Basic Electrical & Electronics Engineering Laboratory

Dos and Don’ts in Laboratory

1. Do not handle any equipment before reading the instructions /Instruction manuals.
2. Read carefully the power ratings of the equipment before it is switched ON, whether ratings 230 V/50 Hz or 115V/60 Hz. For Indian equipment, the power ratings are normally 230V/50Hz. If you have equipment with 115/60 Hz ratings, do not insert power plug, as our normal supply is 230V/50Hz., which will damage the equipment.
3. Observe type of sockets of equipment power to avoid mechanical damage.
4. Do not forcefully place connectors to avoid the damage.
5. Strictly observe the instructions given by the Teacher/ Lab Instructor.

Instructions to Students

Pre-lab activities:

- ✓ Prepare observation note book which contains the following :
  - o Aim/Apparatus/Procedure/precautions to design the circuits discussed in the theory class
  - o Verify the characteristics of the circuits discussed in previous lab.
- ✓ Refer the topics covered in theory class

In-lab activities:

- ✓ Be caution while designing the circuits and while handling the Transformers.
- ✓ Avoid parallax errors while calculating the values.
- ✓ Note down corrections made to the code during the lab session.
- ✓ Answer to viva-voice.
- ✓ Get the observation corrected.

Post-lab activities:

- ✓ Completed experiments should be recorded in the lab record and corrected within one week after completion of the experiment.
- ✓ After completion of every module, a test will be conducted, and assessment results will have weight in the final internal marks.

General Instructions:

- ✓ Student should sign in the log register before going to the test bench (experiment bench).
- ✓ Student is only responsible for any damage caused to the equipment in the laboratory during his session.
- ✓ If a problem is observed in any hardware equipment, please report to the lab staff immediately; do no attempt to fix the problem yourself.
- ✓ After completion of the experiment, components must be submitted properly to the lab Faculty.
- ✓ Please be considerate of those around you, especially in terms of noise level. While labs are a natural place for conversations regarding designing the circuit, kindly keep the volume turned down

Instruction for Laboratory Teachers:-

1. Submission related to whatever lab work has been completed should be done during the next lab session.
2. Students should be instructed to switch on the power supply after getting the checked by the lab assistant / teacher. After the experiment is over, the students must hand over the circuit board, wires, CRO probe to the lab assistant/teacher.
3. The promptness of submission should be encouraged by way of marking and evaluation patterns that will benefit the sincere students.

List of Experiments

Section A: Electrical Engineering:

1. Swimburne's test on D.C. Shunt machine (predetermination of efficiency of a given D.C. shunt machine working as motor and generator).
2. O.C and S.C test on single phase transformer (predetermination of efficiency and regulation at given power factor.
3. Brake test on 3- phase induction motor (determination of performance characteristics).
4. Regulation of alternator by Synchronous impendence method.
5. Speed control of DC shunt motor by a) Armature voltage control b) Field flux control method.
6. Brake test on DC shunt motor.

Section B: Electronics Engineering:

7. PN junction Diode Characteristics.
   a) Forward bias
   b) Reverse bias (Cut-in voltage and resistance calculations).
8. Transistor CE characteristics (Input and Output).
9. Full wave rectifier with and without filters.
10. CE Amplifiers.
11. Class A Power Amplifier.
12. RC Phase Shift Oscillator.

Exp No: 1 **Date:**

SWINBURNE'S TEST

AIM: To perform Swinburne's test on a given DC Shunt machine and predetermine its efficiency at any desired load, both as a motor & as a generator.

NAME PLATE DETAILS:

S.NO.	Specifications	Ratings
01	Voltage	220 V
02	Field Current	0.6A
03	Armature current	12A
04	Speed	1500 rpm
05	Power	3.0 H.P.
06	Ins. Class	B

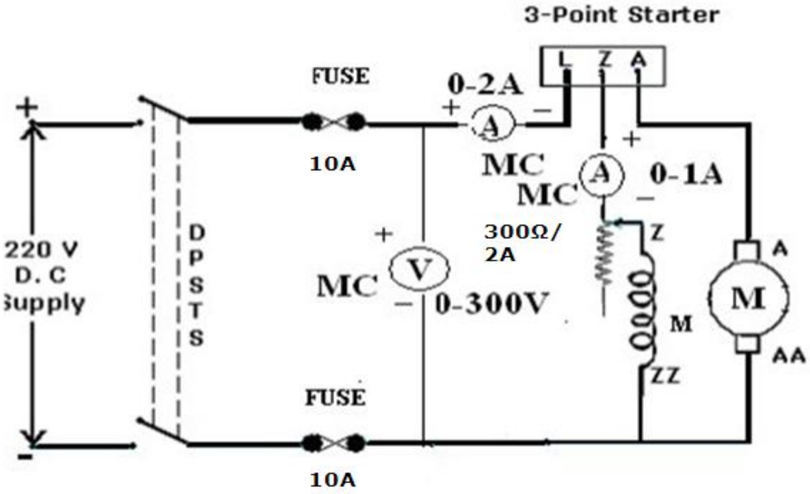
APPARATUS:

S.NO	Apparatus Required	Rating	Type	Qty.
01	Voltmeter	0-300 V	PMMC	1
02	Ammeter	0-2 A	PMMC	2
03	Tachometer	0-10,000rpm	Analog	1
04	Rheostat	300Ω/2A	Wire Wound	1
05	Fuse	6A	TCC	--

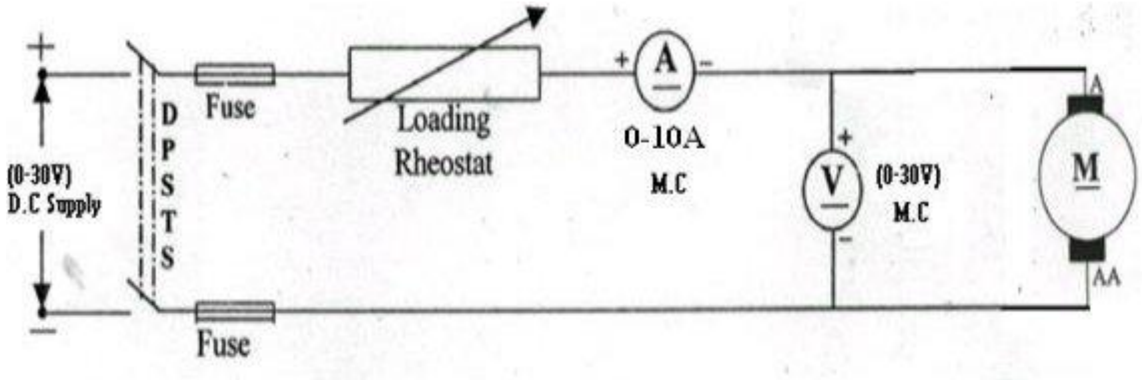
THEORY:

This test is to find out the efficiency of the machine .It is a simple indirect method in which losses are determined separately and from their knowledge, efficiency at any desired load can be predetermined. The only test needed is no-load test. This test cannot be performed on DC series motor. The machine is run as a no load shunt motor at rated speed and with a rated terminal voltage .However, this test is applicable to those machines in which flux is practically constant. The constant losses in a dc shunt machine = W_c = stray losses (magnetic & mechanical losses) +shunt field copper losses

CIRCUIT DIAGRAM:



CIRCUIT DIAGRAM TO FIND ARMATURE RESISTANCE:



PROCEDURE:

1. The connections are made as per the circuit diagram.
2. Initially the starter is in OFF position & the field rheostat is kept in minimum position.
3. 220V DC supply is applied by closing the DPST Switch.
4. The DC motor is started slowly with the starter and brought to the rated speed by varying field rheostat.
5. The no load readings of the motor (input current, field current and input voltage) are noted.
6. Bring the rheostat to initial position and switch OFF of the machine by opening the DPST switch.

PROCEDURE TO FIND Ra:

1. Connections are made as per the circuit diagram.
2. 20V DC supply is applied by closing the DPST Switch.
3. Readings of ammeter & voltmeter are noted by varying the rheostat from maximum position to minimum position.

TABULAR FORM:

S.No	Input voltage(V) volts	Input Current I_L(amps)	Field current I_{sh}(amps)
1			

Armature Resistance R_a = 3.4 Ω

For Motor:

Load	Supply Voltage (V)	Line Current I_L (A)	Arm. Current, I_a(A)	Speed, N (rpm)	Field Current , $I_{sh(A)}$	$I_a^2 R_a$	W_c	$P_{out,}$ (W)	η (%)
Full									
3/4									
1/2									
1/4									

For Generator:

S.No	Supply Voltage (V)	Line Current I_L (A)	Arm. Current, I_a(A)	Speed, N (rpm)	Field Current, $I_{sh(A)}$	$I_a^2 R_a$	W_c	$P_{in,}$ (W)	η (%)
Full									
3/4									
1/2									
1/4									

MODEL CALUCALATIONS:

Constant Losses $W_c = VI_L - (I_a)^2 R_a$

Efficiency of a Generator at Full load:

Full Load Output = V*I_L = -------- W

Armature Copper losses at full load = $I_a^2 R_a = ((I_L + I_{Sh})^2 R_a)$

Total Losses = Wc + $I_a^2 R_a$ =-------------W

% η_g= Output / (Output +Total Losses) X 100= -------------

Efficiency of a Motor:

Let I_a is armature current at which efficiency is required.

Input = V*I_L = --------W

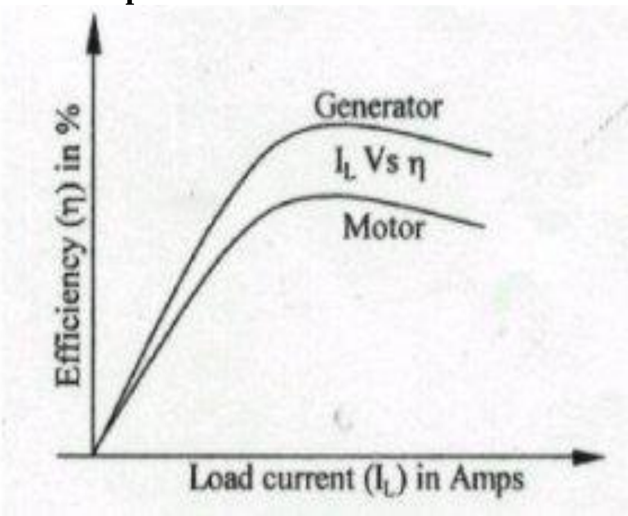
Armature Cu loss = $I_a^2 R_a = ((I_L - I_{Sh})^2 R_a)$

= -------------W

Total losses = $I_a^2 R_a$ + Wc = ----------------W

∴ %η_m = (Input –Total Losses / Input)* 100

Model Graph:



PRECAUTIONS:

1. Avoid loose connections.
2. Switch off the Supply before making connections.
3. Rheostat positions are checked before switching on the motor
4. Do not touch the bare conductors.
5. Avoid parallax error while making observations.

RESULT:

OUTCOME:

Viva questions:

1. What is the significance of swinburn's test?
2. What are the advantages & disadvantages of the test?
3. Why it is not suitable for D.C series motor?
4. What is the purpose of starter?
5. What happened if field is open in D.C motor?
6. Why we have to keep the field rheostat in minimum position?

