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Note : Remove “Table of Content” before including in CP Book

17EEL37 : ELECTRICAL MACHINE LAB-2

A. LABORATORY INFORMATION

1. Lab Overview

Degree:	B.Tech	*Program:*	EE

Year / Semester :	2/ 3	*Academic Year:*	2018-19
Course Title:	Electrical Machine Lab-2	*Course Code:*	17EEL347
Credit / L-T-P:	3 / 0-1-2	*SEE Duration:*	180 Minutes
Total Contact Hours:	30 Hrs	*SEE Marks:*	80 Marks
CIA Marks:	20	*Assignment*	1 / Module
Course Plan Author:	Mr.Raghavendra k	*Sign*	Dt :
Checked By:		*Sign*	Dt :

2. Lab Content

Unit	Title of the Experiments	Lab Hours	Concept	Blooms Level
1	Load test on dc shunt motor to draw speed – torque and horse power – efficiency characteristics	3	Analysis of Losses in D C motors	L4 Analyze
2	Field Test on dc series machines	3	Analysis of Combined losses in D C motors	L4
3	Speed control of dc shunt motor by armature and field control	3	Analysis of load distribution	L4
4	Swinburne's Test on dc motor	3	Analysis of polarity connection	L4
5	Retardation test on dc shunt motor	3	Analysis of connection in 3 phase D C motors	L4
6	Regenerative test on dc shunt machines	3	Analysis of 3 phase-2phase conversion	L4
7	Load test on three phase induction motor	3	Analysis of Seperation of losses	L4
8	No load and Blocked rotor test on three phase induction motor to draw (i) Equivalent circuit and (ii) Circle diagram. Determination of performance parameters at different load conditions from (i) and (ii)	3	Analysis of voltage in motors	L4
9	Load test on induction motor	3	Analysis of voltage in alternators	L4
10	Load test on single phase induction motor to draw output versus torque, current, power and efficiency characteristics	3	Analysis of speed when connected in load	L4
11	Conduct suitable tests to draw the equivalent circuit of single phase induction motor and determine performance parameters	3	Analysis of excitation of motors	L4
12	Conduct an experiment to draw V and Λ curves of synchronous motor at no load and load	3	Analysis Power Angle	L4

			curve of synchronous motor	

3. Lab Material

Unit	Details	Available
1	Text books	
	Nagaranth kothari, V.Kamaraju McGraw Hill 5 th Edition, 2013.	In Lib
2	Reference books	
	B L Theraja	In dept
3	Others (Web, Video, Simulation, Notes etc.)	
		Not Available

4. Lab Prerequisites:

-	-	Base Course:		-	-
SNo	Course Code	Course Name	Topic / Description	Sem	Remarks
1	17EEL47	Electrical machine Lab-2	Knowledge on D C motor operation	3	
			Knowledge of AC and DC motors	-	

Note: If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

5. General Instructions

SNo	Instructions	Remarks
1	Keep the lab neatly.	
2	Maintain silence.	
3	Maintain your lab observation and lab manual.	
4	Prepare your experiment in well advance.	
5	Do not leave the lab without in-charge staff permission.	
6	Do not move around in the lab.	
7	Do not misplace the equipments.	
8	Check the power supply before use.	
9	Maintain discipline in the lab.	
10	After completion of your experiment switch off the power supply.	

6. Lab Specific Instructions

SNo	Specific Instructions	Remarks
1	The equipment must be connected firmly to the mother ground	
2	The electrodes must be cleaned properly before use	

3	Before starting the experiment, make sure the electrodes are properly aligned to zero reading	
4	Any part of the equipment should not be touched	
5	Do not enter High-Voltage area without discharge	
6	Sudden High-Voltage should not be applied to the specimen	
7	Do not enter the test-bay while the equipments are in operation	
8	Ignore the first one reading as the air between the electrodes may be ionized	

B. OBE PARAMETERS

1. Lab / Course Outcomes

#	COs	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
1	Experimentally verify the characteristics of D C motor by open circuit and short ciruit	10	Analysis of Losses in D C motors	Demonstrate	Slip Test	L2
2	Experimentally verify the characteristics of D C motor using two similar D C motors	06	Analysis of Combined losses in D C motors	Demonstrate	Assignment	L2
3	Analyze the load sharing of D C motors	07	Analysis of load distribution	Demonstrate	Assignment and Slip Test	L2
4	Analyze of connection of D C motor	03	Analysis of polarity connection	Simulation	Assignment	L3
5	Analyze different winding connection of D C motor.	03	Analysis of connection in 3 phase D C motors	Tutorial	Slip test	L2
6	Analyze conversion of 3phase to 2phase	03	Analysis of 3 phase-2phase conversion	Tutorial	Assignment	L2
7	Experimentally verify separation of of losses in synchronous motor	03	Analysis of Seperation of losses	Demonstrate	Assignment and Slip Test	L3
8	Analyze the voltage regulation of different methods	03	Analysis of voltage in motors	Demonstrate	Assignment	L2
9	Analyze the bus bar connection to motors	03	Analysis of voltage in alternators	Demonstrate	Assignment	L2
10	Analyze speed control of dc motor when load is connected	03	Analysis of speed when connected in load	Demonstrate	Assignment	L4
11	Analysis excitation of Alternators connected to infinite bus bar	03	Analysis of excitation of motors	Demonstrate	Assignment	L4
12	Analysis direct and quadrature axis reactance	03	Analysis Power Angle curve of	Demonstrate	Assignment	L4

			alternator			
-	**Total**	**60**	**-**	**-**	**-**	**-**

Note: Identify a max of 2 Concepts per unit. Write 1 CO per concept.

2. Lab Applications

SNo	Application Area	CO	Level
1	In power systems, varieties of insulation materials are used to protect the high voltage power apparatus such as D C motor, switchgear, current D C motor, potential D C motor etc.	CO1	L2
2	The D C motor oil is degraded due to the combination of the ageing processes such as partial discharge (PDs), electrical arcing	CO2	L2
3	the effects of different ageing processes on the optical absorption properties of insulating oil of a model D C motor is studied using a UV-visible spectrophotometer diagnostic method which is presently becoming a popular method to identify the ageing of the insulating oil of high voltage D C motors	CO3	L2
4	High voltage (HV) power apparatus determines the stability of any electrical power system	CO4	L3
5	Power D C motors are one of the most critical component of power system in which mineral oil is used for both insulation and cooling purposes. It acts a insulating medium between solid insulations like kraft paper, pressboard etc.	CO5	L2

Note: Write 1 or 2 applications per CO.

3. Articulation Matrix

(CO – PO MAPPING)

-	Course Outcomes	Program Outcomes												
#	COs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	Level
17EEL47.1	Experimentally verify the characteristics of D C motor by open circuit and short ciruit	X		X		X								L3
17EEL47.2	Experimentally verify the characteristics of D C motor using two similar D C motors		X					X						L4
17EEL47.3	Analyze the load sharing of D C motors	X			X					X				L3
17EEL47.4	Analyze of connection of D C motor		X				X							L3
17EEL47.5	Analyze different winding connection of D C motor.			X			X							L2
17EEL47.6	Analyze conversion of 3phase to 2phase	X				X								L2
17EEL47.7	Experimentally verify separation of of losses in synchronous motor				X			X						L3
17EEL47.8	Analyze the voltage regulation of different methods	X			X		X							L4
17EE47.9	Analyze the bus bar connection to motors	X			X		X							L4
17EE47	Average													

Note: Mention the mapping strength as 1, 2, or 3

4. Mapping Justification

Mapping		Mapping Level	Justification
CO	**PO**	**-**	**-**
CO1	PO1	L2	Understanding losses in DC motor
CO1	PO3	L3	Experimentally verify the characteristics of D C motor using two similar D C motors
CO1	PO5	L4	Analyze the load sharing of D C motors
CO2	PO2	L3	Analyze of connection of D C motor
CO2	PO7	L4	Analyze different winding connection of D C motor.
CO3	PO1	L3	Analyze conversion of 3phase to 2phase
CO3	PO4	L4	Experimentally verify separation of of losses in synchronous motor
CO3	PO9	L4	Analyze the voltage regulation of different methods
CO4	PO2	L4	Analyze the bus bar connection to motors
CO4	PO6	L4	Experimentally verify the characteristics of D C motor using two similar D C motors
CO5	PO3	L3	Analyze the load sharing of D C motors
CO5	PO6	L4	Analyze of connection of D C motor
CO6	PO1	L4	Analyze different winding connection of D C motor.
CO6	PO5	L3	Analyze conversion of 3phase to 2phase
CO7	PO4	L4	Experimentally verify separation of of losses in synchronous motor
CO7	PO7	L3	Analyze the voltage regulation of different methods
CO8	PO1	L4	Analyze the bus bar connection to motors
CO8	PO4	L4	
CO8	PO6	L3	

Note: Write justification for each CO-PO mapping.

