BASIC ELECTRICAL AND ELCTRONICS ENGINEERING LABORATORY

LAB MANUAL

Academic Year	**:**	**2017 - 2018**
Course Code	**:**	**AEE103**
Regulations	**:**	**IARE - R16**
Semester	**:**	**III**
Branch	**:**	**(ME / AE)**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal – 500 043, Hyderabad

Department of Electrical and Electronics Engineering

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Dundigal, Hyderabad - 500 043

Department of Electrical and Electronics Engineering

Program Outcomes	
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**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.
PO12	**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.

Program Specific Outcomes	
PSO1	**Professional Skills:** Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.
PSO2	**Problem - Solving Skills:** To explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.
PSO3	**Successful Career and Entrepreneurship:** To be able to utilize of technologies like PLC, PMC, process controllers, transducers and HMI and design, install, test, and maintain power systems and industrial applications.

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ATTAINMENT OF PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

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

BASIC ELECTRICAL AND ELCTRONICS ENGINEERING LABORATORY

OBJECTIVE:

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

OUTCOMES:

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

1. **Understand** the operation and applications of electromechanical energy conversion devices.
2. **Understand** identification and selection of various electrical and electronic components.
3. **Analyze** the characteristics of various electronics components.

EXPERIMENT – 1

VERIFICATION OF KIRCHHOFF'S CURRENT AND VOLTAGE LAWS

1.1 AIM:

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

1.2 APPARATUS REQUIRED:

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

1.3 CIRCUIT DIAGRAMS:

Circuit to verify KVL:

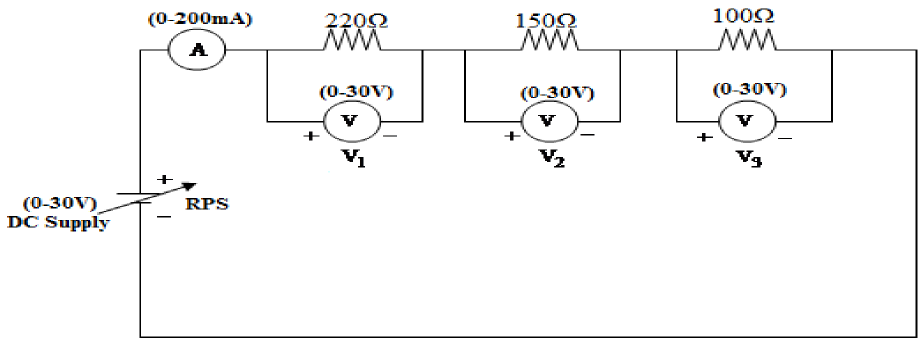

Fig - 1 KVL

To Verify KCL:

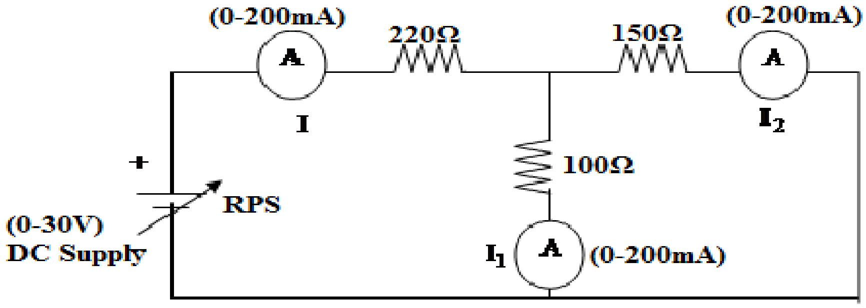

Fig - 1 KCL

1.4 PROCEDURE:

To Verify KVL

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

To Verify KCL

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

1.5 OBSERVATIONS:

For KVL

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

For KCL

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

1.6 PRECAUTIONS:

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

1.7 RESULT:

1.8 PRE LAB VIVA QUESTIONS:

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

1.9 POST LAB VIVA QUESTIONS:

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

EXPERIMENT – 2

VERIFICATION OF OHM'S LAW

2.1 AIM:

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

2.2 APPARATUS REQUIRED:

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

2.3 CIRCUIT DIAGRAM:

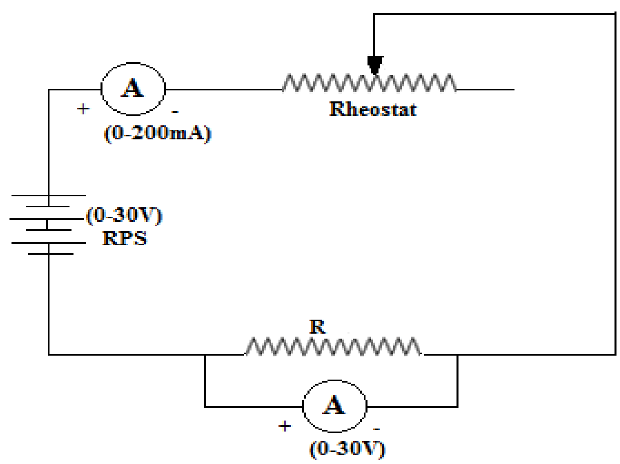

Fig – 2.1 Circuit Diagram

2.4 PROCEDURE:

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

2.5 OBSERVATIONS:

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

2.6 MODEL GRAPH:

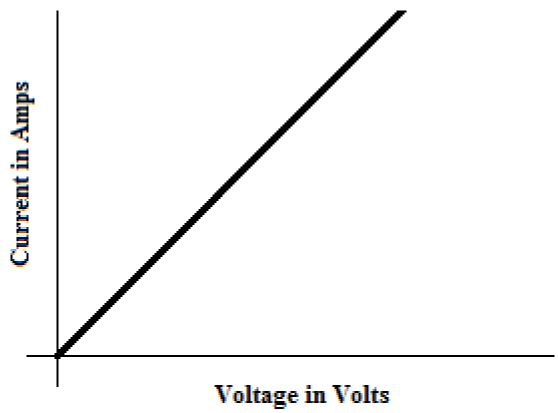

Fig: 2.2 Voltage and Current Characteristics

2.7 PRECAUTIONS:

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

2.8 RESULT:

2.9 PRE LAB QUESTIONS:

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

2.10 POST LAB QUESTIONS:

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

EXPERIMENT – 3

MAGNETIZATION CHARACTERISTICS OF DC SHUNT GENERATOR

3.1 AIM:

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

3.2 APPARATUS REQUIRED:

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

3.3 NAME PLATE DETAILS:

MOTOR

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

GENERATOR

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

3.4 CIRCUIT DIAGRAM:

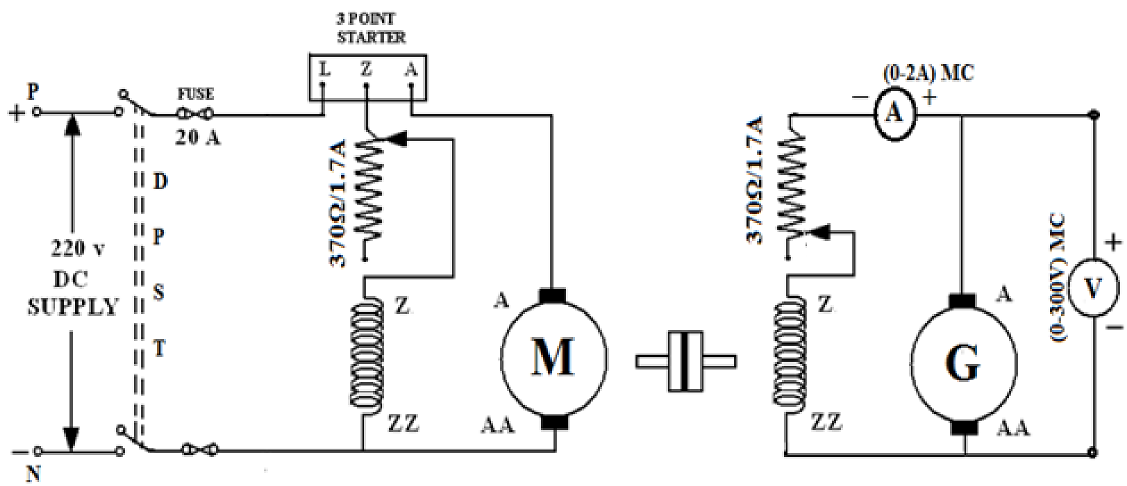

Fig – 3.1Magnetization characteristics (or) open circuit characteristics of a DC shunt generator