Exp No: 2 **Date:**

O C AND S C TEST ON SINGLE PHASE TRANSFORMER

AIM: To obtain the regulation and efficiency of a single phase transformer by conducting OC and SC test..

NAME PLATE DETAILS:

Transformer Specifications:

S.No	Specifications	Rating
1	Transformer Rating :(in KVA)	2 KVA
2	LV (in Volts)	230V
3	LV side current	8.7A
4	HV (in Volts)	440V
5	HV side Current	4.5A
6	Type (Shell/Core)	Core
7	Frequency(Hz)	50Hz

APPARATUS:

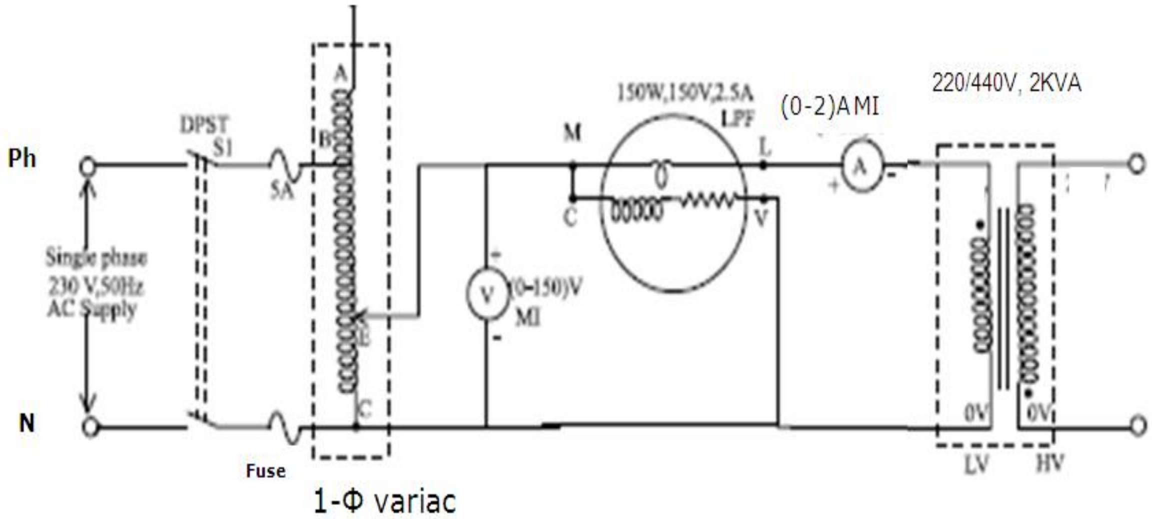
Sl. No.	EQUIPMENT	TYPE	RANGE	QUANTITY
1	Voltmeter	MI	(0-150)V (0-60)V	1 no 1 no
2	Ammeter	MI	(0-2)A (0-10)A	1 no 1 no
3	Wattmeter	Dynamo type	(0-150)V LPF (0-2.5)A	1 no
4	Wattmeter	Dynamo type	(0-150)V UPF (0-10)A	1 no
5	Connecting Wires	*****	*****	Required

THEORY:

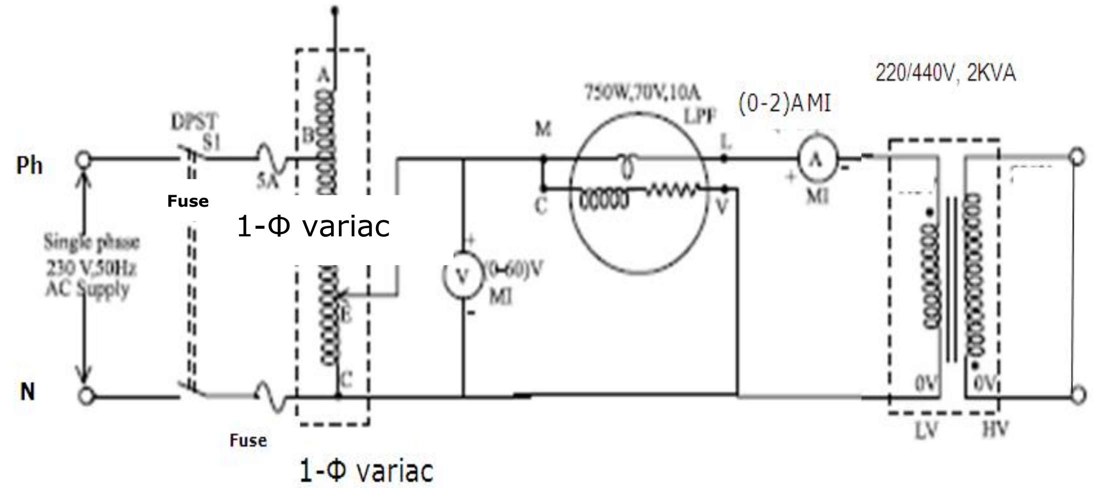
Transformer is a device which transforms the energy from one circuit to other circuit without change of frequency. The performance of any transformer can be determined by conducting tests. The OC and SC tests are conducted on transformer to find the efficiency and regulation of the transformer at any desired load current.

CIRCUIT DIAGRAMS:

OPEN CIRCUIT TEST ON TRANSFORMER



SHORT CIRCUIT TEST ON TRANSFORMER



PROCEDURE:

OPEN CIRCUIT TEST

1. Connections are made as per the circuit diagram.
2. By varying single phase variac, the rated input voltage to be applied on low voltage side of the transformer.
3. Now take down the readings of ammeter, voltmeter and wattmeter.

SHORT CIRCUIT TEST

1. Connections are made as per the circuit diagram.
2. By varying the single phase varic, the rated current is applied to high voltage side of the transformer.
3. Now take down the readings of voltmeter and wattmeter

TABULAR FORMS:

OPEN CIRCUIT TEST:

S.NO	Voc (Volts)	Ioc (Amps)	Woc(watts)
1			

SHORT CIRCUIT TEST:

S.NO	Vsc (Volts)	Isc (Amps)	Wsc(watts)
1			

VOLTAGE REGULATION CHARACTERISTICS:

S.No	% load	Sin Φ	Lagging P.F full load Regulation	Leading P.F full load Regulation
1	0	1		
2	0.2	0.97		
3	0.4	0.91		
4	0.6	0.8		
5	0.8	0.6		
6	1	0		

EFFICIENCY CHARACTERISTICS:

Load ,X	Let Cos Φ=0.8	Let Cos Φ=1
	Efficiency, η	Efficiency, η
x=1/4		
x=1/2		
x=3/4		
x=1		

MODEL CALUCALATIONS:

$\boldsymbol{Z_{SC} = \frac{V_{SC}}{I_{SC}}}$ =

$\boldsymbol{R_{01} = \frac{W_{SC}}{I_{SC}^2}}$ =

$\boldsymbol{X_{01} = \sqrt{Z_{sc}^2 - R_{01}^2}}$ =

Efficiency at Full load, $\boldsymbol{\eta = \frac{x \times KVA \times Cos\,\emptyset}{x \times KVA \times Cos\,\emptyset + W_{OC} + x^2 W_{SC}}}$

KVA = ___ , W_{oc} =_____W , W_{sc} = ____W

<u>Percentage Regulation for lagging Power Factor:</u>

$\boldsymbol{Cos\,\emptyset = 1}$

% R = $\frac{I_{SC}[R_{01}Cos\,\emptyset + X_{01}Sin\,\emptyset]}{V_2} \times 100$=

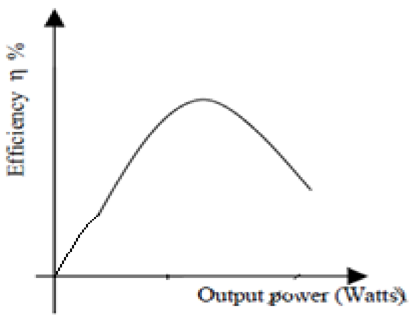
<u>Percentage Regulation for leading Power Factor:</u>

$\boldsymbol{Cos\,\emptyset = 0.8}$

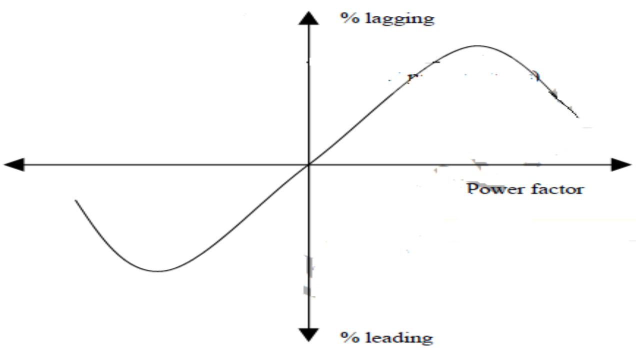
% R = $\frac{I_{SC}[R_{01}Cos\,\emptyset - X_{01}Sin\,\emptyset]}{V_2} \times 100$=

MODEL GRAPHS:

<u>Efficiency Graph</u>:



<u>Percentage Regulation Graph</u>:



PRECAUTIONS:

1. Avoid the loose connections.
2. Avoid connecting of meters directly to the machines.
3. Switch OFF the supply before making the connections.
4. Do not touch the bare conductors.
5. Avoid parallax error while making observations.

RESULT:

OUTCOME:

Viva questions:

1. What is a transformer?
2. Why transformer rated in KVA?
3. What are the losses present in a transformer?
4. What are the applications of transformer?
5. What is voltage regulation of a transformer?

Exp No: 3 **Date:**

BRAKE TEST ON THREE PHASE INDUCTION MOTOR

AIM: To find the performance characteristics of three phase induction motor.

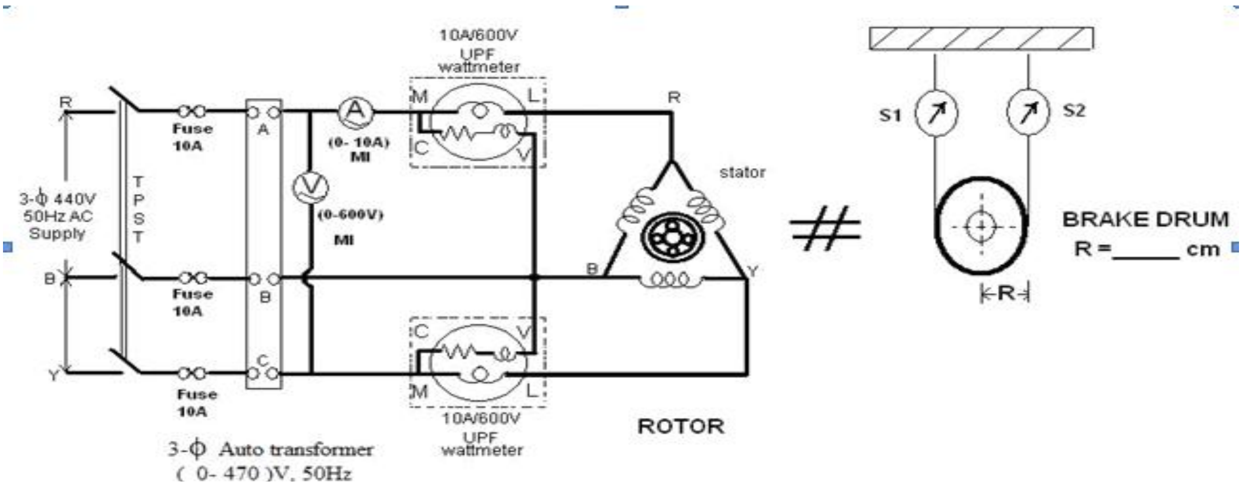
NAME PLATE DETAILS:

S.No	Specifications	Rating
1	Power	3 HP
2	Voltage	415V
3	Current	6A
4	Speed	1440rpm
5	Frequency	50Hz
6	PF	0.8

APPARATUS:

Sl. No.	Equipment	Type	Range	Quantity
1	Voltmeter	MI	(0-600)V	1 no
2	Ammeter	MI	(0-10)A	1 no
3	Wattmeter	Electro dynamo meter type	10A/600V UPF 10A/600V LPF	1 no 1 no
4	Tachometer	Digital	0-9999 RPM	1 no
5	Connecting Wires	*****	*****	Required

CIRCUIT DIAGRAM:



THEORY:

It is the direct method to find the efficiency of the induction motor. In this test the braking of the rotor is done with the help of the belt which surrounds the pulley by using spring balances. When the braking power is increased by tightening the springs then the line current is increased.

