MALLA REDDY ENGINEERING COLLEGE
(Autonomous)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

LAB MANUAL
AC MACHINES LAB

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CLASS	**: III YEAR EEE**
SEMESTER	**: I SEM**
SUBJECT CODE	**: 80216**
REGULATION	**: MR18**
SUBJECT	**: AC Machines Lab**

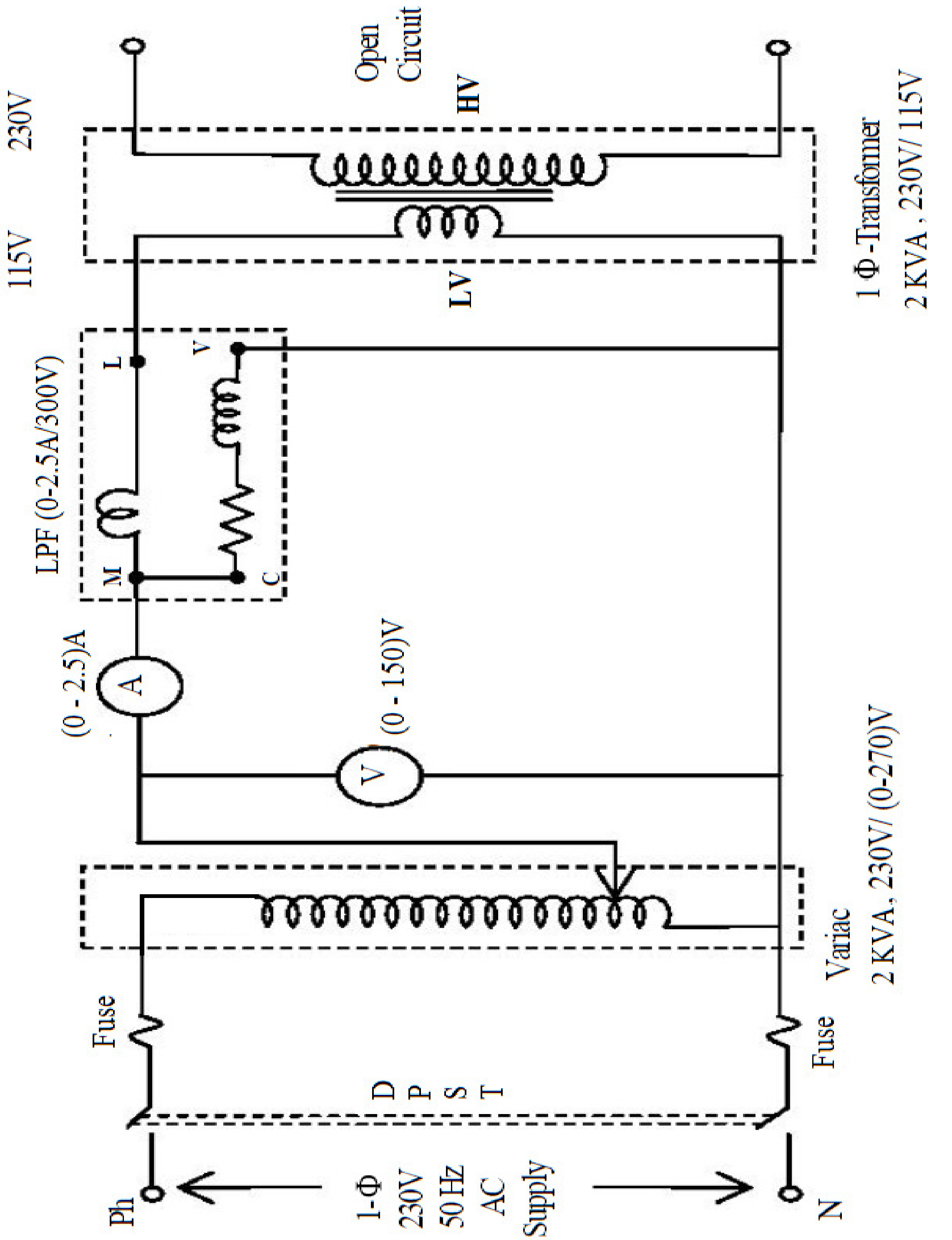
SYLLABUS

1. OC & SC Tests on Single phase Transformer.
2. Sumpner's test on a pair of single phase transformers.
3. Scott connection of transformers.
4. No-load & Blocked rotor tests on three phase Induction motor.
5. Regulation of a three –phase alternator by synchronous impedance & m.m.f. methods.
6. V and Inverted V curves of a three-phase synchronous motor.
7. Equivalent Circuit of a single phase induction motor.
8. Determination of Xd and Xq of a salient pole synchronous machine.
9. Parallel operation of Single phase Transformers.
10. Brake test on three phase Induction Motor.
11. Regulation of three-phase alternator by Z.P.F. and A.S.A methods.
12. Load test of a three-phase alternator.

EXPERIMENT-1

OC & SC TESTS ON SINGLE PHASE TRANSFORMER

CIRCUIT DIAGRAM FOR OPEN CIRCUIT TEST ON 1-PHASE



T/F:

O.C & S.C TESTS ON SINGLE PHASE TRANSFORMER

AIM: a)To predetermine the efficiency and regulation of Single Phase Transformer by conducting no-load test and short circuit test.

b)To draw the equivalent circuit of single phase transformer referred to LV side as well as HV side.

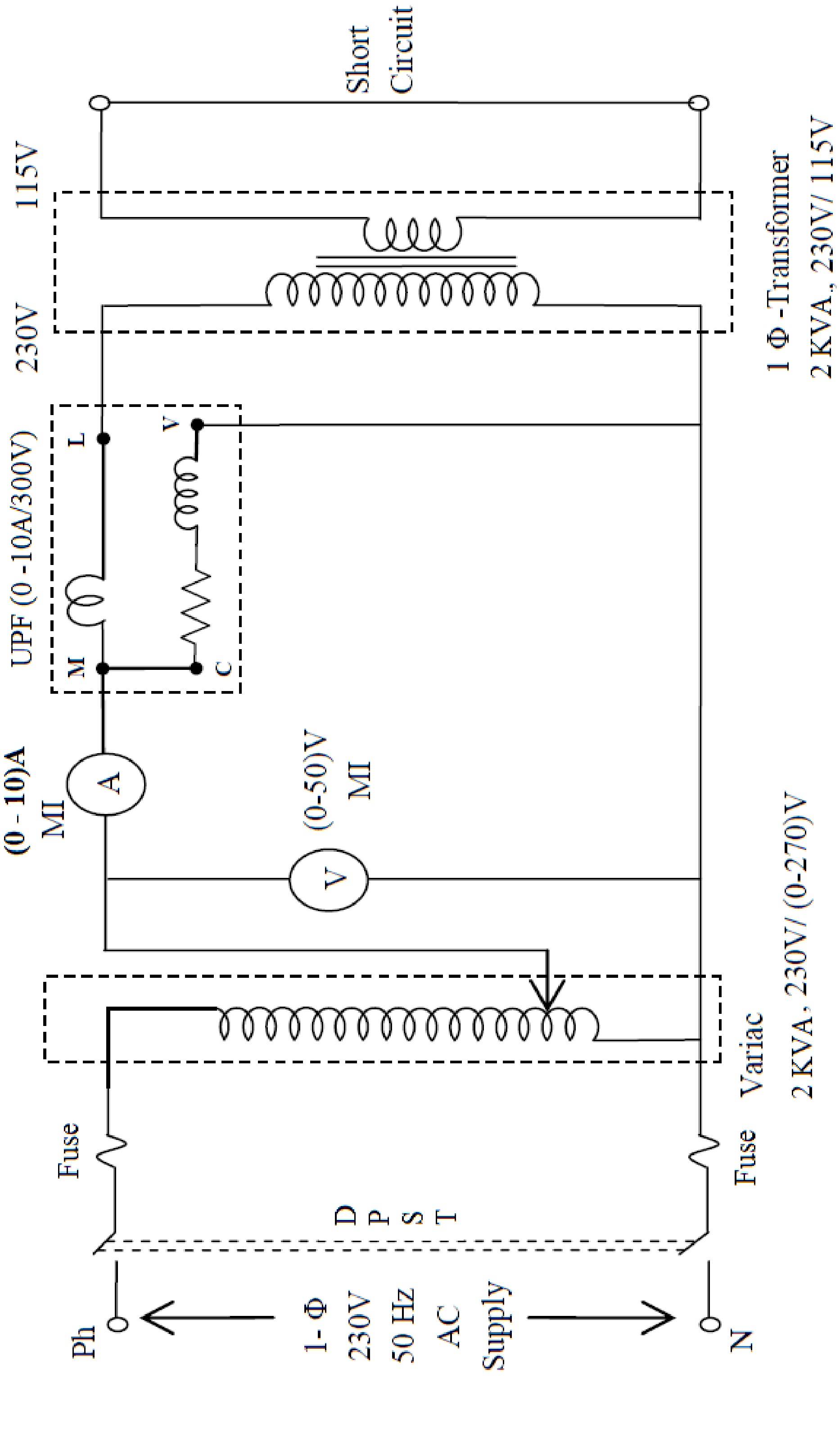
APPARATUS:

S.NO.	NAME OF THE EQUIPMENT	TYPE	RANGE	QUANTITY
1.	Single phase Variac		2KVA,0-270V	1
2.	Ammeter	MI	0-2.5A and 0-10A	1,1
3.	Voltmeter	MI	0-300 V, 0-30V	1,1
4.	Wattmeter	Dynamometer	(0-2.5A/300V) LPF	1
5.	Wattmeter	Dynamometer	(0-10A/300V) UPF	1

NAME PLATE DETAILS:

S.No.	1-Φ TRANSFORMER	
	PARAMETER	**RATING**
1	Capacity	
2	I/P voltage	
3	I/P Current	
4	O/P Voltage	
5	O/P Current	
6	Frequency	

CIRCUIT DIAGRAM FOR SHORT CIRCUIT TEST ON 1-PHASE T/F:



PROCEDURE:

(1) Connect the circuit for no-load test as per the circuit diagram. Shown in fig(1).
(2) Keep the variac in minimum output position and switch on the supply.
(3) Apply the rated voltage to the transformer by properly adjusting the variac.
(4) Note down the readings of various meters and switch off the supply.
(5) Connect the circuit for SC test as per the circuit diagram, shown in fig (2) with appropriate ranges of meters.
(6) Keep the variac in minimum output position and switch on the supply.
(7) Apply proper voltage (low voltage) to the transformer by adjusting the variac such that rated current flows through the transformer.
(8) Note down the readings of various meters and switch off the supply.

PRECAUTIONS:

(i) Connections must be made tight
(ii) Before making or breaking the circuit, supply must be switched off.

OBSERVATIONS:

O.C TEST

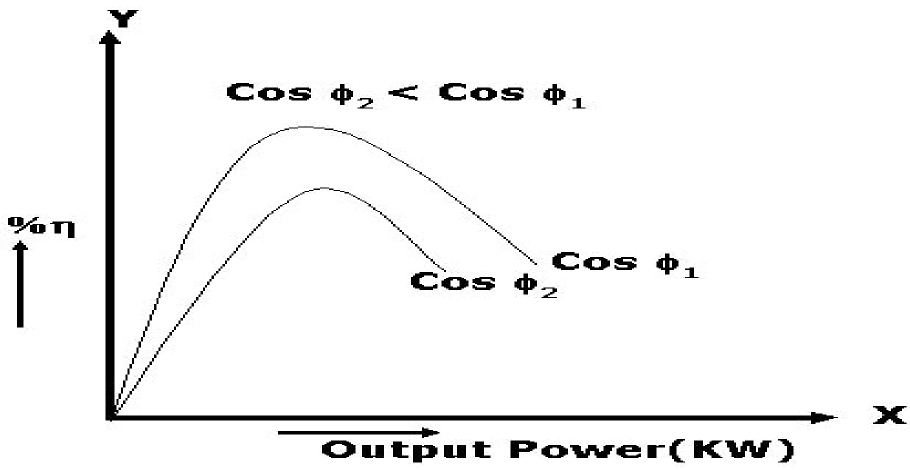
S.NO.	V_o (V)	I_o (A)	Wo(W)

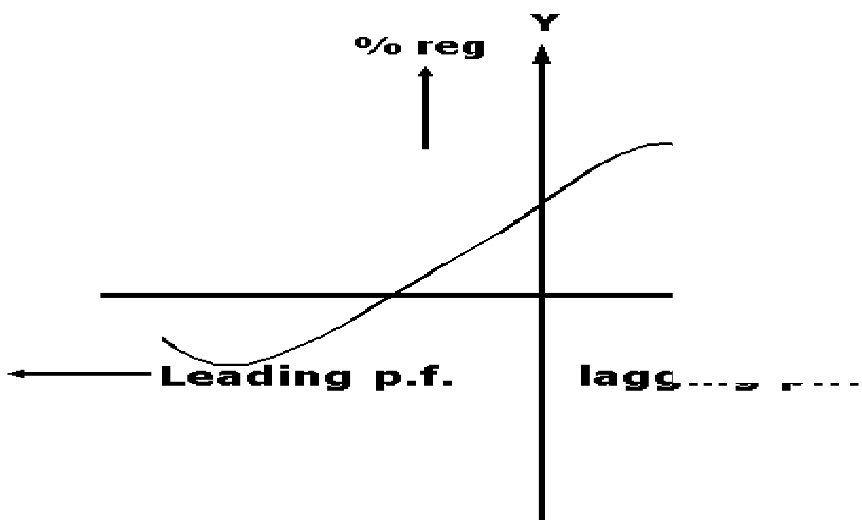
S. C TEST:

S.NO.	V_{SC} (V)	I_{SC} (A)	W_{SC}(W)

MODEL GRAPHS: PLOTS DRAWN BETWEEN

(i) % Efficiency Vs Output
(ii) % Regulation Vs Power Factor





MODEL CALCULATIONS:

Find the equivalent circuit parameters R_0, X_0, R_{01}, R_{02}, X_{01} and X_{02} 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.

Let the transformer be the step-down transformer
Primary is H. V. side.

Secondary is L. V. side

$\cos \phi_0 = \frac{W_0}{V_0 I_0}$ =

$\sin \phi_0 =$

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

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

$R_{02} = \frac{W_{SC}}{I_{sc}^2} =$

$Z_{02} = \frac{V_{SC}}{I_{SC}}$

$X_{02} = \sqrt{Z_{01}^2 - R_{01}^2}$ =

$X_{01} = K^2 X_{02}$ = Where $K = \frac{V_2}{V_1} = 1$ Transformation ratio.

