DEPARTMENT OF

ELECTRICAL & ELCTRONICS ENGINEERING

Lab Manual for

Basic Electrical & Electronics Engineering Lab

(R201236)

Student Name	:
Roll Number	:
Branch	:
Year & Sem	:

SIR C.R.REDDY COLLEGE OF ENGINEERING

Approved by AICTE, Affiliated to JNTUK, Kakinada

Eluru - 534007, West Godavari District, Andhra Pradesh

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Institute Vision & Mission

Vision of the Institute:

To emerge as a premier institution in the field of technical education and research in the state and as a home for holistic development of the students and contribute to the advancement of society and the region

Mission of the Institute:

To provide high quality technical education through a creative balance of academic and industry-oriented learning; to create an inspiring environment of scholarship and research; to instill high levels of academic and professional discipline; and to establish standards that inculcate ethical and moral values that contribute to growth in career and development of society in general.

- M1: To provide high quality technical education through a creative balance of academic and industry oriented learning;
- M2: To create an inspiring environment of scholarship and research;
- M3: To instill high levels of academic and professional discipline and
- M4: To establish standards that inculcate ethical and moral values that contributes to growth in career and development of society in general.

SIR C.R.REDDY COLLEGE OF ENGINEEIRNG
DEPARTMENT OF ELECTRICAL & ELCTRONICS ENGINEEIRNG
Basic Electrical & Electronics Engineering Lab (R201236)

I Year - II Semester

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Section A: Electrical Engineering:

1. Swinburne's test on D.C. Shunt machine (predetermination of efficiency of a given D.C. shunt machine working as motor and generator).

2. OC and SC tests on single phase transformer (predetermination of efficiency and regulation at given power factors).

3. Brake test on 3-phase Induction motor (determination of performance characteristics)

4. Regulation of alternator by Synchronous impedance method.

5. Speed control of D.C. Shunt motor by
a) Armature Voltage control **b)** Field flux control method

6. Brake test on D.C. Shunt Motor.

Section B: Electronics Engineering:

1. PN junction diode characteristics
a) Forward bias **b)** Reverse bias (Cut in voltage and resistance calculations)

2. Transistor CE characteristics (input and output)

3. Half wave rectifier with and without filters.

4. Full wave rectifier with and without filters.

5. CE amplifiers.

6. OP-amp applications

Learning Objectives:

- To predetermine the efficiency of dc shunt machine using Swinburne's test.
- To predetermine the efficiency and regulation of 1-phase transformer with O.C and S.C tests.
- To obtain performance characteristics of DC shunt motor &3-phase induction motor.
- To find out regulation of an alternator with synchronous impedance method.
- To control speed of dc shunt motor using Armature voltage and Field flux control methods.
- To find out the characteristics of PN junction diode & transistor
- To determine the ripple factor of half wave & full wave rectifiers.

Learning Outcomes:

The student should be able to:

- Compute the efficiency of DC shunt machine without actual loading of the machine.
- Estimate the efficiency and regulation at different load conditions and power factors for single phase transformer with OC and SC tests.
- Analyze the performance characteristics and to determine efficiency of DC shunt motor & 3- Phase induction motor.
- Pre-determine the regulation of an alternator by synchronous impedance method.
- Control the speed of dc shunt motor using Armature voltage and Field flux control methods.
- Draw the characteristics of PN junction diode & transistor
- Determine the ripple factor of half wave & full wave rectifiers.

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S. No	Date	Name of the Experiment	Page No	Sign	Grade

Lab In charge

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.

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Exp. S No	Experiment	Program Outcomes Attained	Program Specific Outcomes Attained
1	Swinburne's test on D.C. Shunt machine		
2	OC and SC tests on single phase transformer		
3	Brake test on 3-phase Induction motor		
4	Regulation of alternator by Synchronous impedance method		
5	Speed control of D.C. Shunt motor		
6	Brake test on D.C. Shunt Motor		
7	PN junction diode characteristics		
8	Transistor CE characteristics		
9	Half wave rectifier with and without filters		
10	Full wave rectifier with and without filters		
11,12	CE amplifiers OP-Amp Applications		

BASIC ELECTRICAL AND ELCTRONICS ENGINEERING LABORATORY

OBJECTIVE:

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

OUTCOMES:

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

1. Able to explain the operation and applications of electromechanical energy conversion devices.
2. Identification and selection of various electrical and electronic components.
3. Analyze the characteristics of various electronics components.

INSTRUCTIONS TO STUDENTS

- Before entering the lab the student should carry the following things.
  - Identity card issued by the college.
  - Class notes
  - Lab observation book
  - Lab Manual
  - Lab Record
- Student must sign in and sign out in the register provided when attending the lab session without fail.
- Come to the laboratory in time. Students, who are late more than 15 min., will not be allowed to attend the lab.
- All students must follow a Dress Code while in the laboratory
- Foods, drinks are NOT allowed.
- All bags must be left at the indicated place.
- The objective of the laboratory is learning. The experiments are designed to illustrate phenomena in different areas of Physics and to expose you to measuring instruments, conduct the experiments with interest and an attitude of learning
- You need to come well prepared for the experiment.
- Work quietly and carefully
- Be honest in recording and representing your data.
- If a particular reading appears wrong repeat the measurement carefully, to get a better fit for a graph
- All presentations of data, tables and graphs calculations should be neatly and carefully done
- Graphs should be neatly drawn with pencil. Always label graphs and the axes and display units.
- If you finish early, spend the remaining time to complete the calculations and drawing graphs. Come equipped with calculator, scales, pencils etc.
- Do not fiddle with apparatus. Handle instruments with care. Report any breakage to the Instructor. Return all the equipment you have signed out for the purpose of your experiment.

Experiment No : **Date :**

SWINBURNE'S TEST ON D.C. SHUNT MOTOR

AIM :

To conduct the no load test on the DC shunt motor and determine its efficiency at different loads when operating as a) Motor & b) Generator

NAME PLATE DETAILS:

APPARATUS REQUIRED:

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

PROCEDURE:

1. The connections are made as shown in the circuit diagram.
2. With the motor field rheostat in CUTOUT position, 3-point starter handle at its initial position, the supply switch is closed.
3. The 3-point starter handle is moved clock wise gradually to cut out the resistance in the motor armature circuit so that the motor starts.
4. The motor is brought to its rated speed by varying the motor field rheostat.
5. All the meter readings are noted into the tabular column.
6. The motor field rheostat is brought back to CUT OUT position and the supply switch is opened.

TABULAR COLUMN:-

S No	I_0 (Amp)	I_{sh} (Amp)	V (Volts)

MODEL CALCULATIONS :

Let supply voltage = V volts

No-load current = I_0 amps

Shunt field current = I_{sh}

No-load power input = $V I_0$ watt

Power input to the armature = $V(I_0-I_{sh})$

Armature copper losses = $(I_0-I_{sh})^2R_a$

Constant losses = I/P – Armature copper losses = $V I_0 – (I_0-I_{sh})^2R_a$

Let I_L is the load current at which efficiency is required.

Then $I_a = I_L-I_{sh}$ ---- if machine is motoring

$I_a = I_L+I_{sh}$ ---- if machine is generating

<u>Efficiency when running as a motor :</u>

Input = VI

Constant losses = W_C

Armature copper losses = $Ia^2 R_a = (I-I_{sh})^2R_a$

Total losses = $(I-I_{sh})^2R_a + W_C$

Efficiency of the motor = <u>Input- Output</u> = $\mathbf{VI-(I-I_{sh})^2R_a-W_C}$

<u>Efficiency when running as Generator:</u>

Output = VI

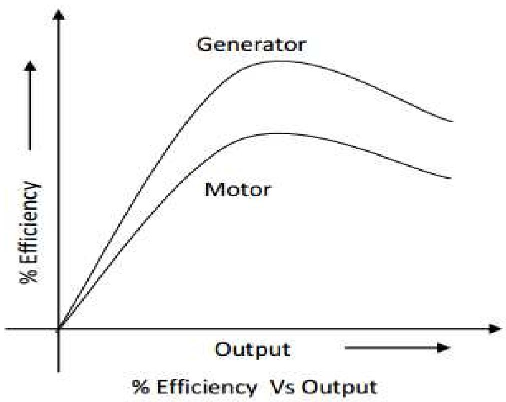
Constant losses = W_C

Armature copper losses = $Ia\ ^2Ra = (I+I_{sh})^2R_a$

Total losses = $(I+I_{sh})^2R_a + W_C$

Efficiency of the motor = $\frac{\text{Input- Output}}{\text{Input}} = \frac{VI}{\mathbf{VI-(I-I_{sh})^2R_a-W_C}}$

MODEL GRAPH:



% Efficiency Vs Output Characteristics

RESULT :

Experiment No : **Date :**

OPEN CIRCUIT AND SHORT CIRCUIT TESTS ON SINGLE PHASE TRANSFORMER

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.

NAME PLATE DETAILS:

APPARATUS REQUIRED:

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

PROCEDURE:

Open Circuit Test:

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

Short Circuit Test:

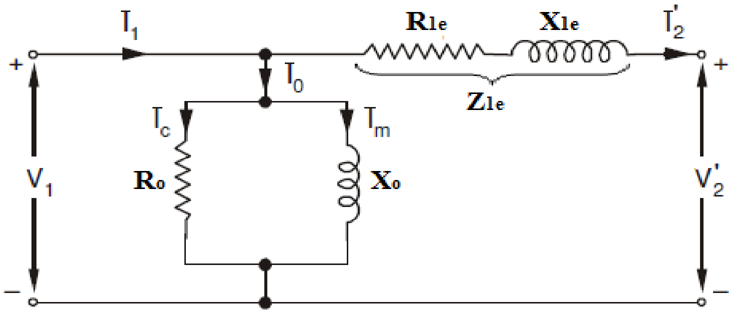
1. Connections are made as per the circuit diagram.
2. Ensure that variac is set to zero output voltage position before starting the experiment.
3. Switch ON the supply. Now apply the rated Current to the Primary winding by using variac.
4. The readings of the Voltmeter, ammeter and wattmeter are noted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

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})

EQUIVALENT CIRCUIT OF TRANSFORMER:



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

<u>From OC test:</u>

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

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

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

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

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

<u>From SC Test:</u>

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

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

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

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

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

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

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

Where n = Fraction of full load
n = 1 (at full load)
n = ½ (at half load)
n = ¼ (at quarter load)

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

Where V_1 is the rated Voltage and
I_1 is the rated current for full load, and for any load $I_1 = n * I_{rated}$
'+' for lagging power factors
'-' for leading power factor

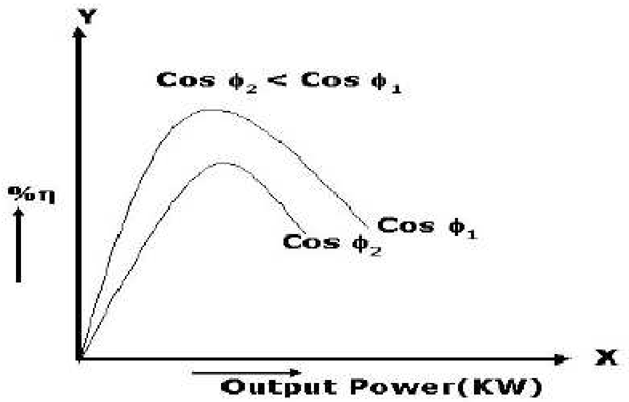
Cosϕ = 1.0

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

MODEL GRAPH :



Load vs Efficiency characteristics

RESULT :

Experiment No : **Date :**

BRAKE TEST ON 3 - PHASE INDUCTION MOTOR

AIM:

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

NAME PLATE DETAILS:

APPARATUS REQUIRED:

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

PROCEDURE:

1. Connections are made as per the circuit diagram and belt is freely suspended.
2. Close the TPST Switch and start the DOL Starter.
3. By the time speed gains rated value, note down the readings of voltmeter, ammeter, and wattmeter at no-load.
4. Now the increase the mechanical load by tightening the belt around the brake drum gradually in steps.
5. Note down the various meters readings at different values of load till the ammeter shows the rated current.
6. Reduce the load on the motor and also bring the variac to minimum position, then switch OFF the supply.

OBSERVATIONS:

S.NO	Voltage	Current	W1	W2	Speed	S1	S2	S1-S2	Torque	Input Power	Output Power	η
1												
2												
3												
4												
5												

MODEL CALCULATIONS:

Input power drawn by the motor $W = (W_1 + W_2)$ watts

Shaft Torque, $T_{sh} = 9.81 * R * (S_1 \sim S_2)$ N-m

Where R is the Radius of drum in meters.