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. With the help of three phase variac, start the machine and run it at no-load. Take the readings of all meters and measure the speed.
3. Gradually tightening the belt, apply the load in steps.
4. At each load take the readings of all meters and measure the speed.
5. Pour water into pulley and cool it when motor is heated.
6. When the full load is reached, slowly reduce the load and stop the machine by disconnected the supply.

S. No	Input Voltage (V)	Input Current (A)	Speed, N (rpm)	W1	W2	Spring Balance		Torque N-m	$P_{in=}$ W1+W2 (W)	$P_{out,}$ (W)	$\eta = P_{out}/P_{in\ X\ 100}$ (%)
						S1	S2				
1											
2											
3											
4											
5											
6											
7											
8											

CALCULATIONS:

Torque = 9.81(S1-S2) R N-m

Output Power = $2\pi NT/60$

Input Power = W1+W2

% Efficiency = (Output/ Input) x100

PRECAUTIONS:

1. Avoid loose connections.

2. Take the readings without parallax error.

3. Double check the circuit before giving the supply.

4. The motor armature rheostat in maximum position and motor field rheostat in minimum position.

RESULT:

OUTCOME:

Viva questions:

1. Explain the working principle of an Induction Motor?
2. What are the types of Induction Motor?
3. Draw the performance characteristics of Induction Motor?
4. Draw the equivalent circuit of Induction Motor?
5. What are the applications of Induction Motor?

Exp No: 4 **Date:**

REGULATION OF A THREE-PHASE ALTERNATOR

AIM: To predict the regulation of Three Phase Alternator using synchronous impedance method.

NAME PLATE DETAILS:

S.No	Specifications	Rating	
		DC Motor(Prime Mover)	3- Φ Alternator
1	KW	5HP	3.2KW
2	Voltage	220V	415V
3	Current	12A	4.2A
4	Speed	1500 rpm	1500 rpm
5	Exctn	Shunt Wound	External
6	Voltage	220V	220
7	Field current	0.6A	1.4

APPARATUS:

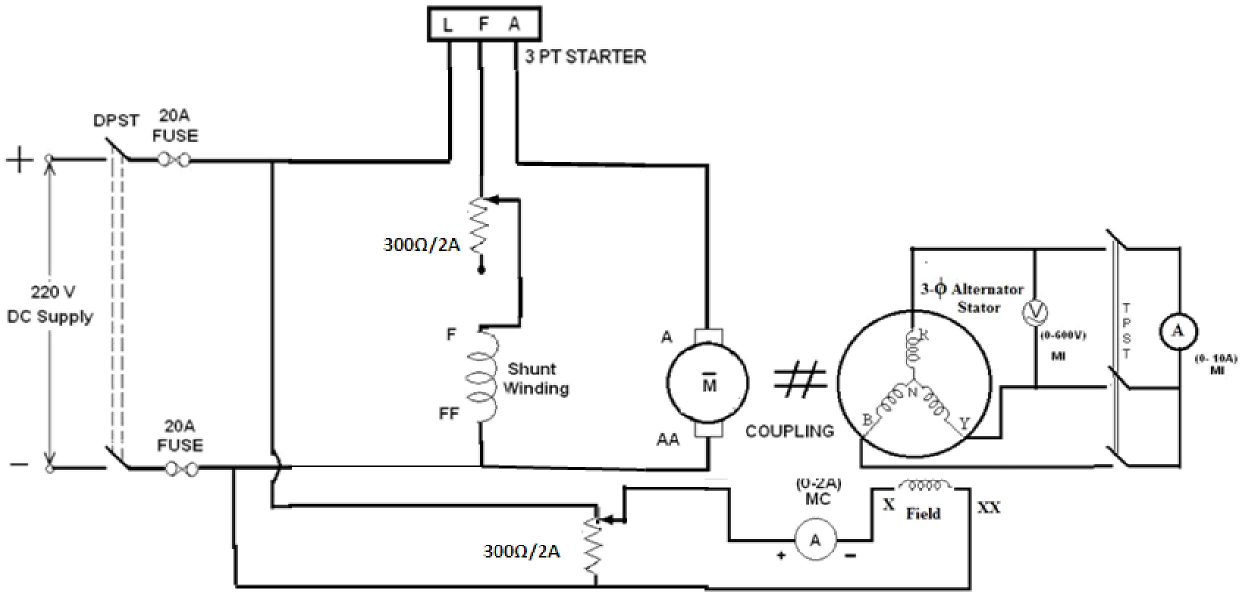
Sl. No.	Equipment	Type	Range	Quantity
1	Voltmeter	MI	(0-300/600)V	1 no
2	Ammeter	MI	(0-10)A	1 no
3	Rheostat	Wire-wound	300 Ω /2A	2 no
4	Tachometer	Digital	0-10000 rpm	1 no
5	Connecting Wires	*****	*****	Required

THEORY:

As the load changes the terminal voltage of an alternator is also changes the magnitude of this change depends not only on the load but also on load power factor. The voltage regulation of an alternator is defined as the raise in voltage when the full load is removed (Field excitation and speed remaining same) divided by the rated terminal voltage.

%Regulation = (Eo – V)/V X100

CIRCUIT DIAGRAM:



PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Switch ON the 220v DC supply.
3. Start the DC Motor using 3 point starter.
4. Adjust the speed of the motor to the rated speed using armature regulator and if necessary with field regulators.
5. Excite the field winding and vary the field current in steps of 0.1 amps and note down the corresponding readings of voltmeter, keeping the speed constant.
6. Repeat the procedure till 110 to 129 % of the rated voltage is reached.
7. Reduce the field current to ‘0’ and close the ‘TPST’ switch.
8. Vary the field current to ‘0’ and close the ‘TPST’ switch in steps of 0.1 amps and note down the corresponding ammeter readings, keeping the speed constant.
9. The procedure is Repeated till rated current is reached

TABULAR FORM:
OPEN CIRCUIT CHARACTERITICS:

S.NO	I_f (amps)	V_{oc} (volts)
1		
2		
3		
4		
5		
6		

SHORT CIRCUIT CHARACTERITICS:

S.NO	I_f (amps)	I_{sc} (amps)
1		

VOLTAGE REGULATION CHARACTERISTICS:

S.No	Cos Φ	Sin Φ	Lagging P.F full load Eo	Leading P.F full load Eo
1	0.2	0.97		
2	0.4	0.91		
3	0.6	0.8		
4	0.8	0.6		
5	1	0		

MODEL CALUCALATIONS:

$V_{Ph} = \frac{V_L}{\sqrt{3}}$ = ________V

$Z = \frac{Voc}{I_{SC}}$ =______Ω

$R_{AC} = 1.5 \times R_{DC}$ = 1.5 X 4.2 = 6.3Ω

$X_S = \sqrt{Z^2 - R_{AC}^2}$ = ________Ω

For lagging P.F:
By substituting all the values in E_o, We will get

$$E_0 = \sqrt{((V_{Ph}Cos\,\emptyset + I_{Sc}R_a)^2) + ((V_{Ph}Sin\,\emptyset + I_{Sc}x)^2)}$$

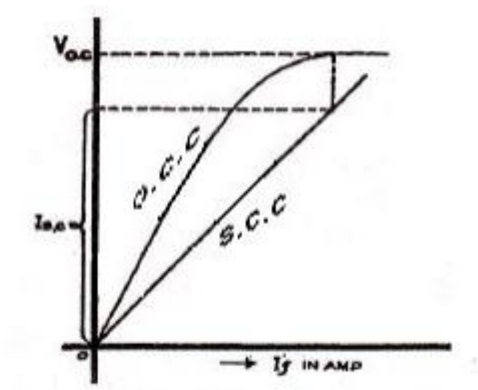
For leading P.F:

By substituting all the values in E_o, We will get

$$E_0 = \sqrt{((V_{Ph}Cos\,\emptyset + I_{Sc}R_a)^2) + ((V_{Ph}Sin\,\emptyset - I_{Sc}x)^2)}$$

Percentage Regulation: % R = $\frac{E_0 - V_{Ph}}{V_{Ph}} \times 100$

MODEL GRAPH:



PRECAUTIONS:

1. Avoid loose connections.
2. Switch OFF the Supply before making connections.
3. Do not touch the bare conductors.
4. Avoid parallax error while making observations.

RESULT:

OUTCOME:

Viva questions:

1. What is an Alternator?
2. What is the principle of alternator?
3. Define regulation of an Alternator?
4. What are the different methods for finding regulation of an alternator?
5. What are the applications of an alternator?

Exp No: 5 **Date:**

SPEED CONTROL OF DC SHUNT MACHINE

AIM: To determine the speed characteristics of D.C. shunt motor by

1. Field Control Method
2. Armature Control Method

NAME PLATE DETAILS:

S.No	Specifications	Rating
1	Rated Voltage	220V
2	Rated Speed	1500rmp
3	Field Current	1.2A

APPARATUS:

S.No	Equipment	Type	Range	Qty
1	DC shunt motor	DC	220V	1
2	Rheostat	Wire wound	300Ω, 2A	2
3	Ammeter	MC	(0-2)A	1
4	Voltmeter	MC	(0-300)V	1
5	Tachometer	Digital	(0-30000)rpm	1

THEORY:

The term speed control means intentional sped variation, carried out manually or automatically. DC motors are most suitable for wide range speed control and are therefore indispensible for many adjustable speed drives. The speed of a motor is given by Wm = (Vt-IaRa)/Kaф Where Ka – armature constant = PZ/2∏A and ф is the flux per pole. Hence it follows that, for a DC motor, there are basically two methods of speed control and these are:

1. Variation of the field flux.
2. Variation of armature terminal voltage.

Variation of the field flux: This method of speed control, also called as flux weakening method or filed current control method gives speeds above the base speed only. Base speed is nothing but the rated speed of the machine. This is one of the simplest and economical methods and is, therefore extensively used in modern electric drives. Under steady state running conditions, if the field circuit resistance is increased, the field current and hence the field flux are reduced. Since the rotor speed cannot change suddenly due to inertia, a decrease in field current causes a reduction of counter emf. As a result of it, more current flows through armature. The percentage increase in armature current is much more than the percentage decrease in the field current. In view of this, the electromagnetic torque is increased and this being more than the load torque, the motor gets accelerated.