5. Curricular Gap and Content

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					

Note: Write Gap topics from A.4 and add others also.

6. Content Beyond Syllabus

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					

Note: Anything not covered above is included here.

C. COURSE ASSESSMENT

1. Course Coverage

Unit	Title	Teaching Hours	No. of question in Exam							CO	Levels
			CIA-1	CIA-2	CIA-3	Asg-1	Asg-2	Asg-3	SEE		
1	a) Open Circuit and Short circuit tests on single phase step up or step down D C motor and predetermination of Efficiency and regulation (b) Calculation of parameters of equivalent circuit by conducting Open Circuit and Short circuit test	03	1	-	-	-	-	-	1	CO1	L2

2	Sumpner's test on similar D C motors and determination of combined and individual D C motor efficiency	03	1	-	-	-	-	-	1	CO2	L3
3	Parallel operation of two dissimilar single-phase D C motors of different kVA and determination of load sharing and analytical verification given the Short circuit test data.	03	1	-	-	-	-	-	1	CO3	L3
4	Polarity test and connection of 3 single-phase D C motors in star – delta and determination of efficiency and regulation under balanced resistive load	03	1	-	-	-	-	-	1	CO4	L3
5	Comparison of performance of 3 single-phase D C motors in delta – delta and V – V (open delta) connection under load.	03	1	-	-	-	-	-	1	CO5	L4
6	Scott connection with balanced and unbalanced loads.	03	-	1	-	-	-	-	1	CO6	L4
7	Separation of hysteresis and eddy current losses in single phase D C motor.	03	-	1	-	-	-	-	1	CO7	L4
8	Voltage regulation of an alternator by EMF and MMF methods.	03	-	1	-	-	-	-	1	CO8	L4
9	Voltage regulation of an alternator by ZPF method.	03	-	1	-	-	-	-	1	CO9	L4
10	Slip test – Measurement of direct and quadrature axis reactance and predetermination of regulation of salient pole synchronous machines.	03	-	1	-	-	-	-	1	CO10	L4
11	Performance of synchronous motor connected to infinite bus, under constant power and variable excitation & vice - versa.	03	-	-	1	-	-	-	1	CO11	L4
12	Power angle curve of synchronous motor	03	-	-	1	-	-	-	1	CO12	L4
-	**Total**	**36**	**5**	**5**	**5**	**5**	**5**	**5**	**20**	**-**	**-**

Note: Write CO based on the theory course.

2. Continuous Internal Assessment (CIA)

Evaluation	Weightage in Marks	CO	Levels
CIA Exam – 1	30	CO1, CO2, CO3, CO4	L23, L3
CIA Exam – 2	30	CO5, CO6, CO7,	L1, L2, L3 . .
CIA Exam – 3	30	CO5, CO6,	L1, L2, L3 . .

Assignment - 1	05	CO1, CO2, CO3, CO4	L2, L3, L4 ...
Assignment - 2	05	CO5, CO6, CO7,	L1, L2, L3 ...
Assignment - 3	05	CO8,	L1, L2, L3 ...
Seminar - 1	05	CO1, CO2, CO3, CO4	L2, L3, L4 . ..
Seminar - 2	05	CO5, CO6,	L2, L3, L4 . ..
Seminar - 3	05	CO8,	L2, L3, L4 . ..
Other Activities – define – Slip test		CO1	L2, L3, L4 . ..
Final CIA Marks	**40**	**-**	**-**

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SNo	Description	Marks
1	Observation and Weekly Laboratory Activities	05 Marks
2	Record Writing	10 Marks for each Expt
3	Internal Exam Assessment	25 Marks
4	Internal Assessment	15 Marks
5	SEE	80 Marks
-	**Total**	**100 Marks**

D. EXPERIMENTS

Experiment 01 : OPEN CIRCUIT & SHORT CIRCUIT TEST ON A SINGLE PHASE D C motor:

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Titlle	OPEN CIRCUIT & SHORT CIRCUIT TEST ON A SINGLE PHASE D C motor						
2	Course Outcomes	Experimentally verify the characteristics of D C motor by open circuit and short ciruit						
3	Aim	To perform open circuit and short circuit test on a single phase D C motor and to pre-determine the efficiency, regulation and equivalent circuit of the D C motor						
4	Material / Equipment Required							

Sl.No.	equipment	Type	Range	Quantity
1	Voltmeter	MI	(0-300)V , (0-150)V	1 no, 1 no
2	Ammeter	MI	(0-2)A , (0-20)A	1 no, 1 no
3	Wattmeter	Dynamo type	(0-300)V (0-2)A LPF	1 no
4	Wattmeter	Dynamo type	(0-150)V (0-10)A UPF	1 no

5	Theory, Formula, Principle, Concept	Find the equivalent circuit parameters R0, X0, R01, R02, X01 and X02 from the O. C. and S. C. Test results and draw the equivalent circuit referred to L. V. side as well as H. V. side No load power factor, **cos**≛ o= Wo / (Vo*Io)

Short circuit power factor, **cos**≛ sc = Wsc / (Vsc*Isc).

$R_0 = \frac{V_1}{I_w}$ where Iw = I0 cosΦ0 $X_0 = \frac{V_1}{I_m}$ Where Im = I0 sin Φ0

$$R_{01} = \frac{W_{sc}}{I_{sc}^2} \quad X_{01} = \sqrt{Z_{01}^2 - R_{01} b^2}$$

		$Z_{01}=\frac{V_{sc}}{I_{sc}}$ $X_{02}=K^2 X_{01}$ Where K = $\frac{V_2}{V_1}$ = Transformation Ratio
6	Procedure, Program, Activity, Algorithm, Pseudo Code	**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 $\mathbf{R_o}$ and $\mathbf{X_o}$ 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 $\mathbf{R_{01}}$ and $\mathbf{X_{01}}$ from the readings.

7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	For OC test

I) For OC test

Sl no.	Voltmeter reading (V_o)	Ammeter reading (I_o)	Wattmeter reading W_o	R_o	X_o	Cos ϕ_o

II) SC test

Sl no.	Voltmeter reading (V_{SC})	Ammeter reading (I_{SC})	Wattmeter reading W_{SC}	R_{01}	Z_{01}	X_{01}

9 Sample Calculations

Calculations to find efficiency and regulation

For example at ½ full load

Cupper losses = Wsc x $(1/2)^2$ watts, where WSC = full – load cupper losses

Constant losses = W0 watts Output = ½ KVA x cos Φ [cos Φ may be assumed]

Input = output + Cu. Loss + constant loss

$$\% = \frac{output}{input} x\,100$$

10	Graphs, Outputs	
11	Results & Analysis	hence performed open circuit and short circuit test on a single phase D C motor and to pre-determine the efficiency, regulation and equivalent circuit of the transforme
12	Application Areas	Used in Generation , Transmission and Distribution
13	Remarks	
14	Faculty Signature with Date	

Experiment 02 : Sumpner's test on similar D C motors and determination of combined and individual D C motor efficiency.

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	Sumpner's test						
2	Course Outcomes	Experimentally verify the characteristics of D C motor using two similar D C motors						
3	Aim	1) To conduct sumpner's test (heat run test) on two identical D C motors and hence to Predetermine the efficiency and regulation. 2) Determine combined and individual D C motor efficiency.						
4	Material / Equipment Required							

Sl No	PARTICULARS	RANGE	TYPE	QUANTITY
1	Ammeter	0-2A	MI	1
		0-10A	MI	1
2	Voltmeter	0-300V, 0-60V, 0-60MV	MI	3
3	Wattmeter	1A,300V 10A,75V	LPF UPF	1 1
4	D C motor	1KVA	1-Φ	2
5	AutoD C motor	-	-	2
6	SPST Switch	-	-	1

5 Theory, Formula, Principle, Concept

Total iron loss of both the D C motors = W_1 Watts.