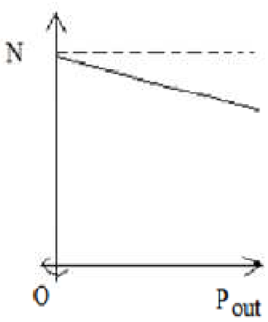
Output power $P_o = \frac{2\pi N T_{sh}}{60}$ watts

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

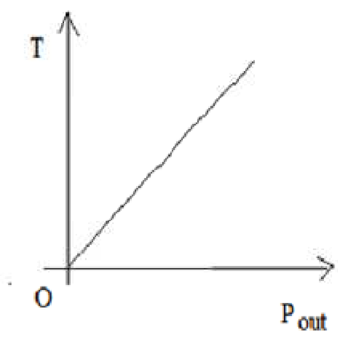
$$\% \ slip = \frac{N_s - N}{N_s} \times 100 \qquad \left[where \ N_s = \frac{120 \times f}{p} \right]$$

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

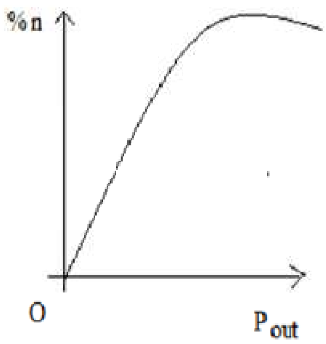
MODEL GRAPH :



Speed vs Output Power



Torque vs Output Power



Efficiency vs Output Power

RESULT :

Experiment No : **Date :**

REGULATION OF AN ALTERNATOR USING SYNCHRONOUS IMPEDANCE METHOD

AIM:

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

NAME PLATE DETAILS:

APPARATUS REQUIRED:

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

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.

Short Circuit Test:

7. 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.
8. Now close the TPST switch.
9. 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)
10. Switch OFF the supply.

OBSERVATIONS:

S.No	OC Test	
	Field current I_f (Amp.)	OC voltage per phase V_o (volts)
1		
2		
3		
4		
5		

S.No	SC Test	
	Field current I_f (Amp)	SC current I_{sc} (Amp)
1		

MODEL CALCULATIONS:

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

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

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.

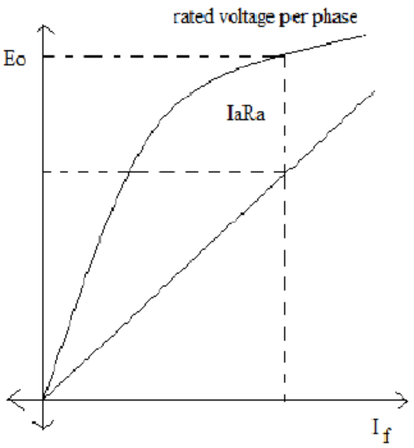
The percentage regulation of alternator for a given p. f. is

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

Where

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

MODEL GRAPH :



OCC and SC characteristics of Alternator

RESULT :

Experiment No : **Date :**

SPEED CONTROL OF D.C. SHUNT MOTOR

AIM:

To control the speed of a D.C. shunt motor by Armature control method and field control method.

NAME PLATE DETAILS:

APPARATUS REQUIRED:

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

PROCEDURE:

For Armature Voltage Control method:

7. The connections are made as shown in the circuit diagram.
8. With the armature rheostat is CUTIN position, the field rheostat in CUTOUT position and the 3-point starter handle at its initial position, the D.C. supply switch is closed.
9. The 3-point starter handle is moved clock wise gradually so that the motor starts and runs at some speed.
10. The field current is adjusted to a certain value by varying the field rheostat such that the motor runs at rated speed.
11. The armature rheostat is increased gradually so that the armature voltage is varied in steps and the corresponding speeds are noted in the tabular column.
12. Step no. 5 is repeated until the armature rheostat is completely CUTIN.
13. The field rheostat is brought back to CUTOUT position, the armature rheostat to CUTIN position and the D.C. supply switch is opened.

For Field Control method:

1. Step nos. 1, 2 & 3 of armature voltage control method are repeated.
2. The armature rheostat is varied such that the rated voltage is applied across the armature terminals.
3. The field resistance is gradually cut in steps so that the field current is varied in steps of 0.05A and the corresponding value of speeds is noted.
4. Step no. 3 is repeated until the motor attains 1.4 times rated speed.
5. Step no. 3 and 4 are repeated for an armature voltage of 200V.
6. The field rheostat is brought back to CUT OUT, the armature rheostat to CUT IN position and the supply switch is opened.

OBSERVATIONS:

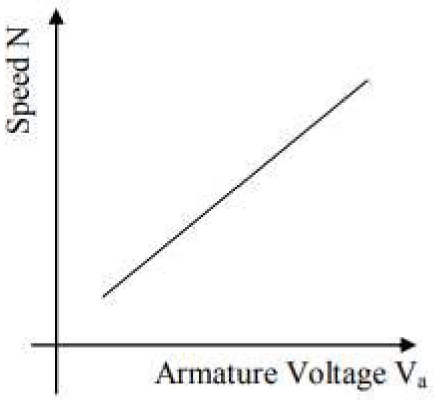
S.No	Armature voltage	Speed
1		
2		
3		
4		
5		

(a) Armature Voltage Control

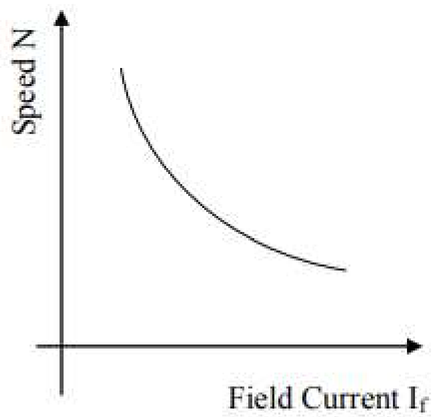
S.No	Field Current	Speed
1		
2		
3		
4		
5		

(b)Field Flux Control

MODEL GRAPH :



Armature Voltage Control method



Flux Control method

RESULT :

Experiment No : **Date :**

LOAD TEST ON D.C. SHUNT MOTOR

AIM :

To conduct the brake load test on D.C. shunt motor and determine its performance characteristics.

NAME PLATE DETAILS:

APPARATUS REQUIRED:

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

PROCEDURE:

1. The connections are made as shown in the circuit diagram.
2. With the motor field rheostat in cut-out position, the 3 point starter handle in initial position and ensuring that the belt over the brake drum is totally loosened, the supply switch is closed.
3. The 3-point starter handle is moved clock wise gradually to cut out the resistance in the motor armature circuit so that the motor starts.
4. The motor is brought to its rated speed by varying the motor field rheostat and all the meter readings as well as speed are noted.
5. The load is applied in steps and for each step all the meter readings, spring balance readings as well as speed are noted.
6. Step no. 5 is repeated until the rated current of the motor is reached.
7. The load is removed in steps, the motor field rheostat is brought back to CUT OUT position and the supply switch is opened.

TABULAR COLUMN:-

S.No	V in (V)	I_{sh} in (A)	S_1 in Kgs	S_2in Kgs	N in rpm	I_a in (A)	Torque	input	output	% efficiency

MODEL CALCULATIONS :

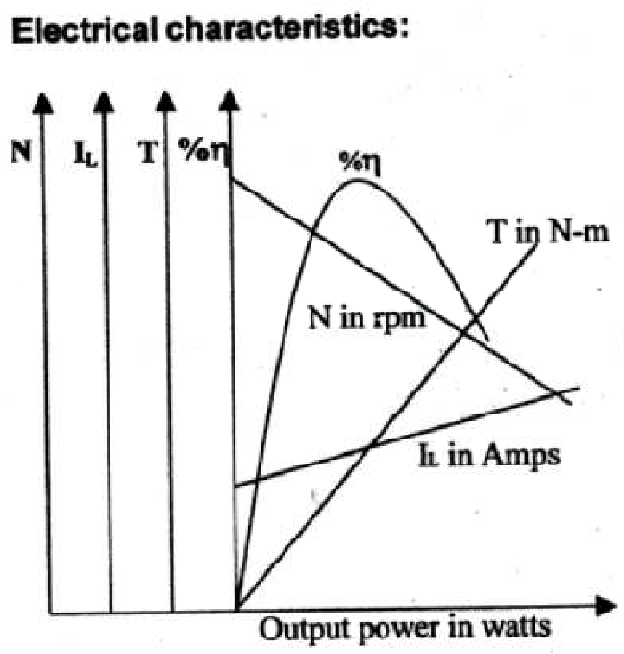
Torque (T) = $(S_1 – S_2)$ R 9.81 N-m

Motor output = $2\Pi NT / 60$ Watts

Motor input = VI Watts

Efficiency = output/ input = $(2\Pi NT / 60)/(VI)$

MODEL GRAPH:



RESULT :

Experiment No : **Date :**

P-N JUNCTION DIODE CHARACTERISTICS

AIM: 1. To Plot the Characteristics of PN Junction Diode under forward and reverse bias Conditions.
2. To find the Cut-in voltage, Static resistance and dynamic resistance in Forward bias condition.

APPARATUS:

S.No	Name	Range / Value	Quantity
1.	DC Regulated Power Supply	(0 – 30)volts	1
2.	Diode	1N 4001	1
3.	Resistor	1KΩ	1
4.	D.C Ammeters	(0–200) mA, (0–500)**µ**A	Each 1
5.	D.C Volt meters	(0–2)V,(0–20)V	Each 1
6.	Bread Board and connecting wires	-	1 Set

PROCEDURE:

FORWARD BIAS CHARACTERISTICS:

1. Connect the Circuit as per the Circuit Diagram on the bread board.
2. Switch on the Regulated Power Supply and slowly increase the source voltage. Increase the Diode Current in steps of 2mA and note down the corresponding voltage across the PN junction Diode under forward Bias condition as per table given below.
3. Take the readings until a Diode Current of 20mA.
4. Plot the graph V_F versus I_F on the graph Sheet .
5. From the graph find out the Static & Dynamic forward Bias resistance of the diode

$$R_{dc} = \frac{V_F}{I_F}, \qquad R_{ac} = \frac{\Delta V_F}{\Delta I_F}.$$

6. Observe and note down the cut in Voltage of the diode.

REVERSE BIAS CHARACTERISTICS:

1. Connect the Circuit as per the Circuit Diagram on the bread board.
2. Switch on the Regulated Power Supply and slowly increase the source voltage. Increase the Diode voltage in steps of 2.0 volts and note down the corresponding Current against the Voltage under Reverse Bias condition as per table given below.
3. Take readings until a Diode Voltage reaches 20V
4. Plot the graph V_R versus I_R on the graph Sheet.

TABULAR FORMS:

FORWARD BIAS:

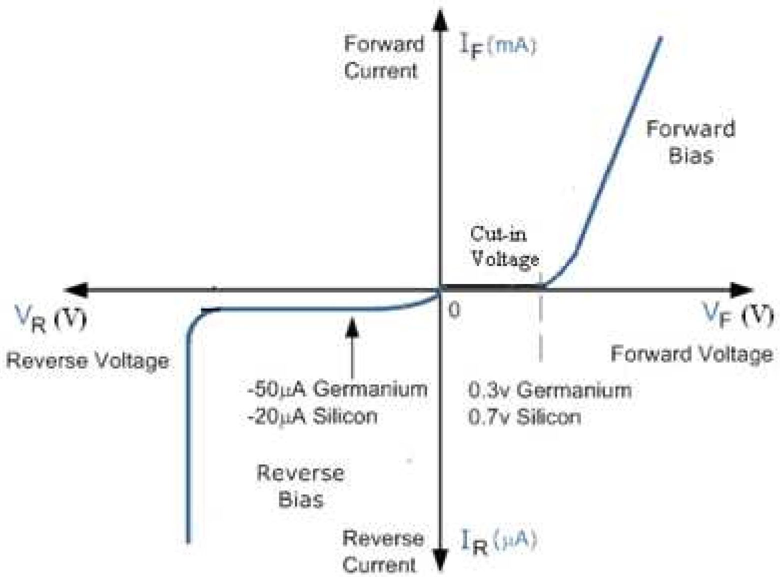
S.No	Voltmeter Reading V_F(Volts)	Ammeter Reading I_F (mA)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

REVERSE BIAS:

S.No	Voltmeter Reading V_R (Volts)	Ammeter Reading I_R (μA)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

MODEL GRAPH:

V-I Characteristics of PN junction diode:



RESULT:

Experiment No : **Date :**

TRANSISTOR CE CHARACTERISTICS

AIM:

To plot the Input and Output characteristics of a transistor connected in Common Emitter Configuration and to find the h – parameters from the characteristics

APPARATUS REQUIRED:

S.No	Name	Range / Value	Quantity
1	Dual Regulated D.C Power supply	(0–30) Volts	1
2	Transistor	BC107	1
3	Resistors	120KΩ	1
4	DC Ammeters	(0-500)µA, (0-200)mA	Each 1 No
5	DC Voltmeters	(0-2)V, (0-20)V	Each 1 No
6	Bread Board and connecting wires	-	1 Set

PROCEDURE:

Input Characteristics:

1. Connect the circuit as in the circuit diagram.
2. Keep V_{BB} and V_{CC} in zero volts before giving the supply
3. Set V_{CE} = 1 volt by varying V_{CC} and vary the V_{BB} smoothly with fine control such that base current I_B varies in steps of 5µA from zero upto 200µA, and note down the corresponding voltage V_{BE} for each step in the tabular form.
4. Repeat the experiment for V_{CE} =2 volts and 3 volts.
5. Draw a graph between V_{BE} Vs I_B against VCE = Constant.