The disadvantages of this method are:

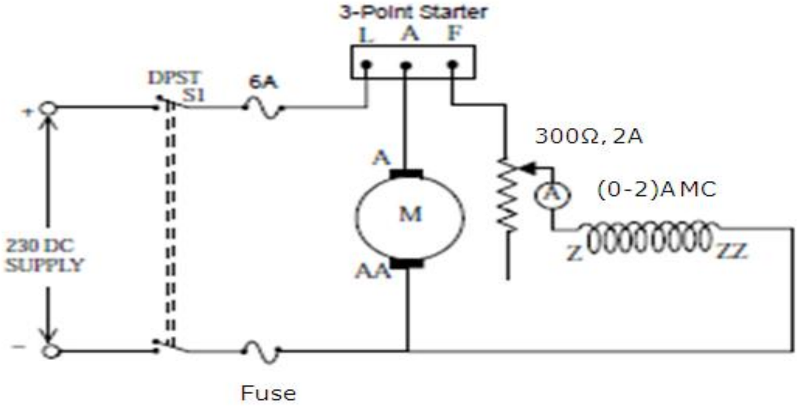
a) The armature may get over heated at higher speeds, because the increased armature current results in more ohmic losses whereas cooling by ventilation does not improve proportionally.

b) If the field flux is weakened considerably, the speed becomes very high and due to these changes; the motor operation may become unstable.

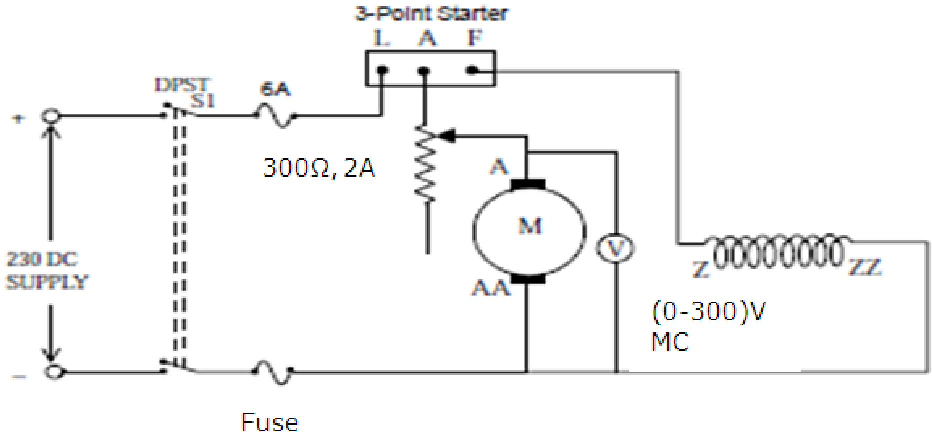
Variation of armature terminal voltage: If the voltage applied to the armature changes the speed changes directly with it. Using this method, speeds below rated speeds are attained.

CIRCUIT DIAGRAM:

For Field Control Method:



For Armature Control Method:



PROCEDURE:

For Field Control method:

1. The connections are made as per the circuit diagram.
2. The field rheostat is kept at minimum position.
3. The motor is started with the help of three point starter.
4. R_f is increased in steps thereby decreasing the field current. The values of I_f and speed are noted down.

Fuse

For Armature Control Method:

1. The connections are made as per the circuit diagram.
2. The armature rheostat is kept at maximum position.
3. The motor is started with the help of the starter.

4. The armature rheostat is varied from maximum value to minimum value in steps.
5. The speed for each value of Va is noted down.

TABULAR FORM:

For Field Control Method:

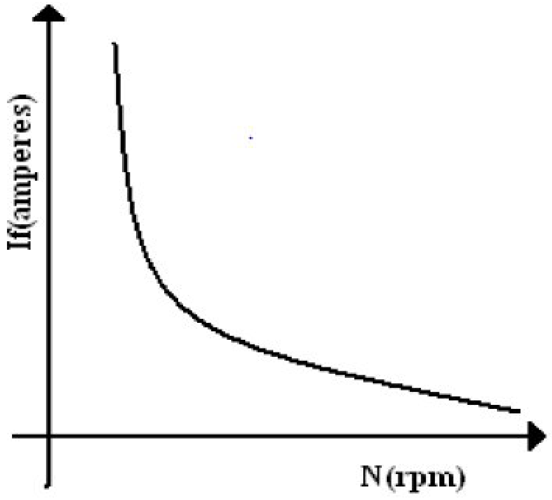
S.No.	Field Current, I_{Sh}(A)	Speed,N(rpm)
1		
2		
3		
4		
5		

For Armature Control Method:

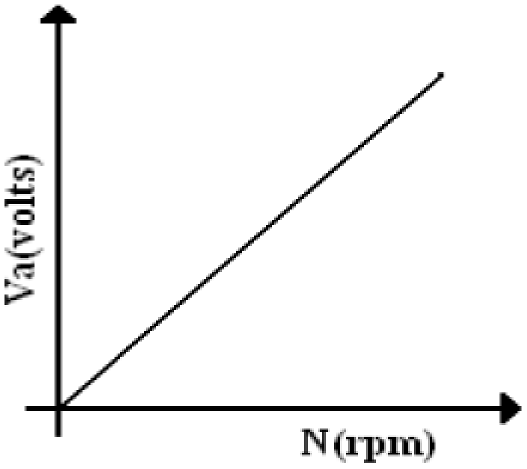
S.No.	Arm. Voltage,V_a (v)	Speed,N(rpm)
1		
2		
3		
4		
5		

MODEL GRAPH:

Armature voltage control:



Field control method:



PRECAUTIONS:

1. Avoid loose connections.
2. Switch OFF the Supply before making connections.
3. Rheostat positions are checked before switching on the motor
4. Do not touch the bare conductors.

5. Avoid parallax error while making observations.

RESULT:

OUTCOME:

Viva questions:

1. Why to control the speed of a DC Motor?
2. What is ment by armature reaction?
3. Draw the characteristics of DC shunt motor?
4. What is the expression for back EMF?
5. What are the applications of Dc Motors?

Exp No: 6 **Date:**

BRAKE TEST ON A DC SHUNT MOTOR

AIM: To obtain the performance characteristic curves of a D.C. shunt motor by conducting brake test on it

NAME PLATE DETAILS:

S.NO.	Specifications	Ratings
01	Voltage	220 V
02	Field Current	0.6A
03	Armature current	12A
04	Speed	1500 rpm
05	Power	3.0 H.P.
06	Ins. Class	B
07	Duty	SI

APPARATUS:

S.NO	Apparatus Required	Rating	Type	Qty.
01	Voltmeter	0-300 V	PMMC	1
02	Ammeter	0-15 A	PMMC	1
03	Ammeter	0-2A	PMMC	1
04	Tachometer	0-10,000rpm	Analog	1
05	Rheostat	300Ω/1.2A	Wire Wound	1
06	Fuse	15A	TCC	--

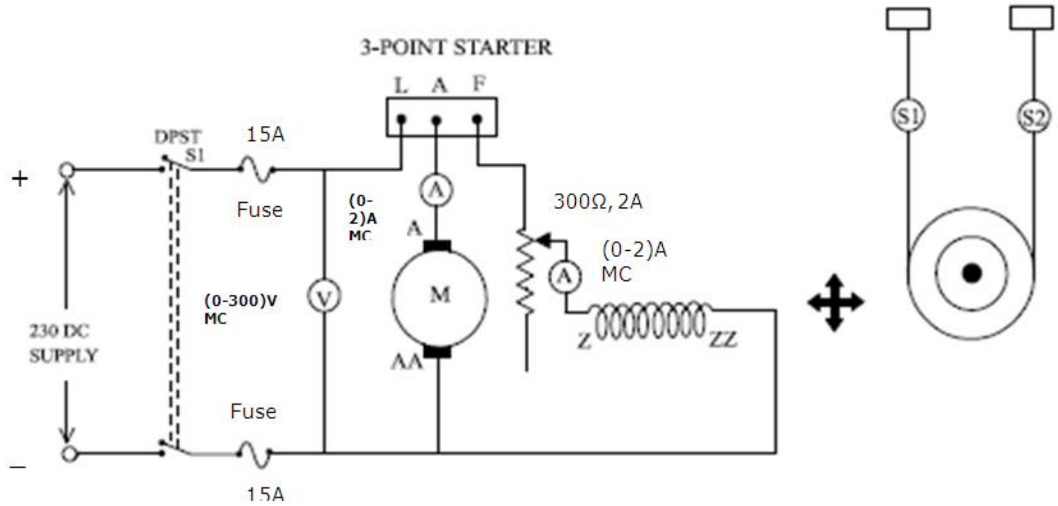
THEORY:

It is a simple method testing DC machines and consists of applying a brake to a water cooled drum mounted on the motor shaft. A rope is wound round the pulley and its two ends are attached to two spring balances S1 & S2. The tension of the rope can be adjusted with the help of swivels. The force acting tangentially on the drum is equal to the difference between the readings of the two spring balances.

a) This test can be used for small motors only, as, in the case of large motors, it is difficult to dissipate the large amount of heat generated at the brake.

b) Where the output power exceeds about 2 H.P., or where the test is of long duration, it's necessary to use water –cooled pulley.

CIRCUIT DIAGRAM:



PROCEDURE:

1. The connections are made as per the circuit diagram.
2. Initially the starter is in off position.
3. The field rheostat is in minimum position.
3. 220V DC supply is applied by closing the DPST Switch.
4. The DC motor is started slowly with the starter and brought to the rated speed.
5. Load is applied on the drum gradually in steps by tightening the belt around it.
6. The readings of the ammeter & voltmeter, two spring balances and the speed at every step are noted.
7. Drum is cooled throughout the loading period by pouring water.
8. The experiment is continued till the full load on the motor is impressed.
9. The machine is switched OFF by opening the DPST switch.

TABULAR FORM:

S.No	Supply Voltage(V)	Arm Current I_a (A)	Speed, N (rpm)	Spring Balance		Field Current, $I_{sh(A)}$	Torque, T(N-m)	$P_{in,}$ (W)	$P_{out,}$ (W)	$\eta=P_{out}/P_{in}$ X 100 (%)
				S_1	S_2					
1										
2										
3										
4										
5										
6										
7										

MODEL CALUCALATIONS:
Let

S1 = Readings on spring balance 1 in Kgf.wt.

S2 = Readings on spring balance 2 in Kgf.wt.

The net force applied on the brake drum is (S1 – S2) Kgf.Wt.

