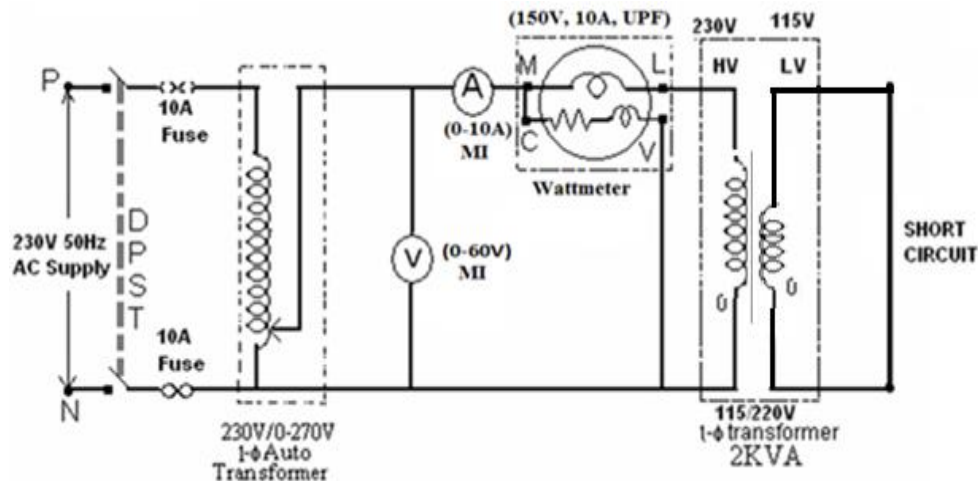


Fig. - 5.2 Short Circuit Test

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		
Voltage (V _o)	Current (I _o)	Power (W _o)

Short Circuit Test		
Voltage (V _{sc})	Current (I _{sc})	Power (W _{sc})

5.7 EQUIVALENT CIRCUIT OF TRANSFORMER:

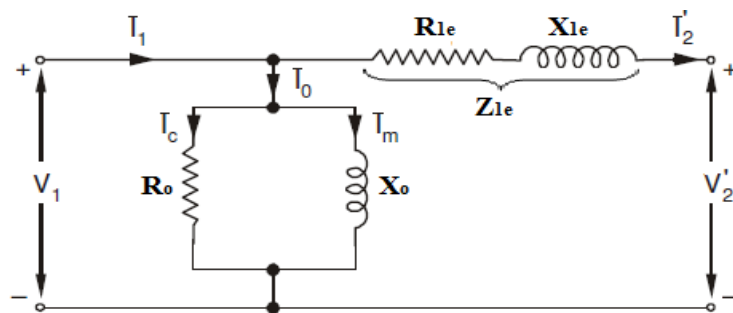


Fig. – 5.3 Equivalent circuit of single phase transformer

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:

$$\cos \phi_0 = \frac{W_o}{V_o \cdot I_o}$$

Working component of current $I_c = I_o \cos \phi_0$

Magnetizing component of current $I_m = I_o \sin \phi_0$

$$R_0 = \frac{V_o}{I_c} \quad \text{Where } I_c = I_o \cos \phi_0$$

$$X_0 = \frac{V_o}{I_m} \quad \text{Where } I_m = I_o \sin \phi_0$$

From SC Test:

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

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

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

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.

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

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

Where $K = \frac{V_2}{V_1}$ = 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

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

Where n = Fraction of full load

n = 1 (at full load)

n = 1/2 (at half load)

n = 1/4 (at quarter load)

$$\% \text{ Regulation } (\% R) = \frac{I_1 R_{1e} \cos \phi \pm I_1 X_{1e} \sin \phi}{V_1} \times 100$$

Where V_1 is the rated Voltage and

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

‘+’ for lagging power factors

‘-’ for leading power factor

Cosφ = 1.0

Load n	Pcu (W) = n ² * Wsc	Pi (W) = Wo	O/P (W) = n* (VA)*Cosφ	I/P (W) = O/P + Pcu + Pi	η (%)	%R	
						Lag	Lead

Cosφ = 0.8

Load n	Pcu (W) = n ² * Wsc	Pi (W) = Wo	O/P (W) = n* (VA)*Cosφ	I/P (W) = O/P + Pcu + Pi	η (%)	%R	
						Lag	Lead

5.9 MODEL GRAPH:

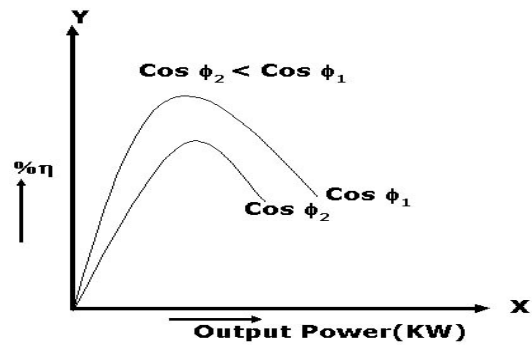


Fig. – 5.4 Load vs Efficiency characteristics

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 THREE PHASE 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:

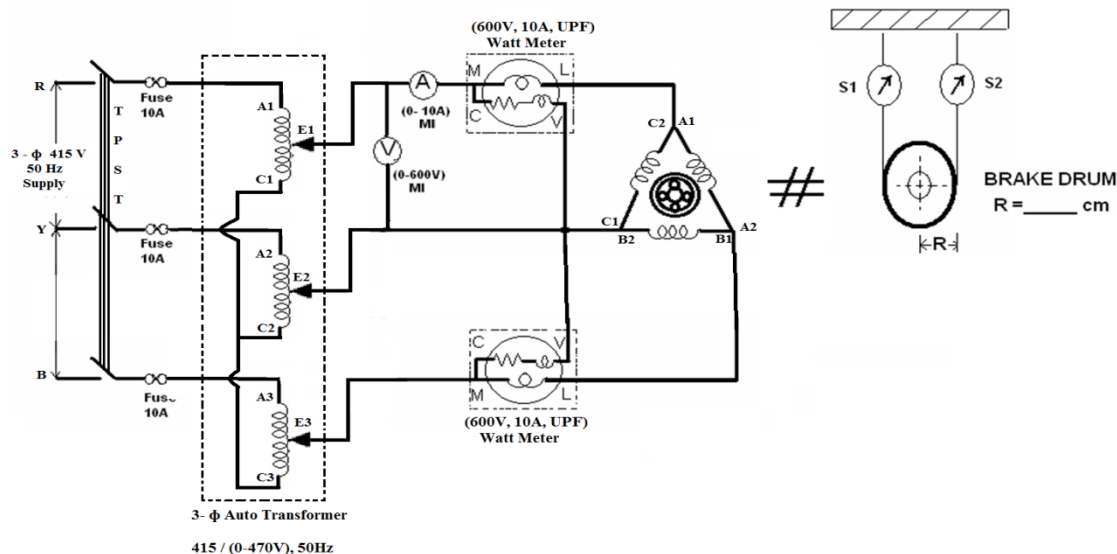


Fig. – 6.1 Brake test on three – phase squirrel cage induction motor

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.