Output Characteristics:

1. Start V_{EE} and V_{CC} from zero Volts.
2. Set the I_B = 20µA by using V_{BB} such that, V_{CE} changes in steps of 0.2 volts from zero upto 10 volts, note down the corresponding collector current I_C for each step in the tabular form.
3. Repeat the experiment for I_E = 40µA and I_E = 60µA, tabulate the readings.
4. Draw a graph between V_{CE} Vs I_C against I_B = Constant.

OBSERVATIONS:

INPUT CHARACTERISTICS;

S.No	V_{CE} = 0V		V_{CE} = 1V		V_{CE} = 2V	
	V_{BE} (V)	I_B (µA)	V_{BE} (V)	I_B (µA)	V_{BE} (V)	I_B (µA)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

OUTPUT CHARACTERISTICS:

S.No	I_B = 20 µA		I_B = 40 µA		I_B = 60 µA	
	V_{CE} (V)	I_C (mA)	V_{CE} (V)	I_C (mA)	V_{CE} (V)	I_C (mA)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

To find the h – parameters:

Calculation of h_{ie}:

Mark two points on the Input characteristics for constant V_{CE}. Let the coordinates of these two points be (V_{BE1}, I_{B1}) and (V_{BE2}, I_{B2}).

$$h_{ie} = \frac{V_{BE2} - V_{BE1}}{I_{B2} - I_{B1}};$$

Calculation of h_{re}:

Draw a horizontal line at some constant I_B value on the Input characteristics. Find V_{CE2}, V_{CE1}, V_{BE2}, V_{BE1}

$$h_{rb} = \frac{V_{BE2} - V_{BE1}}{V_{CE2} - V_{CE1}};$$

Calculation of h_{fe}:

Draw a vertical line on the output characteristics at some constant V_{CE} value. Find Ic_2, Ic_1 and I_{B2}, I_{B1} .

$$h_{fe} = \frac{I_{C2} - I_{C1}}{I_{B2} - I_{B1}};$$

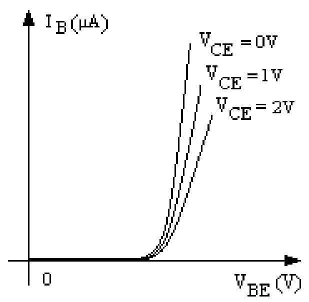
Calculation of h_{oe}:

On the Output characteristics for a constant value of I_B mark two points with coordinates (V_{CE2} , I_{C2}) and (V_{CE1} , I_{C1}) .

$$h_{ob} = \frac{I_{C2} - I_{C1}}{V_{CE2} - V_{CE1}};$$

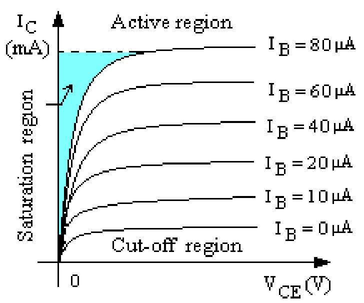
MODEL GRAPHS:

Input Characteristics



CE I/P Characteristics

Output Characteristics



CE O/P Characteristics

RESULT :

Experiment No : **Date :**

HALF WAVE RECTIFIER WITH AND WITHOUT FILTERS

AIM:

To Rectify the AC signal and then to find out Ripple factor and percentage of Regulation in Half wave rectifier with and without Capacitor filter.

APPARATUS:

S.No	Name	Range / Value	Quantity
1	Transformer	230V / 9V	1
2	Diode	1N4001	1
3	Capacitors	1000µF/16V	1
4	Decade Resistance Box	-	1
5	Multimeter	-	1
6	Bread Board and connecting wires	-	1 Set
7	Dual Trace CRO	20MHz	1

PROCEDURE:

Without Filter:

1. Connect the circuit as per the Fig.1
2. Keep the Load Resistance (DRB) at 100 ohms.
3. Apply A.C voltage and take the V_{ac} and V_{dc} Readings with the help of Multimeter.
4. Repeat the above step by varying the load resistance in steps of 100 ohms
5. Tabulate the readings.
6. Disconnect the DRB and note the Vdc at no load condition.
7. Calculate ripple factor = $\left(\gamma = \frac{V_{ac}}{V_{dc}}\right)$
8. Calculate Percentage of Regulation = $\left(\frac{V_{NL} - V_{FL}}{V_{NL}} * 100\%\right)$

With Capacitor Filter:

1. Connect the circuit diagram as in fig 2 and repeat the method followed in the earlier case and tabulate the readings.
2. Calculate the Ripple factor and Percentage of Regulation.
3. Calculate ripple factor = $\left(\gamma = \frac{V_{ac}}{V_{dc}}\right)$
4. Calculate Percentage of Regulation = $\left(\frac{V_{NL} - V_{FL}}{V_{NL}} * 100\%\right)$

TABULAR FORMS:

WITHOUT FILTER:

V no load Voltage (Vdc) =

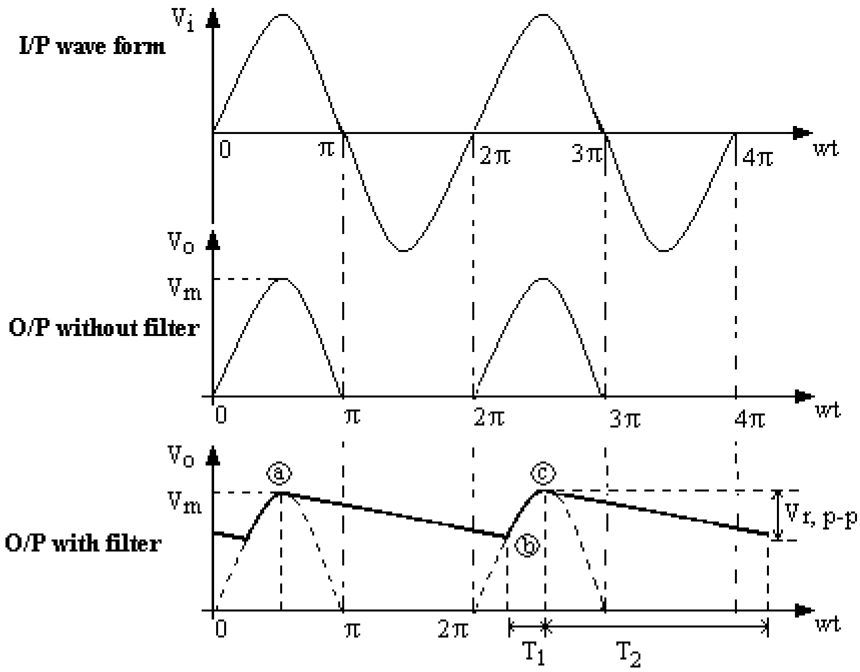
S.No	Load Resistance R_L (Ω)	O/P Voltage (Vo)		Ripple factor $\left(\gamma = \frac{V_{ac}}{V_{dc}}\right)$	% of Regulation $\left(\frac{V_{NL} - V_{FL}}{V_{NL}} * 100\%\right)$
		V_{ac} (V)	V_{dc} (V)		
1	100				
2	200				
3	300				
4	400				
5	500				
6	600				
7	700				
8	800				
9	900				
10	1K				

WITH FILTER:

V no load Voltage (Vdc) =

S.No	Load Resistance R_L (Ω)	O/P Voltage (Vo)		Ripple factor $\left(\gamma = \frac{V_{ac}}{V_{dc}}\right)$	% of Regulation $\left(\frac{V_{NL} - V_{FL}}{V_{NL}} * 100\%\right)$
		V_{ac} (V)	V_{dc} (V)		
1	100				
2	200				
3	300				
4	400				
5	500				
6	600				
7	700				
8	800				
9	900				
10	1K				

MODEL WAVEFORMS:



Half-wave Rectifier with capacitor filter wave form

RESULT :

Experiment No : **Date :**

FULL WAVE RECTIFIER WITH AND WITHOUT FILTERS

AIM:

To Rectify the AC signal and then to find out Ripple factor and percentage of Regulation in full wave rectifier with and without Capacitor filter.

APPARATUS:

S.No	Name	Range / Value	Quantity
1	Transformer	230V / 9-0-9V	1
2	Diode	1N4001	2
3	Capacitors	1000 µF/16V	1
4	Decade Resistance Box	-	1
5	Multimeter	-	1
6	Bread Board and connecting wires	-	1
7	Dual Trace CRO	20MHz	1

PROCEDURE:

Without Filter:

1. Connect the circuit as per the Fig.1
2. Keep the Load Resistance (DRB) at 100 ohms.
3. Apply A.C voltage and take the V_{ac} and V_{dc} Readings with the help of Multimeter.
4. Repeat the above step by varying the load resistance in steps of 100 ohms
5. Tabulate the readings.
6. Disconnect the DRB and note the Vdc at no load condition.
7. Calculate ripple factor $= \left(\gamma = \frac{V_{ac}}{V_{dc}}\right)$
8. Calculate Percentage of Regulation = $\left(\frac{V_{NL} - V_{FL}}{V_{NL}} * 100\%\right)$

With Capacitor Filter:

1. Connect the circuit diagram as in fig 2 and repeat the method followed in the earlier case and tabulate the readings.
2. Calculate the Ripple factor and Percentage of Regulation.
3. Calculate ripple factor $= \left(\gamma = \frac{V_{ac}}{V_{dc}}\right)$
4. Calculate Percentage of Regulation = $\left(\frac{V_{NL} - V_{FL}}{V_{NL}} * 100\%\right)$

TABULAR FORMS:

WITHOUT FILTER:

V no load Voltage (Vdc) =

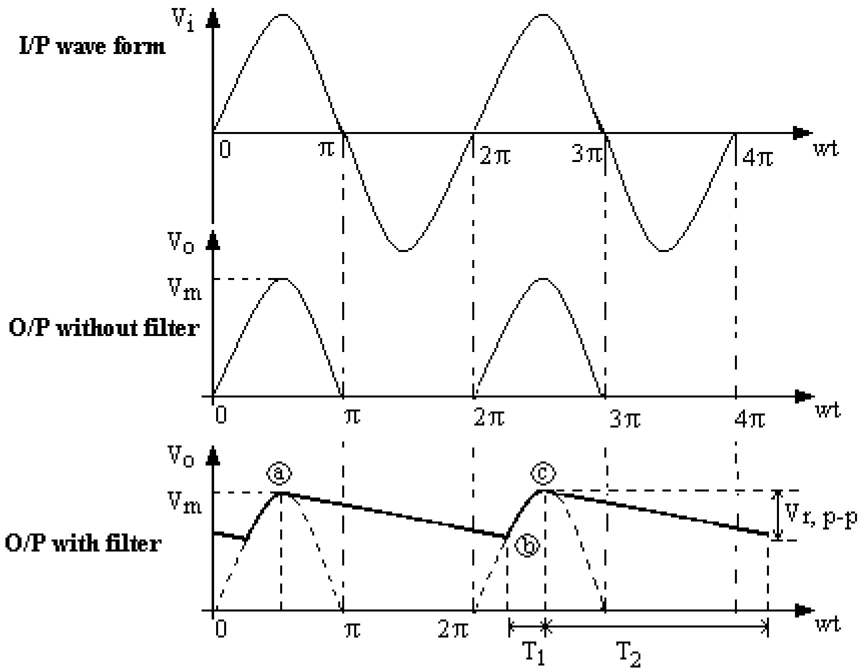
S.No	Load Resistance R_L (Ω)	O/P Voltage (Vo)		Ripple factor $\left(\gamma = \frac{V_{ac}}{V_{dc}}\right)$	% of Regulation $\left(\frac{V_{NL} - V_{FL}}{V_{NL}} * 100\%\right)$
		V_{ac} (V)	V_{dc} (V)		
1	100				
2	200				
3	300				
4	400				
5	500				
6	600				
7	700				
8	800				
9	900				
10	1K				

WITH FILTER:

V no load Voltage (Vdc) =

S.No	Load Resistance R_L (Ω)	O/P Voltage (Vo)		Ripple factor $\left(\gamma = \frac{V_{ac}}{V_{dc}}\right)$	% of Regulation $\left(\frac{V_{NL} - V_{FL}}{V_{NL}} * 100\%\right)$
		V_{ac} (V)	V_{dc} (V)		
1	100				
2	200				
3	300				
4	400				
5	500				
6	600				
7	700				
8	800				
9	900				
10	1K				

MODEL WAVEFORMS:



Half-wave Rectifier with capacitor filter wave form

RESULT :

Experiment No : **Date :**

CE AMPLIFIER

AIM:

To Find the frequency response of a Common Emitter Transistor Amplifier and to find the Bandwidth from the Response, Voltage gain, Input Resistance, output resistance.