$R_{01} = K^2 R_{02}$ =

CALCULATIONS OF EFFICIENCY AND REGULATION

For example at ½ full load

Cupper losses = W_{sc} x $(1/2)^2$ watts, where W_{SC} = full – load cupper losses

Constant losses = Wi watts

Output = ½ KVA x cos ϕ [cos ϕ may be assumed]

Input = output + Cu. Loss + constant loss

$$\% \ efficiency = \frac{Output}{Input} \ x \, 100$$

$$\text{Efficiency at any load} = \frac{S \ x \ \chi \ x \ \cos\phi}{S \ x \ \chi \ x \ \cos\phi + W_i + W_{sc} \, \chi^2} \ X \, 100$$

Regulation:

From open circuit

$$\% \ \text{Re}\, gulation \ = \frac{I_1 R_{01} \ \cos\phi \pm I_1 X_{01} \ \sin\phi}{V_1} \ x \ 100$$

'+' for lagging power factors

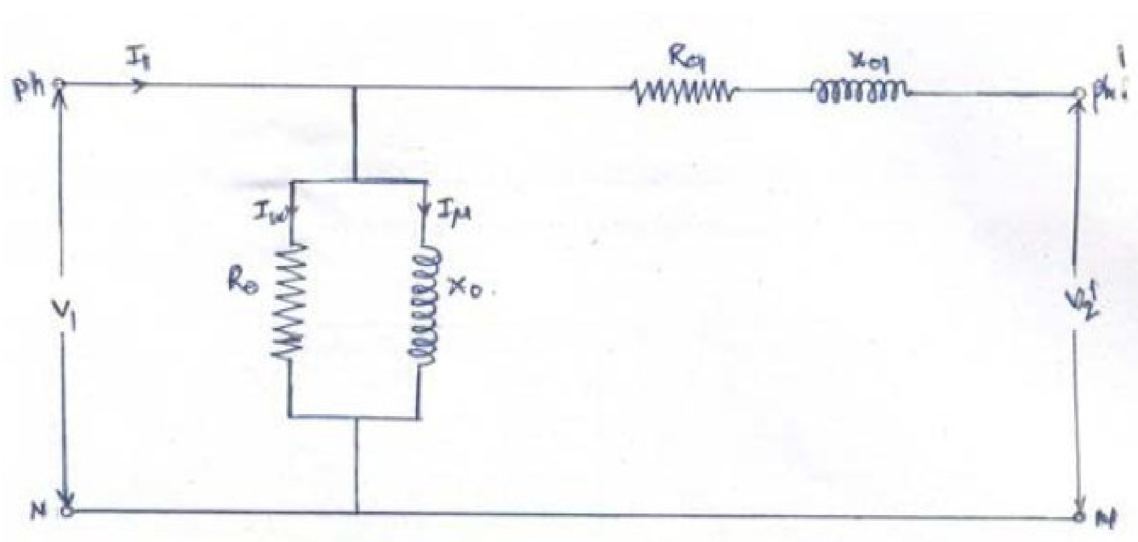
'-' for leading power factors

FOR S.C. TEST:

Regulation: From Short circuit test

$$\% \ \text{Re}\, gulation \ = \frac{I_2 R_{02} \ \cos\phi \pm I_2 X_{02} \ \sin\phi}{V_2} \ x \ 100$$

EQUIVALENT CIRCUIT:

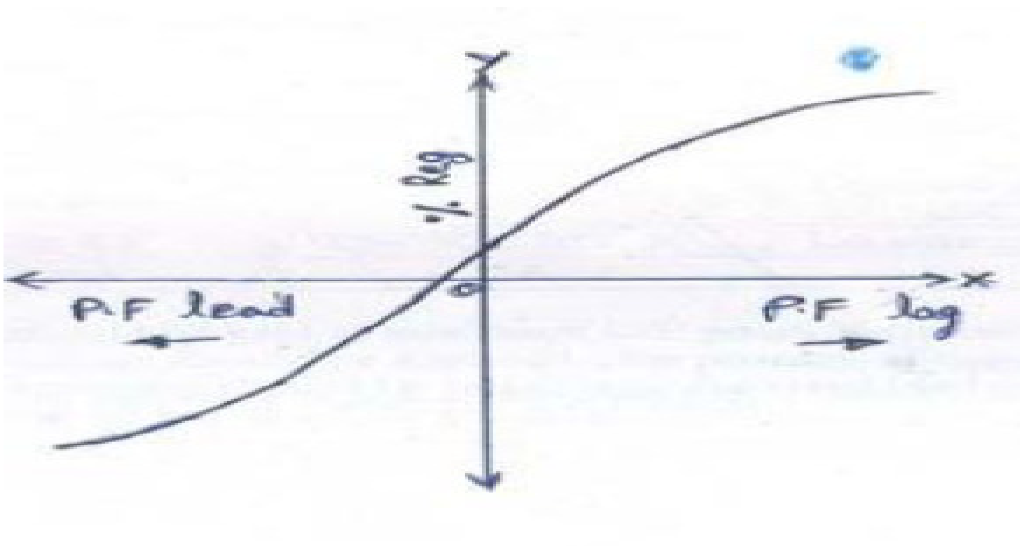


TABULAR FORM

S.No.	Load	Cu.loss (W)	Output (W)	Input (W)	%η		S.N.	Load	Cu.loss (W)	Output (W)	Input (W)	%η
1.	¼F.L.							¼F.L.				
2.	½F.L.							½F.L.				
3.	¾F.L.							¾F.L.				
4.	F.L.							F.L.				

Lagging Pf			Leading Pf		
S.N.	**P.F.**	**% Reg.**	**S. N.**	**P. F.**	**% Reg.**
1.	0.3		1.	0.	
2.	0.4		2.	0.4	
3.	0.5		3.	0.5	
4.	0.6		4.	0.6	
5.	0.7		5.	0.7	
6.	0.8		6.	0.8	
7.	Unity		7.	Unity	

REGULATION MODEL GRAPH:

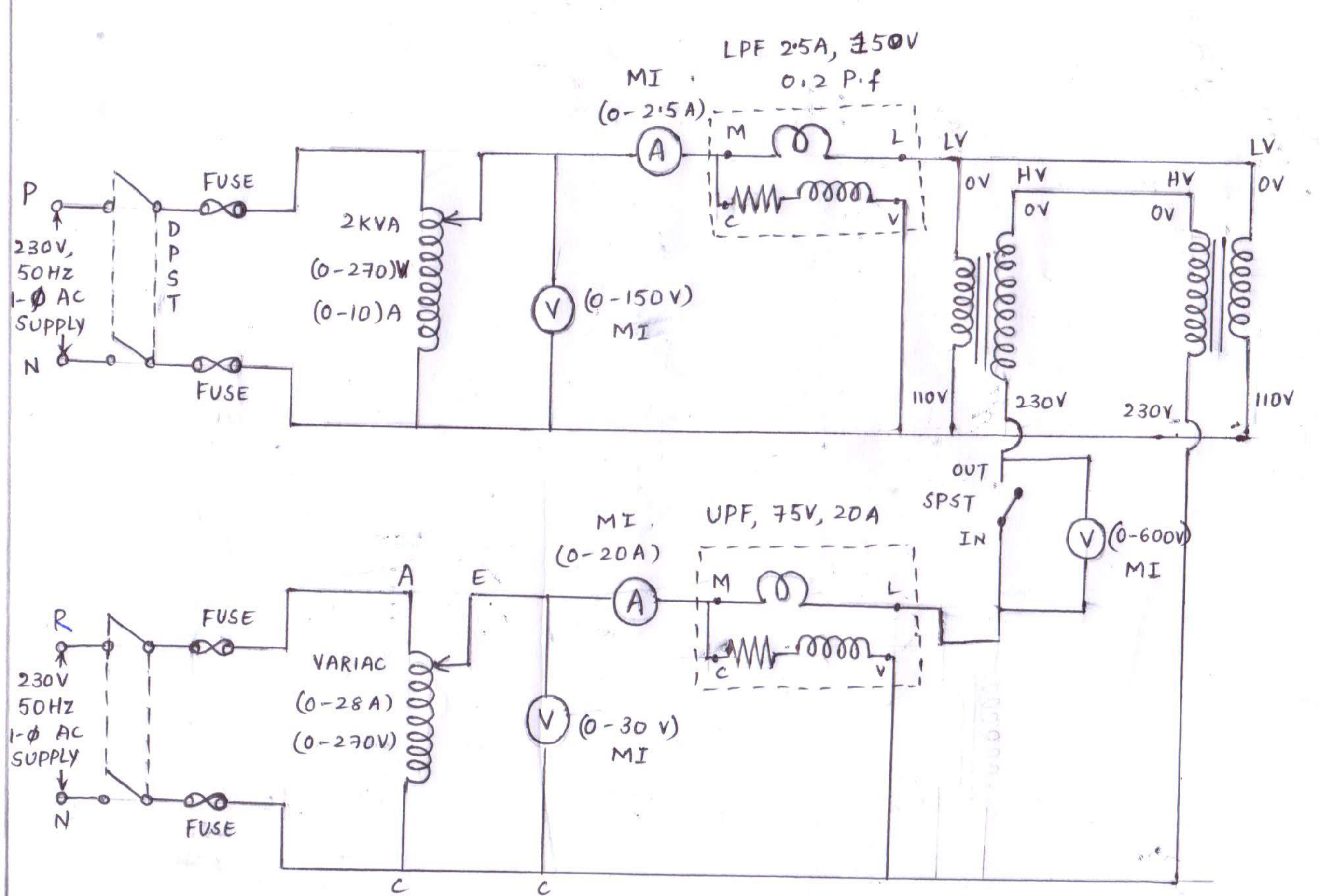


RESULT:

EXPERIMENT-2

SUMPNER'S TEST ON A PAIR OF SINGLE PHASE TRANSFORMERS

CIRCUIT DIAGRAM FOR SUMPNER'S TEST ON 1-Φ TRANSFORMER



SUMPNER'S TEST ON 1-PHASE TRANSFORMER

AIM: (i) To conduct sumpner's test on two identical single phase transformers.

(ii) To find out the iron loss, copper loss and the efficiency of each transformer**.**

NAME PLATE DETAILS:

1-PHASE TRANSFORMER		
S.No.	**NAME**	**RATING**
1	Power	
2	Voltage	
3	Frequency	
4	Taps On H.V	

APPARATUS REQUIRED:

S.No.	**NAME**	**TYPE**	**RANGE**	**QUANTITY**
1	Voltmeter	MI	(0-30)V (0-300)V	1 1
2	Ammeter	MI	(0-2.5)A (0-20)A	1 1
3	Variac	-	(0-20)A	1
4	Wattmeter	Dynamometer type	300V,5A,LPF 75V,10A,UPF	1 1

PROCEDURE:

OC TEST:

1. Connect the circuit as per the circuit diagram.
2. Set the autotransformer at low voltage position.
3. Switch on the low voltage side auto transformer.
4. Apply rated voltage by adjusting the auto transformer.
5. Note the values of applied voltage, current and power readings is given by wattmeter.
6. The readings of wattmeter will give the iron losses.

SC TEST:

1. Close the DPST switch
2. Switch ON the supply 1-phase,50hz,230v on secondary side of the transformer
3. By slowly varying the 1-phase auto t/f till the rated current is reached
4. Now take the voltage voltmeter(v1&v2),ammeter(A1&A2),W1&W2 respectively
5. Switch OFF the supply

PRECAUTIONS:

(iii) Connections must be made tight

(iv) Before making or breaking the circuit, supply must be switched off.

OBSERVATIONS:

O.C TEST

S.NO.	V_o (V)	I_o (A)	Wo(W)

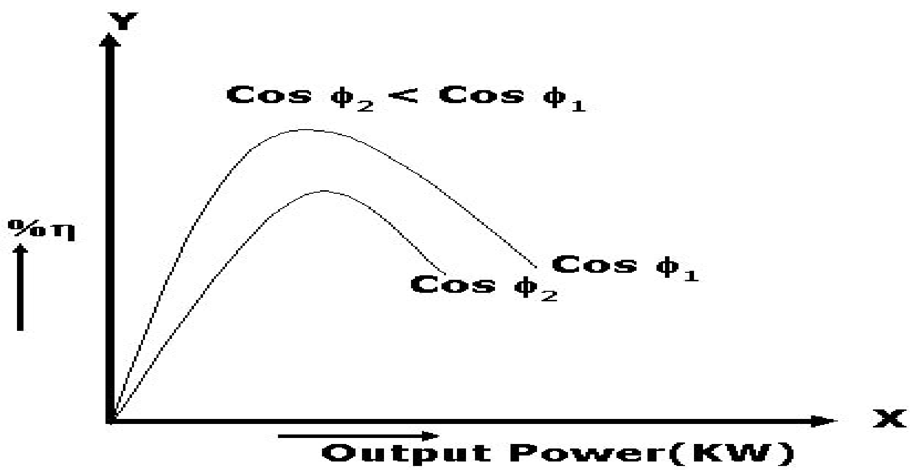
S. C TEST:

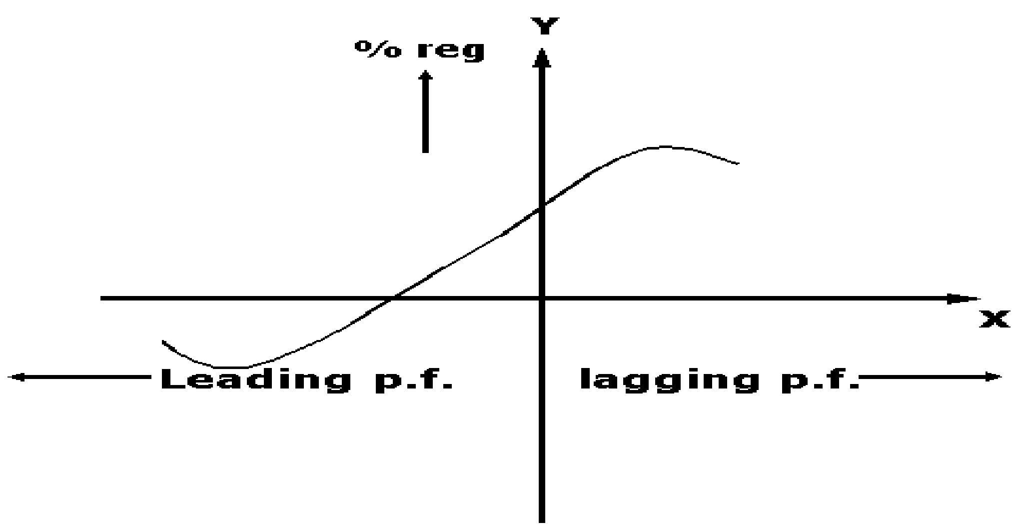
S.NO.	V_{SC} (V)	I_{SC} (A)	W_{SC}(W)

MODEL GRAPHS: PLOTS DRAWN BETWEEN

(iii) % Efficiency Vs Output

(iv) % Regulation Vs Power Factor





MODEL CALCULATIONS:

Find the equivalent circuit parameters R_0, X_0, R_{01}, R_{02}, X_{01} and X_{02} 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.