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

$$\% \text{ Efficiency} = \frac{\text{Output Power in watts}}{\text{Input Power in watts}} \times 100$$

$$\% \text{ slip} = \frac{N_s - N}{N_s} \times 100 \quad \left[\text{where } N_s = \frac{120 \times f}{p} \right]$$

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

6.7 OBSERVATIONS:

[illegible]

6.8 MODEL GRAPHS:

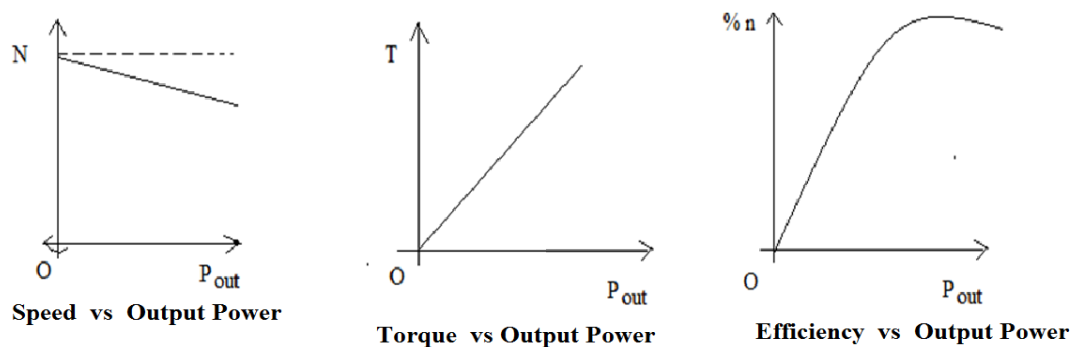


Fig. – 6.2 Performance characteristics of three phase induction motor

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?

EXPERIMENT – 7

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:

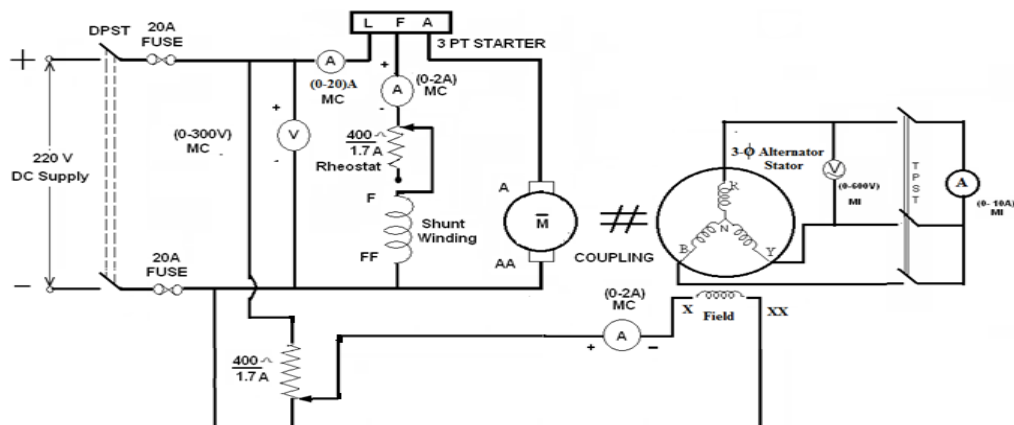


Fig. – 7.1 Regulation of Alternator Using Synchronous Impedance Method

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.

ShortCircuit 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		S. No.	S.C. test	
	Field current I_f (Amp.)	OC voltage per phase V_o (volts)		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 R_a of armature is found out.

7.7.1 CONNECTION DIAGRAM TO FIND R_a :

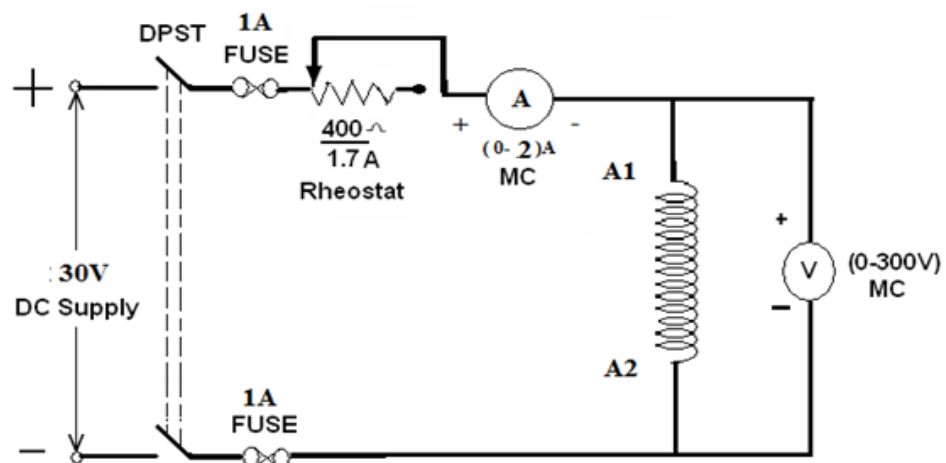


Fig. - 7.2 Circuit diagram for calculation of Resistance of armature winding of alternator

7.7.2 OBSERVATIONS:

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

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:

$$Z_s = \frac{V_{oc}}{I_{sc}} \text{ for the same } I_f \text{ and speed}$$

$$X_s = \sqrt{Z_s^2 - R_a^2} \quad [\because R_a = R_{dc}]$$

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

$$\% \text{ Reg} = \frac{E_0 - V}{V} \times 100$$

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}

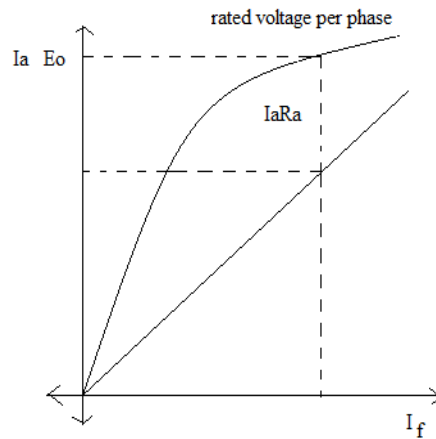


Fig. – 7.3 OCC and SC characteristics of Alternator

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 changing?
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	(0-30) V 1N 4007 OA79 1 K Ω , 1/2 W	1 1 1 1
2.	DC Voltmeter DC Voltmeter	(0-1) V (0-20) V	1 1
3.	DCAmmeter DCAmmeter	(0-200) μ A (0-200) mA	1 1
4.	Connecting wire	5A	10