3.5 PROCEDURE:

1. Choose the proper ranges of meters after noting the name plate details of the given machine and make the connections as per the circuit diagram.
2. Keep the field rheostat of motor in minimum position and field rheostat of generator in maximum position.
3. Switch ON the power supply and start the M-G set by slowly moving the handle of three point starter.
4. Observe the speed of the generator using a tachometer and adjust the speed to rated value by varying the motor field rheostat. Keep the same speed throughout the experiment.
5. Note down the terminal voltage of the generator at zero field current. This is the E.M.F. due to residual magnetism.
6. Increase the generator field current I_f (ammeter) by gradually moving the jockey of generator field rheostat. For every value of I_f, note down the corresponding voltmeter reading. Increase the field current till induced E.M.F. is about 120% of rated value.
7. Repeat the same procedure for decreasing values of the same field currents (I_f) and finally note down the E.M.F. generated due to residual magnetism.
8. Draw the characteristics of generated E.M.F. (E_g) versus field current (I_f) for both increasing and decreasing values of field current.
9. Draw a tangent line to the initial portion of Characteristics from the origin. The slope of this straight line gives the critical field resistance.

3.6 OBSERVAIONS:

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

3.7 MODEL GRAGH:

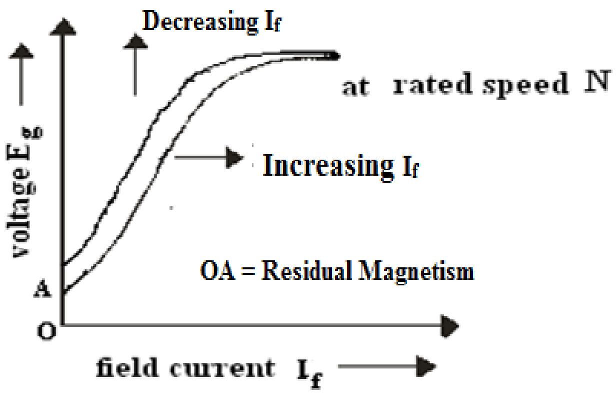

Fig – 3.2 Open Circuit Characteristics of DC shunt generator

3.8 PRECAUTIONS:

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

3.9 RESULT:

3.10 PRE LAB QUESTIONS:

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

3.11 POST LAB QUESTIONS:

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

EXPERIMENT – 4

SWINBURNE'S TEST ON DC SHUNT MACHINE

4.1 AIM:

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

4.2 APPARATUS REQUIRED:

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

4.3 NAME PLATE DETAILS

MOTOR

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

4.4 CIRCUIT DIAGRAM:

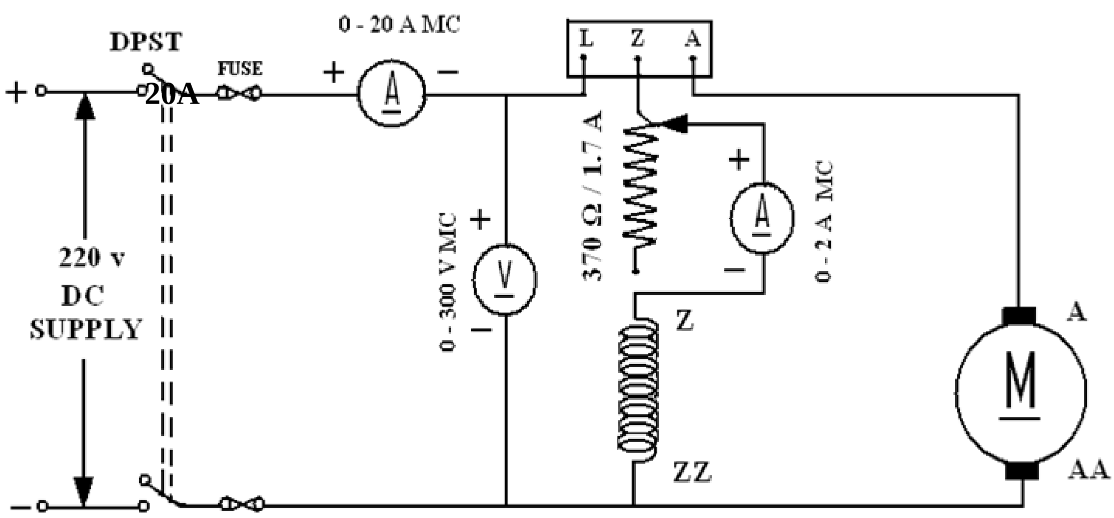

Fig – 4.1 Swinburne's test on a D.C. Shunt Machine

4.5 PROCEDURE:

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

4.6 OBSERVATIONS:

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

4.7 MODEL GRAPH:

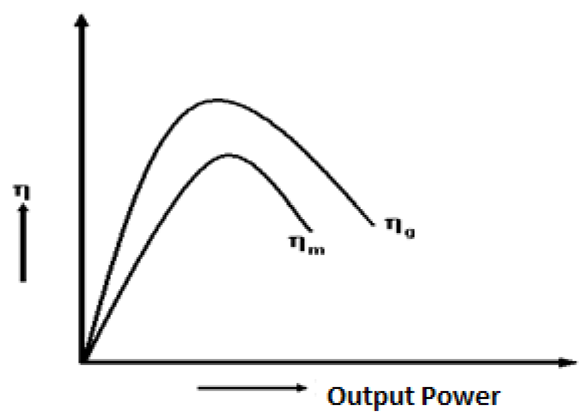

Fig - 4.2 Performance characteristics of DC shunt machine

4.8 CALCULATIONS FOR SWINBURNE'S TEST:

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

Efficiency as motor:

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

Input = $V_L I_L$, V_L is rated voltage of the machine
Assume line currents (I_L) as 2A, 4A,6A,----and find corresponding efficiency

Efficiency as generator:

Efficiency=output/input = output / (output + total losses).
Where losses = constant losses + variable losses
Constant losses are same for both motor and Generator
Armature Current = $I_a = I_L + I_f$
Variable loss = $I_a^2 R_a$
Output power = $V_L I_L$. V_L is rated voltage of the machine
Assume load currents (I_L) as 2A, 4A,6A,---- and find corresponding efficiencies