If R = radius of the pulley in meters (15.2 Cm)

N = Motor speed in rpm then,

Shaft torque, T, developed by the motor is:

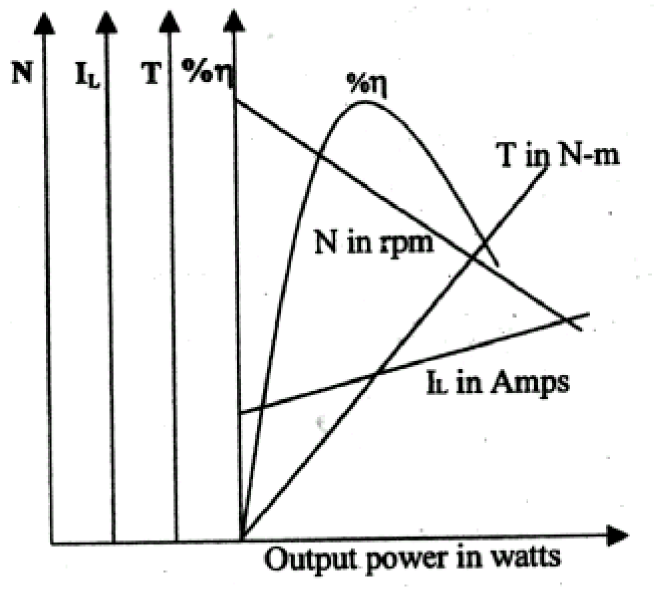
$T = 9.81 \times (S1 - S2) \times R$ N-m

Output power = $2\pi NT/60$ Watts

Input power = $V (I_a + I_{sh})$ Watts

%Efficiency = Output power / Input power X 100

MODEL GRAPH:



PRECAUTIONS:

1. Avoid loose connections.
2. Switch OFF the Supply before making connections.
3. Rheostat positions are checked before switching on the motor
4. Do not touch the bare conductors.
5. Avoid parallax error while making observations.

RESULT:

OUTCOME:

Viva questions:

1. What is the principle of DC Motor?
2. What is the need of starter?
3. What are the types of speed control methods for DC motor?
4. What are the parts of a DC motor?
5. What are losses present in Dc motor?

Exp No: 7 **Date:**

P-N JUNCTION DIODE CHARACTERISTICS

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

b) To calculate the cut-in voltage at which diode conducts.

c) To calculate static and dynamic resistance.

APPARATUS REQUIRED:

S.No	Name of the apparatus	Qty	Range
1	PN Diode IN4007	1	-
2	Regulated power supply	1	0-30V
3	Voltmeter	2	0-20V,0-1V
4	Ammeter	2	0-20mA,0-750 µA
5	Resistor	1	1KΩ
6	Bread board	1	-
7	Connecting wires	-	-

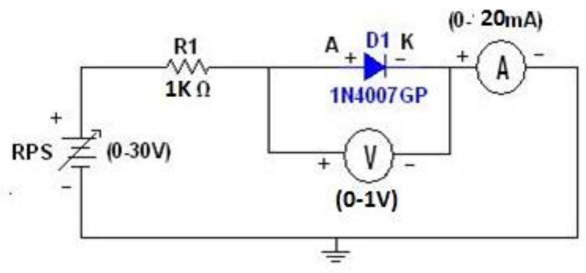
THEORY:

A p-n junction diode conducts only in one direction, the V-I characteristics of p-n diode is a curve plotted between the voltage across diode and current through the diode. When external voltage is zero, circuit is open and the potential barrier does not allow the current to flow. Therefore, the circuit current is zero. When P-type Anode is connected to +ve terminal and N- type Cathode is connected to the –ve terminal of supply voltage the diode is considered to be operating under forward bias condition. When the voltage across the diode is increased in the forward biased condition, the potential barrier is reduced and is altogether eliminated at some forward voltage, resulting in the current to flow through the diode and the circuit. The diode is now said to be in the ON state and the current keeps on increasing with an increase in the forward voltage.

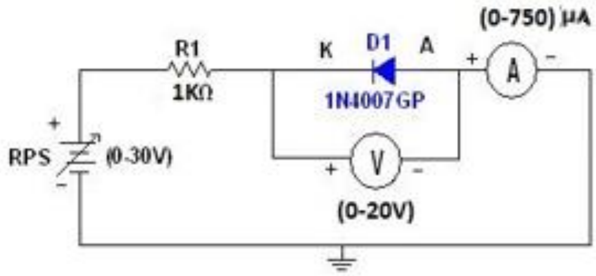
A p-n junction diode is considered to be operating under reverse bias condition when the N-type cathode is connected to +ve terminal and P-type Anode is connected to the –ve terminal of supply voltage. Under reverse bias condition potential barrier across the junction increases with a corresponding rise in the supply voltage, hence junction resistance becomes very high and a very small reverse saturation current flows in the circuit due to minority charge carriers. The diode is now said to be in the OFF state.

CIRCUIT DIAGRAM:

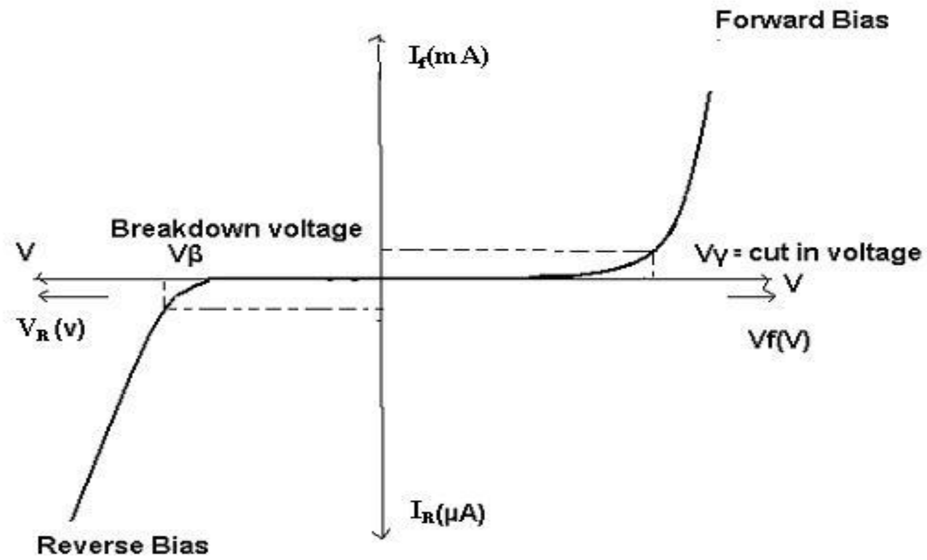
Forward Bias:



Reverse Bias:



Model Waveform:



PROCEDURE:

<u>Forward Bias</u>:-

1. Connections are made as per the circuit diagram.
2. Under forward bias, the RPS +ve terminal is connected to the anode of diode and RPS –ve Terminal is connected to the cathode of the diode.
3. Switch on the power supply and increase the input voltage (supply voltage) in Steps.
4. Note down the corresponding current flowing through the diode and voltage across the Diode for each and every step of the input voltage.
5. Tabulate the readings of voltage and current.
6. Plot the graph between voltage and current.
7. Find the cut-in voltage in forward bias.
8. Calculate the static and dynamic resistances.

<u>Reverse Bias</u>:

1. Connections are made as per the circuit diagram.
2. Under reverse bias, the RPS -ve terminal is connected to the anode of diode and RPS +ve Terminal is connected to the cathode of the diode.
3. Switch on the power supply and increase the input voltage (supply voltage) in Steps.
4. Note down the corresponding current flowing through the diode and voltage across the Diode for

each and every step of the input voltage.
5. Tabulate the readings of voltage and current.
6. Plot the graph between voltage and current.
7. Calculate the dynamic resistance.

Observations for Forward Bias:-

S.NO	APPLIED VOLTAGE(V)	VOLTAGE ACROSS DIODE V_f (V)	CURRENT THROUGH DIODE I_f (mA)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			

Observations for Reverse Bias:-

S.NO	APPLIEDVOLTAGE (V)	VOLTAGE ACROSS DIODE V_R(V)	CURRENT THROUGH DIODE I_R(μA)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

Calculations:

Forward Bias:

Static resistance $R_D = V_D/I_{D=}$____KΩ

Dynamic resistance $r_d = \Delta V_d / \Delta I_d$ =_______KΩ

Reverse Bias:

Static resistance $R_D = V_D/I_D$ =___KΩ

Dynamic resistance $r_d = \Delta V_d / \Delta I_{d=}$____KΩ

Applications:

- As Rectifier in DC Power Supplies.
- In Demodulation or Detector Circuits.
- As DC Restorer in clamping networks.
- In clipping circuits used for waveform generation.
- As switches in digital logic circuits.

PRECAUTIONS:

1. Avoid loose connections.
2. The supply voltage should not exceed the rating of the component.
3. Meters should be connected properly according there polarity.

RESULTS:

Forward and Reverse Bias characteristics of p-n diode are obtained.

Cut-in voltage =

Static Resistance in Forward Bias =

Dynamic resistance in Forward Bias =

Static Resistance in Reverse Bias =

Dynamic resistance in Reverse Bias =

OUTCOME:

Viva Questions:

1. Define depletion region of a diode?
2. What is meant by transition & space charge capacitance of a diode?
3. Is the V-I relationship of a diode Linear or Exponential?
4. Define cut-in voltage of a diode and specify the values for Si and Ge diodes?
5. What are the applications of a p-n diode?
6. Draw the ideal characteristics of P-N junction diode?
7. What is the diode equation?
8. What is PIV?
9. What is the break down voltage?
10. What is the effect of temperature on PN junction diodes?
11. How does the diode act as a switch?
12. Differentiate cut-in and cut-off voltages?

Exp No: 8 **Date:**

TRANSISTOR COMMON EMITTER CHARACTERSTICS

AIM: To draw the input and output characteristics of transistor connected in CE Configuration

APPARATUS REQUIRED:

S.No	Name of the apparatus	Qty	Range
1	Transistor(BC 107)	1	-
2	Regulated power supply	2	0-30V
3	Voltmeter	2	0-20V
4	Ammeter	2	0-20mA,0-750 µA
5	Resistor	1	1KΩ
6	Bread board	1	-

THEORY:

A transistor is a three terminal device. The terminals are emitter, base, collector. In common emitter configuration, input voltage is applied between base and emitter terminals and output is taken across the collector and emitter terminals. Therefore the emitter terminal is common to both input and output.

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

The output characteristics are drawn between I_c and V_{CE} at constant $I_{B.}$ The collector current varies with V_{CE} until few volts only. After this the collector current becomes almost constant, and independent of $V_{CE.}$ The value of V_{CE} up to which the collector current changes with V_{CE} is known as Knee voltage. The transistor always operated in the region above Knee voltage, I_C is always constant and is approximately equal to $I_{B.}$ It operates in three regions: active region, cut-off region and saturation region.

<u>Active region:</u> When E-B junction is forward biased and C-B junction is reverse biased then the transistor is said to be in active region.

<u>Cut-off region:</u> When E-B junction is reverse biased and C-B junction is reverse biased then the transistor is said to be in cut-off region.