8.3 CIRCUIT DIAGRAMS:

8.3.1 Forward Bias

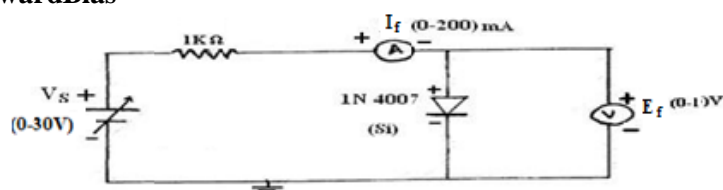


Fig. – 8.3 Forward Bias Circuit

8.3.2 Reverse Bias

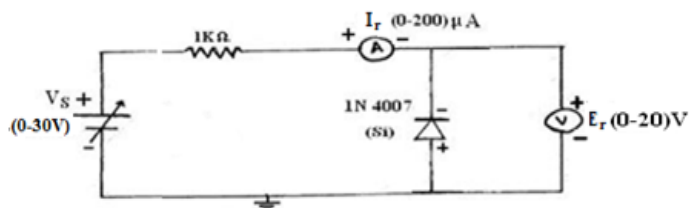


Fig.– 8.4 Reverse Bias Circuit

8.4 EXPECTED GRAPHS:

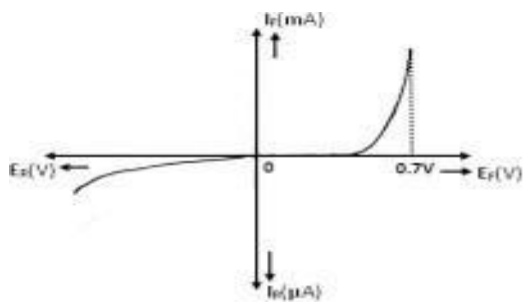


Fig. – 8.5Volt Ampere Characteristics of P-N Junction Diode

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?

EXPERIMENT NO: 9

ZENER DIODE CHARACTERISTICS

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 PowerSupply. b) ZenerDiode c) ZenerDiode d) Carbon FilmResistor	(0-30) V 4.7V 6.2V 1 K Ω , 1/2 W	1 1 1 1
2.	DC Voltmeter DC Voltmeter	(0-1) V (0-20) V	1 1
3.	a) DCAmmeter b) DCAmmeter	(0-200) μ A (0-200) mA	1 1
4.	Connecting wires	5A	10

9.3 CIRCUIT DIAGRAMS:

Forward Bias

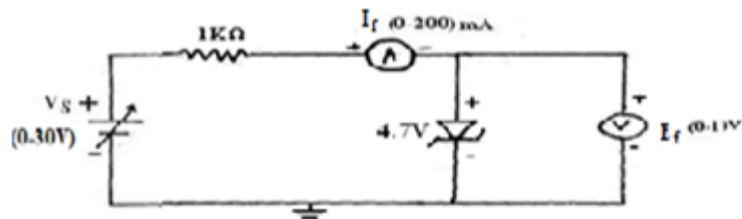


Fig.– 9.1 Forward Bias Circuit

Reverse Bias

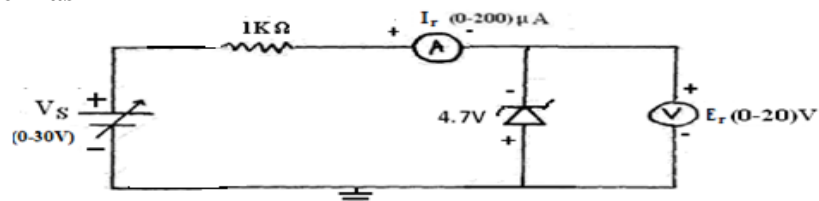


Fig. – 9.2 Reverse Bias Circuit

Zener Diode as Voltage Regulator

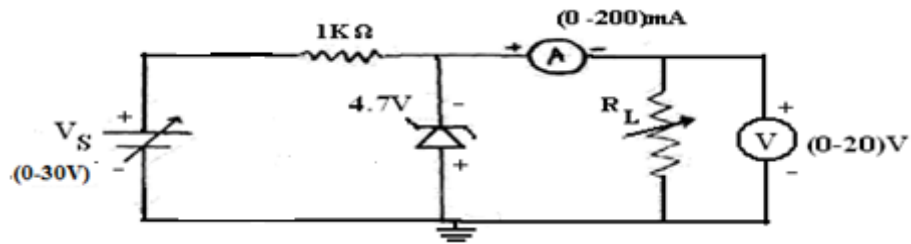


Fig. – 9.3 Zener Diode as Voltage Regulator

9.3 PROCEDURE:

Forward Bias

1. Connect the circuit as shown in Fig.9.1.
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 Fig.9.2.
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:

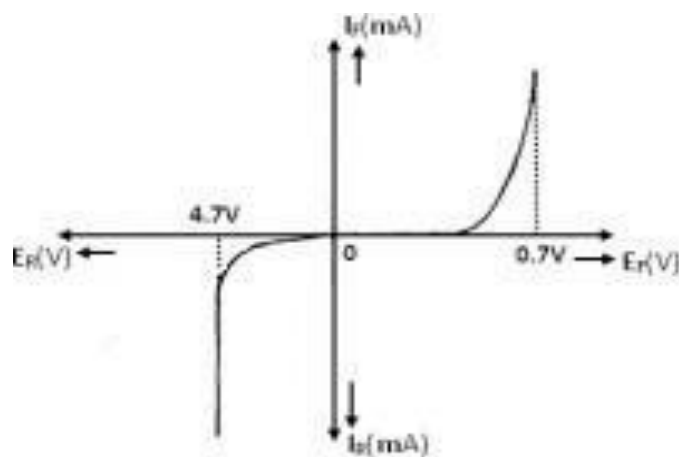


Fig. – 9.4. Zener Diode as Voltage Regulator

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:

$V_{in}=15V$, $V_{NL}=$ _____

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

$R_L=15K$

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 6 mA = $\Delta E_f / \Delta I_f$
Reverse Static resistance at 6 mA = E_r / I_r Reverse Dynamic resistance at 6 mA = $\Delta E_r / \Delta I_r$

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 is affected?
3. How the breakdown voltage of a particular diode can be controlled?
4. What type of temperature coefficient does the Avalanche breakdown have?

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 RECTIFIER 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 , $1\text{ K}\Omega$ and $10\text{ K}\Omega$ respectively. Calculate ripple factor with a filter capacitor of $100\mu\text{F}$ and the load of $1\text{K}\Omega$, $2\text{K}\Omega$ and $10\text{K}\Omega$ 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	(12-0-12) V 1N 4007 100 μF	1 1 1
2	a) DC Voltmeter b) AC Voltmeter	(0-20)V (0-20)V	1 1
3	DC Ammeter	(0-200) mA	1
4	Cathode Ray Oscilloscope	(0-20) MHz	1
5	Decade Resistance Box	10 Ω -100K Ω	1
6	Connecting wires	5A	12