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

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

$R_{02} = \frac{W_{SC}}{I_{sc}^2} =$

$Z_{02} = \frac{V_{SC}}{I_{SC}}$

$X_{02} = \sqrt{Z_{01}^2 - R_{01}^2}$ =

$X_{01} = K^2 \ X_{02}$ = Where $K = \frac{V_2}{V_1} =$ 1 Transformation ratio.

$R_{01} = K^2 \ R_{02}$ =

CALCULATIONS OF EFFICIENCY AND REGULATION

For example at ½ full load

Cupper losses = W_{sc} x $(1/2)^2$ watts, where W_{SC} = full – load cupper losses

Constant losses = Wi watts

Output = ½ KVA x cos ϕ [cos ϕ may be assumed]

Input = output + Cu. Loss + constant loss

$$\% \ efficiency = \frac{Output}{Input} \ x \ 100$$

Efficiency at any load = $\dfrac{S \times x \times \cos\phi}{S \times x \times \cos\phi + W_i + W_{sc}\, x^2} \times 100$

Regulation:

From open circuit

$$\% \ \text{Re}\,gulation = \frac{I_1 R_{01} \cos\phi \pm I_1 X_{01} \sin\phi}{V_1} \ x \ 100$$

'+' for lagging power factors

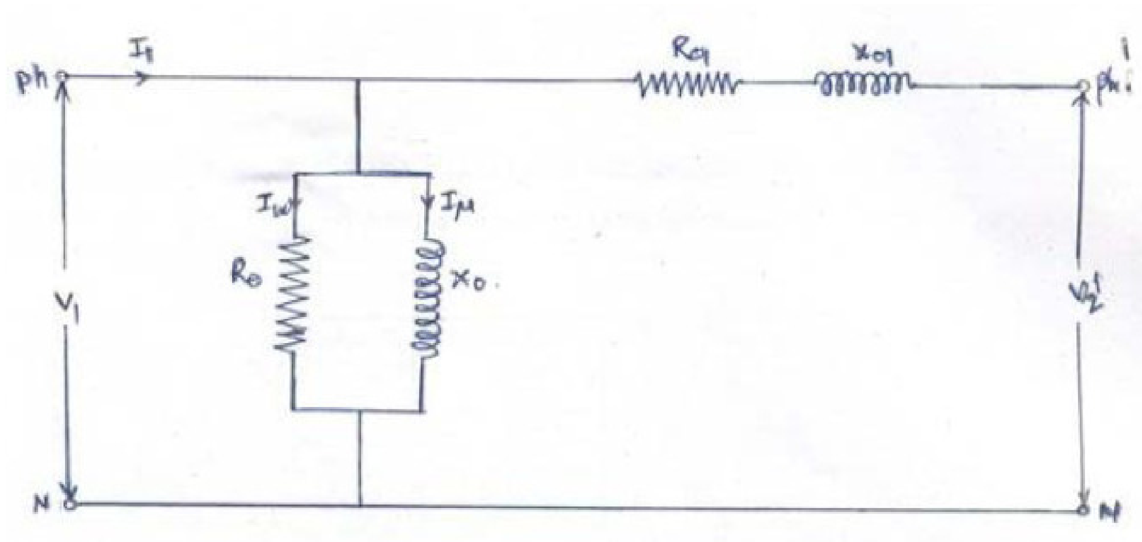
'-' for leading power factors

FOR S.C. TEST:

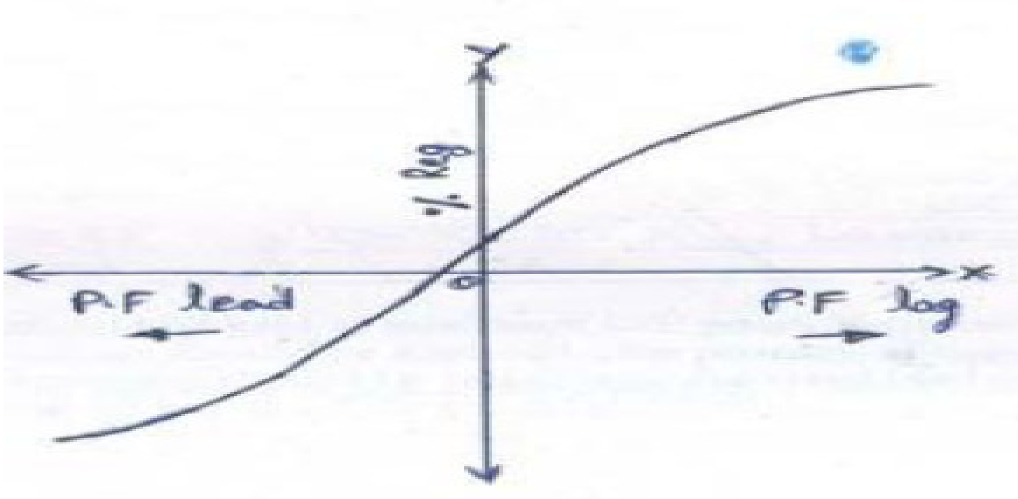
Regulation: From Short circuit test

$$\% \ \text{Re}\,gulation = \frac{I_2 R_{02} \cos\phi \pm I_2 X_{02} \sin\phi}{V_2} \ x \ 100$$

EQUIVALENT CIRCUIT:



REGULATION MODEL GRAPH:



TABULAR FORM

S.No.	Load	Cu.loss (W)	Output (W)	Input (W)	%η		S.N.	Load	Cu.loss (W)	Output (W)	Input (W)	%η
1.	¼F.L.							¼F.L.				
2.	½F.L.							½F.L.				
3.	¾F.L.							¾F.L.				
4.	F.L.							F.L.				

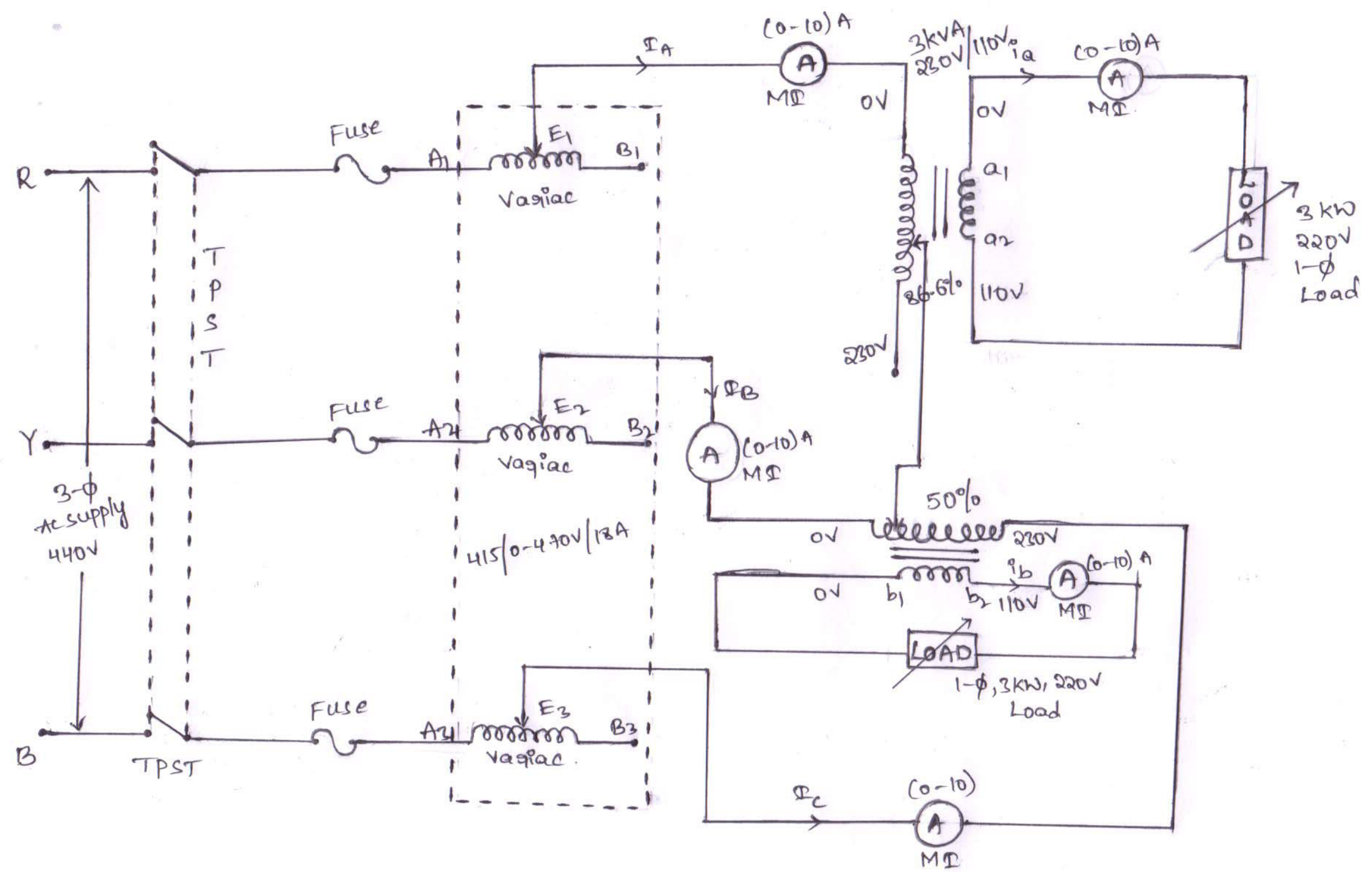
Lagging Pf			Leading Pf		
S.N.	**P.F.**	**% Reg.**	**S. N.**	**P. F.**	**% Reg.**
1.	0.3		1.	0.	
2.	0.4		2.	0.4	
3.	0.5		3.	0.5	
4.	0.6		4.	0.6	
5.	0.7		5.	0.7	
6.	0.8		6.	0.8	
7.	Unity		7.	Unity	

RESULT:

EXPERIMENT-3

SCOTT CONNECTION OF TRANSFORMERS

Cigcuit diaggam fog Scott Connection of Tqansfogmegs :



SCOTT CONNECTION OF TRANSFORMERS

AIM:To verify the conversion of 3-phase to 2 1-phase of 90 degrees apart supplies and also verify the primary current from the 1-phase side.

NAME PLATE DETAILS:

SCOTT TRANSFORMERS	
Transformer rating	
Rated Voltage	
Taps on HV	

APPARATUS REQUIRED:

Sl. No.	Name of the Equipment	Range	Type	Quantity
1	Transformer	-	1-phase ,50%86.6%	2
2	Variac	(0-470)V	3-phase	1
3	Transformer	230/110V	1-phase	1
4	Ammeter	(0-10)A		5
5	VOltmeter			

OBSERVATIONS:

V_{in}=101V

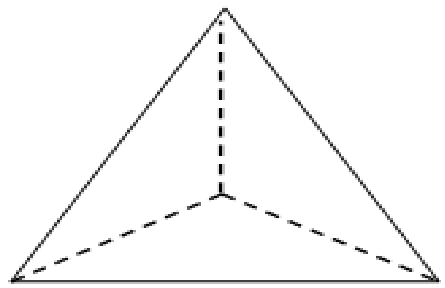
S.No.	V_{a1a2}(V)	V_{b1b2}(V)	V_{a2b2}(V)

V1 = 3-φ Line Supply,V2 = 2-φ Phase Voltage,V3 = 2-φ Line Voltage

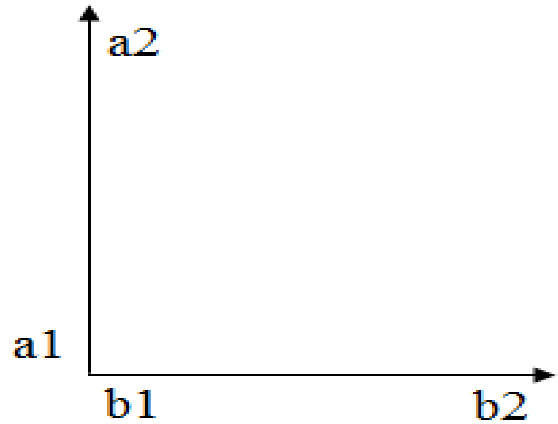
OBSERVATIONS (BALANCED LOAD):

S.No.	LOAD(A)	I_A	I_B	I_C	i_a	i_b

MODEL PHASOR DIAGRAMS FOR SCOTT CONNECTION:



Primary Voltage



Secondary Voltage

PROCEDURE:

1. Give all connections as per the circuit diagram.
2. Ensure the 3-phase variac and switch ON main supply
3. Increase the variac voltage or output voltage to 200V line to line.
4. Measure the 1-phase voltage on L.V side.
5. By shorting a_1,b_1 to be shorted ,measure the voltage across a_2,b_2 and verify the scott connection tapping.
6. Reduce the variac voltage to zero and connect the loads to each 1-phase as shown in figure.
7. Apply rated voltage in each winding through 3-phase variac to 3-phase side.
8. Note down the voltage and currents on 3-phase side and 1-phase side.
9. Vary the values of V & I at each step.
10. Take around a half of a dozen readings.
11. Verify the 3-phase and measure the values of voltage and currents and represent in tabular column.
12. Draw the vector diagram for any particular load.

PRECAUTIONS:

1) The Dimmerstat should be kept at minimum O/P position initially.

2) The Dimmerstat should be varied slowly & uniformly.