4.9 OBSERVATIONS:

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

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

As a Generator:
Rated voltage VL = **Rated speed N =**

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

4.10 PRECAUTIONS:

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

4.11 RESULTS:

4.12 PRE LAB QUESTIONS:

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

4.13 POST LAB QUESTIONS:

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

EXPERIMENT – 5

OPEN CIRCUIT AND SHORT CIRCUIT TESTS ON SINGLE PHASE TRANSFORMER

5.1 AIM:

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

5.2 APPARATUS REQUIRED:

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

5.3 NAME PLATE DETAILS:

Transformer Specifications

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

Autotransformer Specifications

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

5.4 CIRCUIT DIAGRAMS:

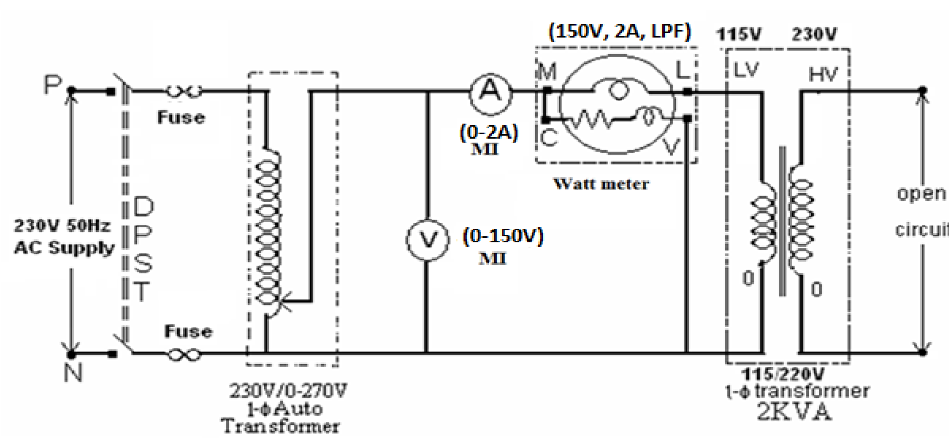

Fig -5.1 Open Circuit Test

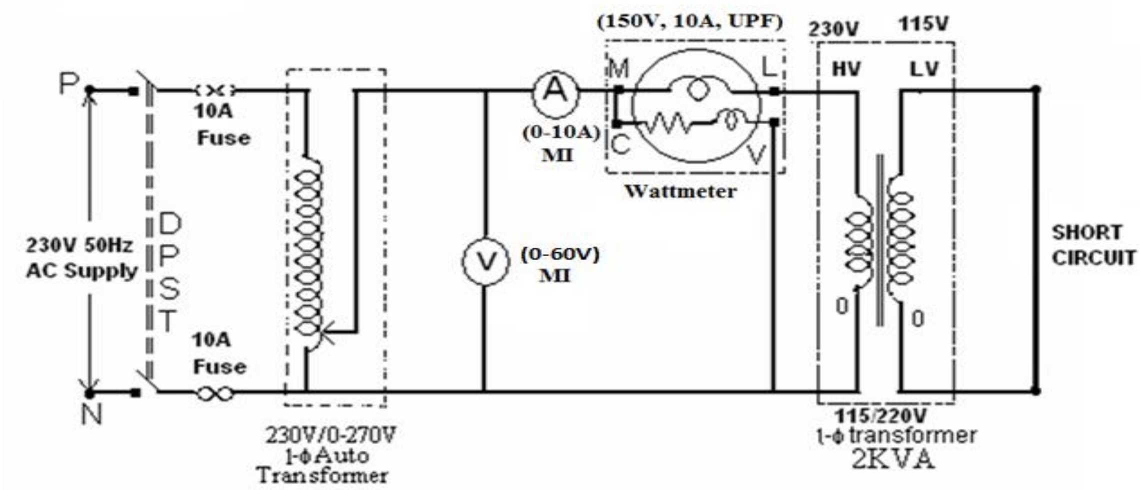

Fig - 5.2 Short Circuit Test

5.5 PROCEDURE:

Open Circuit Test:

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

Short Circuit Test:

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

5.6 OBSERVATIONS:

Open Circuit Test		
Voltage (V_o)	Current (I_o)	Power (W_o)

Short Circuit Test		
Voltage (V_{SC})	Current (I_{SC})	Power (W_{SC})

5.7 EQUIVALENT CIRCUIT OF TRANSFORMER:

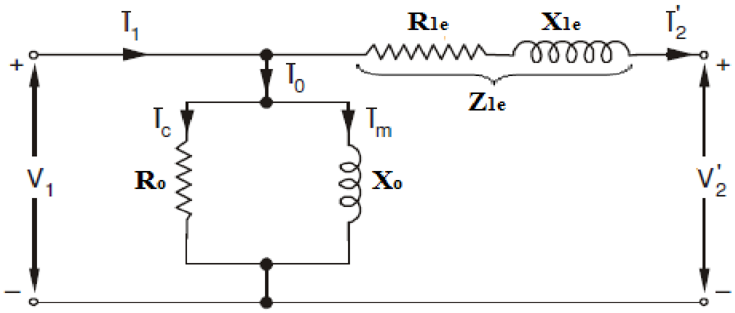

Fig – 5.3 Equivalent circuit of single phase transformer

5.8 MODEL CALCULATIONS:

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

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

Primary is H. V. side.