10.3 CIRCUIT DIAGRAMS:

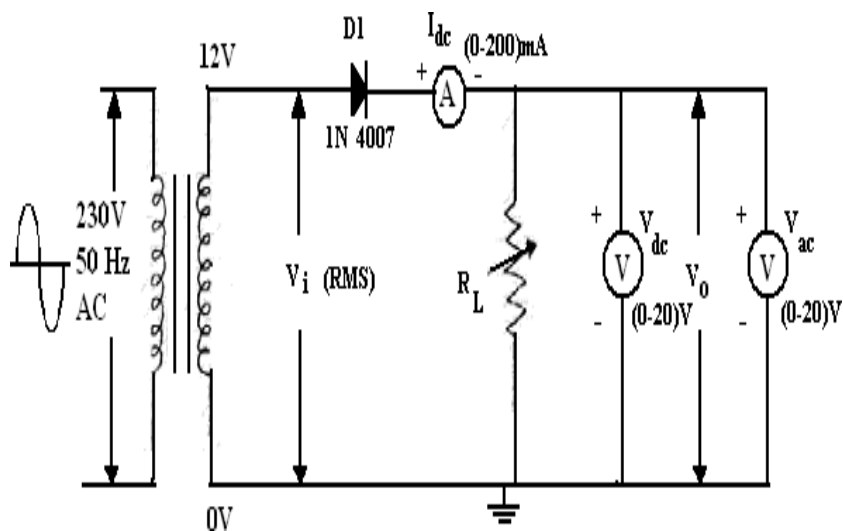


Fig. – 10.1. Half Wave Rectifier without Filter

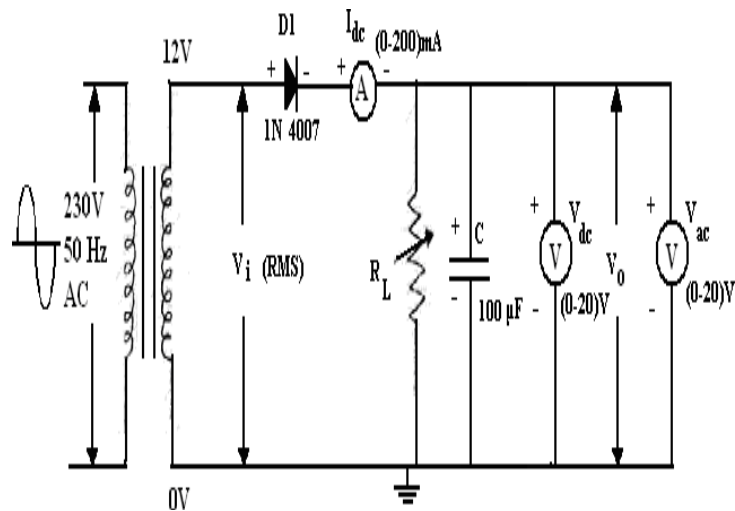


Fig. – 10.2. Half Wave Rectifier with Filter

10.4 PROCEDURE:

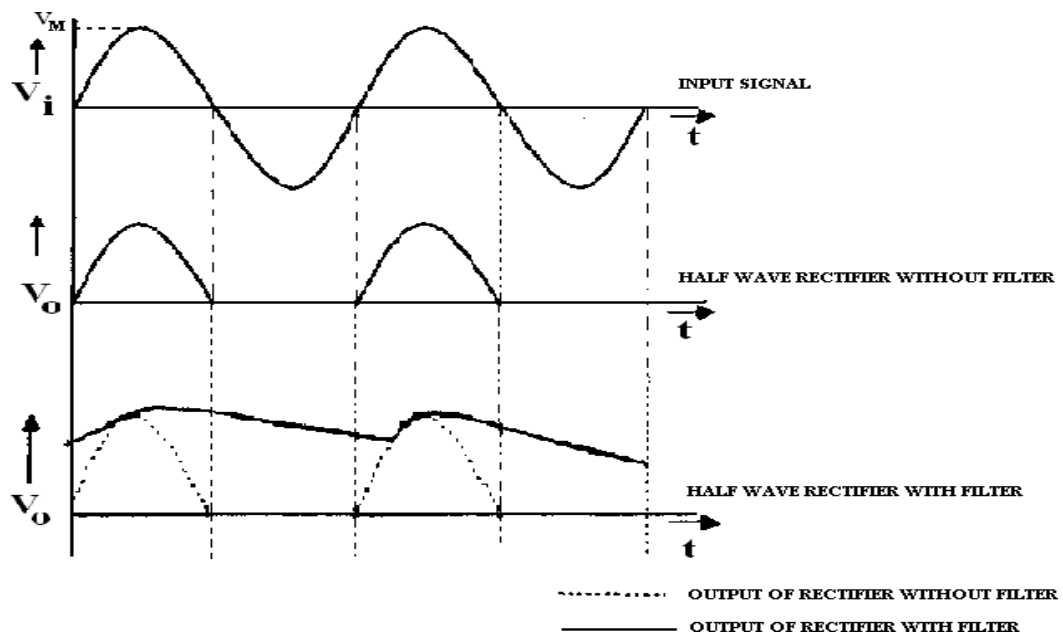
Half Wave Rectifier without filter

1. Connect the circuit as shown in Fig. 10.1.
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 load resistance, R_L to $1K\Omega$ and repeat the procedure as above. Also repeat for $10K\Omega$.
5. Readings are tabulated as per the tabular column.

Half Wave Rectifier with filter

1. Connect the circuit as shown in Fig. 10.2 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 $\Gamma = V_{ac}/V_{dc}$

Half Wave Rectifier with Filter C=100Mf

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 $\Gamma = V_{ac}/V_{dc}$

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, $C = 680\mu F$.

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 $500\Omega =$

$1K\Omega =$

$10 K\Omega =$

3. For Half-wave rectifier with filter:- γ , Ripple factor at $1K\Omega$, $100\mu F =$

$2K\Omega$, $100\mu F =$

$10 K\Omega$, $100\mu F =$

EXPERIMENT – 11

FULLWAVE RECTIFIER 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 , $1\text{ K}\Omega$ and $10\text{ K}\Omega$ respectively.

Calculate ripple factor with a filter capacitor of $100\mu\text{F}$ and the load of $1\text{ K}\Omega$, $2\text{ K}\Omega$ and $10\text{ K}\Omega$ 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	(12-0-12) V 1N 4007 100 μF	1 2 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	10 Ω -100K Ω	1
6	Electrolytic Capacitor	100 μF	1
7	Connecting wires	5A	12