Total copper loss of both the D C motors = W_2 watts.

Iron loss/ D C motor = $W_{IRON} = W_1 / 2$ Watts.

Copper loss / D C motor = $W_{COPPER} = W_2 / 2$ Watts

$$\text{Losses in each D C motor} = \frac{W_i + W_c}{2}$$

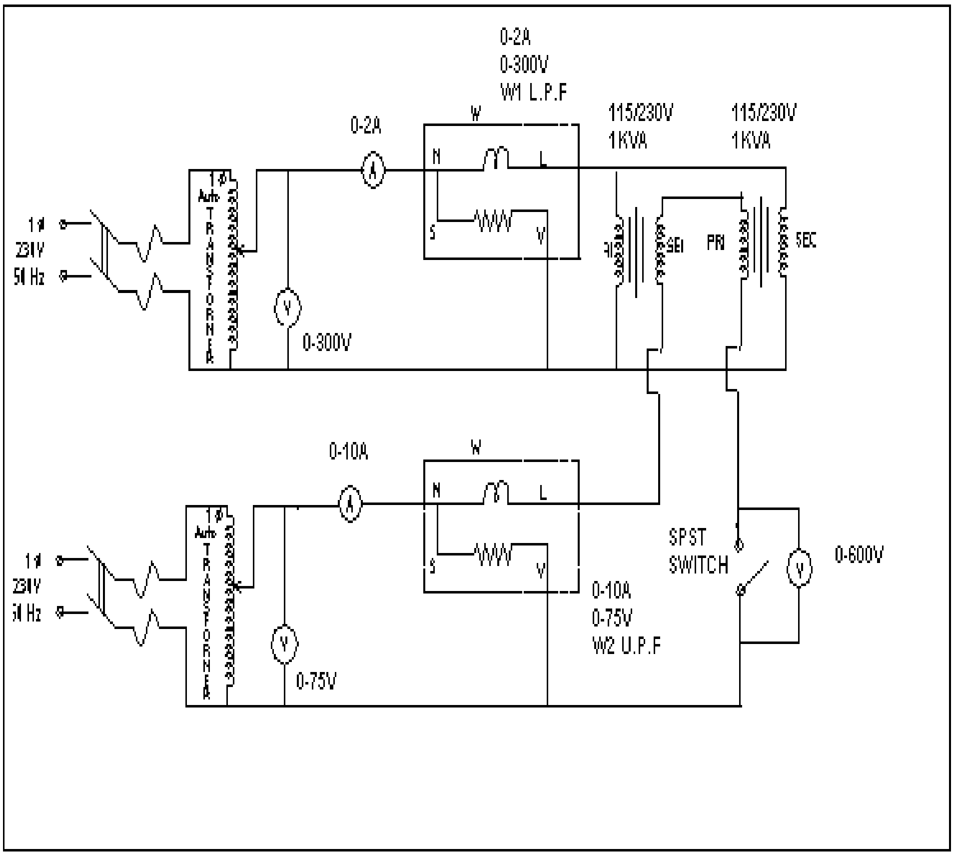
$$\%\eta \text{ combined} = \frac{V I_1}{V I_1 + W_i + W_c} x\ 100$$

$$\text{Efficiency of each D C motor } (\%\eta) = \frac{V I_1}{V I_1 + \frac{W_i}{2} + \frac{W_c}{2}} x100$$

The efficiency can be found out at unity power factor (Cos ϕ = 1) for different values of load factor.

6	Procedure, Program, Activity, Algorithm,	

	Pseudo Code	
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	



8 Observation Table, Look-up Table, Output

I_1 Amps	W_1*K_1 Watts	I_2 Amps	W_2*K_2 Watts

9 Sample Calculations

Wattmeter Constant, K = $\dfrac{V_{selected} X I_{selected} X p.f}{Maximum Scale of Wattmeter}$

Wattmeter Constant, K_1= Wattmeter Constant, K_2=

CALCULATIONS:

Total iron loss of both the D C motors = W_1 Watts.

Total copper loss of both the D C motors = W_2 watts.

Iron loss/ D C motor = W_{IRON} =W_1 / 2 Watts.

Copper loss / D C motor = W_{COPPER} =W_2 /2 Watts

Losses in each D C motor = $\dfrac{W_i + W_c}{2}$

$$\%\eta \text{ combined} = \frac{V I_1}{V I_1 + W_i + W_c} x\ 100$$

$$\text{Efficiency of each D C motor } (\%\eta) = \frac{V I_1}{V I_1 + \frac{W_i}{2} + \frac{W_c}{2}} x100$$

The efficiency can be found out at unity power factor (Cos ϕ = 1) for different values of load factor.

10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	Used to protect highly sensitive and high rating electrical equipments
13	Remarks	
14	Faculty Signature with Date	

Experiment 03 : Parallel operation of two dissimilar single-phase D C motors of different kVA and determination of load sharing and analytical verification given the Short circuit test data

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	Parallel operation of two dissimilar single-phase D C motors of different kVA and determination of load sharing and analytical verification given the Short circuit test data						
2	Course Outcomes	Analyze the load sharing of D C motors						
3	Aim	To study the performance of two dissimilar single phase D C motors when connected in Parallel & determination of load sharing and analytical verification given short circuit test data						

4 Material / Equipment Required

Sl No	PARTICULARS	RANGE	TYPE	QUANTITY
1	D C motor		1-Φ	2
2	Ammeter	0-10A, 0-5A, 0-20A	MI	3
3	Voltmeter	0-600V, 0-300V	MI	2
4	Wattmeter	10A,150V, 20A,150V	UPF	2
5	SPST Switch	-	-	1

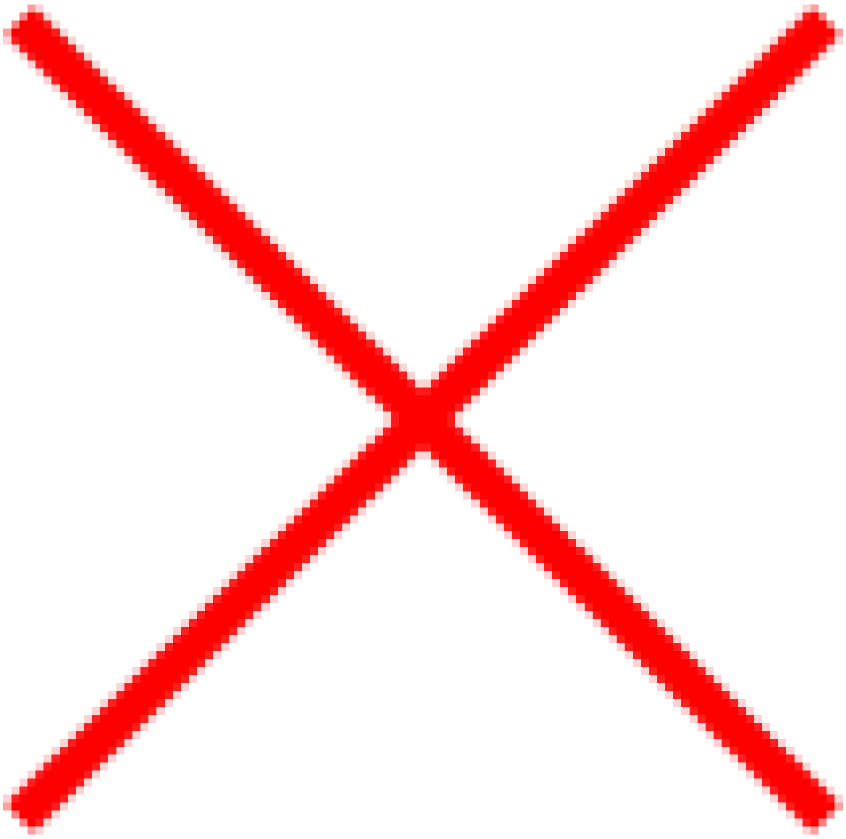
5 Theory, Formula, Principle, Concept

$$Z_B = \frac{V_{sc2}}{I_{sc2}} = ¿¿$$

$$R_A = \frac{W_{sc1}}{I_{sc1}^2} = \text{------------}\,\Omega \qquad R_B = \frac{W_{sc2}}{I_{sc2}^2} = \text{-----------}\,\Omega$$