Secondary is L. V. side

From OC test:

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

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 $I_m = I_0 \sin \phi_0$

From SC Test:

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

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

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

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)

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

Where V_1 is the rated Voltage and

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

'+' for lagging power factors

'-' for leading power factor

Cosϕ = 1.0

Load n	Pcu (W) = 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

5.9 MODEL GRAPH:

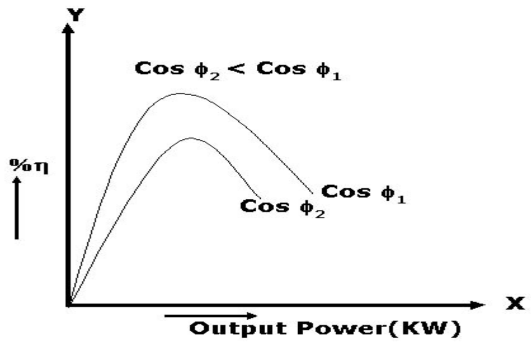

Fig – 5.4 Load vs Efficiency characteristics

5.10 PRECAUTIONS:

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

5.11 RESULT:

5.12 PRE LAB QUESTIONS:

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

5.13 POST LAB QUESTIONS:

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

EXPERIMENT – 6

BRAKE TEST ON 3- ϕ SQUIRREL CAGE INDUCTION MOTOR

6.1 AIM:

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

6.2 APPARATUS REQUIRED:

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

6.3 NAME PLATE DETAILS:

3- ϕ Squirrel Cage Induction Motor

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

3- ϕ Auto Transformer

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

6.4 CIRCUIT DIAGRAM:

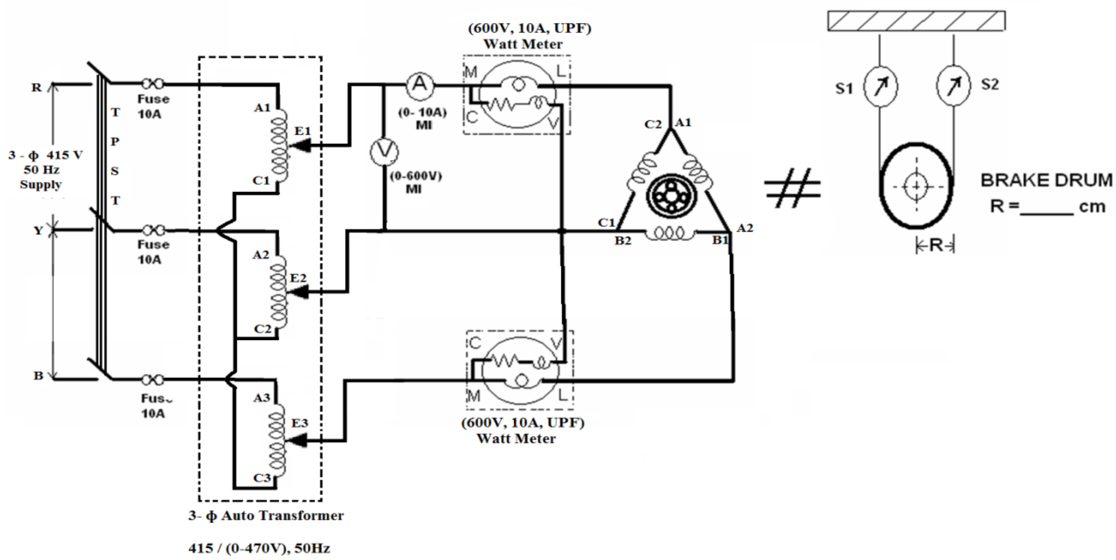

Fig – 6.1 Brake test on three – phase squirrel cage induction motor

6.5 PROCEDURE:

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

6.6 MODEL CALCULATIONS:

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

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

Where R is the Radius of drum in meters.