11.3 CIRCUIT DIAGRAMS:

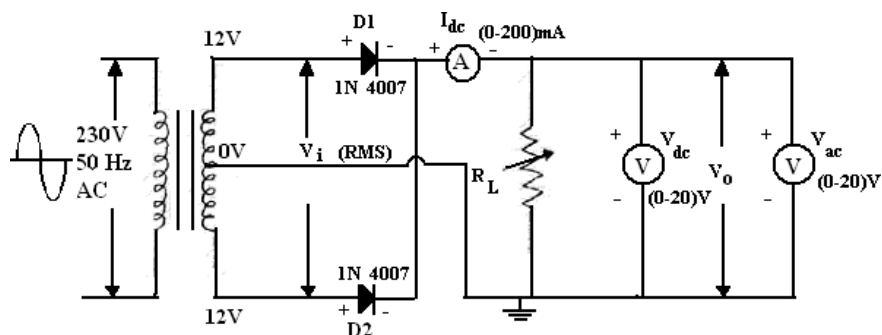


Fig. – 11.1. Full Wave Rectifier (Center-tap) Without Filter

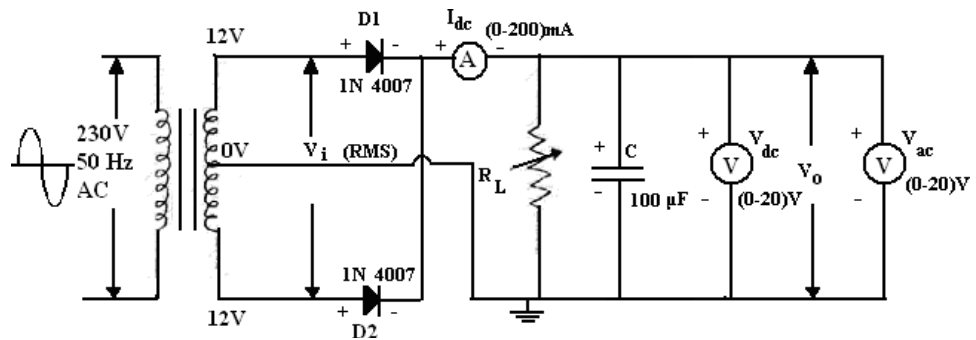


Fig. – 11.2. Full Wave Rectifier (Center-tap) With Filter

11.4 PROCEDURE:

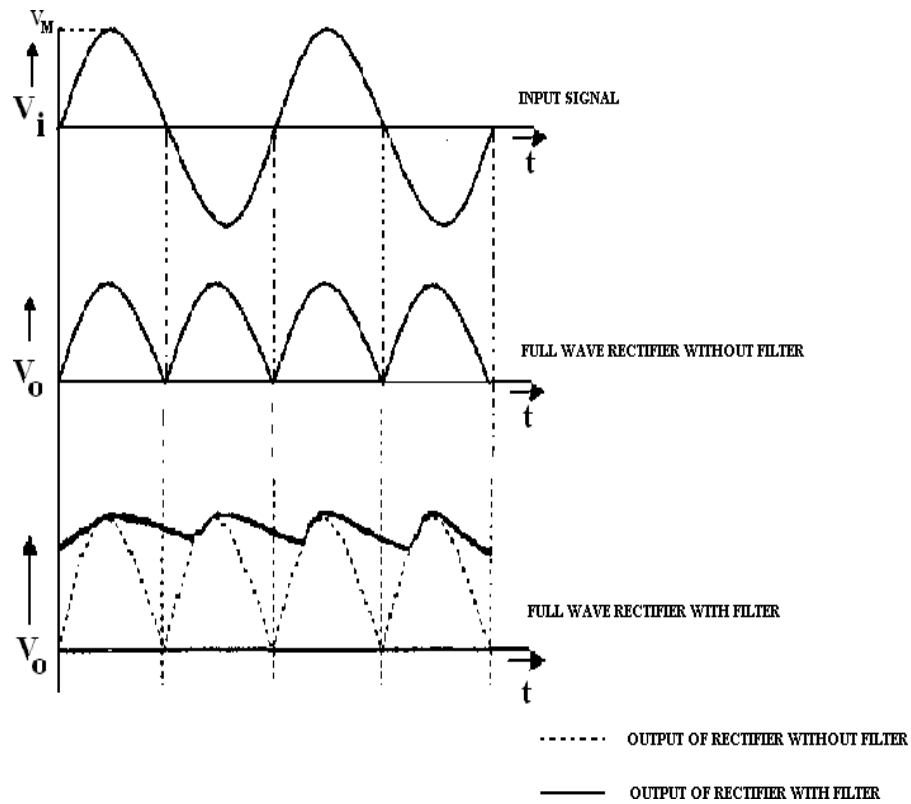
Full-wave Rectifier without filter

1. Connect the circuit as shown in the Fig.11.1.
2. Adjust the load resistance R_L to 500Ω 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 1000Ω and repeat the procedure as above. Also repeat for $10K\Omega$.
5. Readings are tabulated as per the tabular column.

Full-wave Rectifier with filter

1. Connect the circuit as shown in the Fig.11.2.
2. Adjust the load resistance R_L to $1K\Omega$ and connect a capacitor of $100\mu F$ 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 $1K\Omega$ and repeat the procedure as the above. Also repeat for $10K\Omega$.
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 $\Gamma = V_{ac}/V_{dc}$

Full wave Rectifier (Center-tap)WithFilter C = _____ μ F

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 $\Gamma=V_{ac}/V_{dc}$

11.8 PRE LAB QUESTIONS:

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

11.9 LAB ASSIGNMENT:

Plot the wave forms of full wave rectifier with $R=500$ ohms, $C = 470\mu F$.

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 thefilter?
3. Define regulation. Why regulation is poor in the case of inductorfilter?
4. Define timeconstant?
5. What happens to the o/p wave form if we increase the capacitor value? What happens if we increase the capacitorvalue?

11.11 RESULT:

1. Input and Output waveforms of a full-wave (center tapped) and bridge rectifier with /without filters are observed andplotted.
2. For Full-wave rectifier(center tapped) withoutfilter-
 - i. γ , Ripple factor at 500Ω , $100\mu F=$
 - a. $2K\Omega$, $100\mu F=$
3. For full-wave rectifier (Center tapped) withfilter-
 - i. γ , Ripple factor at 500Ω , $100\mu F=$
 - a. $2K\Omega$, $100\mu F=$

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 $I_e = 12 \text{ mA}$, output resistance R_o at $V_{CB} = 8 \text{ V}$ and current gain at $V_{CB} = 6 \text{ V}$.

12.2 APPARATUS:

S.No.	Device	Range /Rating	Quantity (in No.s)
1.	Transistor CB trainer Board Containing a) DC PowerSupply. b) PNPTransistor c) Carbon FilmResistor	(0-30) V BC107 470Ω, 1/2 W	2 1 2
2.	a) DCVoltmeter b) DCVoltmeter	(0-1) V (0-20) V	1 1
3.	DC Ammeter	(0-200) mA	2
4.	Connecting wires	5A	12

12.3 CIRCUIT DIAGRAM:

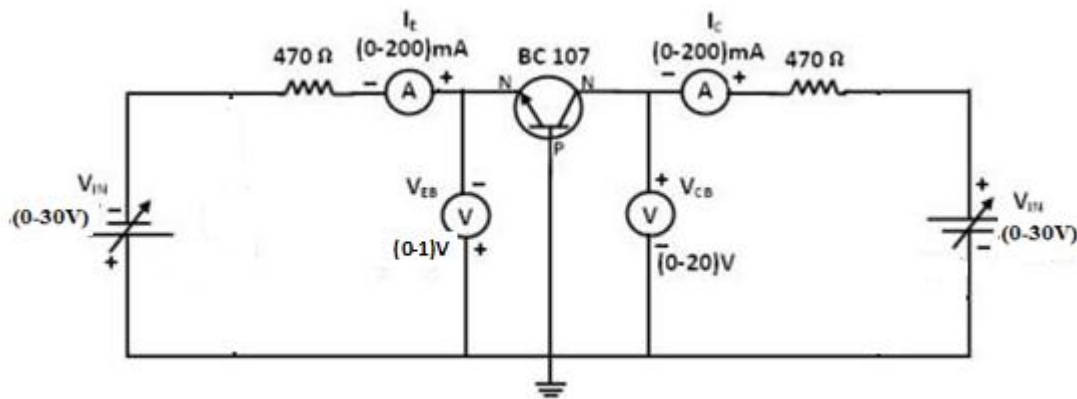


Fig. – 12.1. Transistor CB Characteristics

12.4 PROCEDURE:

12.4.1 Input Characteristics:

1. Connect the transistor as shown in Fig. 12.1
2. Keep the V_{CB} constant at 4V and 8V. Vary the V_{EB} in steps and note corresponding I_E values as per tabular form.