X_A = $((Z_A)^2 - (R_A)^2)^{1/2}$ = ________Ω X_B = $((Z_B)^2 - (R_B)^2)^{1/2}$ = ________Ω

		$I_A = \frac{I_L * Z_B}{Z_A + Z_B} = Amps\, I_B = \frac{I_L * Z_A}{Z_A + Z_B} = Amps$ $Q_A = \frac{Q * Z_B}{Z_A + Z_B} = Q_B = \frac{Q * Z_A}{Z_A + Z_B} = ¿¿$
6	Procedure, Program, Activity, Algorithm, Pseudo Code	**01.** The circuit is rigged up as shown in the circuit diagram **02**. Keep autoD C motor in minimum position and the SPST switch is kept open; the main supply is switched ON. A small voltage (say 50V) is applied to the primaries of the D C motors by varying the output of the variac. **Note:** If the voltmeter across SPST switch shows zero reading, it indicates that the two secondary windings of the two D C motors are connected properly. If the voltmeter shows some value other than zero, it indicates that the two secondary windings of the D C motors are not connected properly. In that case, the output of the variac reduced to zero and the supply is switched OFF. Then the connections of the secondary terminals of any one of the D C motors are interchanged. After interchange secondary terminals, the supply is switched ON and a small voltage is applied. Now, the voltmeter will show zero reading. **03.** The SPST switch is closed after confirming the zero voltage across it and the rated voltage of the D C motor is applied to the primary windings. **04.** The no load readings of all the meters are noted down. **05.** The lamp loads are applied in equal steps and the corresponding meter readings are noted down and tabulated. **06.** Loading is continued till one of the D C motors carries its rated current. **07.** The loads are reduced to zero, the output of variac is reduced to zero and the supply switch is opened. **08.** Now, the connections are removed and short circuit test is conducted on both the D C motors separately, as explained in experiment number 01, and the readings are tabulated. 1. Bring the variac to minimum position and switch OFF the main supply. 2. Repeat the same procedure and note down 3 to 4

		breakdown voltages.
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	(see table below)
9	Sample Calculations	
10	Graphs, Outputs	
11	Results & Analysis	Breakdown strength of oil = (Breakdown voltage/ Distance between the two electrodes) in kV/ mm
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Sl. No.	I_A Amps	I_B Amps	I_L Amps	W_A watts	W_B Watts	V_L Volts	W_L watts

Experiment 04 :Polarity test and connection of 3 single-phase D C motors in star – delta and determination of efficiency and regulation under balanced resistive load.

	Experiment No.:	3	Marks	3	Date Planned		Date Conducted	

1 **Title**

Polarity test and connection of 3 single-phase D C motors in star – delta and determination of efficiency and regulation under balanced resistive load.

2 **Course Outcomes**

Analyze of connection of D C motor

3 **Aim**

To obtain the flash over characteristics of the following electrode configuration in air subjected to

HVAC

1 Plane - plane electrodes
2 Point - point electrodes
3 Plane - point electrodes

4 **Material / Equipment Required**

Sl No	PARTICULARS	RANGE	TYPE	QUANTITY
1	Ammeter	0-5A 0-10A	MI MI	2 1
2	Voltmeter	0-30V	MI	2
3	Wattmeter	0-5A,0-400V	UPF	2
4	3Φ Load	-	-	1
5	3Φ Auto TFR	-	-	1
6	1Φ TFR of equal rating	1KVA	-	3

5 **Theory, Formula, Principle, Concept**

Let V_{L1}= Line voltage on primary side

V_{L2} = Line voltage on secondary side

V_{ph1} = phase voltage on primary side

V_{ph2} = phase voltage on secondary side

K= transformation ratio

$V_{ph1} = \frac{V_{L1}}{\sqrt{3}}$, $\frac{V_{ph2}}{V_{ph1}} = K$

Therefore $V_{ph2}\,K\,V_{ph1} = K\frac{V_{L1}}{\sqrt{3}}$

Since secondary is connected in delta.

$V_{ph2} = V_{L2}$

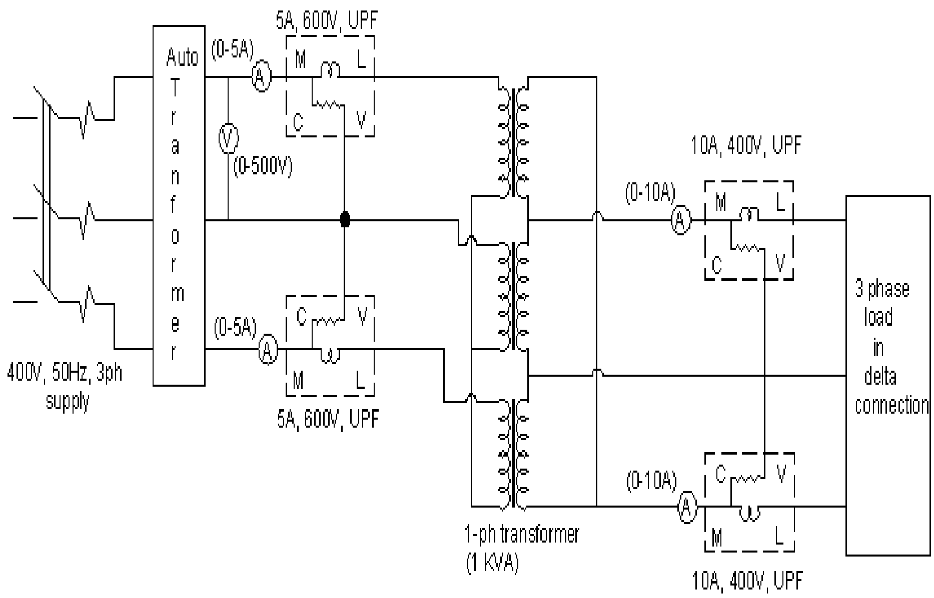
$V_{L2} = K\frac{V_{L1}}{\sqrt{3}} = \frac{K}{\sqrt{3}} V_{L1}$

Output $= W_3 + W_4$ =

Input $= W_1 + W_2$ =

6 **Procedure, Program,**

1. The circuit is rigged up as shown in the circuit diagram.
2. Keeping the load switch in minimum & the 3-phase autoD C motor

	Activity, Algorithm, Pseudo Code	in minimum position, the 3-phase supply is switched closed. 3. The 3-phase autoD C motor is varied to supply the rated voltage. 4. Gradually load is applied & at each step all the meter readings are noted down. 5. Load is applied until the rated current of the D C motor is reached. 6. Gradually load is decreased, 3-phase autoD C motor is bring back to initial zero position & supply switch is opened.
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	

8 Observation Table, Look-up Table, Output

Sl. No	V_1 (v)	W_1xK (W)	W_2xK (W)	W_3xK (W)	W_4xK (W)	I_1 (A)	I_2 (A)	I_3 (A)	I_4 (A)	%η

9 Sample Calculations

%η = (Output/ Input)*100 =

%Regulation= $(V_o – V_{1)}$ / V_0 * 100 =

10 Graphs, Outputs

11	Results & Analysis	
12	Application Areas	Used in industries generating stations
13	Remarks	
14	Faculty Signature with Date	

Experiment 05 : Comparison of performance of 3 single-phase D C motors in delta – delta and V – V (open delta) connection under load.