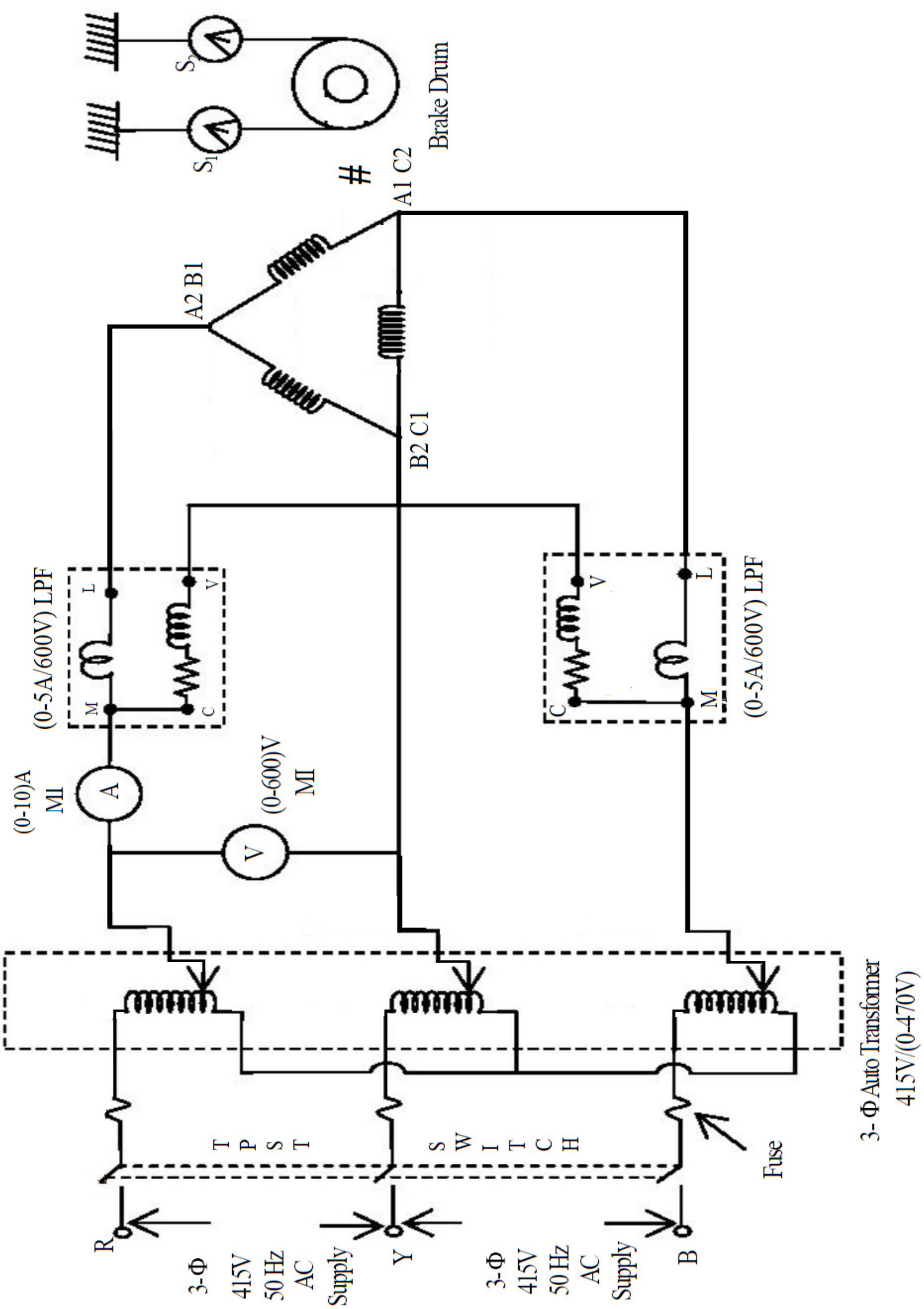
3) Rated voltage should be applied to the primary of the Transformer.

RESULT:

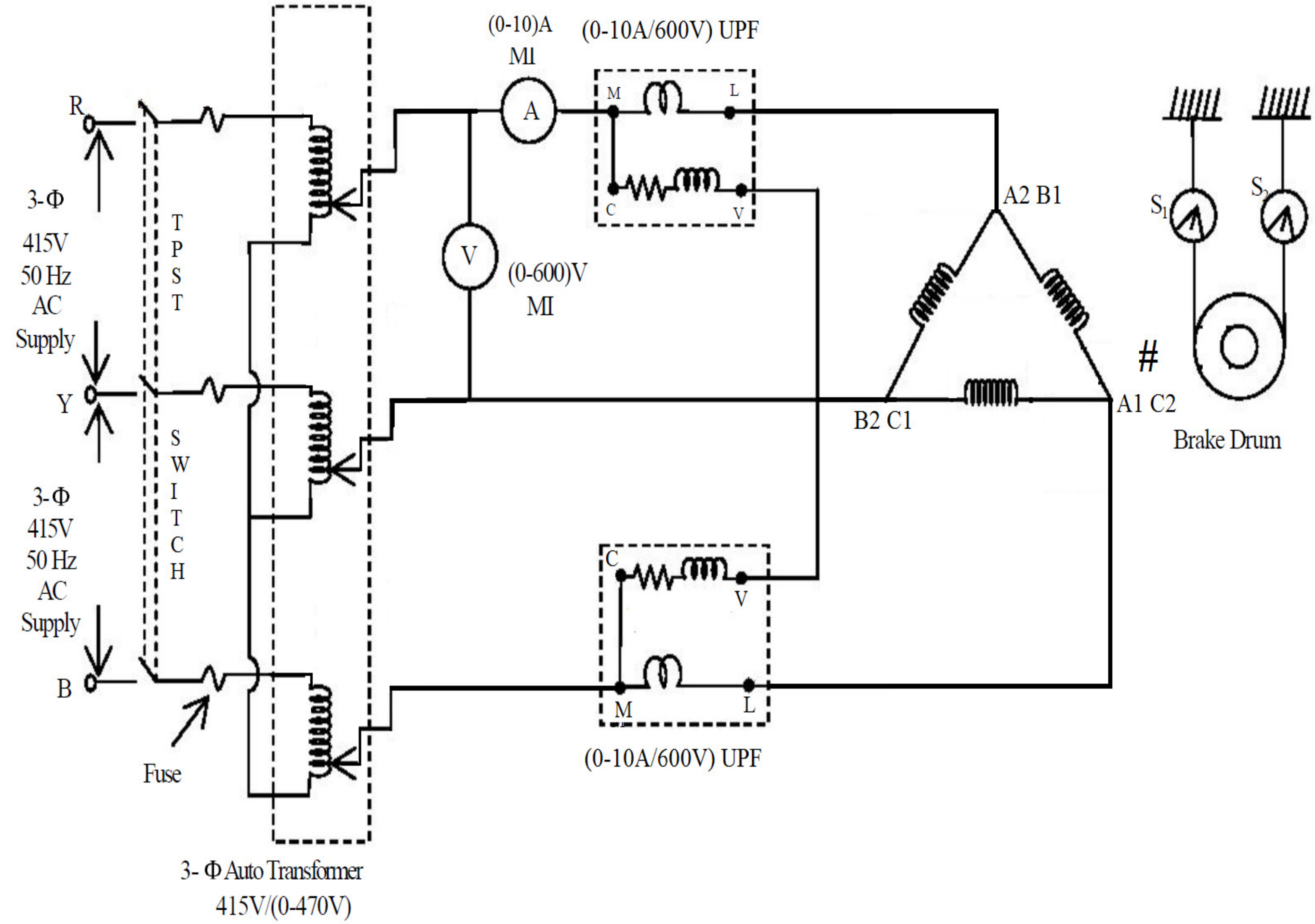
EXPERIMENT NO 4

NO-LOAD AND BLOCKED ROTOR TEST ON 3-PHASE INDUCTION MOTOR

CIRCUIT DIAGRAM FOR NO LOAD TEST:



CIRCUIT DIAGRAM FOR BLOCKED ROTOR TEST:



R
Y
B
3-Φ
415V
50 Hz
AC
Supply
3-Φ
415V
50 Hz
AC
Supply
TPST
SWITCH
Fuse
3- Φ Auto Transformer
415V/(0-470V)
(0-10)A
MI
A
V
(0-600)V
MI
(0-10A/600V) UPF
M
L
C
V
(0-10A/600V) UPF
A2 B1
B2 C1
A1 C2
#
S1
S2
Brake Drum

NO-LOAD AND BLOCKED ROTOR TEST ON 3-PHASE INDUCTION MOTOR

AIM: To draw the equivalent circuit of a 3 phase induction motor and construct the circle diagram by conducting No-load and blocked rotor tests.

NAME PLATE DETAILS:

3-PHASE INDUCTION MOTOR		
S.No.	**NAME**	**RATINGS**
1	Power	
2	Voltage	
3	Current	
4	Phase	
5	Frequency	
6	Speed	

APPARATUS:

S.No.	NAME OF THE EQUIPMENT	TYPE	RANGE	QUANTITY
1	Voltmeter	MI	0-150V 0-600V	1 1
2	Ammeter	MI	0-5A	1
3	Wattmeter	-	600V/5A,LPF 150V/10A,UPF	2 2
4	Tachometer	-	-	1

PROCEDURE:

NO LOAD TEST:

1. Connect the no load circuit as per the circuit diagram.

2. Close the DPST and start the motor with the help of DOL starter.

3. Note the voltage ,no load current, power in wattmeter.

4. Switch off the starter and open the DPST.

BLOKED ROTOR TEST:

1. Connect the blocked rotor circuit as per the circuit diagram.
2. Keep the autotransformer at minimum position and blocked the rotor by lightening the belt over the pulley.
3. Close the DPST and apply the rated current by increasing voltage with the help of autotransformer.
4. Note down the voltage, load current, power in wattmeter.
5. Minimize the auto transformer and open the DPST.

MEASUREMENT OF STATOR RESISTANCE

1. Connect the circuit as per the circuit diagram shown in fig (2).
2. Keeping rheostat in maximum resistance position switch on the 220 V Dc supply.
3. Using volt-ammeter method measure the resistance of the stator winding.
4. After finding the stator resistance, R_{dc} must be multiplied with 1.6 so as to account for skin effect i.e. $R_{ac} = 1.6\ R_{dc}$.

OBSERVATION:

No load test

S.No.	Voltage(v)	Current(I_0)	POWER(W_1)	POWER(W_2)	Total power $W_0=W_1+W_2$

Blocked rotor test

S.No.	Voltage(V_{sc})	Current(I_{SC})	Power(W_1)	POWER(W_2)	Total power $W_{SC}=W_1+W_2$

CONSTRUCTION OF CIRCLE DIAGRAM:

1. Draw a line representing the applied voltage per phase $V_{1.}$
2. Draw the no load current I_0 at the no load power factor angle $( )_0$ with the reference phasor V_I current scale may be suitably chosen, keeping in mind the short-circuit current at rated voltage.
3. Draw short-circuit or blocked rotor current corresponding to the rated phase voltage at power factor angle $( )_b$ with the ret phasor V_1.
4. Join AB , which represents the output line of the rotor.
5. Draw the horizontal line AF and erect a perpendicular bisector on the output line, so O^1 as center and AO^1 as the radius, draw the semi circle ABF.
6. Draw the vertical line from the point B , So as to meet the line AF at the point D .Drive the line BD in the ratio of rotor copper losses to stator copper losses at point E.

   i.e, BE/DE=rotor copper losses/stator copper losses

CALCULATIONS:

1.No load power factor=P_{NL}/square root of [$3V_{BL}I_{NL}$]

2.Blocked rotor power factor=P_{BL}/square root of [$3V_{BL}I_{BL}$]

From no load test

1. $G_0=W_0/3V_0^2$

2.$Y_0=I_0/V_0$

3. B_0=square root[$Y_0^2-G_0^2$]

From blocked rotor test

1.$Z_{01}=V_{SC}/I_{SC}$

2.$R_{01}=W_{SC}/3I_{SC}^2$

3.X_{01}=square root[$Z_{01}^2-R_{01}^2$]

For circle diagram

1.Cos($)_0=W_0$/square root[3]$V_0I_0=W_{SC}$/square root[3]$V_{SC}I_{SC}$

2.$I_{SN}=I_{SC}*(V_0/V_{SC})$

3.$W_{SN}=W_{SC}*(V_0/V_{SC})^2$

PRECAUTIONS:

1. Loose connections should be avoided.
2. Operate the instruments carefully.
3. Load currents should not be exceeding beyond their rating.

RESULT:

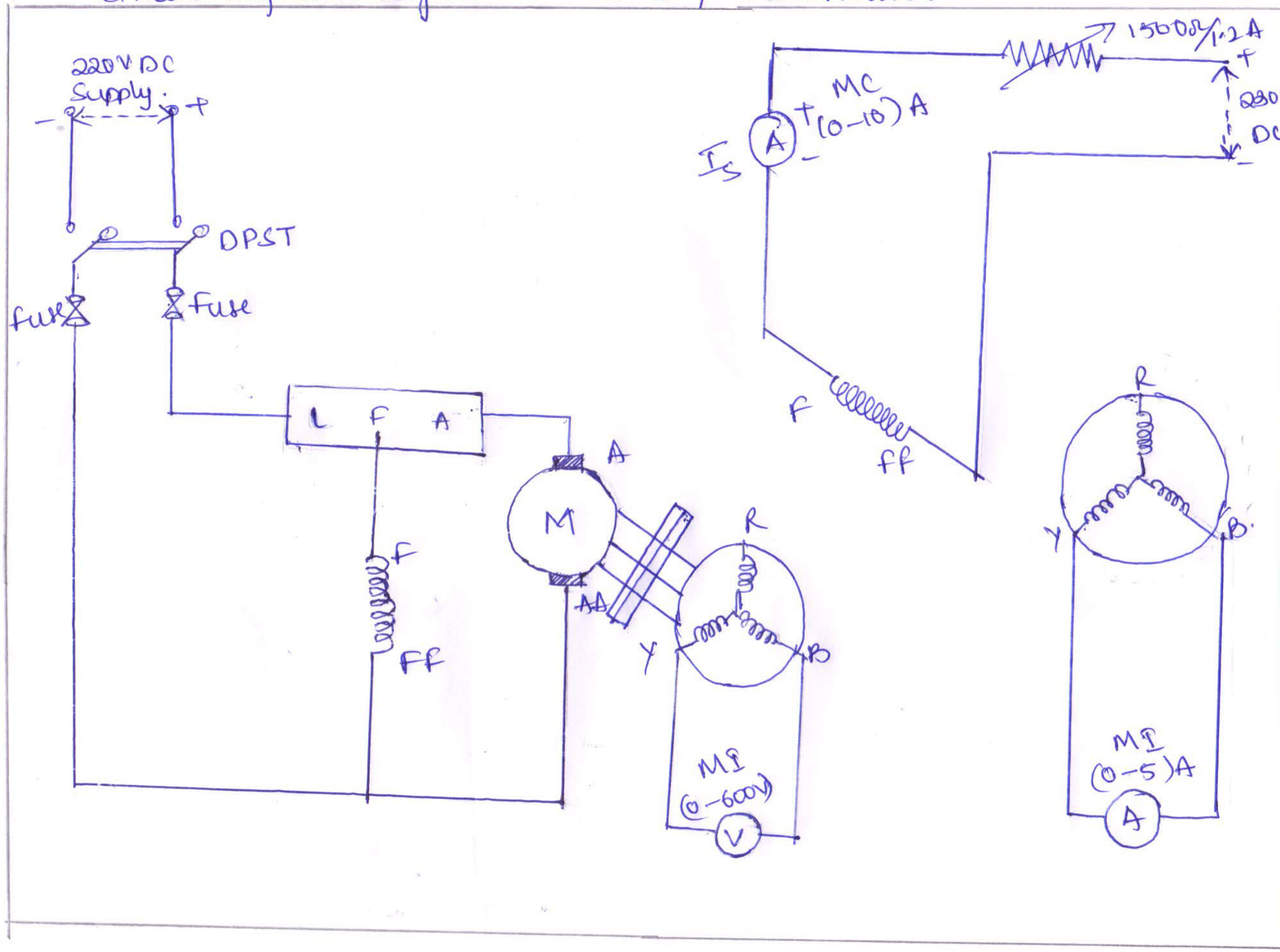
QUESTIONS:

1. Explain why the locus of the induction motor current is a circle.
2. What is the difference between the transformer equivalent circuit and induction motor equivalent circuit?
3. What are the reasons in conducting no-load test with rated voltage and blocked-rotor test with rated current?
4. Why do you choose LPF wattmeter in load test and hpf wattmeter in blocked rotor test?
5. How do you reverse the direction of rotation of induction motor?
6. What are the various applications of this motor?