APPARATUS REQUIRED:

S.No	Name	Range / Value	Quantity
1.	Regulated D.C Power supply	(0–30) Volts	1
2.	Transistor	BC107	1
3.	Resistors	1KΩ	2
4.	Resistors	100kΩ,10KΩ, 4.7KΩ.	Each 1
5.	Capacitors	10µf	3
6.	Potentio Meter	--	1
7.	Signal Generator	(0 – 1)MHz	1
8.	Dual Trace CRO	20MHz	1
9.	Bread Board and connecting wires	--	1 Set

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Apply Voltage of 20mV at 1 KHz from the Signal Generator and observe the O/P on CRO.
3. 3. Vary the frequency from 50 Hz to 1MHz in appropriate steps and note down the corresponding O/P Voltage V_o in a tabular form.

OBSERVATIONS:

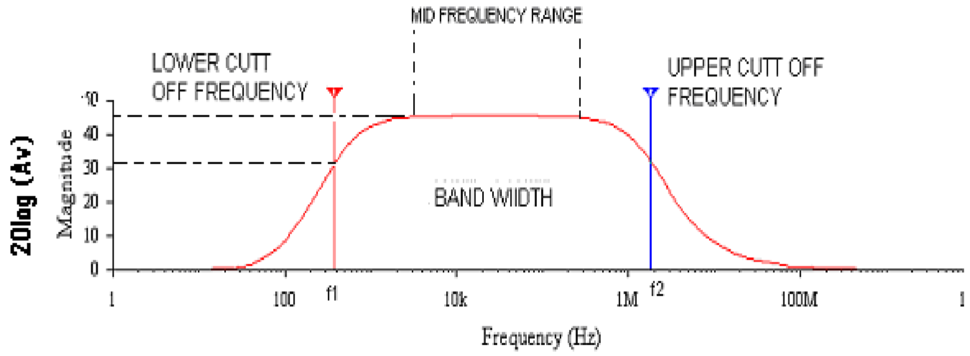
I/P Voltage, V_s = 20mV

S.No	Frequency (Hz)	O/P Voltage, Vo (V)	Voltage Gain Av =Vo/Vi	Av in dB = 20 log (Av)
1	100			
2	200			
3	300			
4	500			
5	700			
6	1K			
7	3K			
8	5K			
9	7K			
10	10K			
11	30K			
12	50K			
13	70K			
14	100K			
15	300K			
16	500K			
17	700K			
18	1M			

CALCULATION OF BANDWIDTH:

1. Calculate the Voltage Gain Av = V_o/V_s and note down in the tabular form.
2. Plot the frequency (f) Vs Gain (A_v) on a Semi-log Graph sheet
3. Draw a horizontal line at 0.707 times A_v and note down the cut off points and the Bandwidth is given by B.W = $f_2 - f_1$.

MODEL GRAPH:



RESULT :

OPERATIONAL AMPLIFIER APPLICATIONS

AIM: To check the following applications of OP-AMP.

a) Inverting Amplifier. b) Non inverting amplifier.
c) Voltage Follower. d) Summer.

APPARATUS:

S.No	Name	Range / Value	Quantity
1.	Regulated power supply	[- 15V – 0V – +15V]	1
2.	OP-AMP	μA741C	1
3.	Resistors	1KΩ, 4.7KΩ, 10KΩ, 33KΩ	Each 1
4.	Function generator	--	1
5.	CRO	--	1

PROCEDURE:

INVERTING & NON - INVERTING AMPLIFIER:

1. Connect the circuit as shown in the figure -1
2. Switch on the power supply and signal generator.
3. Apply a sinusoidal signal with peak to peak amplitude of 20mV at a frequency of 1KHz.
4. Note down the amplitude of O/P signal in the C.R.O.
5. Repeat the above steps for different values of R_f.
6. Repeat the above steps for the circuit of fig –2.
7. Tabulate the readings.

VOLTAGE FOLLOWER:

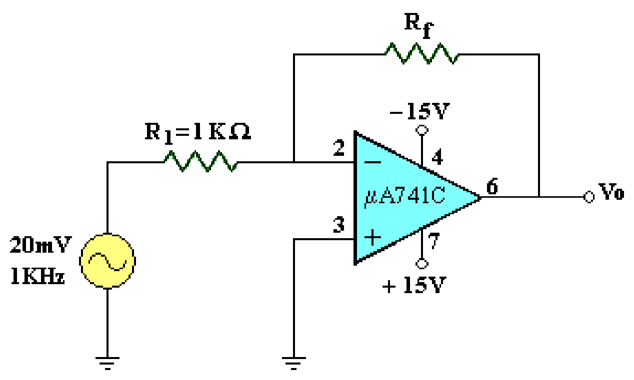
1. Connect the circuit as shown in the fig –3 apply a 20 mV sinusoidal signal at a frequency of 1KHz.
2. Vary the frequency in steps of 1KHz and note the amplitude of the O/P wave form.
3. Tabulate the readings.

SUMMER:

1. Connect the circuit as shown in the figure-4.
2. Apply the DC signals as shown in the fig-4 and measure the O/P and compare it with the theoretical value.

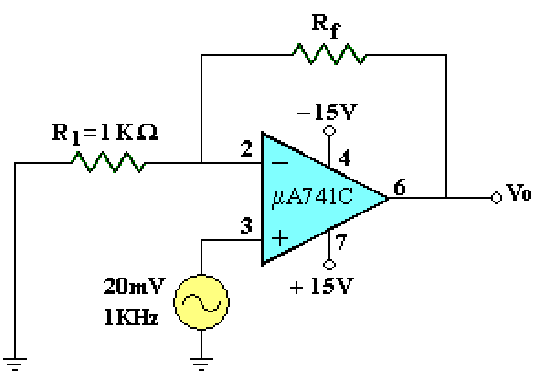
CIRCUIT DIAGRAM:

Inverting Amplifier:



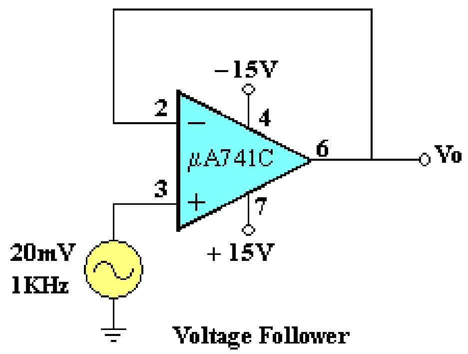
Inverting Amplifier

Non - inverting Amplifier:



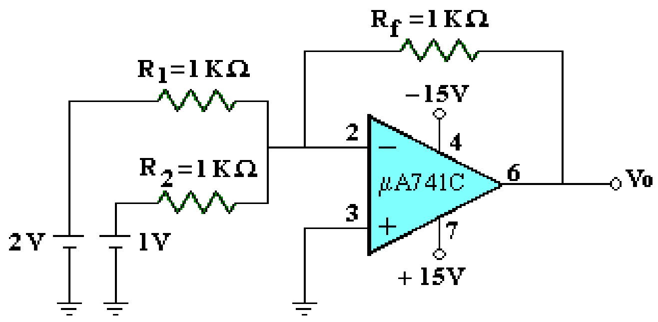
Non-Inverting Amplifier

Voltage Follower:



Voltage Follower

Summer:



Summing Amplifier

INVERTING AMPLIFIER:

V_i = 20mV

S.NO	R_f (Ω)	R_1(Ω)	V_0 (mV)	Gain = V_0 / V_i	Theoretical Gain = ($-R_f/R_1$)
1	4.7K	1K			
2	10K	1K			
3	33K	1K			

NON-INVERTING AMPLIFIER:

V_i = 20mV

S.NO	R_f (Ω)	R_1(Ω)	V_0 (mV)	Gain= V_0 / V_i	Theoretical Gain = ($1+R_f/R_1$)
1	4.7K	1K			
2	10K	1K			
3	33K	1K			

VOLTAGE FOLLOWER:

V_i = 20mV

S.No	Frequency (KHz)	V_0 (mV)
1	100	
2	200	
3	300	
4	400	
5	500	
6	600	
7	700	
8	800	
9	900	
10	1K	

SUMMER:

V_0 (Theoretical) $= -\frac{R_f}{R_1}(V_1 + V_2)$ = --------Volts.

V_0 (Practical) = --------Volts.

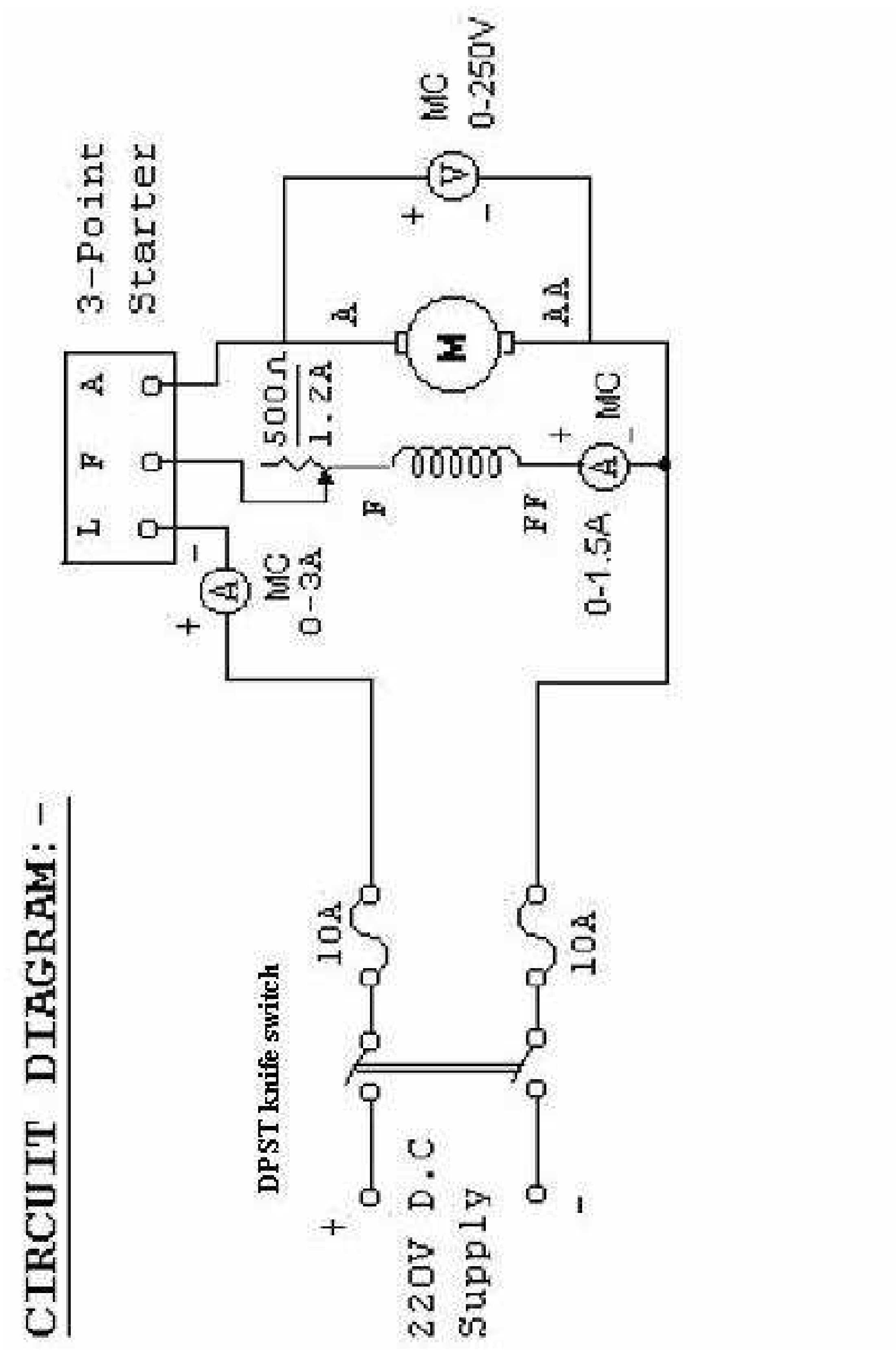
RESULT:

VIVA QUESTIONS:

1. What are the ideal Characteristics of an OPAMP ?
2. Explain the concept of virtual ground?
3. What are the internal stages in an OPAMP IC ?
4. What type of transistor Configuration is used at the front end of an OPAMP IC ?
5. Draw the circuit diagram of an integrator and a differentiator using an OPAMP ?
6. Why square wave is used to test any amplifier ?