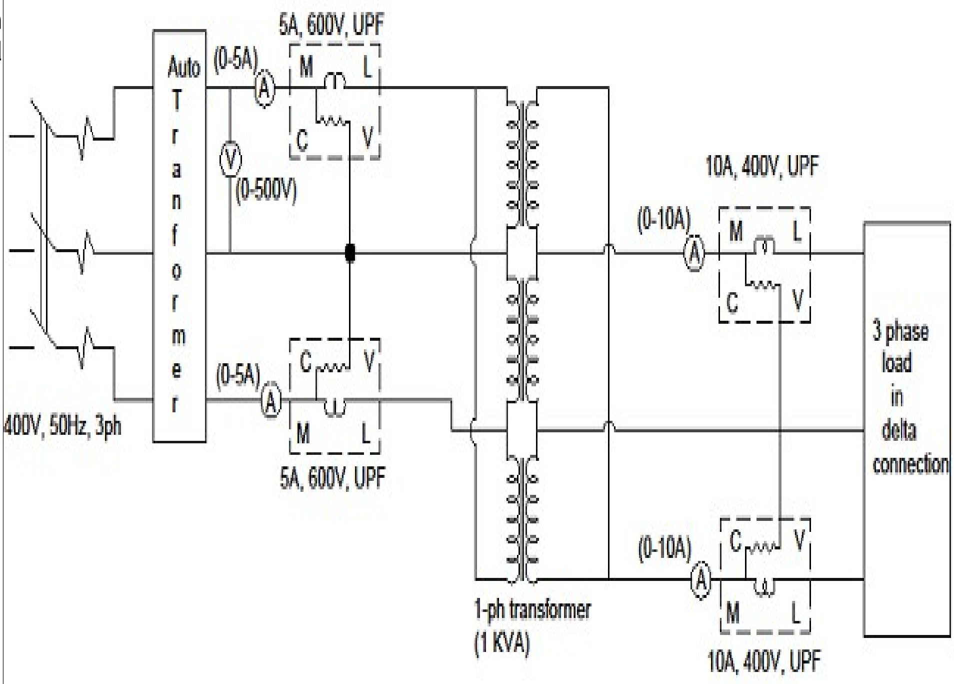
-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	Comparison of performance of 3 single-phase D C motors in delta – delta and V – V (open delta) connection under load.						
2	Course Outcomes	Analyze different winding connection of D C motor.						
3	Aim	To compare the performance of 3 single-phase D C motors in delta – delta and v – v (open delta) connection under load						
4	Material / Equipment Required	(see table below)						
5	Theory, Formula, Principle, Concept							
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1. The circuit is rigged up as shown in the circuit diagram. 2. Keeping the load switch in minimum & the 3-phase autoD C motor in minimum position, the 3-phase supply is switched closed.						

Material / Equipment Required:

Sl No	PARTICULARS	RANGE	TYPE	QUANTITY
1	Ammeter	0-5A, 0-10A	MI	2, 1
2	Voltmeter	0-30V	MI	2
3	Wattmeter	0-5A,0-400V	UPF	2
4	3Φ Load	-	-	1
5	3Φ Auto TFR	-	-	1
6	1Φ TFR of brating	1KVA equal	-	3

3. The 3-phase autoD C motor is varied to supply the rated voltage.
4. Gradually load is applied & at each step all the meter readings are noted down.
5. Load is applied less than the rated current of the D C motor is reached.
6. Gradually load is decreased, 3-phase autoD C motor is bringing back to initial zero position & supply switch is opened

7 Block, Circuit, Model Diagram, Reaction Equation, Expected Graph



8 Observation Table, Look-up Table, Output

Sl. No	V_1 (v)	W_1xK (W)	W_2xK (W)	W_3xK (W)	W_4xK (W)	I_1 (A)	I_2 (A)	I_3 (A)	I_4 (A)	%η

9 Sample Calculations

Let V_{L1}= Line voltage on primary side
V_{L2} = Line voltage on secondary side
V_{ph1} = phase voltage on primary side
V_{ph2} = phase voltage on secondary side
K= transformation ratio

		For delta connection, $V_{ph1} = V_{L1}$, Now $\frac{V_{ph2}}{V_{ph1}} = K$ Therefore $V_{ph2}\ K\ V_{ph1}$ But again since secondary is connected in delta. $V_{ph2} = V_{L2} = K\,V_{L1}$ Output $= W_3 + W_4$ = Input $= W_1 + W_2$ = $\%\eta$ = (Output/ Input)*100 = %Regulation= $(V_o - V_{1)}) / V_0 * 100$ =
10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	To check the break-down voltage of a D C motors
13	Remarks	
14	Faculty Signature with Date	

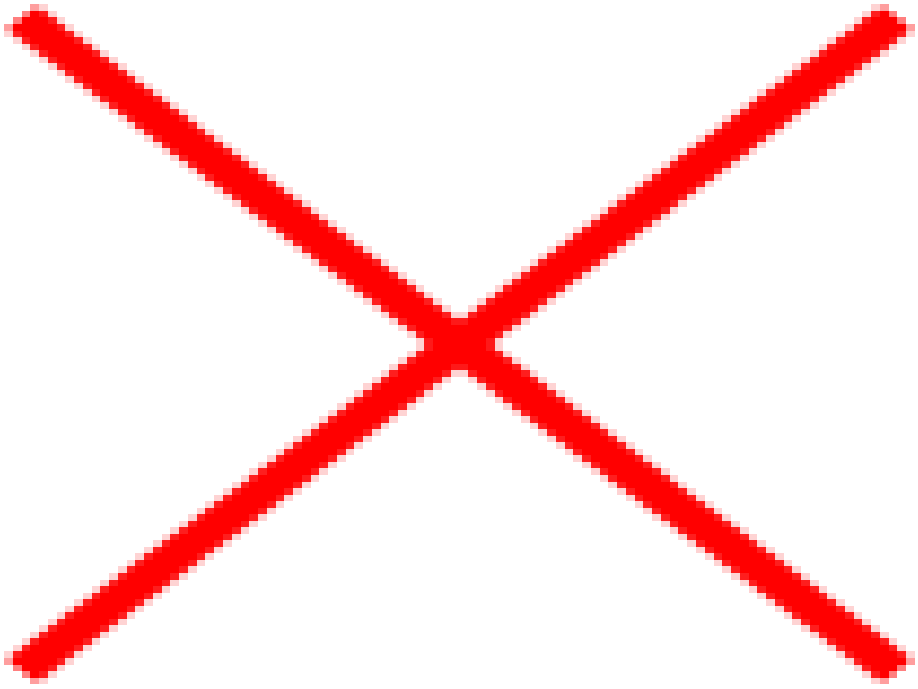
Experiment 06 : Scott connection with balanced and unbalanced loads.

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	Scott connection with balanced and unbalanced loads						
2	Course Outcomes	Analyze conversion of 3phase to 2phase						
3	Aim	Scott connection with balanced and unbalanced loads.						
4	Material / Equipment Required							

Sl No	PARTICULARS	RANGE	TYPE	QUANTITY
1	D C motor (With tapings)	2KVA	1-Φ	2
2	Ammeter	0-10A	MI	2
3	Voltmeter	0-300V	MI	2
4	Wattmeter	10A,300V	UPF	2

5	Theory, Formula, Principle, Concept	
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1.The circuit is rigged up as shown in the circuit diagram. 2. Keeping the 3-phase auto D C motor in minimum position, the 3-phase supply is switched ON. 3.The 3-phase auto D C motor is varied to supply 230V between the lines. 4.The secondary are loaded equally in steps and the readings of various meters are noted down and tabulated. (Equal loading) 5.Now, the load on one of the secondary is kept constant, and the load on the other secondary is increased in steps to load the D C motors unequally and the readings of various meters are noted down and tabulated. 6.The efficiencies of D C motors at different loads are calculated. A graph of efficiency Vs load is plotted for both equal and unequal loading conditions

7 Block, Circuit, Model Diagram, Reaction Equation, Expected Graph



8 Observation Table, Look-up Table, Output

Balanced Load

Sl.No	W_1*K1 watts	W_2 * K2 watts	V_1 volts	V_2 volts	I_1 Amps	I_2 Amps	
1							
2							
3							
4							
5							
6							
7							
8							

2) Unbalanced Load

Sl.No	W_1*K1 watts	W_2 * K2 watts	V_1 volts	V_2 volts	I_1 Amps	I_2 Amps	
1							
2							
3							
4							
5							
6							
7							

		8							
		ηη							
9	Sample Calculations								
10	Graphs, Outputs								
11	Results & Analysis								
12	Application Areas								
13	Remarks								
14	Faculty Signature with Date								

Experiment 07 : Separation of hysteresis and eddy current losses in single phase D C motor.