EXPERIMENT NO 5

REGULATION OF 3-PHASE ALTERNATOR BY SYNCHRONOUS IMPEDENCE AND MMF METHOD

Circuit diagram for Regulation of 3-ϕ alternator



REGULATION OF 3-PHASE ALTERNATOR BY SYNCHRONOUS IMPEDENCE AND MMF METHOD

AIM: To predetermine the regulation of an alternator by

a) Synchronous impedance method and
b) MMF method

NAME PLATE DETAILS:

S.NO.	DC SHUNT MOTOR		3 PHASE ALTERNATOR	
	PARAMETER	UNITS	PARAMETER	UNITS
1				
2				
3				
4				

APPARATUS REQUIRED:

S.NO	EQUIPMENT	TYPE	RANGE	QUANTITY
1	Ammeter	MC	(0-25)A	1
2	Ammeter	MI	(0-5)A	1
3	Voltmeter	MI	(0-600)V	1
4	Rheostat	-	-	1
5	Tachometer	Digital	-	1

PROCEDURE:

1. Make the connections as per the circuit diagram, start the alternator with the help of prime mover (DC shunt motor) and adjust speed to the synchronous speed. The speed of the alternator is to be kept constant throughout the experiment.
2. Excite the field winding alternator keeping armature open .
3. Note down the terminals voltage at different value of field currents.

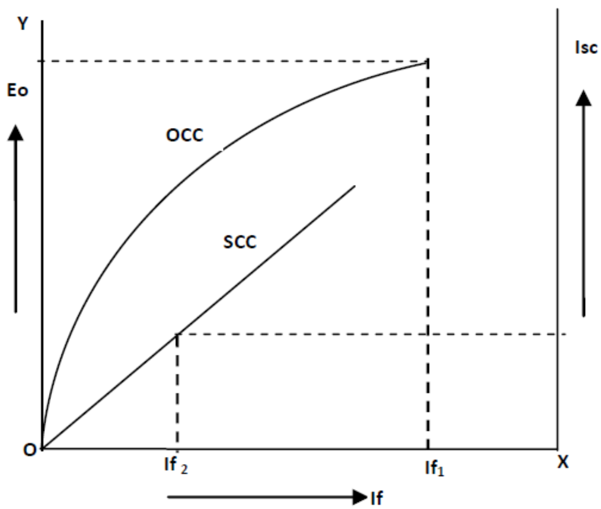
4. Draw the gram a of armature voltage Vs field current to get open circuit characteristic (OCC) of the alternator.
5. Close the TPST switch.
6. Excite the field winding of the alternator till the rated current flows through the armature.
7. Note down all meter readings.
8. Draw the graph of the short circuit current Vs field current to get the short circuit characteristics (SCC)
9. Obtain the synchronous impendence corresponding to the rated voltage $Z_S = V_{OC}/I_{SC} = I_F$ constant.
10. Measure the armature resistance per phase by drop method the A.C resistance will be 20% more than DC resistance R_a=1.2 Ohm DC.
11. Calculate the synchronous reactance X_S= SQ Root of $Z_S^2-R_{ac}^2$
12. Calculate the generated EMF with full load at a power factor.
13. $E=[(V\cos\Phi+IR_a)^2 (V\sin\Phi+IX_S)^2]^{1/2}$
14. Positive sign for lagging power factor and Negative sign for leading power factor
15. Calculate full load regulation at different power factor
16. Draw the graph of regulation Vs power factor

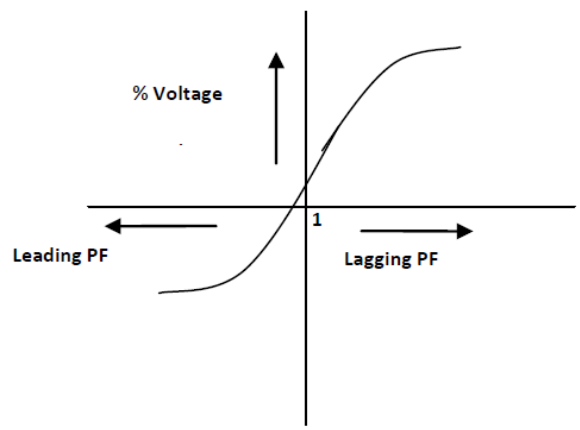
TABULAR FORM:

OCC METHOD			**SCC METHOD**			
S.No.	**V(V)**	**I_F(A)**	**S.No.**	**I_F(A)**	**I_A(A)**	**I_{SC}(A)**

CALCULATIONS:

MODEL GRAPH:



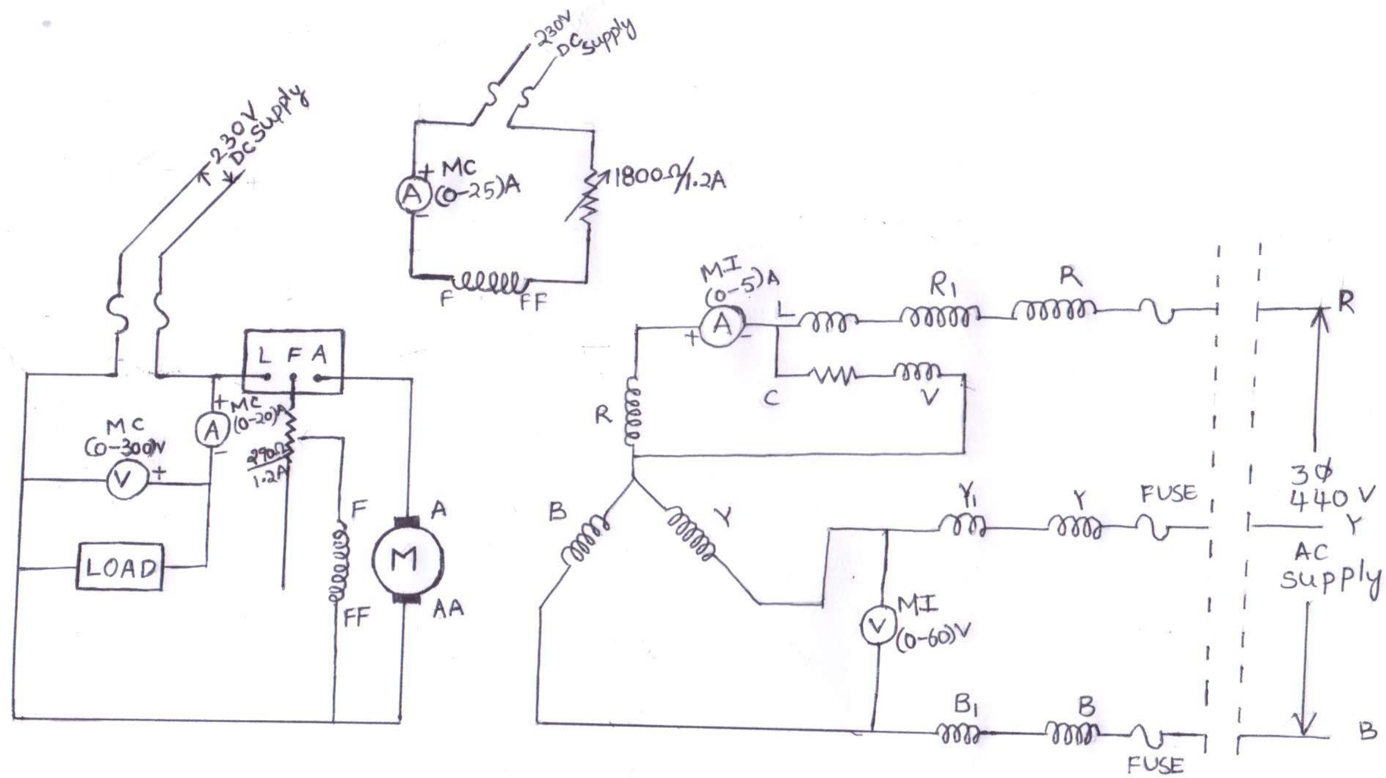


RESULT:

EXPERIMENT NO 6

V AND INVERTED V CURVES OF 3-PHASE SYNCHRONOUS MOTOR

Circuit diagram for 'V' and Inverted V curves of 3-ϕ Synchronous motor.



V AND INVERTED V CURVES OF 3-ϕ SYNCHRONOUS MOTOR

V AND INVERTED V CURVES OF 3-PHASE SYNCHRONOUS MOTOR

AIM: To draw the V and inverted V-curves of synchronous motor

APPARATUS:

S.NO	NAME	RANGE	TYPE	QUANTITY
1	Ammeter	(0-25)A	MI	1
2	Ammeter	(0-20A)/3A	MI	2
3	Voltmeter	(0-600)/300V	MI	3
4	Wattmeter	(0-300)W	MC	1
5	Rheostat	(290Ω/12A)	-	1
6	Tachometer	-	Digital	1

PROCEDURE:

1. Connection are made as per diagram.
2. Ensuring minimum resistance in I_f of DC supply is switch ON.
3. Using 3-point starter , the rotor is started and brought to rated speed.
4. The alternator is bought to rated voltage.
5. Keeping the synchronous open 3-phase supply to alternator is ON and following observation are made on the synchronous board.
6. The voltage of alternator is adjusted. to supply voltage
7. Speed of alternator is adjusted such that bulbs glow and become dark slow.
8. At constant ,when bulbs has no glow,switch is closed.
9. The supply is supplied to alternator and DC motor this condition is floating condition.
10. DC motor supply is switched OFF ,so that it acts as generator and alternator as motor.
11. The excitation increases then it has loading P.F and if excitation decreases then it has lagging.
12. Without load on generator of value for both lag and lead PF is verified.
13. A graph is plotted between I_f/I_a and P_f Vs I_f.

PRECAUTIONS:

1. There should not be any load on the motor.
2. Initially the field current should be adjusted to rated value.

3. The direction of the rotation of the rotor should be in proper direction only.
4. If Ia value is increased more than rated value, then it should be brought to rated value by adjusting the field current.
5. The I/P voltage should be kept constant through out the experiment.
6. After completion of the experiment only 3-phase supply should be disconnected first and then DC supply.

TABULAR FORM:

FULL LOAD

I_f(A)	I_a(A)	POWER(W)	Cos(ϕ)

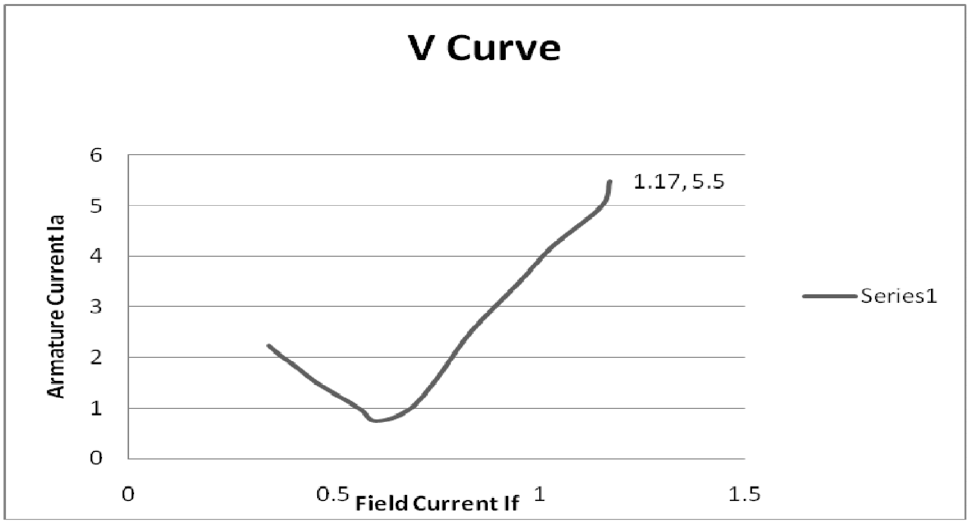
NO LOAD

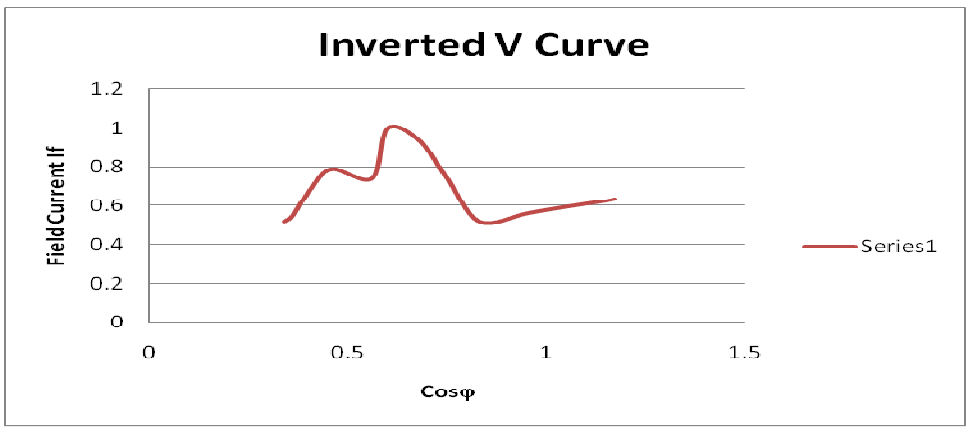
I_f(A)	I_a(A)	POWER(W)	Cos(ϕ)

FORMULA:

$\cos\phi_1 = W_0/\sqrt{3}V_aI_a$

MODEL GRAPH:



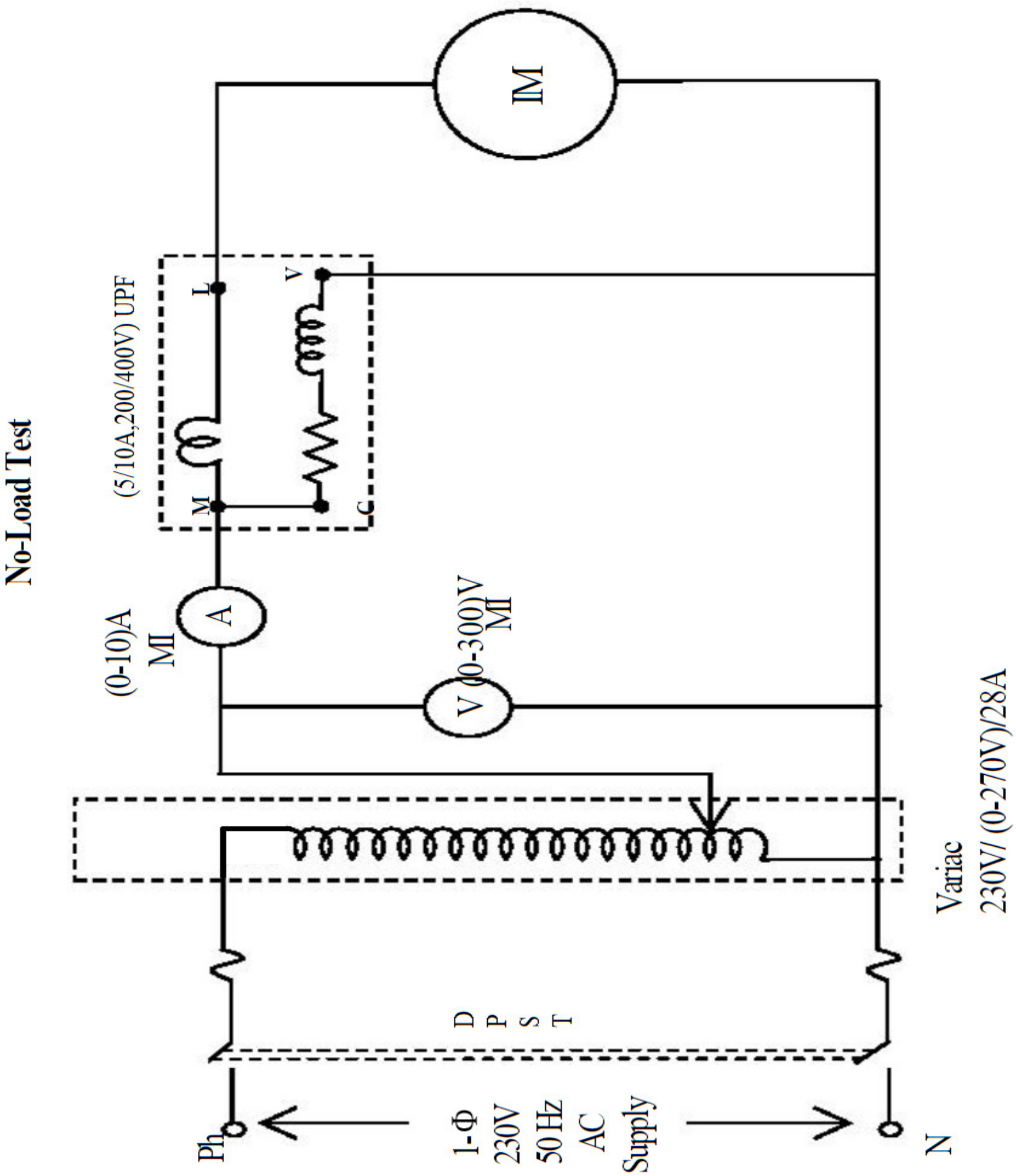


RESULT:

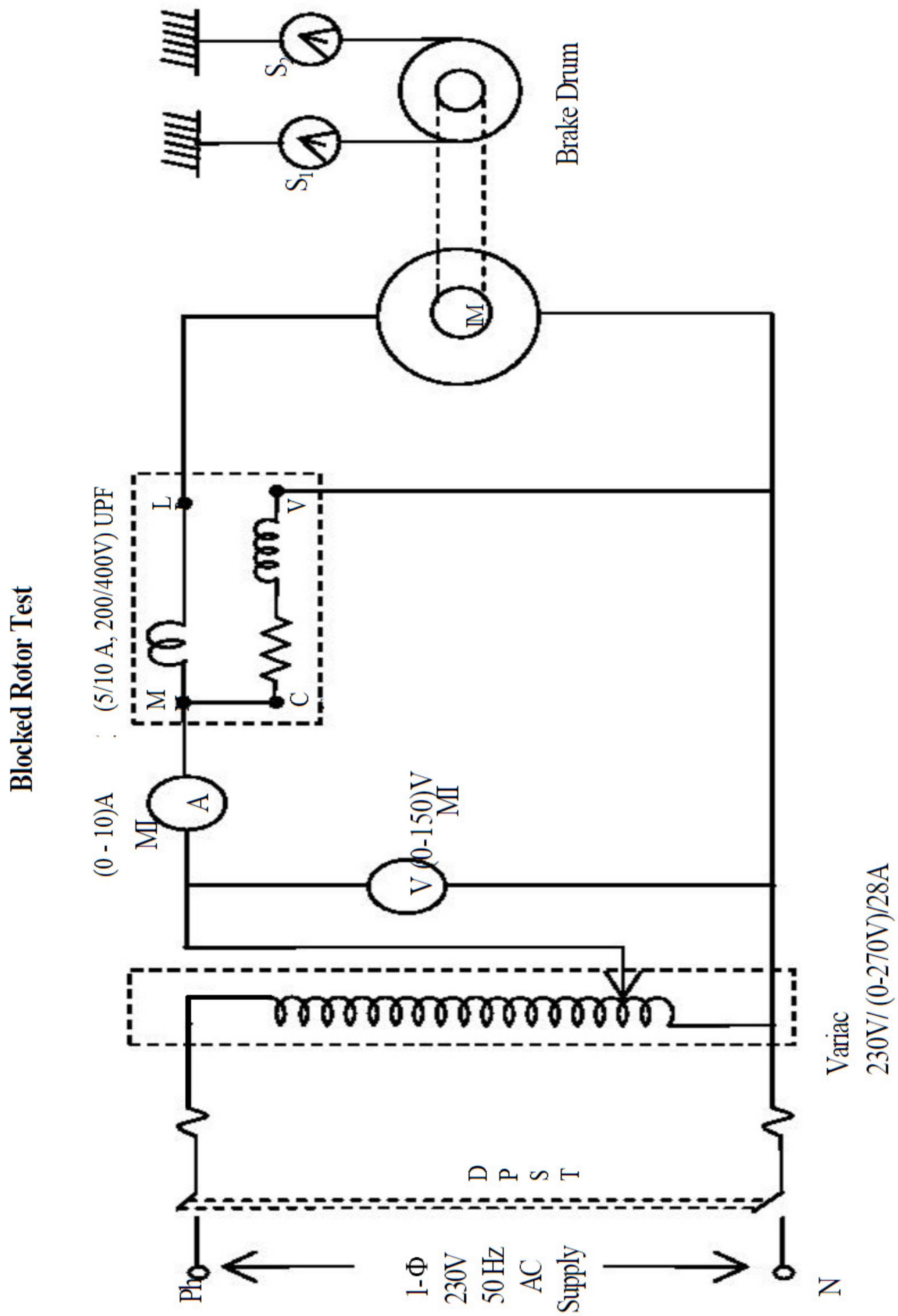
EXPERIMENT NO 7

EQUIVALENT OF A SINGLE PHASE INDUCTION MOTOR

CIRCUIT DIAGRAM FOR NO-LOAD TEST:



CIRCUIT DIAGRAM FOR BLOCKED ROTOR TEST:



EQUIVALENT OF A SINGLE PHASE INDUCTION MOTOR

AIM : To conduct OC & SC tests on the given 1-Induction motor and to determine its equivalent circuit parameters.

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NAME PLATE DETAILS :

1Φ- INDUCTION MOTOR		
S.NO.	**NAME**	**RATING**
1	Power	
2	Voltage	
3	Current	
4	Phase	
5	Frequency	
6	Speed	

APPARATUS REQUIRED :

S.NO.	NAME	TYPE	RANGE	QUANTITY
1.	Voltmeter	MI	0-300V	1
2.	Ammeter	MI	0-10A	1
3.	Wattmeter	MI MI	300V ,5A UPF 150V ,10A LPF	1 1

PROCEDURE :

NO LOAD TEST:

1.Connect the no load circuit as per the circuit diagram.

2.Close the DPST & Start the motor with the help of DOL starter without load.

3.Note down the No load voltage , No load current and Power .

4.Switch off the starter and open the DPST.

BLOCKED MOTOR TEST:

1.Connect the blocked motor circuit as per the circuit diagram.

2.Keep the auto transformer at minimum position and blocked the motor.

3.Close the DPST & Apply the rated current by increasing voltage.

4.Note down the voltage, load current ,power .

5. Minimize the auto transformer & open the DPST.

CALCULATIONS :

NO LOAD TEST:

1.Iron losses (W_0) = [$V_0 I_0 \cos(\varphi)$]watts

2.$\cos(\varphi) = W_0/(V_0 I_0)$

3.Iron component = $I_w = I_0 \cos(\varphi)$ Amp

4.Magnetizing current $I_m = I_0 \sin(\varphi)$ Amp

5.Loss component $R_0 = (V_0 / I_0)$ Ohms

6.Magnetizing reactance $X_m = (V_0 / I_m)$ Ohms

BLOCKED MOTOR TEST:

1.Equivalent impedance $Z_{Eq} = (V_{SC} / I_{SC})$ Ohms

2.Total resistance $R_{eq} = (W_{SC} / I_{SC}^2)$ Ohms

3.Leakage reactance X_{eq} = square root of $(Z_{eq}^2 - R_{eq}^2)$

PRECAUTIONS :

1) The Dimmerstat should be kept at minimum O/P position initially.
2) In the rotor-blocked test, the rotor should be blocked firmly.
3) In SC test, the Dimmerstat should be varied slowly such that current should not exceed the rated value.
4) If the wattmeter shows negative deflection, then reverse either pressure coil or current coil & take that reading as negative.

5)Loose connections should be avoided.

6)Load current should not be exceeding their rating.

OBSERVATIONS :

S.No.	NO LOAD TEST			BLOCKED MOTOR TEST		
	V_0(V)	I_0(A)	W_0(W)	V_{SC}(V)	I_{SC}(A)	W_{SC}(W)

OBSERVATIONS:

O.C.Test:

V_0	I_0	W_0
220	5.56	30x8=240

S.C. Test:

Vsc	Isc	Wsc
30	8.18	20X8=160

MODEL CALCULATIONS:

(A) No-load Test:

Power factor Cosφ = $\frac{W_0}{V_0 I_0}$ =

Sinφ =

Reactive component Ic =Io Cosφ

=

Magnetizing Component Im =Io Sinφ

=

Ro =$\frac{V_0}{I_c}$ =

X_0=$\frac{V_0}{I_m}$ =

R_{o1} =R_{dc} X 1.3

$=R_0 \times 1.3$

=

Blocked Rotor Test:

Power factor Cosφ = $\frac{W_{sc}}{V_{sc} I_{sc}}$ =

Sinφ = 0.7583

$R_{1e} = \frac{W_{sc}}{(Isc)^2} =$

$\mathbf{Z_{1e}} = \frac{V_{sc}}{Isc} =$

$\mathbf{X_{1e}} = \sqrt{{Z_{1e}}^2 - {R_{1e}}^2}$

=

=

$X_1 = X_2^{l} = \frac{X_{1e}}{2}$

=

$R_2' = R_{1e} - R_1$ [Where R1 = 1.1 to 1.3]

=

$X_{2f} = X_{2b} = \frac{1}{2} X_2'$

=

=

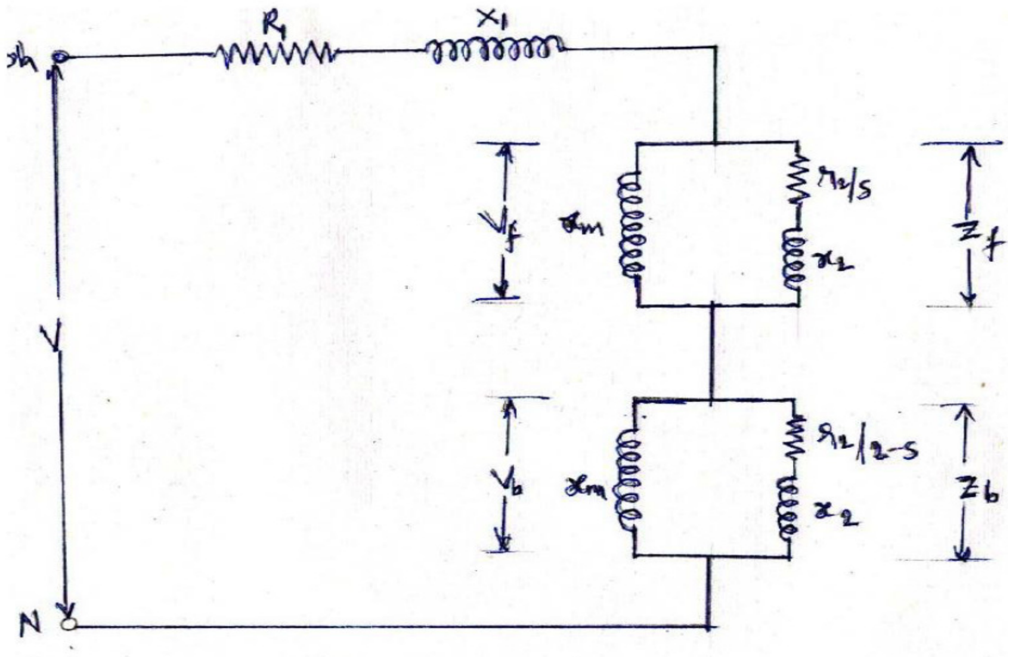
$R_{2r} = R_{2b} = \frac{1}{2} R_2'$

=

Xm/2 = Vo/Io Sinφ =[$X_1 + \frac{1}{2} X_2'$**]**

=

EQUIVALENT CIRCUIT:

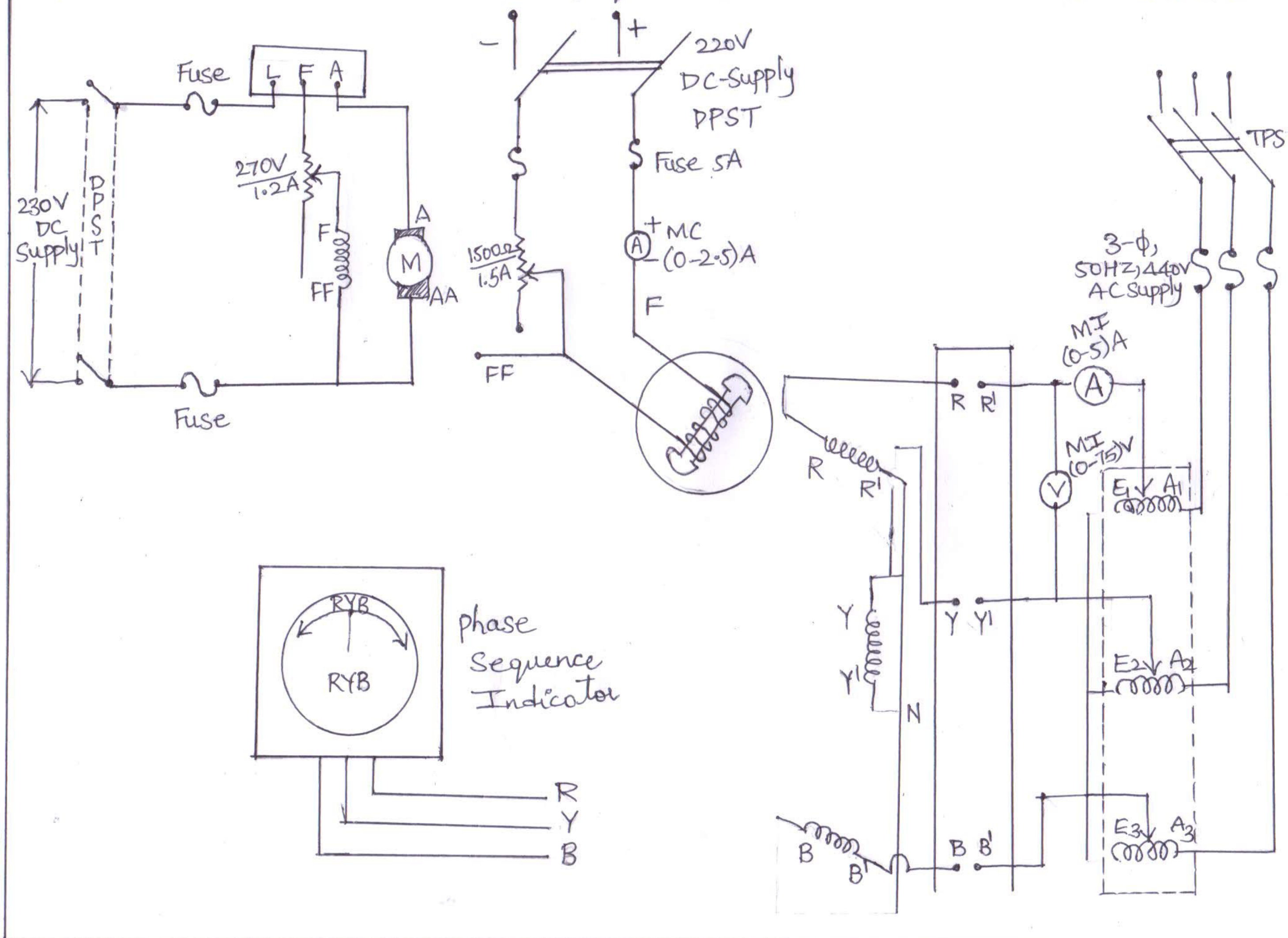


RESULT:

EXPERIMENT NO 8

DETERMINATION OF X_d AND X_q OF SALIENT POLE SYNCHRONOUS MACHINE

CIRCUIT FOR DETERMINATION OF X_d & X_q OF SALIENT POLE SYNCHRONOUS MACHINE



DETERMINATION OF X_d AND X_q OF SALIENT POLE SYNCHRONOUS MACHINE

AIM: To determine X_d and X_q of salient pole type of synchronous machine

NAMEPLATE DETAILS:

S.No.	DESCRIPTION	D.C. SHUNT MOTOR	3-φ ALTERNATOR
1	Capacity		
2	Voltage		
3	Current		
4	Speed		
5	Frequency		

APPARATUS REQUIRED:

S.No.	NAME	TYPE	RANGE	QUANTITY
1	Ammeter	MC	(0-25)A	1
2	Ammeter	MI	(0-7.5)A,(0-2.5)A	2
3	Voltmeter	-		1
4	Rheostat	-	-	1
5	Tachometer	-	-	1
6	3-ϕ variac	-	(0-600)V , 290Ω/1.2A	1
7	3- ϕ alternator with prime mover	Salient	3.3KVA/415V/1500RPM	1

PROCEDURE:

1. Make connections as per the circuit diagram
2. Run the alternator through DC motor at near synchronous speed, keeping AC supply OFF
3. Note down field winding is to be kept open through out.
4. Keeping the variac output voltage at minimum connect the AC supply to variac.
5. Increase the variac output voltage so that a reasonable current passes through the armature .
6. If directions of rotation of rotor and stator fields are same then a slight adjustment of speed causes significant oscillation of armature current
7. When ammeter shows below wide oscillations note I_{max} and I_{min} and corresponding voltages v_{min} and v_{max} and calculate X_d & X_q
8. Using x_d &x_q the regulation of silent pole alternator at specified load condition can be determined using appropriate phasor diagram .

PRECAUTIONS:

1. 1) Check the phase sequence of the machine with that of external supply before closing the switches.
2. 2) Disconnect the excitation supply of the alternator while giving external supply.
3. 3) Slip should be made as small as possible.

TABULAR FORM:

S.No.	$V_{ph\ min}$	$V_{ph\ max}$	I_{min}	I_{max}	$X_d(\Omega)$	$X_q(\Omega)$

CALCULATIONS:

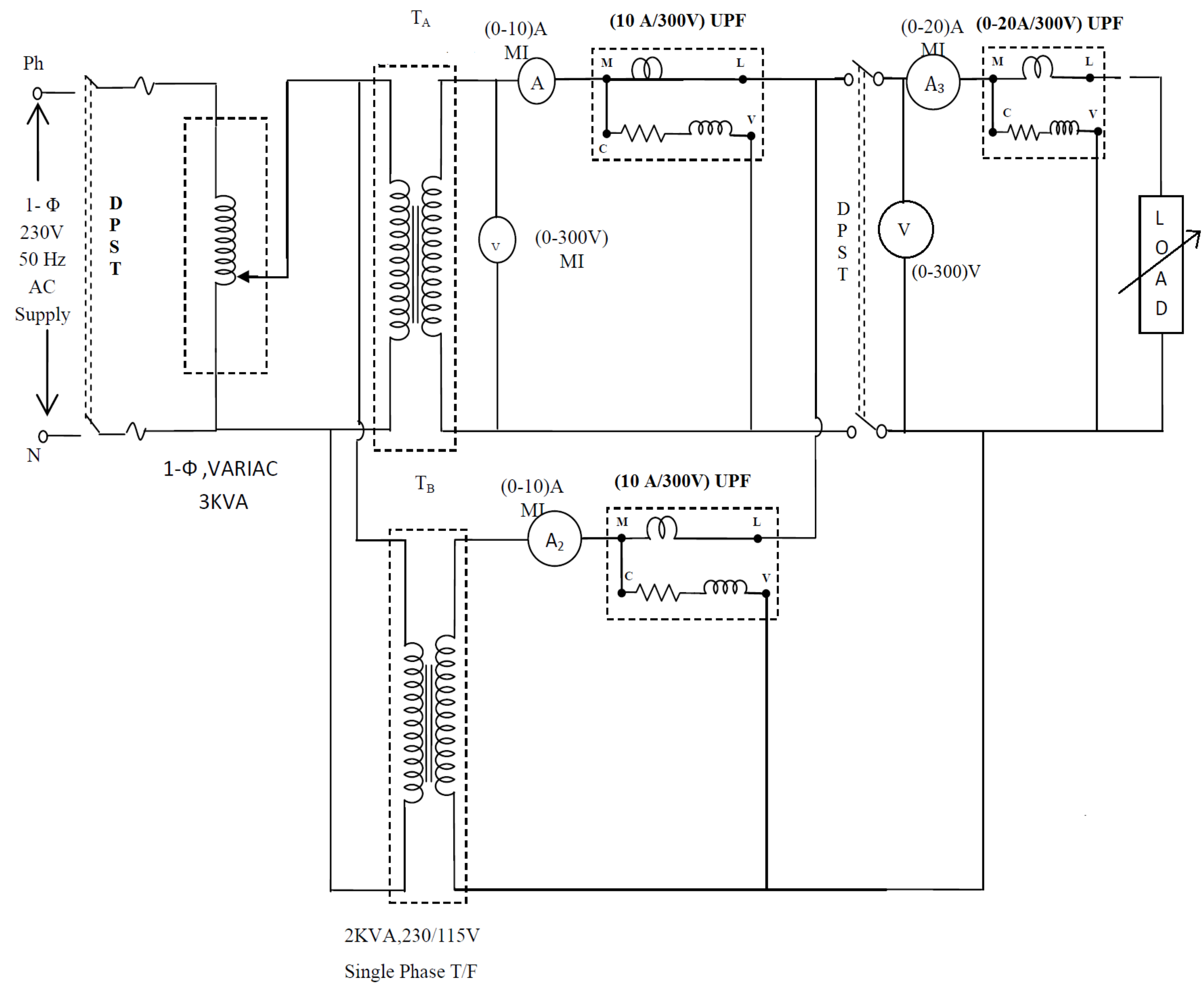
X_d = (max volts per phase/max current per phase)=(V_{max}/I_{min})

X_q = (min volts per phase/min current per phase)=(V_{min}/I_{max})

RESULT:

EXPERIMENT NO 9

PARALLEL OPERATION OF SINGLE PHSE TRANSFORMERS



T_A
(0-10)A
MI
A
(10 A/300V) UPF
M
L
C
V
(0-20)A
MI
A3
(0-20A/300V) UPF
Ph
1- Φ
230V
50 Hz
AC
Supply
N
D
P
S
T
V
(0-300V)
MI
(0-300)V
LOAD
1-Φ ,VARIAC
3KVA
T_B
(0-10)A
MI
A2
(10 A/300V) UPF
2KVA,230/115V
Single Phase T/F

PARALLEL OPERATION OF SINGLE PHSE TRANSFORMERS

AIM : To operate the given two 3KVA, 230/110V single phase Transformers in parallel and study the load sharing between them when supplying resistive load .

NAME PLATE DETAILS :

TWO 1-Φ TRANSFORMERS		
S.No.	**NAME**	**RATING**
1	Power	3KVA
2	No. of phases	1-PHASE
3	Voltage	230V
4	Frequency	50 Hz
5	Taps on HV	100% ,86.6% 50% ,25%

APPARATUS :

S.NO.	NAME	TYPE	RANGE	QUANTITY
1.	1-phase transformer	-	3KVA ,230/110V	2
2.	Voltmeter	MI	0-600V , 0-300V	1 1
3.	Ammeter	MI	0-30A , 0-15A	1 1
4.	Resistive Load	-	0-150V/300V 230V ,20A	2

PROCEDURE :

1.Connect the circuit as per the circuit diagram.

2.Keep the variac at minimum voltage position &switch on the supply.

3.Apply the small voltage & measure the voltage on LV & HV side.

4.Increase the load in steps & repeat.

5.Note the readings.

OBSERVATION TABLE

S.NO.	VOLTAGE	LOAD	I_{T1}(Amp)	I_{T2}(Amp)	I_L(Amp)
1					
2					
3					
4					
5					

FORMULA :

$$I_L = I_{T1} + I_{T2}$$

CALCULATIONS:

PRECAUTIONS :

1.The transformers must have same voltage ratio.

2.The transformers must be connected with correct polarities.

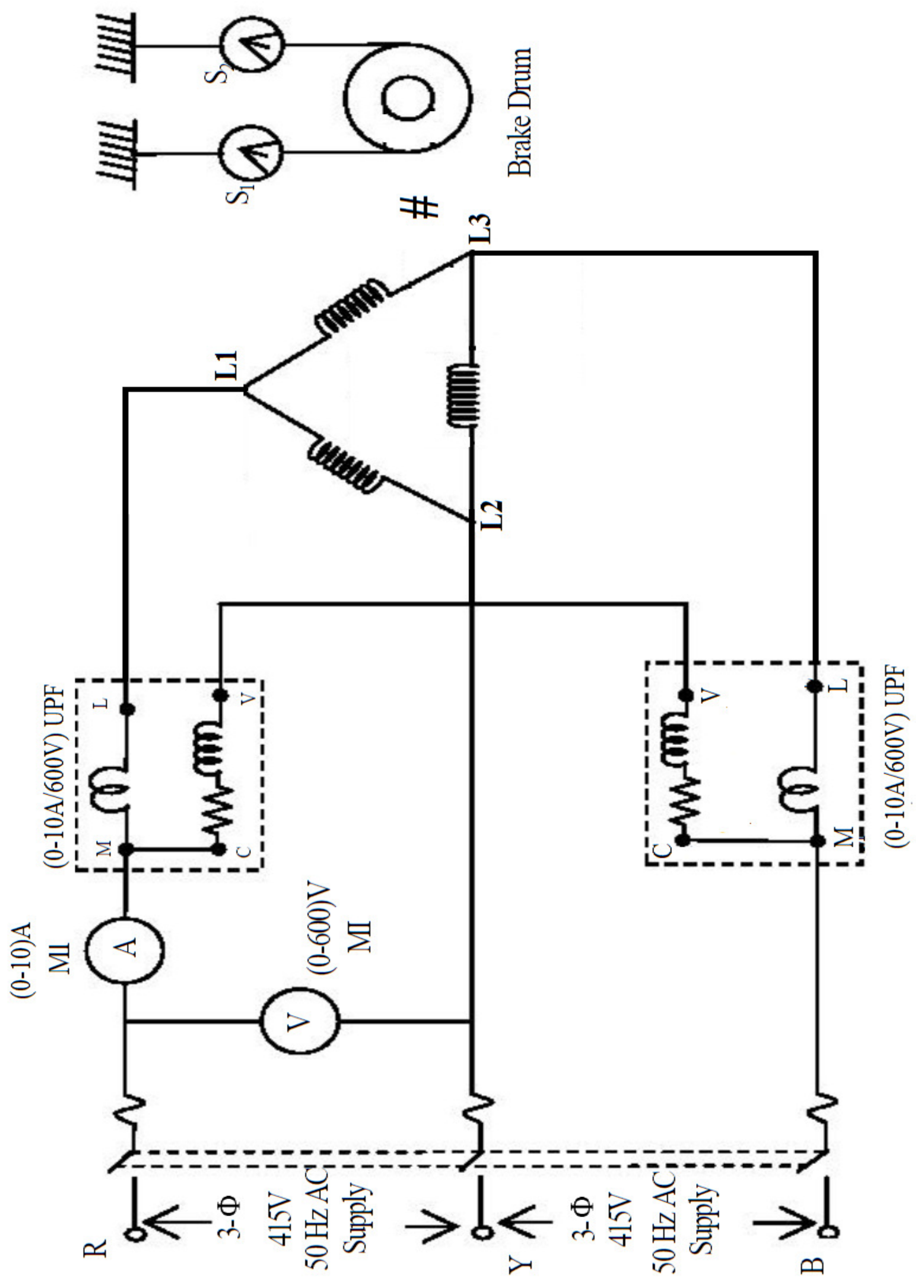
3. Load current should not exceed beyond rating.