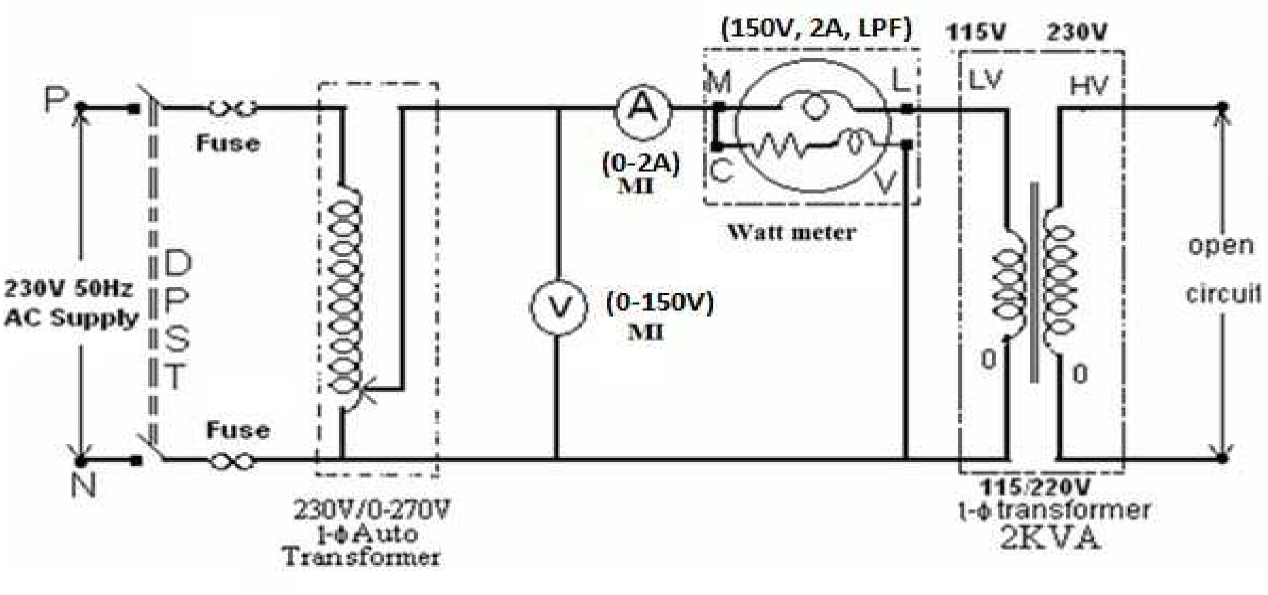
****

Swinburne’s test on D.C. Shunt machine

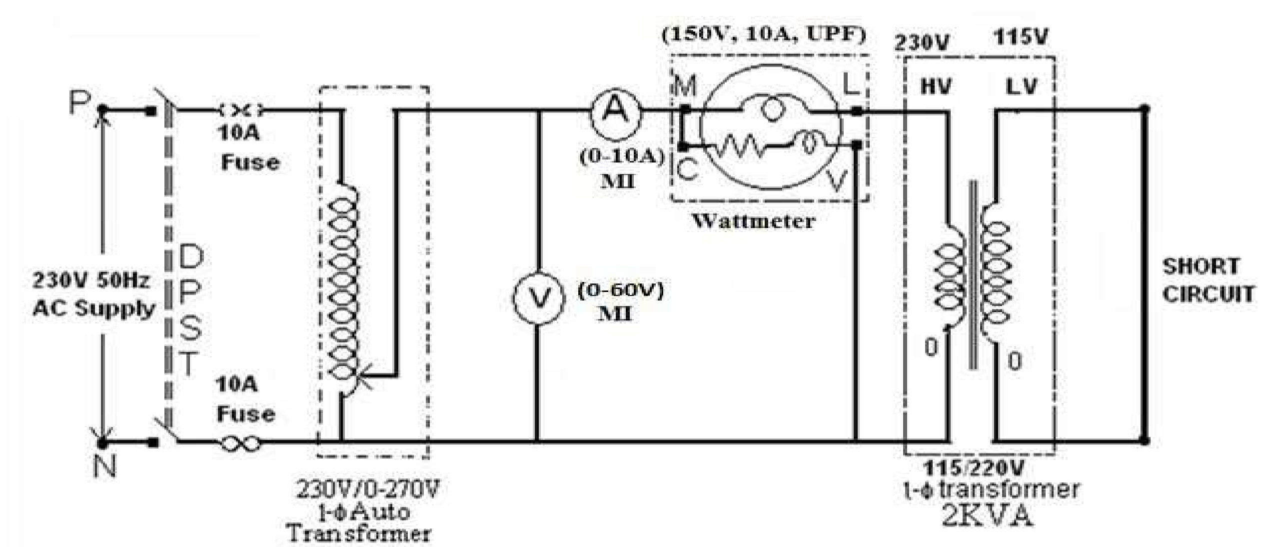


OC and SC tests on single phase transformer

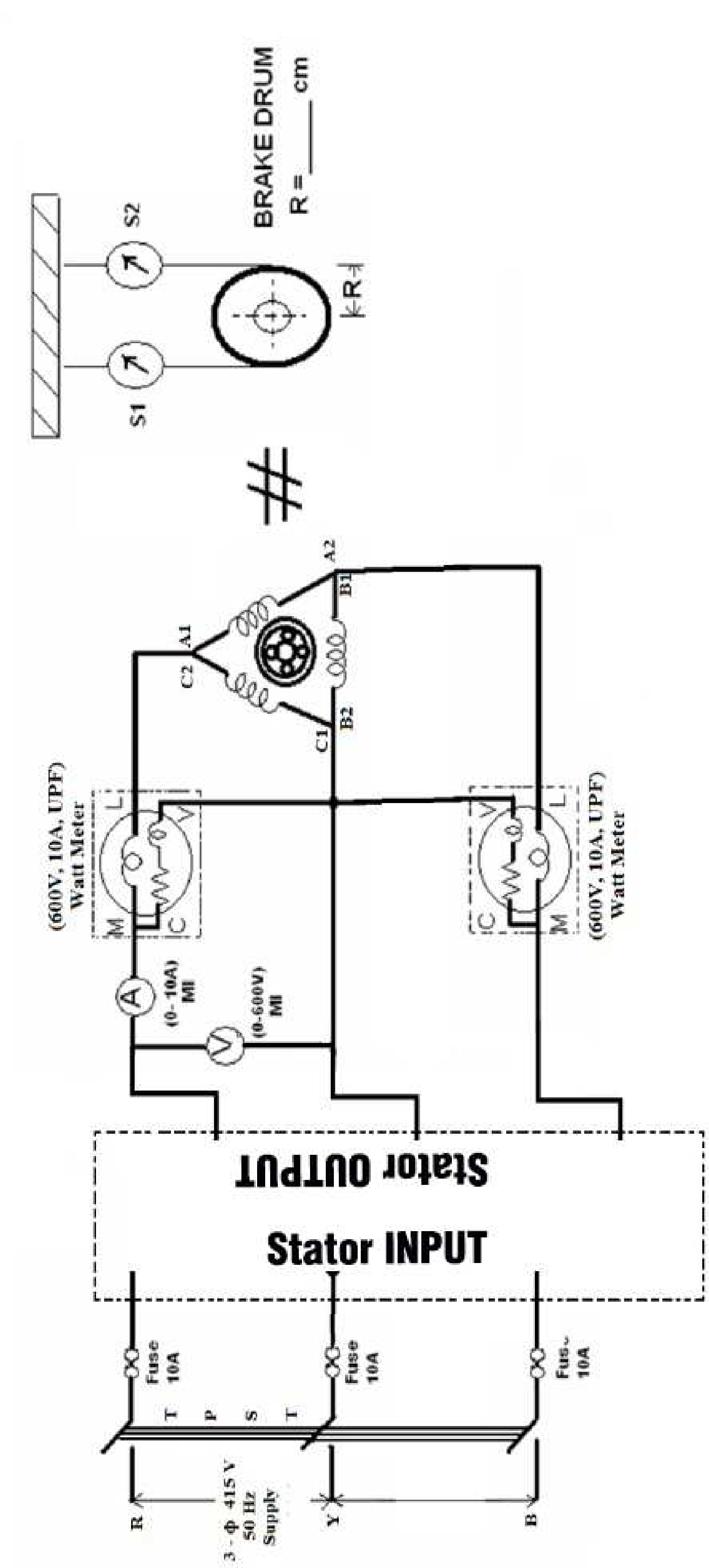
Open Circuit Test



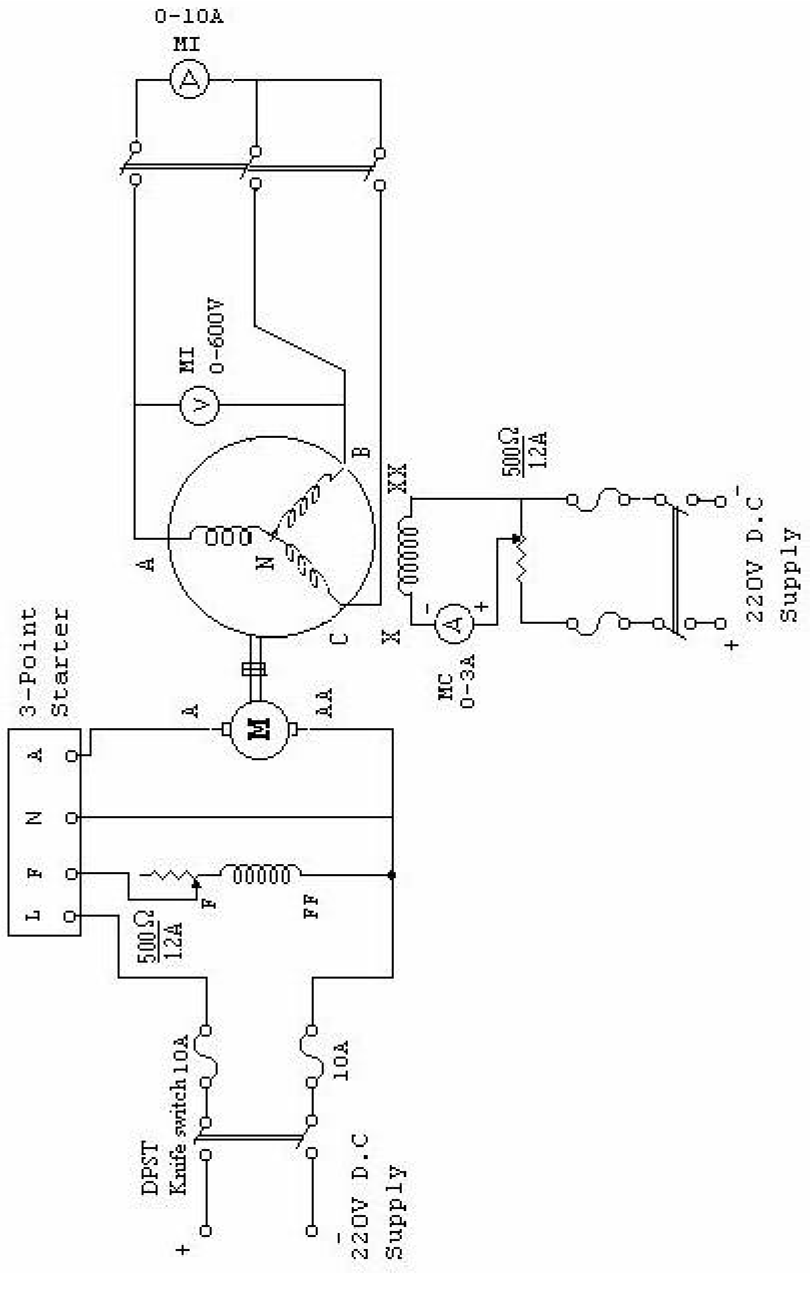
Short Circuit Test



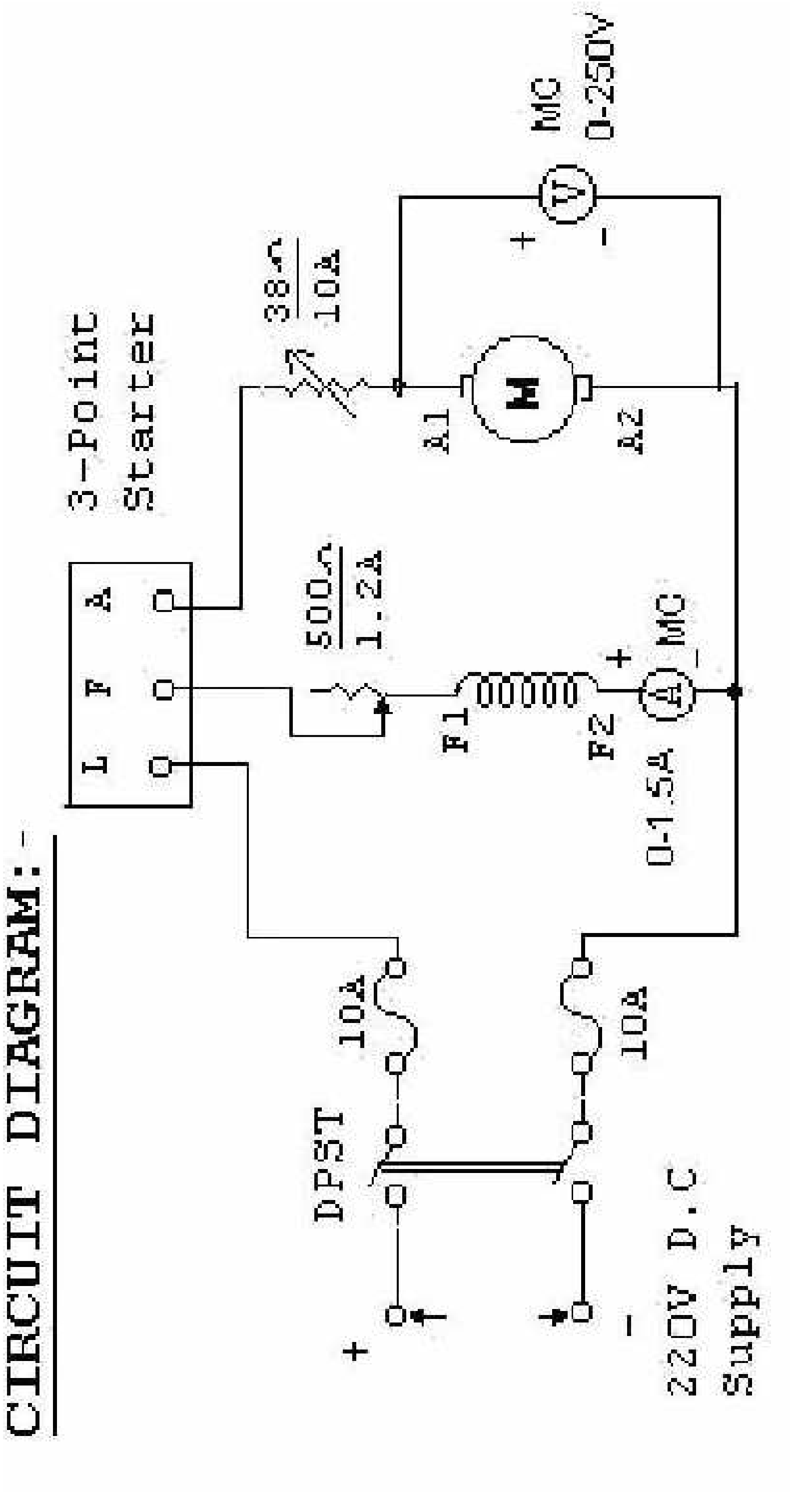
Brake test on 3-phase Induction motor