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	SEPARATION OF NO LOAD LOSSES IN 1-Φ D C motor						
2	Course Outcomes							
3	Aim	Separation of hysteresis and eddy current losses in single phase D C motor.						
4	Material / Equipment Required	(see table below)						
5	Theory, Formula, Principle, Concept							
6	Procedure, Program, Activity, Algorithm, Pseudo Code	(see procedure below)						

Sl.No.	Equipment	Type	Range	Quantity
1	Voltmeter	MI	(0-300V)	1 no
2	Ammeter	MC	(0-2)A	1 no
3	Rheostat	Wire-wound	570Ω /1.2A, 570Ω /1.2A	1 no, 1no
4	Wattmeter	Electro dynamo meter type	10A/600V LPF	1 no

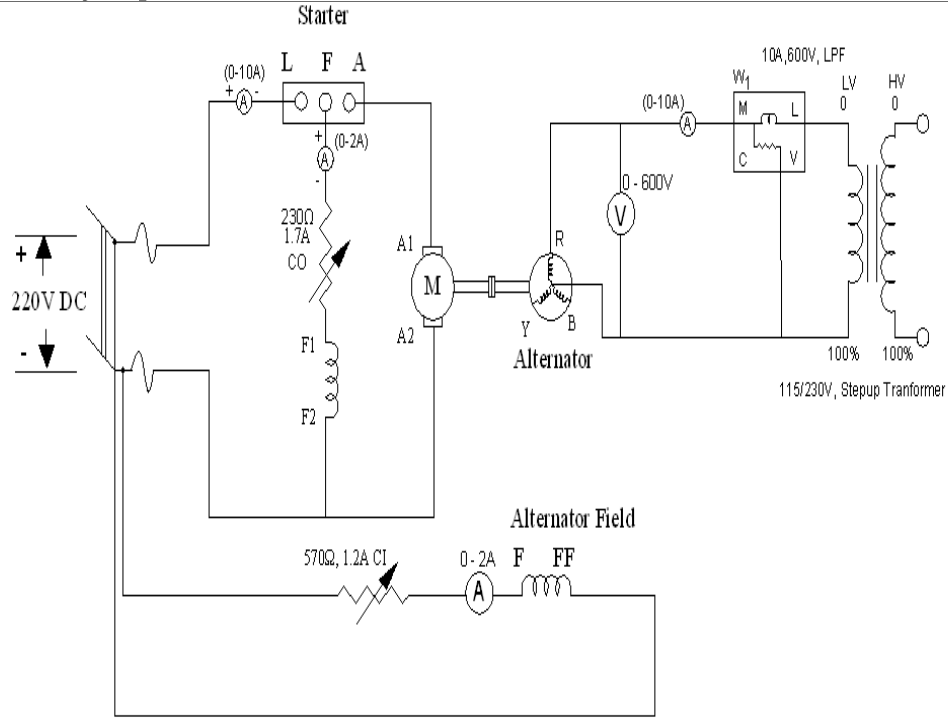
1. Make the circuit connections as per the circuit diagram.
2. The prime mover is started with the help of 3-point starter and it is made to run at rated speed.
3. By varying alternators field rheostat gradually, the rated primary voltage is applied to D C motor.
4. By adjusting the speed of prime mover the required frequency, is obtained and corresponding reading
   are noted.
5. The experiment is repeated for different frequency and corresponding

readings are tabulated.

6. The prime mover is switched off using the DPIC switch after bringing all the rheostats to initial position

7. From the tabulated readings the iron loss is separated from eddy current loss and hysteresis loss by using respective formulae

7 Block, Circuit, Model Diagram, Reaction Equation, Expected Graph



8 Observation Table, Look-up Table, Output

S. No	Speed of the prime moverN(rpm)	Supply frequency (f)Hz	Primary voltage (V)volts	Wattmeter readings(w)		Iron orcore Loss (Wi)watts	Wi/f
				Observed (watts)	Actual (watts)		

9 Sample Calculations

1. Frequency (f) =PNs/120
Where P-number of poles; Ns-Synchronous speed in rpm

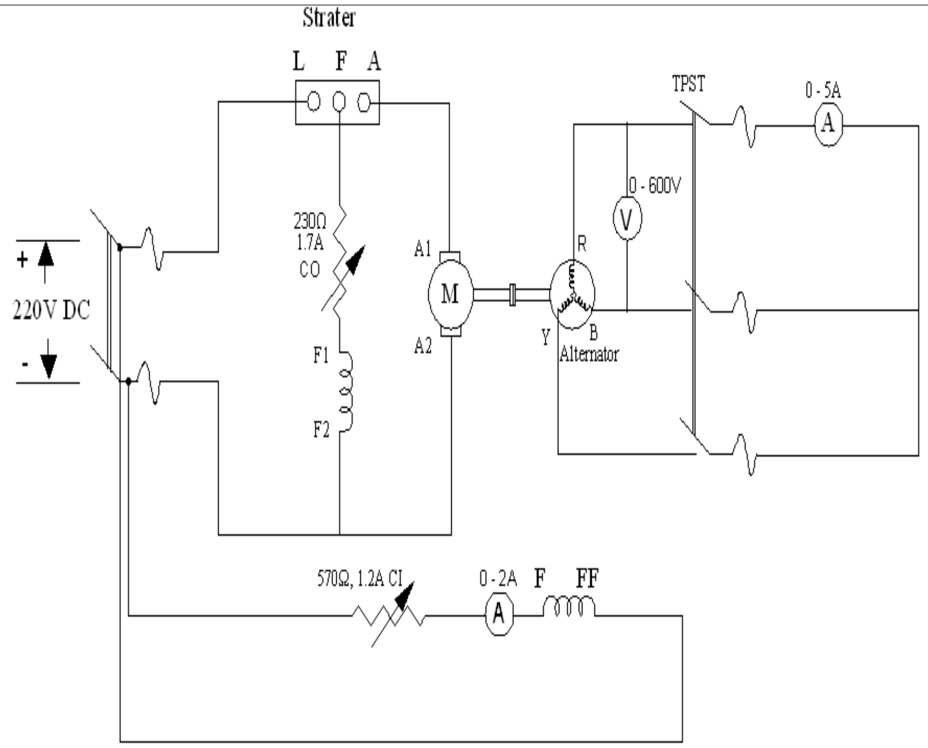
2. Hysteresis loss (Wh) =Af

3. Eddy current loss (We)=Bf^2

4. Iron loss or core loss (Wi)= We+Wh

10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Experiment 08 : VOLTAGE REGULATION OF AN ALTERNATOR BY I) EMF METHOD II) MMF METHOD.

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	VOLTAGE REGULATION OF AN ALTERNATOR BY I) EMF METHOD II) MMF METHOD						
2	Course Outcomes							
3	Aim	To perform the OC and SC tests on 3ϕ alternator and to predetermine the regulation by EMF and MMF methods						
4	Material / Equipment Required	: 1. Rheostat 230Ω/1.7A, 500 Ω/1.2A 2. DC ammeter 0-2A 3. AC ammeter 0-5A 4. AC voltmeter 0-600V 5. DC voltmeter 0-30V						
5	Theory, Formula, Principle, Concept							
6	Procedure, Program, Activity, Algorithm, Pseudo Code	**Open circuit test:** 1. Connections are made as shown in the circuit diagram. 2. DC motor is started by means of starter and brought to its rated speed by adjusting its field circuit Resistance. 3. With TPST switch open, field circuit resistance of alternator is varied						

in Steps. Note down the voltmeter and ammeter readings.

4. This procedure is repeated till 125% of alternator rated voltage is reached.

Short circuit test:

Steps 1 and 2 of OC test are repeated.

1. TPST switch is closed keeping alternator field circuit resistance maximum.
2. It is adjusted so that different current flow in the armature, each time
3. note down the readings of ammeter and voltmeter.

This is repeated till rated current is reached.