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

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

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

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

6.7 OBSERVATIONS:

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

6.8 MODEL GRAPHS:

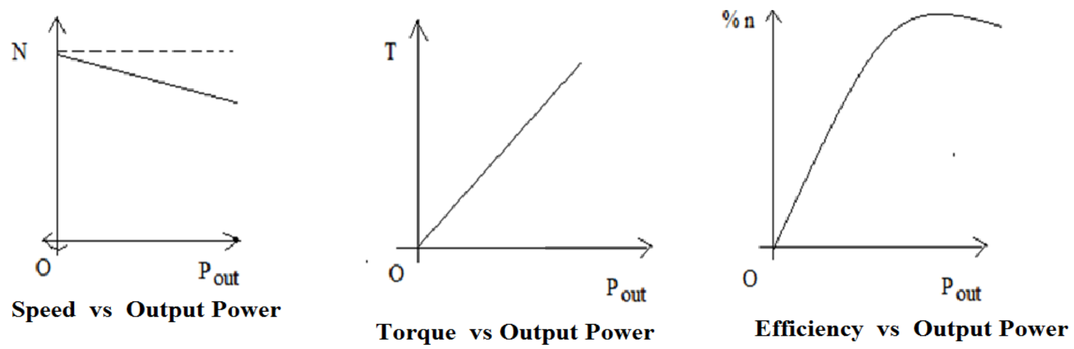

Fig – 6.2 Performance characteristics of three phase induction motor

6.9 PRECAUTIONS:

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

6.10 RESULT:

6.11 PRE LAB QUESTIONS:

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

6.12 POST LAB QUESTIONS:

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

EXPERIMENT – 7

REGULATION OF AN ALTERNATOR USING SYNCHRONOUS IMPEDANCE METHOD

7.1 AIM:

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

7.2 APPARATUS REQUIRED:

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

7.3 NAME PLATE DETAILS:

DC Motor

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

3- ϕ Alternator

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

7.4 CIRCUIT DIAGRAM:

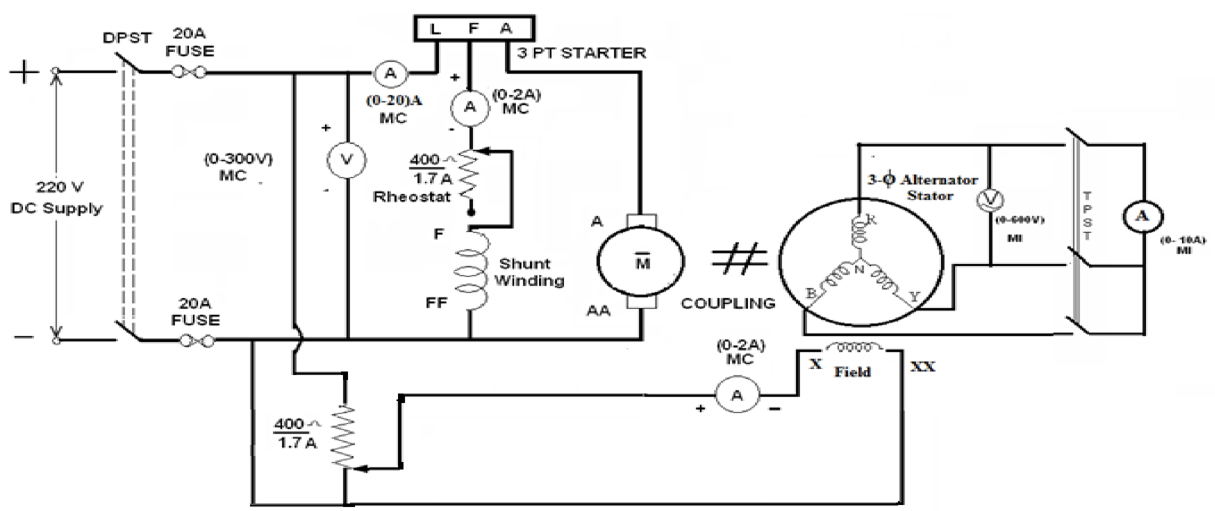

Fig – 7.1 Regulation of Alternator Using Synchronous Impedance Method

7.5 PROCEDURE:

Open Circuit Test:

1. Make the connections as per the circuit diagram.
2. Before starting the experiment, the potential divider network in the alternator field circuit and field regulator rheostat of motor circuit is set minimum resistance position.
3. Switch ON the supply and close the DPST switch. The DC motor is started by moving starter handle.
4. Adjust the field rheostat of DC motor to attain rated speed (equal to synchronous speed of alternator)
5. By decreasing the field resistance of Alternator, the excitation current of alternator is increased gradually in steps.
6. Note the readings of field current, and its corresponding armature voltage in a tabular column.
7. The voltage readings are taken upto and 10% beyond the rated voltage of the machine.