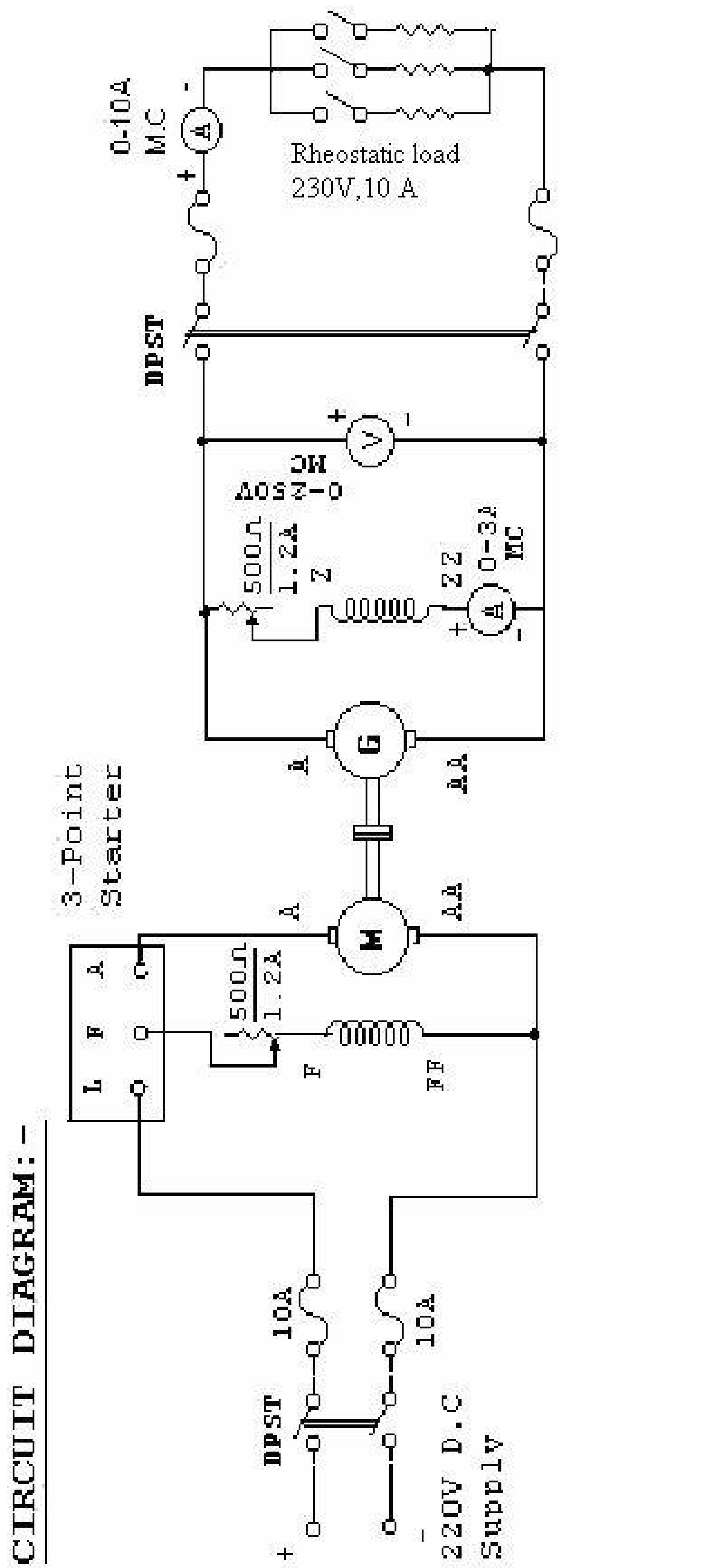
Regulation of alternator by Synchronous impedance method



Speed control of D.C. Shunt motor

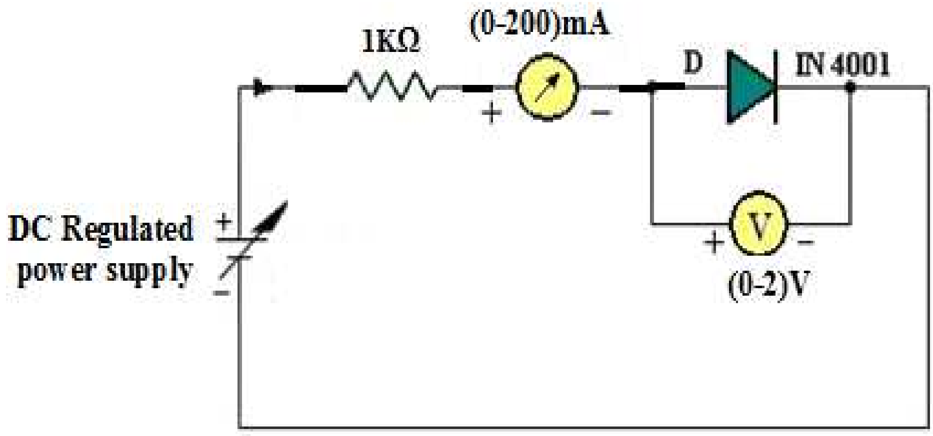


Brake test on D.C. Shunt Motor

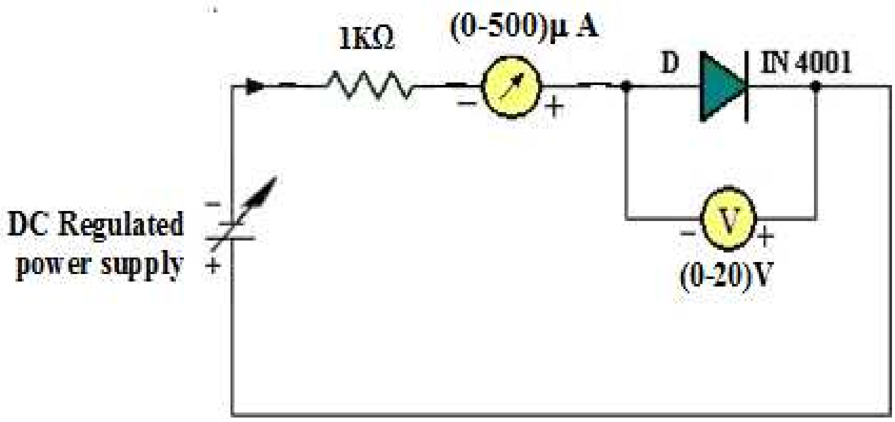


PN junction diode characteristics

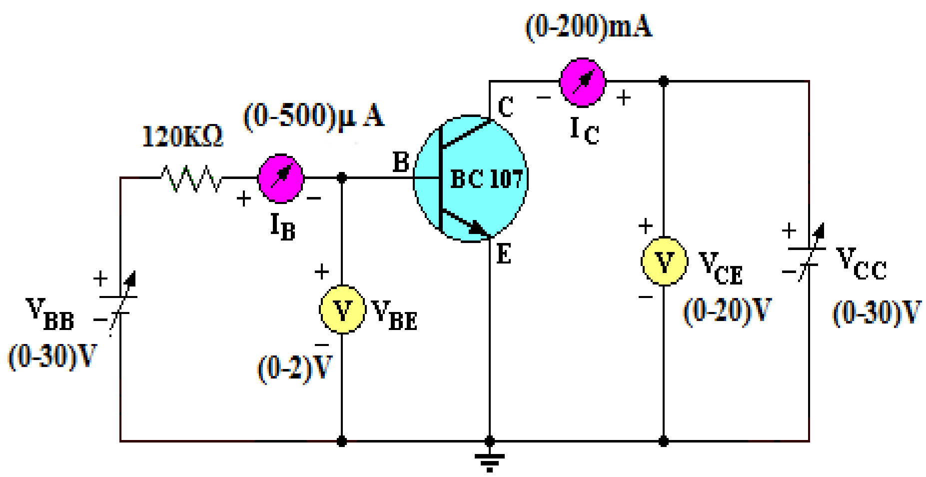
Forward bias Characteristics:



Reverse bias Characteristics:

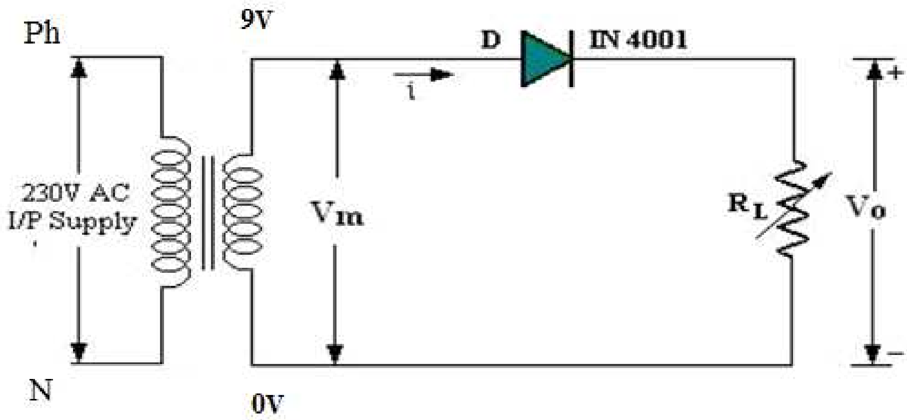


Transistor CE characteristics

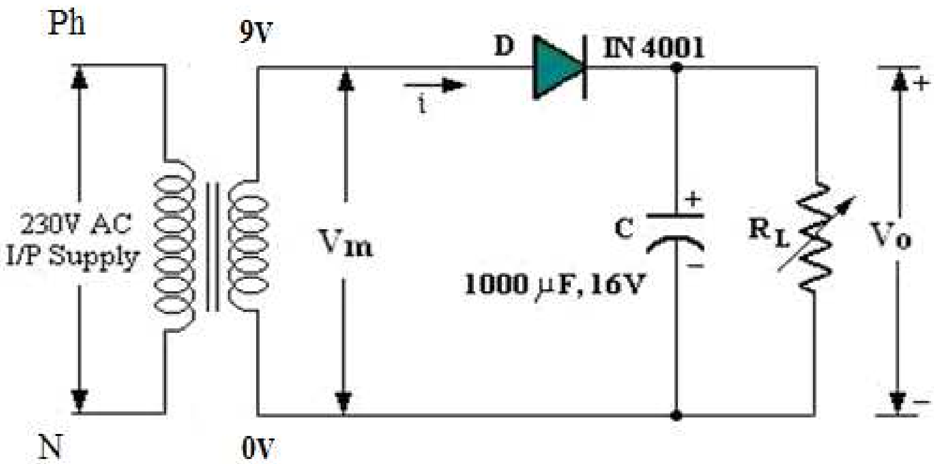


Half wave rectifier with and without filters

Half wave Rectifier without filter:

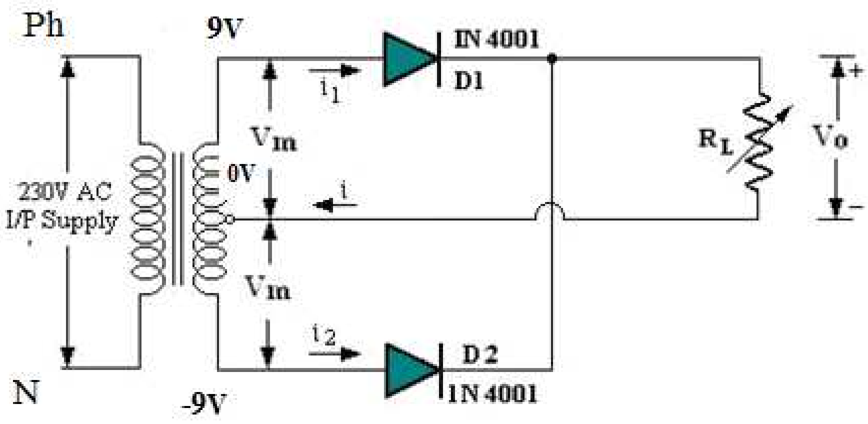


Half wave Rectifier with filter:

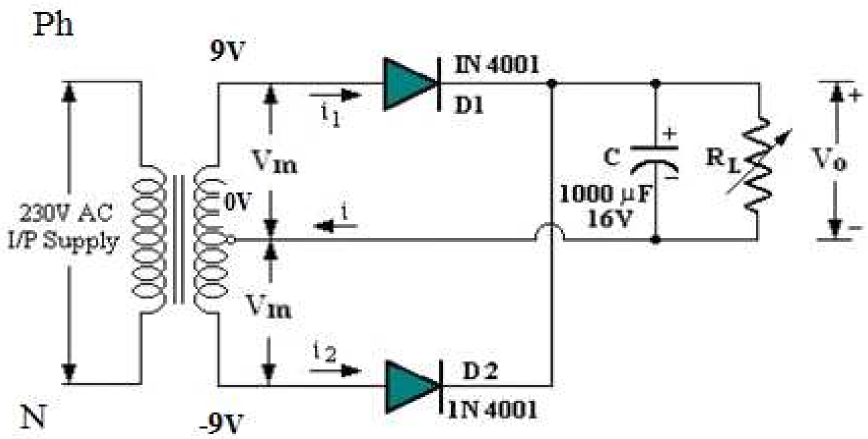


Full wave rectifier with and without filters

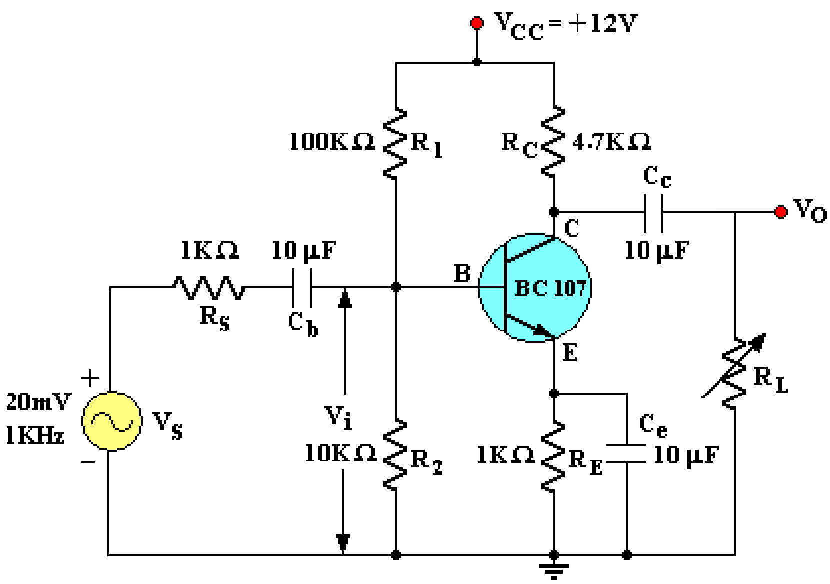
Full wave Rectifier without filter:



Full wave Rectifier with filter:



CE amplifiers

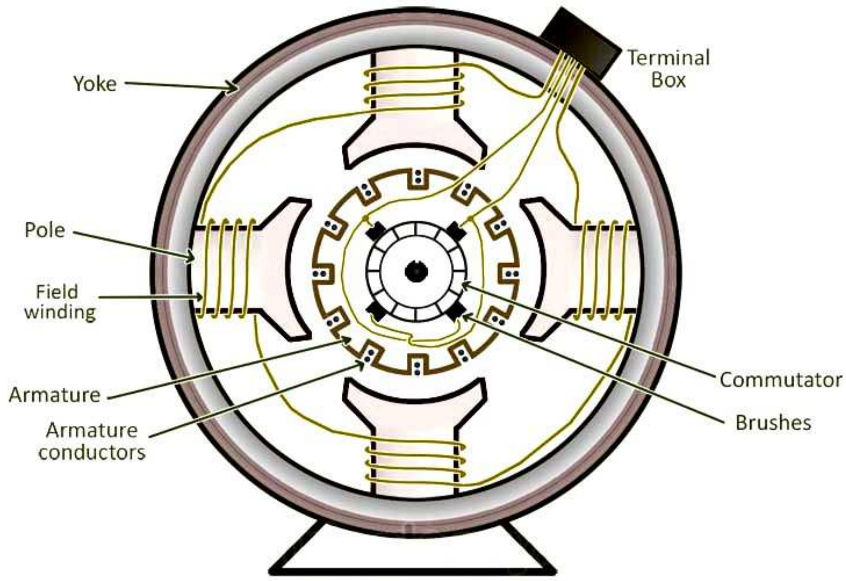


DC Generator

A dc generator is an electrical machine which converts mechanical energy into **direct current electricity**. This energy conversion is based on the principle of production of dynamically induced emf.

Construction of a DC machine:

Note: A DC generator can be used as a DC motor without any constructional changes and vice versa is also possible. Thus, a DC generator or a DC motor can be broadly termed as a **DC machine**. These basic constructional details are also valid for the **construction of a DC motor**. Hence, let's call this point as **construction of a DC machine** instead of just 'construction of a dc generator'.



Working principle of a DC generator:

According to Faraday's laws of electromagnetic induction, **whenever a conductor is placed in a varying magnetic field (OR a conductor is moved in a magnetic field), an EMF (electromotive force) gets induced in the conductor.**

The magnitude of induced emf can be calculated from the emf equation of dc generator. If the conductor is provided with a closed path, the induced current will circulate within the path. In a DC generator, field coils produce an electromagnetic field and the armature conductors are rotated into the field. Thus, an electromagnetically induced emf is generated in the armature conductors. The direction of induced current is given by Fleming's right hand rule.

Working principle of a DC motor

An electric motor is an electrical machine which converts electrical energy into mechanical energy. The basic **working principle of a DC motor** is:

"*whenever a current carrying conductor is placed in a magnetic field, it experiences a mechanical force"*.

The direction of this force is given by Fleming's left-hand rule and its magnitude is given by F = BIL. Where, B = magnetic flux density, I = current and L = length of the conductor within the magnetic field.

Back EMF

When the armature of a motor is rotating, the conductors are also cutting the magnetic flux lines and hence according to the Faraday's law of electromagnetic induction, an emf induces in the armature conductors. The direction of this induced emf is such that it opposes the armature current (I_a). The circuit diagram below illustrates the **direction of the back emf and armature current**. Magnitude of the **Back emf** can be given by emf equation of a DC generator.

Significance of back emf:

Magnitude of back emf is directly proportional to speed of the motor. Consider the load on a dc motor is suddenly reduced. In this case, required torque will be small as compared to the current torque.

Speed of the motor will start increasing due to the excess torque. Hence, being proportional to the speed, magnitude of the back emf will also increase. With increasing back emf armature current will start decreasing. Torque being proportional to the armature current, it will also decrease until it becomes sufficient for the load. Thus, speed of the motor will regulate.

On the other hand, if a dc motor is suddenly loaded, the load will cause decrease in the speed. Due to decrease in speed, back emf will also decrease allowing more armature current. Increased armature current will increase the torque to satisfy the load requirement. Hence, presence of the **back emf makes a dc motor 'self-regulating'**.

Three Phase Induction Motor

A **three phase induction motor** runs on a three phase AC supply.

3 phase induction motors are extensively used for various industrial applications because of their following advantages -

They have very simple and rugged (almost unbreakable) construction

- they are very reliable and having low cost
- they have high efficiency and good power factor
- minimum maintenance required
- **3 phase induction motor is self starting** hence extra starting motor or any special starting arrangement is not required

Working principle of an Induction Motor

In a DC motor, supply is needed to be given for the stator winding as well as the rotor winding. But in an **induction motor** only the stator winding is fed with an AC supply.

- Alternating flux is produced around the stator winding due to AC supply. This alternating flux revolves with synchronous speed. The revolving flux is called as "Rotating Magnetic Field" (RMF).
- The relative speed between stator RMF and rotor conductors causes an induced emf in the rotor conductors, according to the Faraday's law of electromagnetic induction. The rotor conductors are short circuited, and hence rotor current is produced due to induced emf. That is why such motors are called as **induction motors**.
  (This action is same as that occurs in transformers, hence induction motors can be called as **rotating transformers**.)
- Now, induced current in rotor will also produce alternating flux around it. This rotor flux lags behind the stator flux. The direction of induced rotor current, according to Lenz's law, is such that it will tend to oppose the cause of its production.
- As the cause of production of rotor current is the relative velocity between rotating stator flux and the rotor, the rotor will try to catch up with the stator RMF. Thus the rotor rotates in the same direction as that of stator flux to minimize the relative velocity. However, the rotor never succeeds in catching up the synchronous speed. This is the **basic working principle of induction motor** of either type, single phase of 3 phase.