7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	(see below)

Open Circuit test: N= ___________rpm

Short Circuit Test

sl. no	Voltage	• current

Sl. no	I_a (Amps)	I_f (amps)

9 Sample Calculations

Synchronous Impedance =Zs = AC (volt) / √3 BC (amps) ohms

Synchronous reactance =Xs = $\sqrt{Z_S^2 - R_a^2}$

Synchronous reactance =Xs = $\sqrt{Zs^2 - Ra^2}$

$E_0 = \sqrt{(V cos + I a Ra)2 + (V sin \pm I a X s)2}$

'+' for lag p.f, '-' for lead p.f

Where, E_0 = per phase induced emf on No load V= rated terminal voltage /phase

Cos =P.F. of the load

% regulation(Vr) = [(E_0 –V) / V] x100

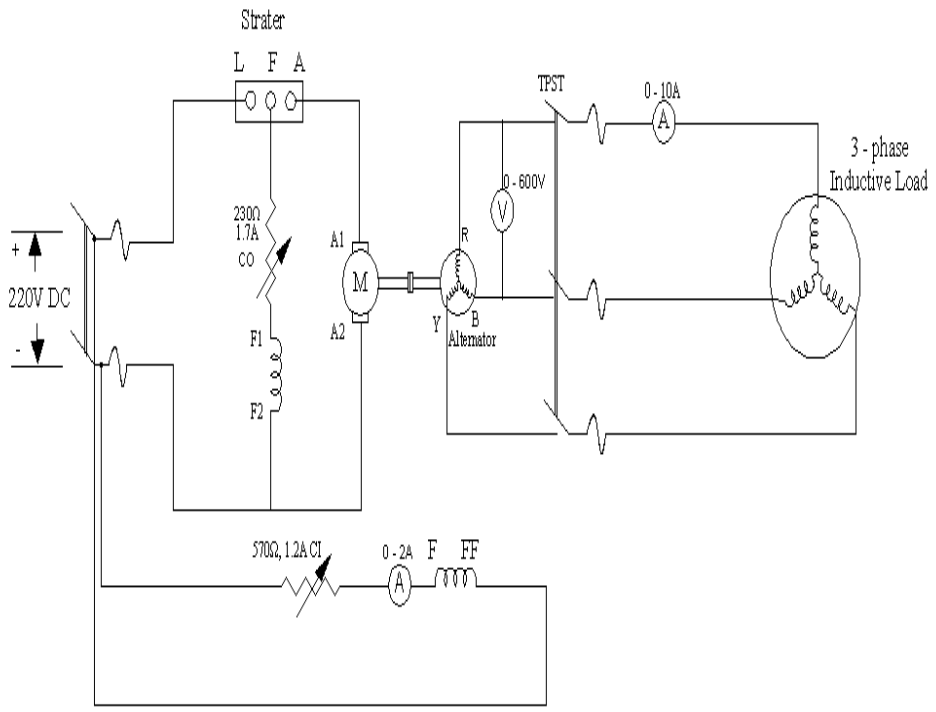
10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	

13	Remarks	
14	Faculty Signature with Date	

Experiment 09 :VOLTAGE REGULATION OF AN ALTERNATOR BY ZPF METHOD.

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	VOLTAGE REGULATION OF AN ALTERNATOR BY ZPF METHOD.						
2	Course Outcomes							
3	Aim	To perform the OC and SC tests on 3ϕ alternator and to predetermine the regulation by EMF and MMF methods						
4	Material / Equipment Required	1. Rheostat 230Ω/1.7A, 500 Ω/1.2A 2. DC ammeter 0-2A 3. AC ammeter 0-5A 4. AC voltmeter 0-600V 5. DC voltmeter 0-30V						
5	Theory, Formula, Principle, Concept							
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1. The OCC of the alternator is first drawn on a graph sheet. 2. The points A and A' on the ZPF characteristics are located using the readings taken during the ZPF & SC tests respectively. 3. From A', A' Q is drawn equal to and parallel to OA. From Q, QR is drawn parallel to airline, the initial straight part of OCC. 4. The triangle A'RQ is the **potier triangle.** This triangle is transferred along the OCC to get different points on the ZPF characteristics. 5. Now RS is drawn perpendicular to A' Q 6. A' Q represents the armature leakage reactance drop $IX_{L,}$ A' S represents the field current necessary to overcome demagnetizing effect of the armature reaction fig. B shows the vector diagram for lagging power factor load. The length of SQ represents field current required to induce an e.m.f for balancing leakage reactance drop RS.						

7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	



8	Observation Table, Look-up Table, Output	

P.F	%Reg
0.2 Lag	
0.4 Lag	
0.6 Lag	
0.8 Lag	
1.0	
0.8 Lead	
0.6 Lead	
0.4 Lead	
0.2 Lead	

-
-

9	Sample Calculations	
10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Experiment 10 : SLIP TEST ON SALIENT POLE ALTERNATOR

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	SLIP TEST ON SALIENT POLE ALTERNATOR						
2	Course Outcomes							
3	Aim	Measurement of direct and quadrature axis reactance and						

predetermination of regulation of salient pole synchronous machines

4 Material / Equipment Required

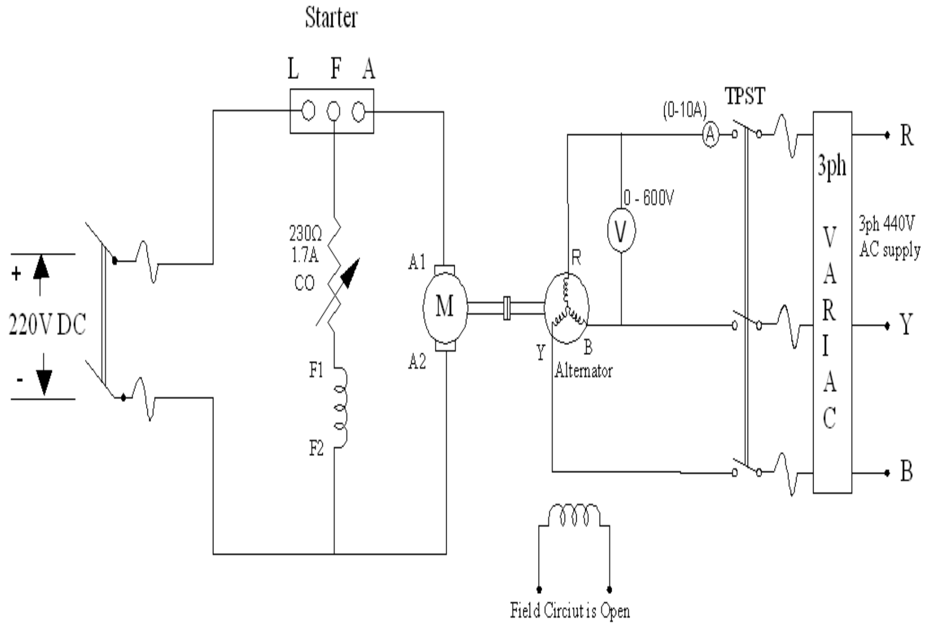
Sl. No.	Equipment	Type	Range	Quantity
1	Voltmeter	MI	(0-300)V	1 no
2	Ammeter	MI	(0-5)A	1 no
3	Rheostat	Wire-wound	570 Ω /1.2A	1 no

5 Theory, Formula, Principle, Concept

6 Procedure, Program, Activity, Algorithm, Pseudo Code

1. Connections are made as per the circuit diagram.
2. Initially set field regulator, 3-ϕ variac at minimum position and TPST switch open.
3. The DC motor is started slowly by sliding starter handle and it is run at a speed slightly less than the synchronous speed of the alternator.
4. Close the TPST switch.
5. With field winding left open, a positive sequence balanced voltages of reduced magnitude (around 25% of rated Value) and of rated frequency are impressed across the armature terminals.
6. The prime mover (DC motor) speed is adjusted till ammeter and voltmeters pointers swing slowly between maximum and minimum positions.
7. Under this condition, readings of maximum and minimum values of both ammeter and voltmeter are recorded

7 Block, Circuit, Model Diagram, Reaction Equation, Expected Graph



8 Observation Table, Look-up Table, Output

I_{max} amps	I_{min} amps	$V_{p\,max}$ volts	$V_{p\,min}$ volts	X_d	X_q	P.f(cos ㄹㅂ)	ㄹㅂ	Sin ㄹㅂ