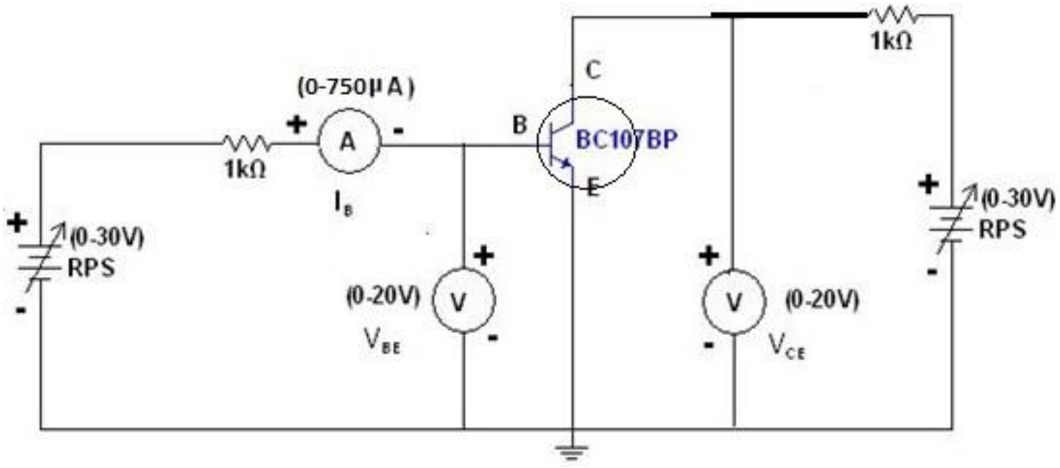
<u>Saturation region:</u> When E-B junction is forward biased and C-B junction is forward biased then the transistor is said to be in saturation region.

The current amplification factor of CE configuration is given by

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

CIRCUIT DIAGRAM:

Input Characteristics:



PROCEDURE:

Input Characteristics:

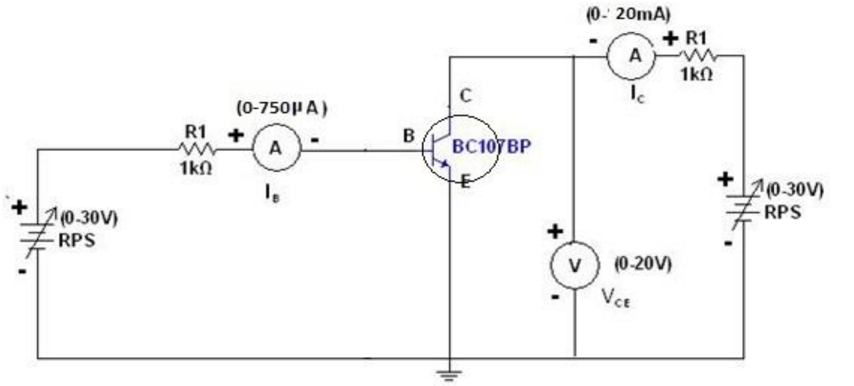
1. Connect the circuit as per the circuit diagram.
2. For plotting the input characteristics the output voltage V_{CE} is kept constant at 1V and for different values of $V_{BE.}$ Note down the values of I_C.
3. Repeat the above step by keeping $V_{CE\ at}$ 2V and 4V.
4. Tabulate all the readings.
5. Plot the graph between $V_{BE\ and}$ I_B for constant VCE.

Observations:

Input Characteristics:

S.No	V_{CE} = 1V		V_{CE} = 2V	
	V_{BE}(V)	I_B(μA)	V_{BE}(V)	I_B(μA)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Output Characteristics:



Output characteristics:

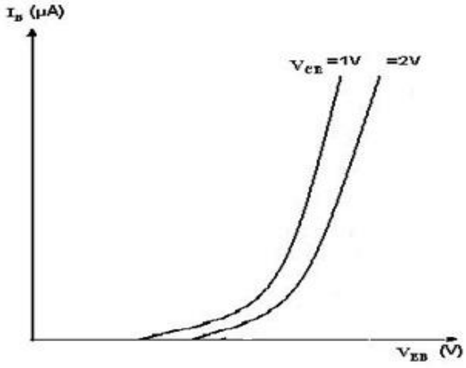
1. Connect the circuit as per the circuit diagram.
2. For plotting the output characteristics the input current IB is kept constant at 10µA and for different values of VCE, note down the values of I_C.
3. Repeat the above step by keeping I_B at 75 µA and 100 µA.
4. Tabulate the all the readings.
5. Plot the graph between V_{CE} and I_C for constant I_B.

Output Characteristics:

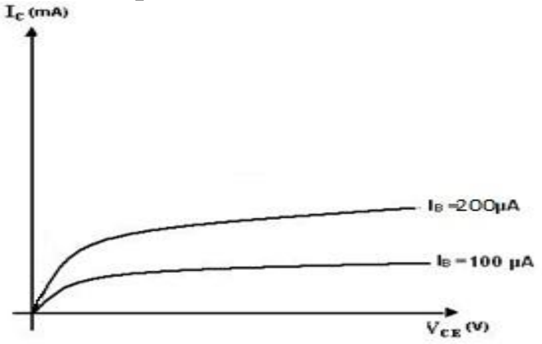
S.No	I_B = 50 µA		I_B = 70µA	
	V_{CE}(V)	I_C(mA)	V_{CE}(V)	I_C(mA)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Model Graphs:

Input Characteristics:-



Output Characteristics:-



Applications:

1. Acts as a switch
2. As an amplifier
3. As an inverter
4. In oscillators

PRECAUTIONS:

1. Avoid loose connections.
2. The supply voltage should not exceed the rating of the component.
3. Meters should be connected properly according there polarity.

RESULT:

Outcome:

Viva Questions:

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

Exp No: 9 **Date:**

FULL-WAVE RECTIFIER

AIM: - Design the Full-Wave Rectifier

a) To obtain the load regulation characteristics of full-wave rectifier

b) To determine the ripple factor and efficiency of a full-wave rectifier.

1. with Filter
2. without Filter

APPARATUS REQUIRED:

S.No	Name of the apparatus	Qty	Range
1	Transformer	1	(9-0-9)
2	PN diode,(IN4007)	2	-
3	Multimeter	1	-
4	Filter Capacitor	1	100µF/25v
5	Load Resistor	1	Decade Resistance Box
6	Bread board	1	-
7	CRO	1	-

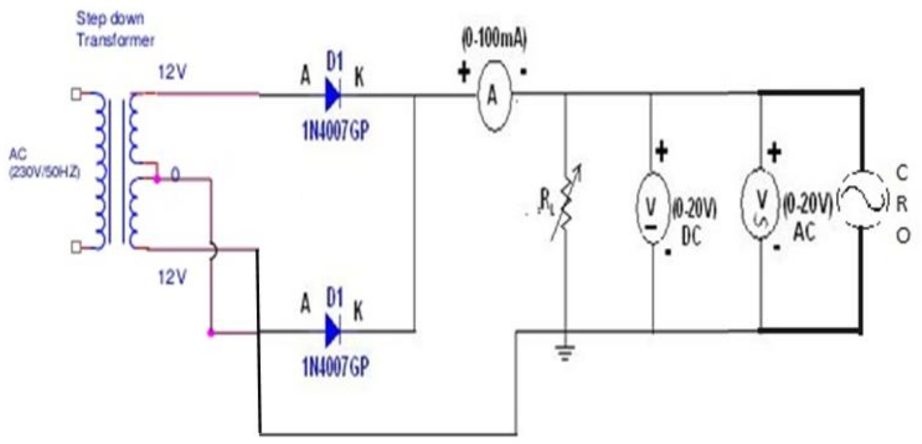
THEORY:

The circuit of a center-tapped full wave rectifier uses two diodes D1&D2. During positive half cycle of secondary voltage (input voltage), the diode D1 is forward biased and D2 is reverse biased. The diode D1 conducts and current flows through load resistor R_L. During negative half cycle, diode D2 becomes forward biased and D1 reverse biased. Now, D2 conducts and current flows through the load resistor R_L in the same direction. There is a continuous current flow through the load resistor R_L, during both the half cycles making the direction of current unidirectional as show in the model graph.

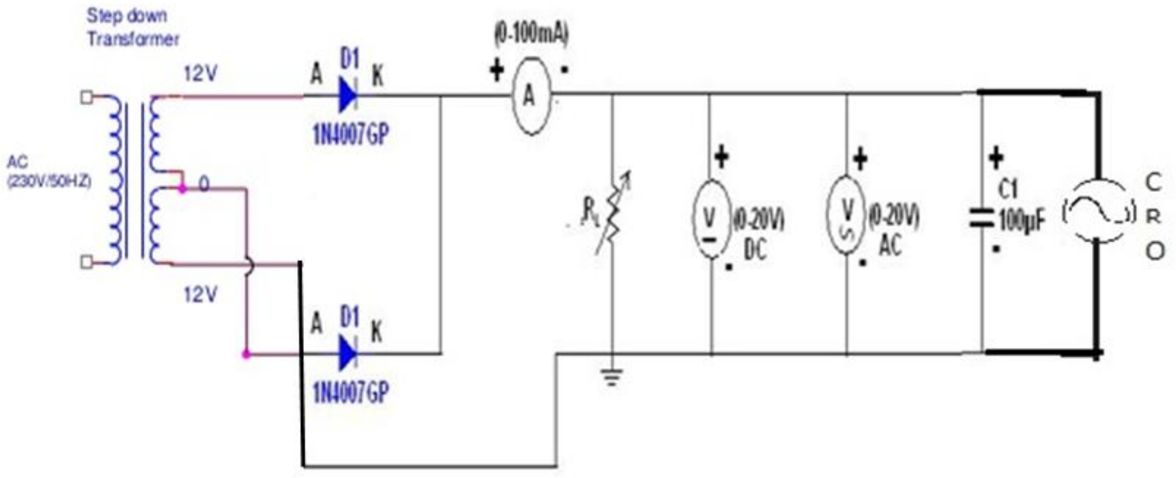
The difference between full wave and half wave rectification is that a full wave rectifier allows unidirectional (one way) current to the load during the entire 360 degrees of the input signal and half-wave rectifier allows the current only during one half cycle (180 degree).

CIRCUIT DIAGRAM:

With Out Filter:



With Filter:



PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Connect the primary of the transformer to ac mains and the secondary to the rectifier input.
3. Measure the ac input voltage of rectifier and dc voltage at the output of the rectifier using multi-meter.
4. Find the theoretical value of dc voltage by using the formula,

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

Where Vm= 2Vrms, (Vrms= output ac voltage.)
The Ripple factor is calculated by using the formula
r=ac output voltage (Vrms)/dc output voltage (Vdc).

Regulation Characteristics:-

1. Connections are made as per the circuit diagram.
2. By increasing the value of the rheostat, the voltage across the load and current flowing through the load are measured.
3. The reading is tabulated.
4. Draw a graph between load voltage (V_L) and load current (I_L) taking V_L on X-axis and I_L on y-axis.
5. From the value of no-load voltages, the %regulation is calculated using the formula.

Observations:-

Without Filter:-

V_{NL} = -----V, V_{ac} = ------V

Sno.	R(Ω)	I_{dc}(mA)	V_{dc}(V)	V_{ac}(V)	Ripple factor r = V_{ac}/V_{dc}	%Reg = (V_{NL}- V_{FL})/ V_{FL} X 100
1	100					
2	200					
3	400					
4	600					
5	800					
6	1000					
7	2000					
8	3000					
9	4000					
10	5000					

WITH FILTER:-

V_{NL} =_------V ,V_{ac} =-------V

Sno.	R(Ω)	I_{dc}(mA)	V_{dc}(V)	V_{ac}(V)	Ripple factor r = V_{ac}/V_{dc}	%Reg = (V_{NL}- V_{FL})/ V_{FL} X 100
1	100					
2	200					
3	400					
4	600					
5	800					
6	1000					
7	2000					
8	3000					
9	4000					
10	5000					

Theoretical Calculations:-

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

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

Without filter:-

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

With filter:-

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

Where f =50Hz

C =100µF
R_L=1KΩ

Practical Calculations:-

Without filter:-

Vac=
Vdc=
Ripple factor, r=Vac/Vdc =

With filters:-

Vac=
Vdc=
Ripple factor, r=Vac/Vdc =

PRECAUTIONS:

1. Avoid loose connections.
2. The supply voltage should not exceed the rating of the component.
3. Meters should be connected properly according there polarity.