Synchronous speed:

The rotational speed of the rotating magnetic field is called as synchronous speed.

$$N_s = \frac{120 \times f}{P} \quad \text{(RPM)}$$

where, f = frequency of the supply

P = number of poles

Slip:

Rotor tries to catch up the synchronous speed of the stator field, and hence it rotates. But in practice, rotor never succeeds in catching up. If rotor catches up the stator speed, there wont be any relative speed between the stator flux and the rotor, hence no induced rotor current and no torque production to maintain the rotation.

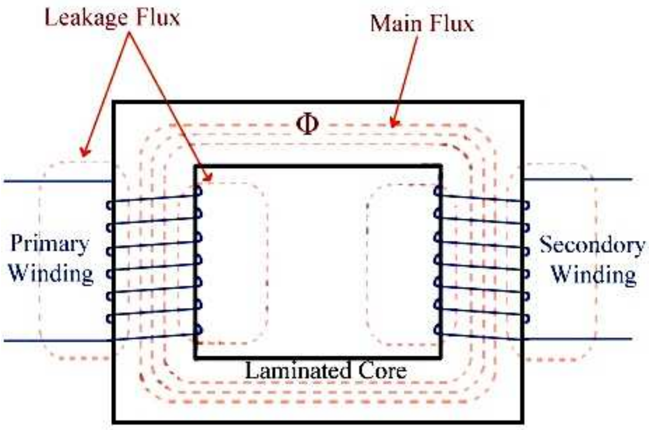
However, this won't stop the motor, the rotor will slow down due to lost of torque, the torque will again be exerted due to relative speed. That is why the rotor rotates at speed which is always less the synchronous speed. The difference between the synchronous speed (N_s) and actual speed (N) of the rotor is called as slip.

$$\% \text{ slip} \quad s = \frac{Ns - N}{Ns} \times 100$$

Electrical Transformer

Electrical transformer is a static electrical machine which transforms electrical power from one circuit to another circuit, without changing the frequency. Transformer can increase or decrease the voltage with corresponding decrease or increase in current.

Working principle of transformer



The **basic principle behind working of a transformer** is the phenomenon of mutual induction between two windings linked by common magnetic flux. The figure shows the simplest form of a transformer. Basically a transformer consists of two inductive coils; primary winding and secondary winding. The coils are electrically separated but magnetically linked to each other.

When, primary winding is connected to a source of alternating voltage, alternating magnetic flux is produced around the winding. The core provides magnetic path for the flux, to get linked with the secondary winding. Most of the flux gets linked with the secondary winding which is called as 'useful flux' or main 'flux', and the flux which does not get linked with secondary winding is called as 'leakage flux'. As the flux produced is alternating (the direction of it is continuously changing), EMF gets induced in the secondary winding according to Faraday's law of electromagnetic induction. This emf is called 'mutually induced emf', and the frequency of mutually induced emf is same as that of supplied emf. If the secondary winding is closed circuit, then mutually induced current flows through it, and hence the electrical energy is transferred from one circuit (primary) to another circuit (secondary).

SWINBURNE'S TEST ON D.C. SHUNT MOTOR

It is a simple indirect method in which losses are measured separately. The machine is run as motor on no-load at its rated speed and voltage. The machine supplies the following losses.

1. Constant losses
    a). Iron losses in core
    b). Friction losses
    c). Windage losses
2. Armature copper losses

LOAD TEST ON D.C. SHUNT MOTOR

It is a direct method in which a braking force is applied to a pulley mounted on the motor shaft. A belt is wound round the pulley and its two ends are attached to the frame through two spring balances S1 and S2.

The tension of the belt can be adjusted with the help of tightening wheels. The tangential force acting on the pulley is equal to the difference between the readings of the two spring balances.

SPEED CONTROL OF D.C. SHUNT MOTOR

The speed of a DC motor is given by the relation,

$$N = \frac{VI - I_a R_a}{Z\phi} \cdot \frac{A}{P} = K \frac{VI - I_a R_a}{\phi}$$

Therefore, the speed of such motor can be controlled by varying either the flux per pole, (field flux control) or the armature resistance, Ra (Armature control).

Field flux control method:

It can be seen that N α (1/ ϕ). Hence, the speed can be increased by decreasing the flux and vice versa. The flux of a DC shunt motor can be changed by changing the shunt field current (I_{sh}) with the help of a rheostat in the shunt field circuit. This method is commonly used to get speeds above rated speed.

Armature control method:

This method is used when speeds below the no-load speed are required. As supply voltage is normally constant, the voltage across the armature is varied by Inserting a variable rheostat (called controller resistance) in series with the armature circuit. As the controller resistance increased, potential difference across the armature is decreased, Thereby decreasing the armature speed. For a load of constant torque, speed is approximately proportional to the potential difference across the armature. From the speed/ armature current characteristic it is seen that greater the resistance in the armature circuit, greater is the fall in speed.

The speed (N) with a total armature resistance Rt is related to the No-load speed N0 by the following equation. $N = No (1 - I_a R_t / V)$

The load current following the speed will be zero is obtained by putting N = 0 in the

Above formula. Ia = V/ Rt

This is the maximum armature current and is known as stalling current.

OPEN CIRCUIT AND SHORT CIRCUIT TESTS ON SINGLE PHASE TRANSFORMER

The purpose of the OC test is determine the no load loss (core loss) at rated voltage and rated frequency. Shunt branch parameters of equivalent circuit R_0&X_0 and the no load current of the transformer on winding of the transformer. In the open circuit test the primary load current is very small (2.6% of rated current) copper loss is negligibly small in the primary and is nil in the secondary is opened. The equivalent circuit parameters R_0&X_o referred to LV side can be calculated from the test result.

SC Test is to conduct for determining the full load copper loss and the equivalent resistance and resistance of the transformer as referred to the metering side. In this test one winding usually LV side is solidly short circuited and a low voltage (2-12% of primary voltage) is applied to the HV side such that rated current flows through the winding since applied voltage is very low, iron losses are very small and may be neglected. Hence the wattmeter shows the full load copper loss P_{cu} for the whole transformer. If V_{SC} is the voltage required to circulate the rated current I_2 Then the equivalent circuit parameters can be found.

Voltage regulation of synchronous generator using EMF method:

Generally, we use this **Synchronous Impedance Method** for high-speed **Alternators or synchronous generator**. This method is also known as **EMF method**. Before calculating the voltage regulation we need to calculate the following data.

1.Armature Resistance per phase [Ra]

2.Open Circuit characteristics which is a graph between open circuit voltage [Vo.c.] and field current.

3.Short circuit characteristics which is a graph between short circuit current [Is.c.] and field current.

Load Test On 3-Phase Squirrel Cage Induction Motor

The load test on 3-phase induction motor is performed to obtain its various characteristics including efficiency. A belt and brake drum arrangement as shown in the circuit diagram can load the motor. If S1 and S2 are the tensions provided at the two sides of the belt, then the load torque is calculated.

Diode, Thyristor & Transistor

A **diode** is a two terminal device formed by the combination of a p and an n type semiconductor Material that allows conduction in single direction only.

Practically it is said that the diode allows conduction only when forward biased and restricts the flow of current in reverse biased condition.

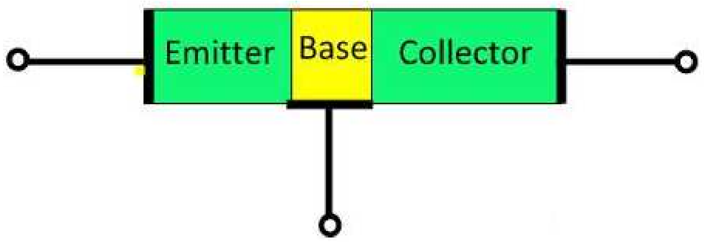
Thyristor is a 4 layer device formed by alternate combination of p and n type semiconductor materials. It is a device used for rectification and switching purpose. SCR is the mostly used member of thyristor family and it is the name commonly used when we talk about thyristors.

SCR also allows the flow of current in one direction and its action is controlled by an external trigger pulse applied at its gate terminal.

The **transistor** is a semiconductor device which transfers a weak signal from low resistance circuit to high resistance circuit. The words trans mean transfer property and istor mean resistance property offered to the junctions. In other words, it is a switching device which regulates and amplify the electrical signal likes voltage or current.

The transistor consists two PN diode connected back to back. It has three terminals namely emitter, base and collector. The base is the middle section which is made up of thin layers. The right part of the diode is called emitter diode and the left part is called collector-base diode. These names are given as per the common terminal of the transistor. The emitter based junction of the transistor is connected to forward biased and the collector-base junction is connected in reverse bias which offers a high resistance.

Transistor Terminals



Emitter – The section that supplies the large section of majority charge carrier is called emitter. The emitter is alway connected in forward biased with respect to the base so that it supplies the majority charge carrier to the base. The emitter-base junction injects a large amount of majority charge carrier into the base because it is heavily doped and moderate in size.

Collector – The section which collects the major portion of the majority charge carrier supplied by the emitter is called a collector. The collector-base junction is always in reverse bias. Its main function is to remove the majority charges from its junction with the base. The collector section of the transistor is moderately doped, but larger in size so that it can collect most of the charge carrier supplied by the emitter.

Base – The middle section of the transistor is known as the base. The base forms two circuits, the input circuit with the emitter and the output circuit with the collector. The emitter-base circuit is in forward biased and offered the low resistance to the circuit. The collector-base junction is in reverse bias and offers the higher resistance to the circuit. The base of the transistor is lightly doped and very thin due to which it offers the majority charge carrier to the base.

P-N JUNCTION DIODE

The semi conductor diode is created by simply joining an n-type and a p-type material together nothing more just the joining of one material with a majority carrier of electrons to one with a majority carrier of holes.

The P-N junction supports uni-directional current flow. If +ve terminal of the input supply is connected to anode (P-side) and –ve terminal of the input supply is connected to cathode (N- side), then diode is said to be forward biased. In this condition the height of the potential barrier at the junction is lowered by an amount equal to given forward biasing voltage.

Both the holes from p-side and electrons from n-side cross the junction simultaneously and constitute a forward current(injected minority current – due to holes crossing the junction and entering N-side of the diode, due to electrons crossing the junction and entering P-side of the diode).

RECTIFIERS

A device is capable of converting a sinusoidal input waveform into a unidirectional waveform with non zero average component is called a rectifier.

HALF WAVE RECTIFIER

half wave rectifier with a resistive load the During positive half cycle of the input the diode conducts and all the input voltage is dropped across R_L. During the negative half cycle the diode is reverse biased and it acts as almost open circuit so the output voltage is zero.

The filter is simply a capacitor connected from the rectifier output to ground. The capacitor quickly charges at the beginning of a cycle and slowly discharges through R_L after the positive peak of the input voltage. The variation in the capacitor voltage due to charging and discharging is called ripple voltage. Generally, ripple is undesirable, thus the smaller the ripple, the better the filtering action.

FULL WAVE RECTIFIER

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

BJT CHARACTERISTICS

Bipolar junction transistor (BJT) is a 3 terminal (emitter, base, collector) semiconductor device. There are two types of transistors namely NPN and PNP. It consists of two P-N junctions namely emitter junction and collector junction.

In Common Emitter configuration the input is applied between base and emitter and the output is taken from collector and emitter. Here emitter is common to both input and output and hence the name common emitter configuration.

Input characteristics are obtained between the input current and input voltage taking output voltage as parameter. It is plotted between V_{BE} and I_B at constant V_{CE} in CE configuration.

Output characteristics are obtained between the output voltage and output current taking input current as parameter. It is plotted between V_{CE} and I_C at constant I_B in CE configuration.

It operates in three regions: active region, cut-off region and saturation region.

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

Cut-off region: 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.

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

CE AMPLIFIER

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.

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SKILL DEVELOPMENT CENTRES

1. Dassault 3D Experience Lab
2. Applied Robotic control Lab
3. Basic Pneumatics Lab
4. Advanced Pneumatics Lab.
5. Basic Hydraulics Lab
6. Advanced Hydraulics Lab
7. CNC Machines Lab
8. Advanced Welding Techniques Lab.
9. 4- Wheelers Training Lab
10. 2- Wheelers Training Lab
11. Think Tronics Lab
12. Amazon Web Services Lab
13. Electronics Office Lab
14. Electronics Home Lab
15. Computer Based Training Lab

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