-
-

9 Sample Calculations

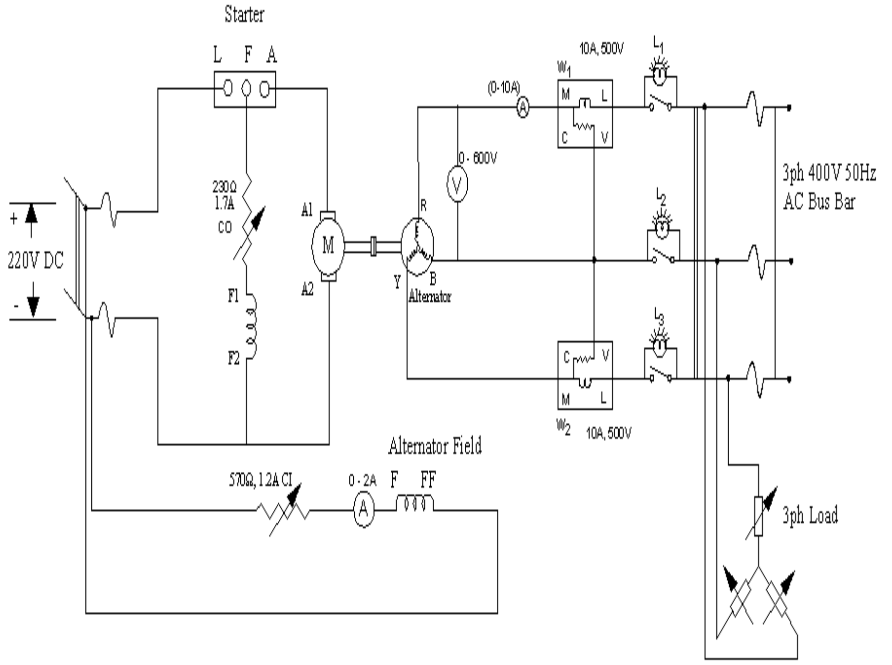
CALCULATIONS:

- $X_d = \frac{maximum\ armature\ terminal\ voltage\ per\ phase}{minimum\ armature\ current\ per\ phase}$
-
- $X_q = \frac{minimum\ armature\ terminal\ voltage\ per\ phase}{maximum\ armature\ current\ per\ phase}$
-
-
- X_d =Vmax /√3 Imin , X_q=Vmin/√3 Imax,
- =$\cos^{-1}$(p.f)
- Ia =√ (Imax) ^{2}+ (Imin) ^{2}
- θ =$\tan^{-1}$ (Vsin +I_qX_q / Vcos +Ia Ra)
- δ = θ –
- I_d = Ia sin θ, I_q =Ia cos θ
- Eo = V cos δ +I_q R_a +I_d X_d
- %regulation = [(Eo –v) / v] X100

10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Experiment 11 : PERFORMANCE OF SYNCHRONOUS MOTOR CONNECTED TO INFINITE BUS, CONSTANT POWER VARIABLE EXCITATION & VICE VERSA

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	PERFORMANCE OF SYNCHRONOUS MOTOR CONNECTED TO INFINITE BUS, CONSTANT POWER VARIABLE EXCITATION & VICE VERSA						
2	Course Outcomes							
3	Aim	To Observe the Performance of synchronous motor connected to infinite bus, under constant power and variable excitation and vice –versa						
4	Material / Equipment Required							
5	Theory, Formula,							

	Principle, Concept	
6	Procedure, Program, Activity, Algorithm, Pseudo Code	step 1: step 2: step 3: step 4: step 5: step 6: step 7:
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	see below
9	Sample Calculations	
10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	
13	Remarks	

i)EFFECT OF VARYING EXCITATION:

- N =____________ rpm

Field current amps	W1 watts	W2 watts	P.F =W!W2 /√3 VIL	Load current Amps
•	•	•	•	•
•	•	•	•	•
•	•	•	•	•
•	•	•	•	•

- **ii) EFFECT OF VARYING POWER INPUT**
- I_F = _______________amps

Sl.no	Speed (N) Rpm	Ia Amps	W1 Watts	W2 Watts	W=W1+W2
	•	•	•	•	•

-
-

14	Faculty Signature with Date	

Experiment 12 : POWER ANGLE CURVE OF SYNCHRONOUS motor

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	POWER ANGLE CURVE OF SYNCHRONOUS motor						
2	Course Outcomes							
3	Aim	To determine direct and quadrature axis reactance and plot power Vs load angle graph						
4	Material / Equipment Required	(see table below)						
5	Theory, Formula, Principle, Concept							
6	Procedure, Program, Activity, Algorithm, Pseudo Code	(see procedure below)						

Sl. No.	Equipment	Type	Range	Quantity
1	Voltmeter	MI	(0-300)V	1 no
2	Ammeter	MI	(0-5)A	1 no
3	Rheostat	Wire-wound	570 Ω /1.2A	1 no

1. Connections are made as per the circuit diagram.

2. Initially set field regulator, 3-ϕ variac at minimum position and TPST switch open.

3. The DC motor is started slowly by sliding starter handle and it is run at a speed slightly less than the synchronous speed of the alternator.

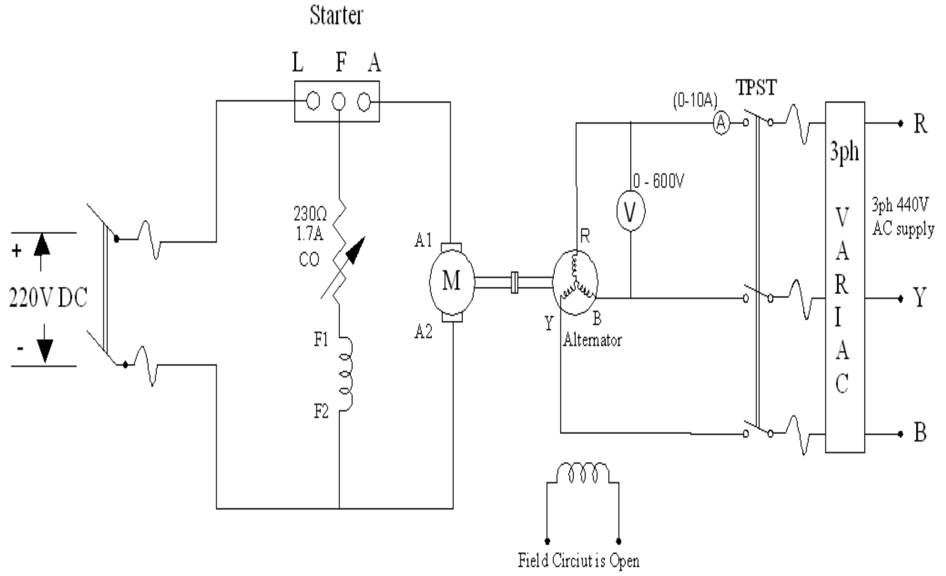
4. Close the TPST switch.

5. With field winding left open, a positive sequence balanced voltages of reduced magnitude (around 25% of rated Value) and of rated frequency are impressed across the armature terminals.

6. The prime mover (DC motor) speed is adjusted till ammeter and voltmeters pointers swing slowly between maximum and minimum positions.

7. Under this condition, readings of maximum and minimum values of both ammeter and voltmeter are recorded

7 Block, Circuit, Model Diagram, Reaction Equation, Expected Graph



8 Observation Table, Look-up Table, Output

Speed	I_{max} amps	I_{min} amps	$V_{p\ max}$ volts	$V_{p\ min}$ volts	X_d	X_q	P.f	ㄹㅂ

9 Sample Calculations

$$X_d = \frac{maximum\ armature\ terminal\ voltage\ per\ phase}{minimum\ armature\ current\ per\ phase}$$

$X_q =$

- $X_d = V_{max} / \sqrt{3}\ I_{min}$, $X_q = V_{min} / \sqrt{3}\ I_{max}$
- $= \cos^{-1}(p.f)$
- $I_a = \sqrt{(I_{max})^2 + (I_{min})^2}$

$\theta = \tan^{-1} (V\sin \ + I_q X_q / V\cos \ + I_a R_a)$

$\delta = \theta -$

		$I_d = Ia \sin\theta$ $I_q = Ia \cos\theta$ $Eo = V \cos\delta + I_q R_a + I_d X_d$
10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	