Output Characteristics:

1. Keep I_E constant at 4mA and 8mA. Vary the voltage 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:

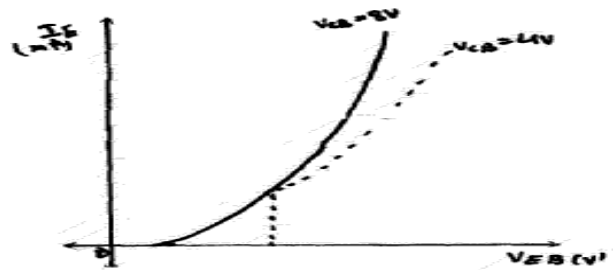


Fig. – 12.2. Transistor CB Input Characteristics

Output characteristics:

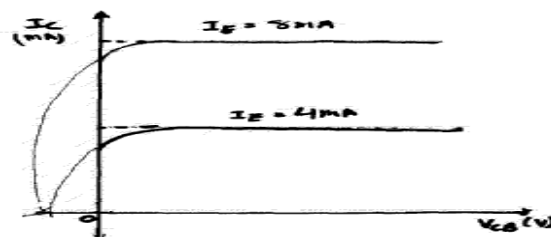


Fig. – 12.3. Transistor CB output Characteristics

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

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

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

Output resistance ($I_E = 4 \text{ mA}$) = $\Delta V_{CB} / \Delta I_C$ 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 $V_{CC} = 12V$, $V_{EE} = 6V$, $R_E = 100K$ ohms, $R_C = 1K$ ohms, $\alpha = 0.98$, $V_{BE} = 0.7V$.

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
$$' \alpha ' = \quad \quad \quad (\text{at } V_{CB} = 6V)$$

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 $I_B = 20\mu A$, 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 PowerSupply. b) NPN Transistor c) Carbon Film Resistor	(0-12) V	2
		BC107	1
		470 Ω , 1/2 W	1
		100K Ω , 1/2 W	1
2.	a) DC Voltmeter b) DC Voltmeter	(0-1) V	1
		(0-20) V	1
3.	DC Ammeter	(0-50) mA	1
		(0-200) μA	1
4.	Connecting wires	5A	12

13.3 CIRCUIT DIAGRAM:

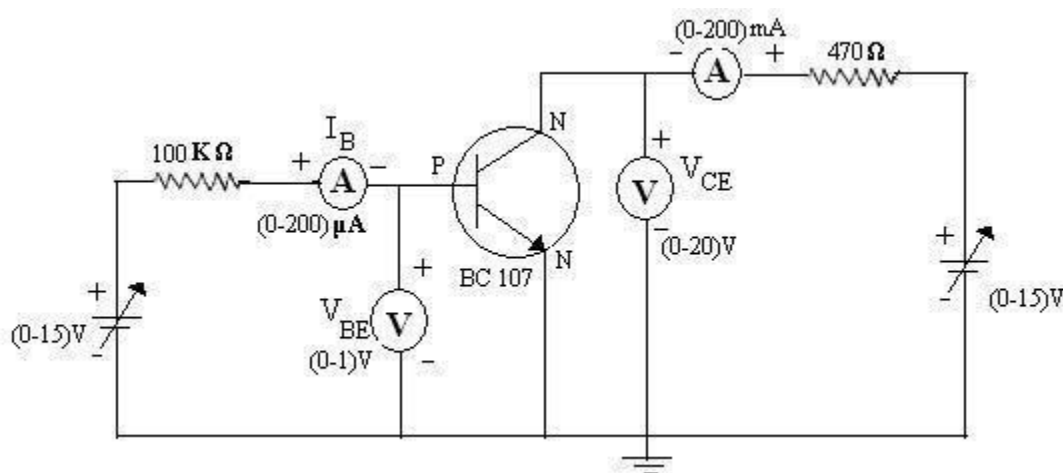


Fig. – 13.1. Transistor CE Characteristics

13.4 PROCEDURE:

Input Characteristics:

1. Connect the transistor as shown in Fig.13.1
2. Keep the V_{CE} constant at 2V and 6V.
3. Vary I_B in steps and note down the corresponding V_{BE} 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:

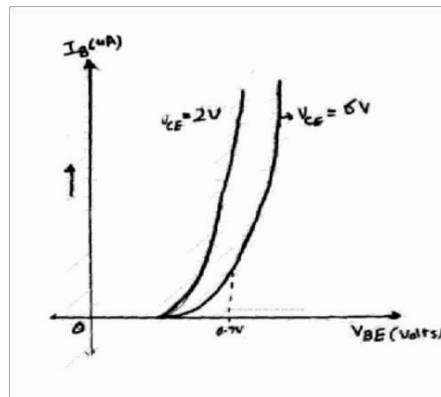


Fig. – 13.2 Transistor CE Input Characteristics

Output Characteristics:

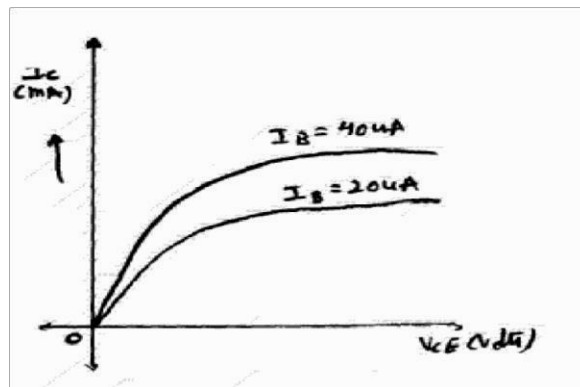


Fig. – 13.3 Transistor CE Output Characteristics

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

$V_{CE} = 2V$		$V_{CE} = 6V$	
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 = 20μA		I_B = 40μA	
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?

EXPERIMENT – 14

STUDY OF CRO

AIM:-To study block wise construction of Cathode Ray Oscilloscope

THEORY:

CRO:

The Cathode Ray Oscilloscope is probably the most versatile tool for deployment of electronic circuit and system. The CRO allows the amplitude of the electronic signals where they are voltage, current or power to be displayed as a function of time. The CRO depends on the moments of an electron beam which is being bombarded (impinged) on a screen coated with a fluorescent material to produce a visual spot. If the electron is being deflected along the conventional axes, i.e. x-axis & y-axis, two different displays are produced.