RESULT:

OUTCOME:

Viva Questions:-

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

Exp No: 10 **Date:**

TRANSISTOR CE AMPLIFIER

AIM: 1. To Measure the voltage gain of a CE amplifier using hardware model
2. To draw the frequency response curve of the CE amplifier

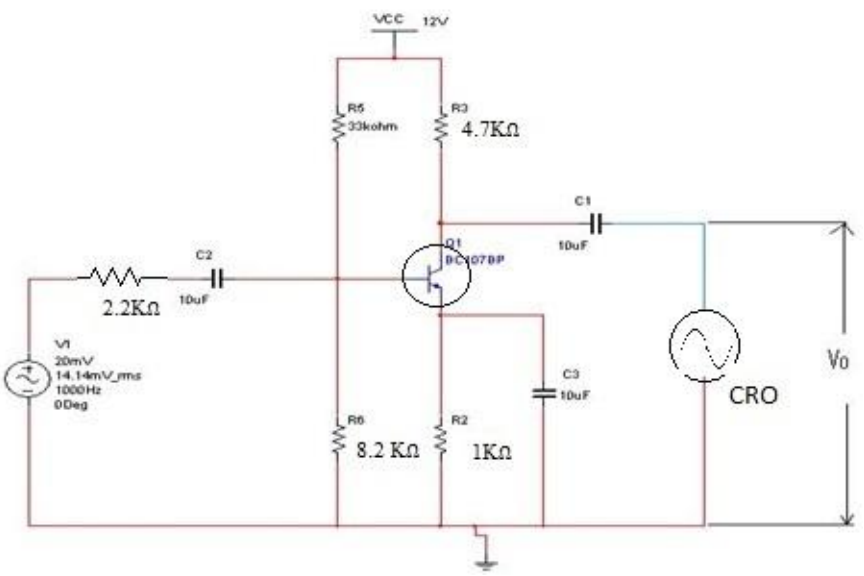
APPARATUS:

S.No	Name of the apparatus	Qty	Range
1	Transistor BC-107	1	-
2	Regulated power supply	1	(0-30V,1A)
3	Function Generator	1	-
4	Capacitor	3	100μF
5	Resistors	5	33KΩ, 8.2KΩ, 1KΩ, 2.2KΩ, 4.7KΩ
6	Bread board	1	-
7	CRO	1	-
8	Connecting wires	-	-

THEORY:

The CE amplifier provides high gain &wide frequency response. The emitter lead is common to both input & output circuits and is grounded. The emitter-base circuit is forward biased. The collector current is controlled by the base current rather than emitter current. The input signal is applied to base terminal of the transistor and amplifier output is taken across collector terminal. A very small change in base current produces a much larger change in collector current. When +VE half-cycle is fed to the input circuit, it opposes the forward bias of the circuit which causes the collector current to decrease, it decreases the voltage more – VE. Thus when input cycle varies through a -VE half-cycle, increases the forward bias of the circuit, which causes the collector current to increases thus the output signal is common emitter amplifier is in out of phase with the input signal.

Circuit Diagram:



PROCEDURE:

1. Connect the circuit as shown in circuit diagram.
2. Apply the input of 20mV peak-to-peak and 1 KHz frequency using Function Generator.
3. Measure the Output Voltage Vo (p-p) for various load resistors.
4. Tabulate the readings in the tabular form.
5. The voltage gain can be calculated by using the expression $A_v = (V_0/V_i)$.
6. For plotting the frequency response the input voltage is kept Constant at 20mV peak-to-peak and the frequency is varied from 100Hz to 1MHz Using function generator.
7. Note down the value of output voltage for each frequency.
8. All the readings are tabulated and voltage gain in dB is calculated by Using The expression $A_v = 20 \log_{10} (V_0/V_i)$
9. A graph is drawn by taking frequency on x-axis and gain in dB on y-axis On Semi-log graph.

The band width of the amplifier is calculated from the graph Using the expression, Bandwidth, $BW = f_2 - f_1$

Where f_1 lower cut-off frequency of CE amplifier, and f_2 upper cut-off frequency of CE amplifier

The bandwidth product of the amplifier is calculated using the Expression Gain Bandwidth product =3-dBmidband gain X Bandwidth

Observations:

Input voltage Vi=20mV

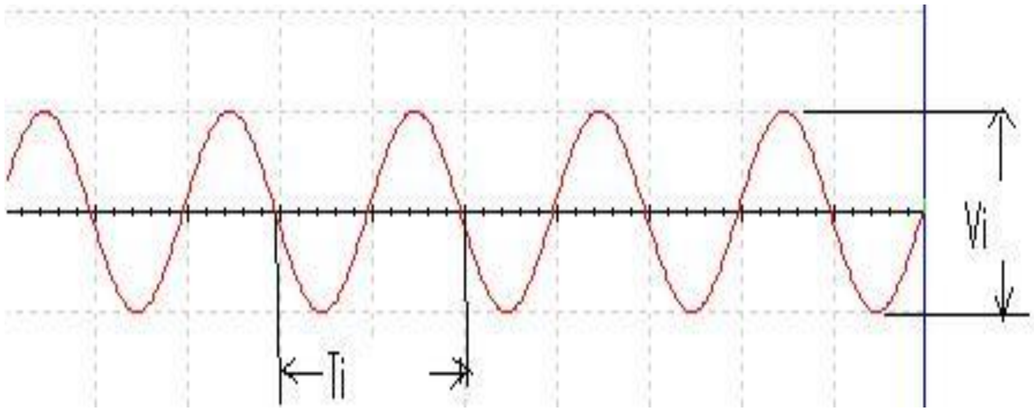
Frequency Response:

Vi=20mv

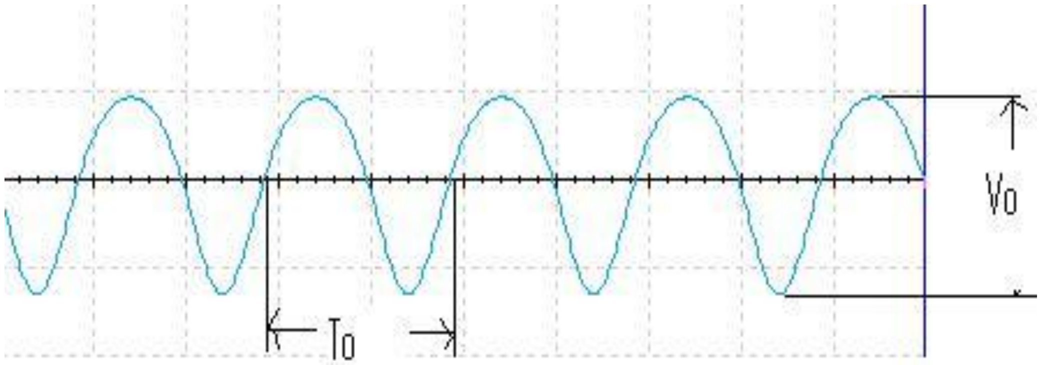
FREQUENCY(Hz)	OUTPUT VOLTAGE (V_0)	GAIN IN dB $A_v = 20 \log_{10} (V_0/V_i)$
300		
600		
900		
1K		
2K		
3K		
4K		
5K		
6K		
7K		
8K		
9K		
10K		
20K		
30K		
40K		
50K		
60K		
70K		
80K		
90K		
100K		
200K		
300K		
400K		
500K		
600K		

Model Graphs:

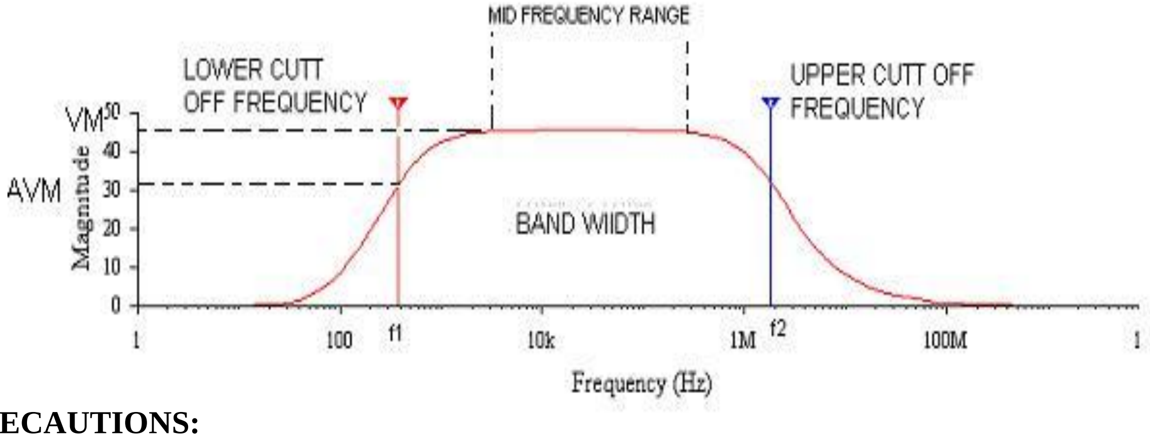
Input Wave Form:



Output Wave Form



Frequency Response:



PRECAUTIONS:

1. Avoid loose connections.
2. The supply voltage should not exceed the rating of the component.
3. Meters should be connected properly according there polarity.

RESULT:

OUTCOME:

Viva Questions:

1. What is phase difference between input and output waveforms of CE amplifier?
2. What type of biasing is used in the given circuit?
3. If the given transistor is replaced by a p-n-p, can we get output or not?
4. What is effect of emitter-bypass capacitor on frequency response?
5. What is the effect of coupling capacitor?
6. What is region of the transistor so that it is operated as an amplifier?
7. How does transistor acts as an amplifier?
8. Draw the h-parameter model of CE amplifier?
9. What type of transistor configuration is used in intermediate stages of a multistage amplifier?
10. What is early effect?

Exp No: 11 **Date:**

CLASS A POWER AMPLIFIER

AIM: To Measure the voltage gain of a power amplifier using hardware model.