Short Circuit Test:

1. For Short circuit test, before starting the experiment the potential divider is brought back to zero output position, i.e., resistance should be zero in value.
2. Now close the TPST switch.
3. The excitation of alternator is gradually increased in steps until rated current flows in the machine and note down the readings of excitation current and load current (short circuit current)
4. Switch OFF the supply.

7.6 OBSERVATIONS:

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

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

7.7 PROCEDURE TO FIND ARMATURE RESISTANCE OF ALTERNATOR:

1. Connections are made as per the circuit diagram.
2. Switch ON the supply. By varying the rheostat, take different readings of ammeter and voltmeter in a tabular column.
3. From the above readings, average resistance Ra of a armature is found out.

7.7.1 CONNECTION DIAGRAM TO FIND Ra:

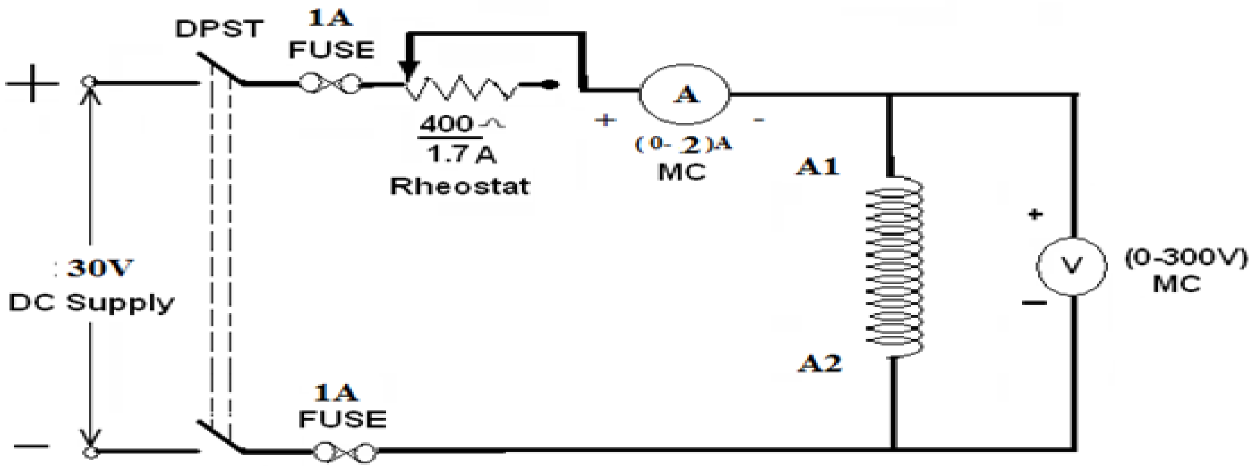

Fig - 7.2 Circuit diagram for calculation of Resistance of armature winding of alternator

7.7.2 BSERVATIONS:

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

7.8 PROCEDURE:

1. Plot open circuit voltage, short circuit current verses field current on a graph sheet.
2. From the graph, the synchronous impedance for the rated value of excitation is calculated.
3. The excitation emf is calculated at full load current which is equal to the terminal voltage at No load.
4. The voltage regulation is calculated at rated terminal voltage.

7.9 MODEL CALCULATIONS:

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

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

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

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

Where

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

7.10 MODEL GRAPHS:

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

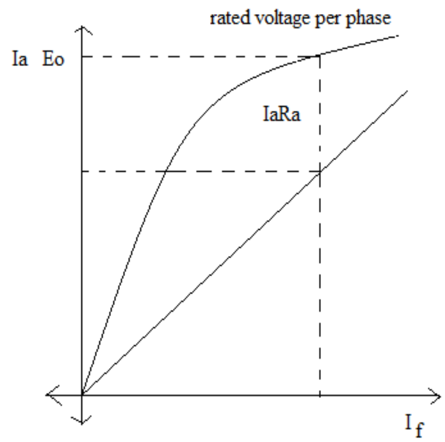

Fig – 7.3 OCC and SC characteristics of Alternator

7.11 PRECAUTIONS:

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

7.12 RESULT:

7.13 PRE LAB QUESTIONS:

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

7.14 POST LAB QUESTIONS:

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