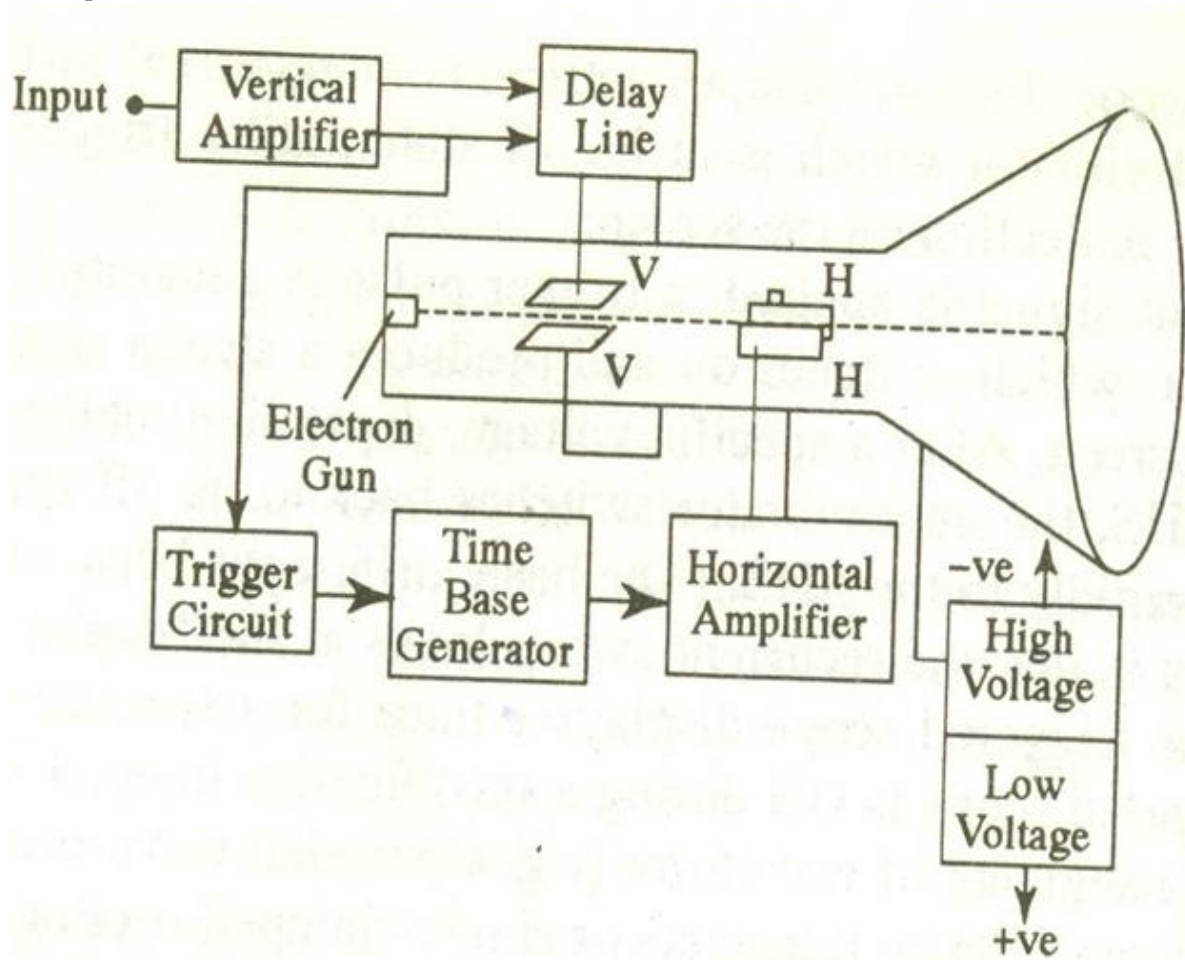


Fig. - 14.1 Block Diagram of CRO

MAIN PARTS OF CRO:

CRT: This is cathode ray tube in which electron beam strikes the screen internally to provide visual display of signal.

Vertical Amplifier: This is a wide band amplifier used to amplify signal in the vertical section of the signal.

Delay line: It is used to delay signal for sometime in the vertical section.

Time Base: It is used to generate sawtooth voltage which it is applied to Horizontal deflection plates.

Horizontal Amplifier: This is used to amplify the sawtooth voltage before it is applied to horizontal deflection plates.

Trigger Circuit: This is used to convert the incoming signal into trigger pulse so that the input signal and the sweep frequency can be synchronized.

Power Supply: There are two power supplies, A negative high voltage (HV). supply and a +ve low voltage supply (LV). . The +ve voltage supply is from +300V to 400V, the negative voltage supply is from -1000V to -1500V.

FRONT PANEL CONTROLS:

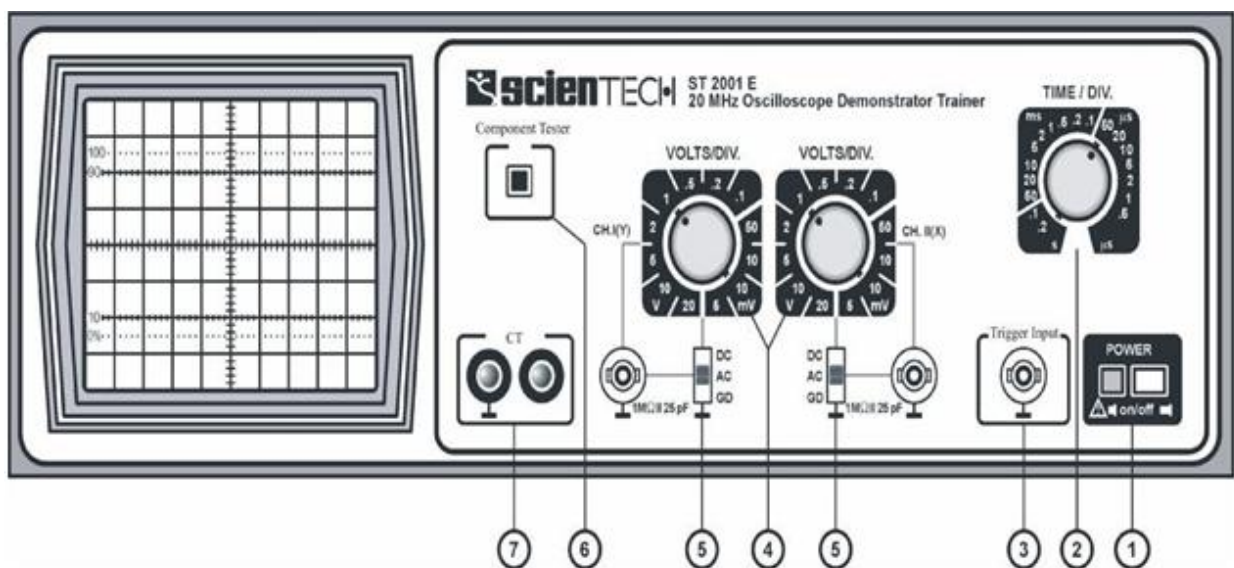


Fig. - 14.2 Front Panel of CRO

Power 'ON/OFF' : Turns 'On' & 'Off'. LED indicates power 'On'. Use position & Int/Focus controls to get the beam. All are push buttons

Time / Div : Rotary Switch for TB speed control.

Trigger Input : For feeding external trigger signal.