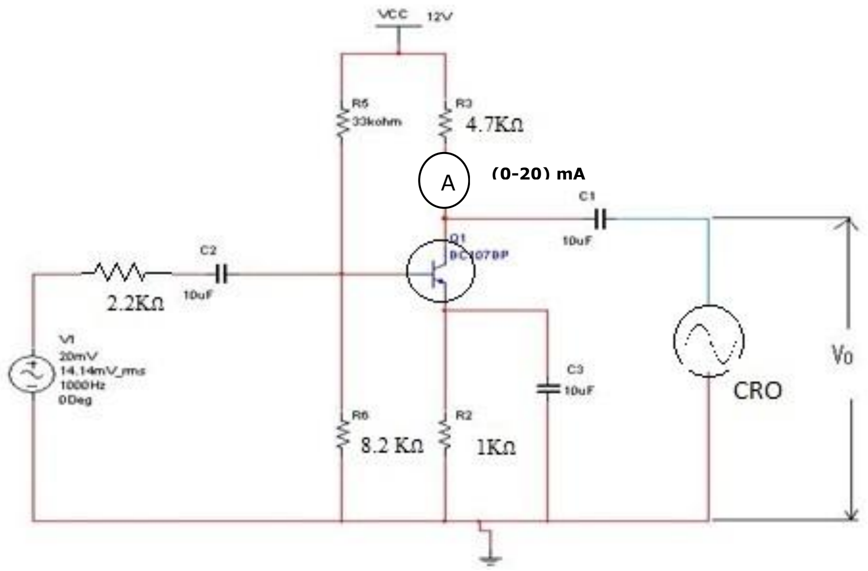
APPARATUS:

S.No	Name of the apparatus	Qty	Range
1	Transistor CL - 100	1	-
2	Regulated power supply	1	(0-30V,1A)
3	Function Generator	1	-
4	Capacitor	3	100µF
5	Resistors	5	33KΩ, 8.2KΩ, 1KΩ, 2.2KΩ, 4.7KΩ
6	Bread board	1	-
7	CRO	1	-
8	Ammeter	1	(0-20) mA
9	Connecting wires	-	-

THEORY:

The CE amplifier provides high gain &wide frequency response. The emitter lead is common to both input & output circuits and is grounded. The emitter-base circuit is forward biased. The collector current is controlled by the base current rather than emitter current. The input signal is applied to base terminal of the transistor and amplifier output is taken across collector terminal. A very small change in base current produces a much larger change in collector current. When +VE half-cycle is fed to the input circuit, it opposes the forward bias of the circuit which causes the collector current to decrease, it decreases the voltage more – VE. Thus when input cycle varies through a -VE half-cycle, increases the forward bias of the circuit, which causes the collector current to increases thus the output signal is common emitter amplifier is in out of phase with the input signal.

Circuit Diagram:



PROCEDURE:

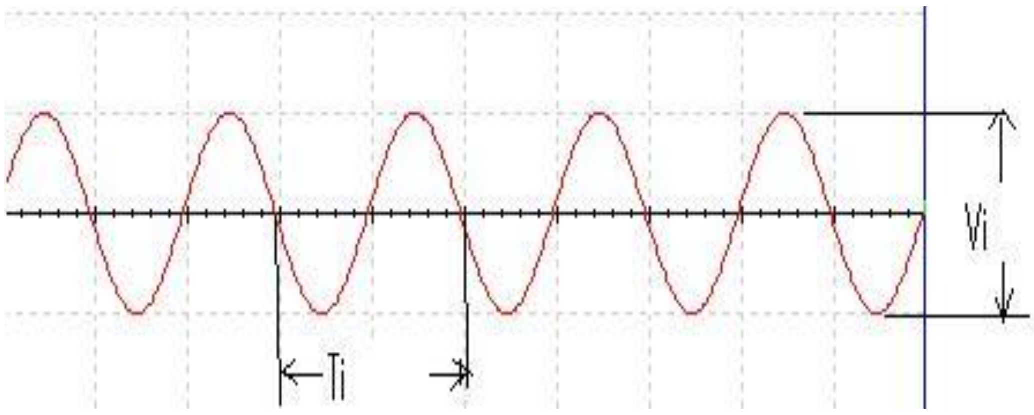
1. Connect the circuit as shown in circuit diagram.
2. Apply the input of 20mV peak-to-peak and 1 KHz frequency using Function Generator
3. By keeping the input voltage signal constant, measure the output voltage Vo peak to peak and current.

Observations:

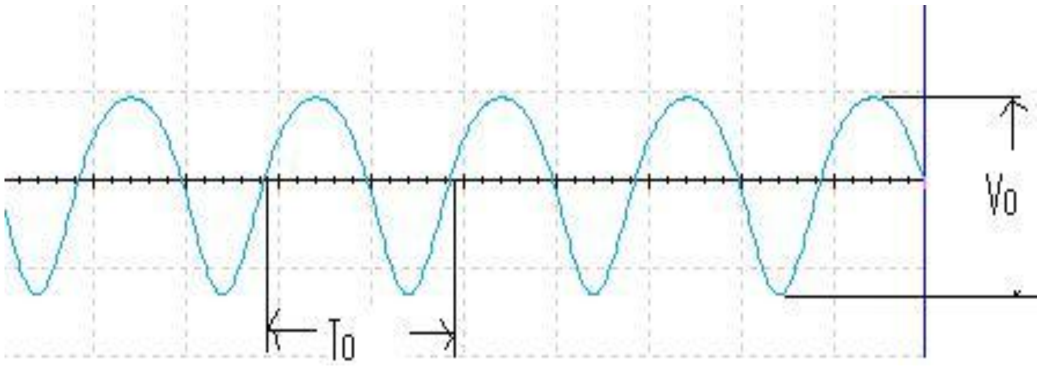
Input voltage Vi=20mV
Rc = 4.7KΩ , Vdc=12V
Load frequency = 1K Hz
Ic=1.6A , Vmax = 5/2 = 2.5V
Vo= 5V
Pac= V^2_{max} / 2Rc =———W
Pdc= Vdc X Ic = -------W
% η = (Pac/Pdc) X 100 =

Model Graphs:

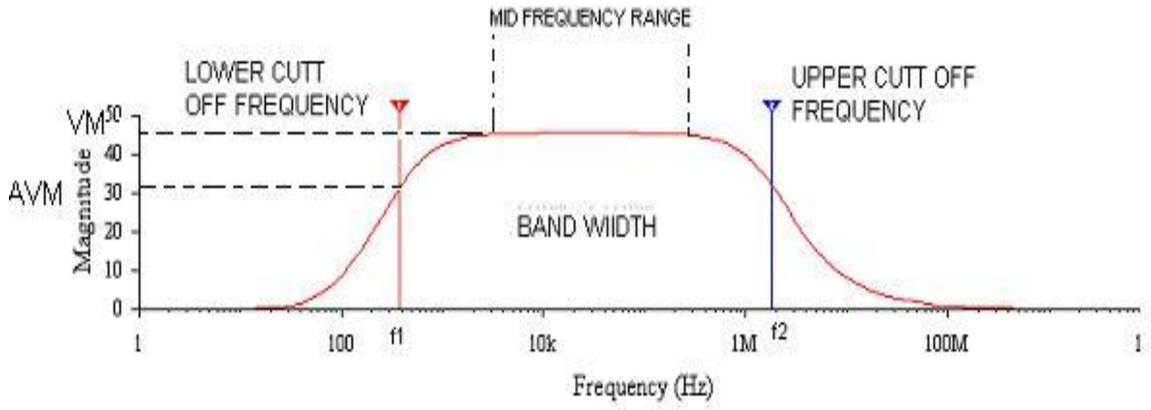
Input Wave Form:



Output Wave Form:



Frequency Response:



PRECAUTIONS:

1. Avoid loose connections.
2. The supply voltage should not exceed the rating of the component.
3. Meters should be connected properly according there polarity.

RESULT:

OUTCOME:

Viva Questions:

1. What is phase difference between input and output waveforms of CE amplifier?
2. What type of biasing is used in the given circuit?
3. If the given transistor is replaced by a p-n-p, can we get output or not?
4. What is effect of emitter-bypass capacitor on frequency response?
5. What is the effect of coupling capacitor?
6. What is region of the transistor so that it is operated as an amplifier?
7. How does transistor acts as an amplifier?
8. Draw the h-parameter model of CE amplifier?
9. What type of transistor configuration is used in intermediate stages of a multistage amplifier?
10. What is early effect?

Exp No: 12 **Date:**

RC PHASE SHIFT OSCILLATOR

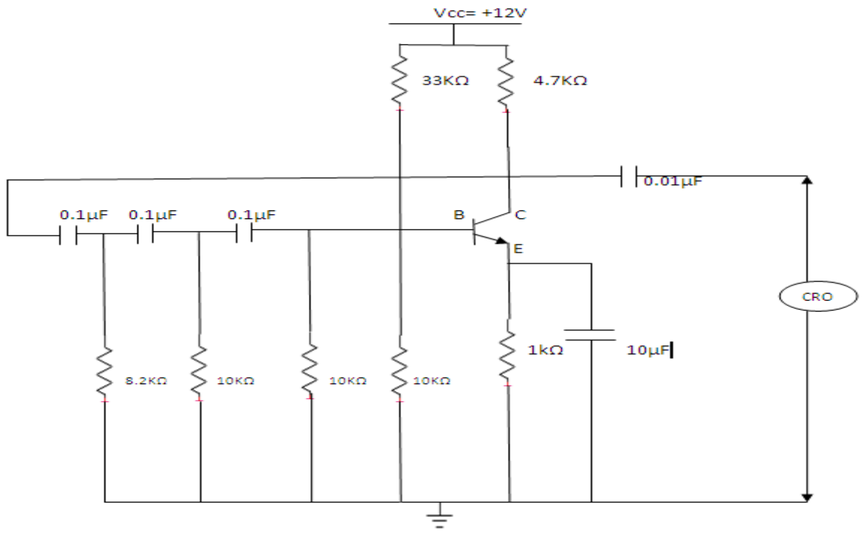
AIM: To conduct experiment on RC phase shift oscillator.
Assume R1 = 100k, R2 = 22K, RC = 4 K, RE =1K & VCC = 12V.

APPARATUS:

S.no	Name	Qty
1	Resistors	10KΩ-3, 1KΩ-1,4.7KΩ-1,8.2KΩ-1 & 33KΩ-1
2	Capacitors 0.01µF	4
3	CRO	1
4	Power Supply	1
5	Transistor BC 107	1
6	Connecting wires	Required

THEORY: RC phase shift oscillator or simply RC oscillator is a type of oscillator where a simple RC network (resistor-capacitor) network is used for giving the required phase shift to the feedback signal. In LC oscillators like Hartley oscillator and Colpitts oscillator an LC network (inductor-capacitor network) is used for providing the necessary positive feedback. The main feature of an RC phase shift oscillator is the excellent frequency stability. The RC oscillator can output a pure sine wave on a wide range of loads.

CIRCUIT DIAGRAME:



PROCEDURE:

1. Connect the circuit as shown in the figure.
2. By giving Vcc = 12V to the resistance, connect the CRO to the capacitor. i.e. 0.01µF.
3. We obtain the sine wave across the capacitor.
4. Note down the time period of the sine wave.
5. Find the frequency f = 1/T.

CALCULATIONS:

Theoretical value

$$f_r = \frac{1}{2\pi R_C \sqrt{6}}$$

=____________Hz

Where R= 10KΩ , C= 0.01µF

Practical value

f = 1/T = ___________Hz

PRECAUTIONS:

1. Avoid loose connections.
2. The supply voltage should not exceed the rating of the component.
3. Meters should be connected properly according there polarity.

RESULT:

OUTCOME:

<u>Viva Questions</u>:

1. What is an Oscillator circuit?
2. What is the main difference between an amplifier and an oscillator?
3. State Barkhausen criterion for oscillation.
4. State the factors on which oscillators can be classified.
5. Give the expression for the frequency of oscillation and the minimum gain required for sustained oscillations of the RC phase shift oscillator.
6. Why three RC networks are needed for a phase shift oscillator? Can it be two or four?