Volts/Div : For sensitivity selection of CH 1 & CH2.

DC-AC-Gnd : Switch provided for Input coupling. BNC inputs provided for connecting the Input signal.

Component Tester : Switch when pressed converts scope into Component Tester mode.

CT : Input & Gnd terminals to be used for CT.

CONTROLS ON PCB

Intensity : Controls the brightness.

Focus : Controls the sharpness.

Trace Rotation : Controls the horizontal alignment of the trace.

X Pos : Controls the horizontal position.

Y Pos I & II : Controls vertical position of the trace.

X Y : When pressed cuts-off internal TB & connects external horizontal signal via. CHII.

X 5 : When pressed gives 5 times magnification.

External : When pressed allows ext.trigger

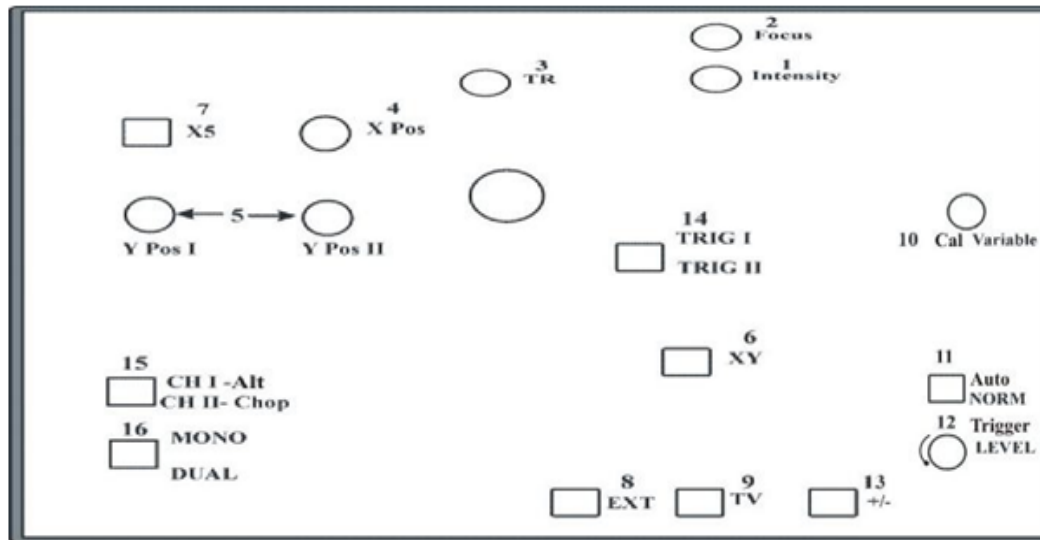


Fig. - 14.3 Controls on PCB

TV : When pressed allows TV frame to be synchronized.

Cal Variable : Controls the time speed in between the steps.

Auto/ Norm : In AT gives display of trace & auto trigger. When pressed becomes normal & gives variable level trigger.

Level : Controls the trigger level from positive peak to negative peak.

+ / - : Selects the slope of triggering.

Trig 1/ Trig 2 : When out triggers CH I and when pressed triggers CH II

CH I Alt/ : When out selects CH I and when pressed selects CH II. When dual switch also pressed this selects Alt or Chop modes.

Mono / Dual : When out, selects CH I only. When pressed selects both.

AMPLITUDE MEASUREMENTS :

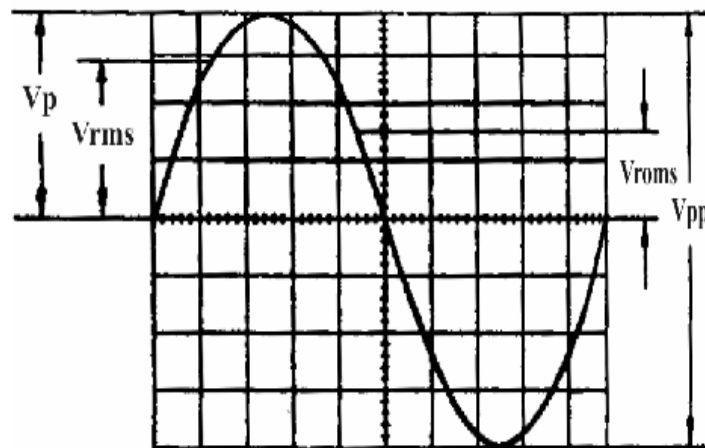


Fig. - 14.4 Amplitude measurement using CRO

V_{rms} = effective value

V_p = simple peak or crest value V_{pp} = peak-to-peak value V_{mom} = momentary value

FREQUENCY MEASUREMENT

T = time in seconds for one period

F = recurrence frequency in Hz of the signals, $F = 1/T$,

$T_{tot} = 1.6 \text{ cm} \times 0.5 \text{ s/cm} : 5 = 160 \text{ ns}$

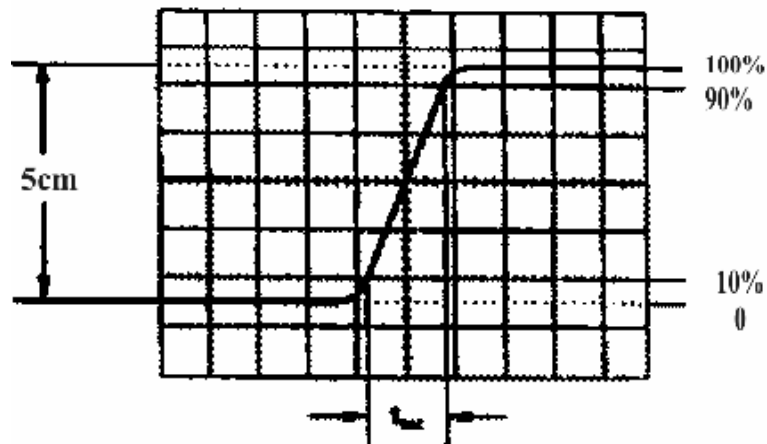


Fig. - 14.5 Frequency measurement using CRO

PHASE MEASUREMENT:

$\sin q = a/b$

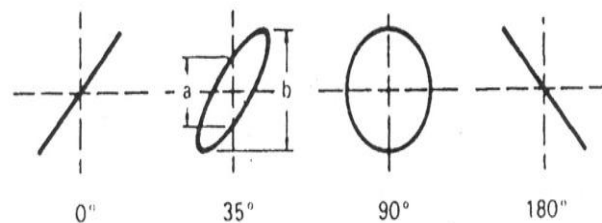


Fig. - 14.6 Phase measurement using CRO

PRECAUTIONS:

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

RESULT:**PRE LAB QUESTIONS:**

1. What is a cathode ray oscilloscope?
2. What are the essential components of a CRT?
3. Why is the grid in a CRO provided with a hole in it?
4. What is meant by the deflection factor of a CRO?
5. For what purpose vertical and horizontal plates are provided in a CRO?

POST LAB QUESTIONS:

1. What is the need of CRO in radio applications?
2. What is meant by curve tracers?
3. How to measure the AC and DC current in CRO?
4. What is the stage of amplifier?
5. Why is a delay line used in a CRO?

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