RESULT :

EXPERIMENT NO 10

BRAKE TEST ON 3-PHASE INDUCTION MOTOR

CIRCUIT DIAGRAM :



BRAKE TEST ON 3-PHASE INDUCTION MOTOR

AIM: To perform the brake test on 3-phase slip ring induction motor and obtain its performance characteristics.

APPARATUS REQUIRED:

S.NO	NAME	TYPE	RANGE	QUANTITY
1.	Wattmeter	UPF	(0-10)A/600V	1No.
2.	Ammeter	MC	(0-10)A	1No.
3.	Voltmeter	MI	(0-600)V	1No.
4.	Tachometer	Digital	(0-1500)rpm	1No.

NAME PLATE DETAILS:

3-PHASE INDUCTION MOTOR		
S.NO	**NAME**	**RANGE**
1.	Voltage	
2.	Rated current	
3.	Rated power	
4.	Rated speed	

PROCEDURE:

1. Make the connections as per the circuit diagram.
2. Start the 3-phase induction motor on no load by means of 3-phase auto transformer.
3. Note down the meter readings and the speed at no load.
4. Apply brake by tightening the best of brake drum and note down the readings of the meter spring balance and speed.
5. Repeat the above step-4 until motor draws F-L current
6. Calculate torque slip power factor for each readings.
7. Draw the performance curves of output vs efficiency, torque, speed, Ia ,Power factor on graph sheet.

OBSERVATION TABULAR FORM:

S.No.	V_L	I_L	W_1	W_2	S_1	S_2	N	T	%S	0/P	I/P	EFFICIENCY

Where $T=(S_1-S_2)*R+9.81$ $O/P=2\prod NT/60$ $Slip=(N_S-N)/N_S$

CALCULATIONS:

1. Power i/p= wattmeter readings x multiplying factor
2. Torque τ= w x g x r N-m

   (Where r is the radius of the brake drum power o/p)
3. O/p Power = $2\Pi NT/60$ Watts

   % $= (N_S-N)/N_S \times 100$

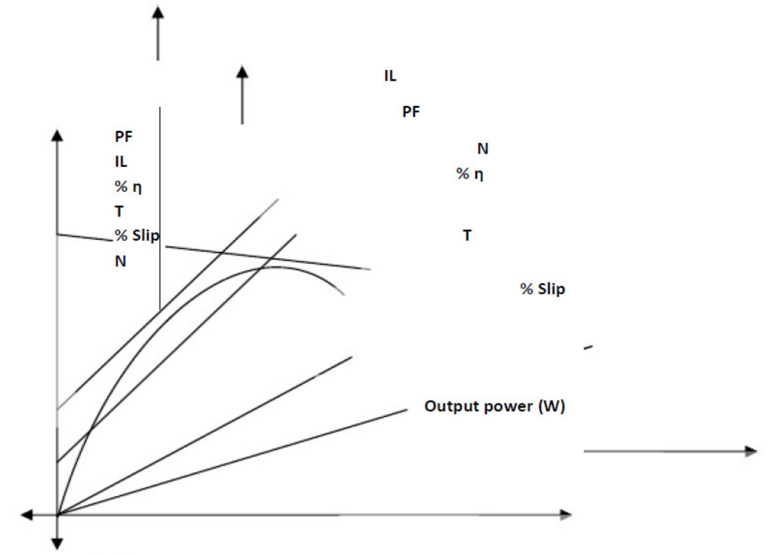
4.Cos $\Phi = R/ 3\ V_L I_L$

PRECAUTIONS:

1. There shouldn't be any load on motor initially.
2. The brake drum should be filled with water to cool it.
3. If wattmeter shows negative deflection reverse either pc or CC and take that readings are negative.
4. The rotor external resistance should be kept at maximum Position.

MODEL GRAPH:

A graph is drawn b/w output power, speed, torque, current, slip and efficiency.

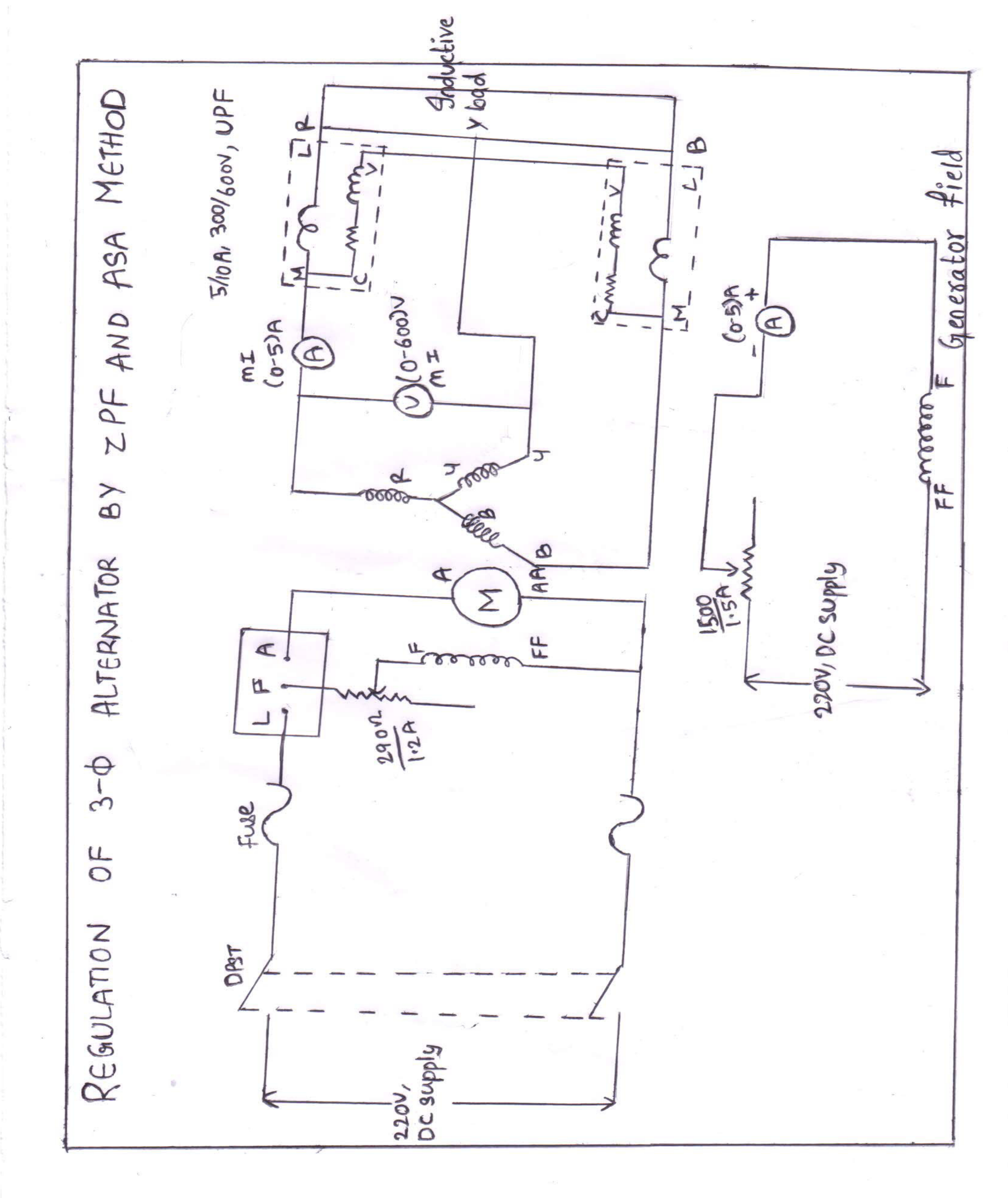


RESULT:

EXPERIMENT NO 11

REGULATION OF 3-PHASE ALTERNATOR BY ZPF AND ASA METHODS

CIRCUIT DIAGRAM



REGULATION OF 3-PHASE ALTERNATOR BY ZPF AND ASA METHODS

AIM : To determine the regulation of a 3-phase alternator by ZPF and ASA method.

NAME PLATE DETAILS:

S.NO.	MOTOR		3 PHASE ALTERNATOR	
	PARAMETER	**RATINGS**	**PARAMETER**	**RATINGS**
1	RATED POWER			
2	RATED VOLTAGE			
3	RATED CURRENT			
4	RATED SPEED			

APPARATUS REQUIRED:

S.NO.	EQUIPMENT	TYPE	RANGE	QUANTITY
1	3-Phase alternator	-	-	1
2	Ammeter	MC	(0-15)A	1
3	Ammeter	MI	(0-5)A	1
4	Voltmeter	MI	(0-600)V	1
5	Tachometer	Digital	-	1

PRECAUTION:

1. The motor field rheostat should be kept in the minimum resistance position.
2. The Alternator field potential divider should be in the position of minimum potential.
3. Initially all switches are in open position.

PROCEDURE FOR BOTH POTIER AND ASA METHODS:

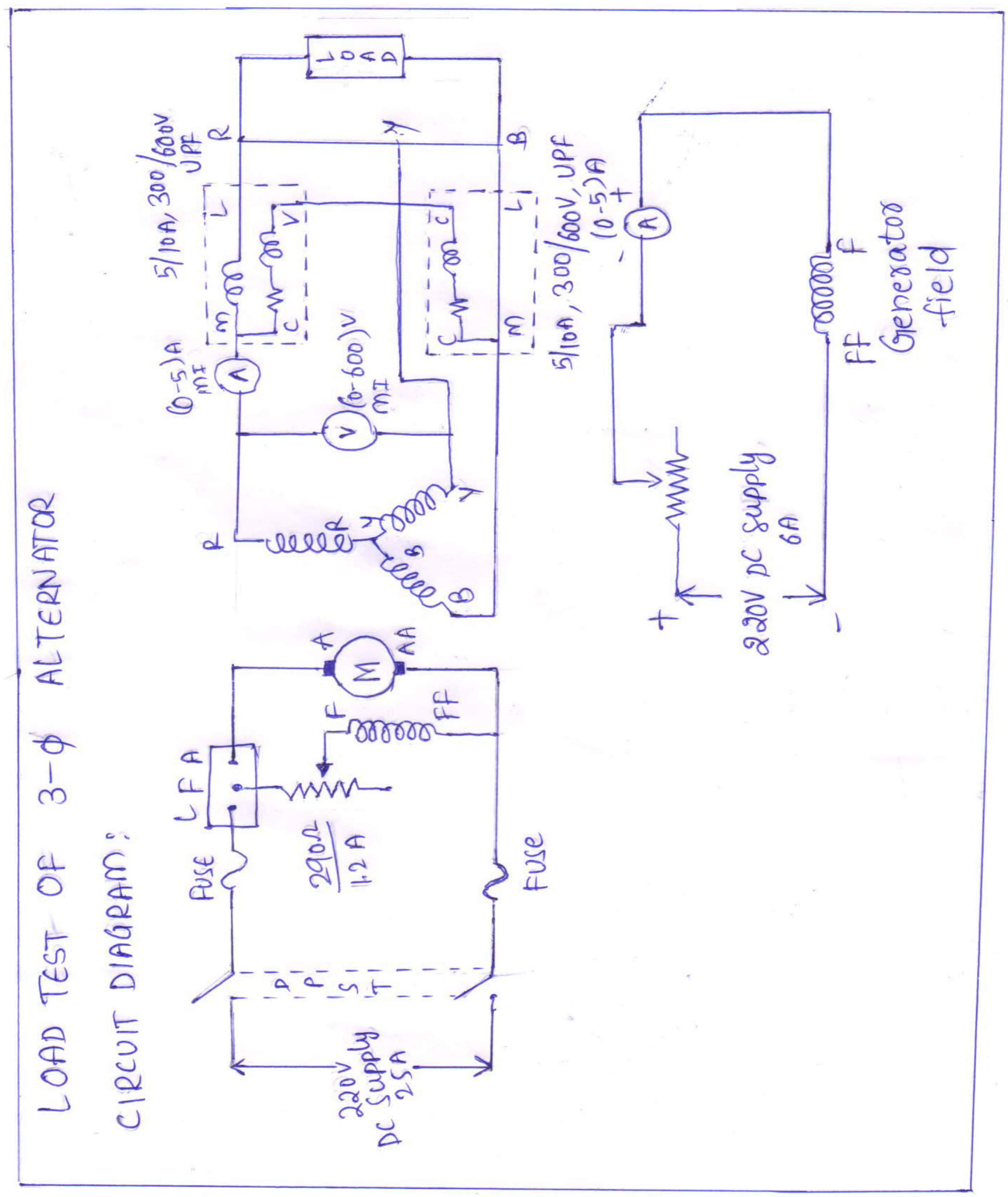
1. Note down the complete nameplate details of motor and alternator.
2. Connections are made as per the circuit diagram.
3. Switch on the supply by closing the DPST main switch.
4. Using the Three point starter, start the motor to run at the synchronous speed by varying the motor field rheostat.
5. Conduct an Open Circuit Test by varying the Potential Divider for various values of Field current and tabulate the corresponding Open circuit voltage readings.
6. Conduct a Short Circuit Test by closing the TPST knife switch and adjust the potential divider the set the rated Armature current, tabulate the corresponding Field current.
7. Conduct a ZPF test by adjusting the potential divider for full load current passing through either an inductive or capacitive load with zero power and tabulate the readings.
8. Conduct a Stator Resistance Test by giving connection as per the circuit diagram and tabulate the voltage and Current readings for various resistive loads.

RESULT:

EXPERIMENT NO 12

LOAD TEST ON THREE PHASE ALTERNATOR

CIRCUIT DIAGRAM



LOAD TEST ON OF 3-PHASE ALTERNATOR

AIM: To determine the efficiency of a 3-phase alternator.

NAME PLATE DETAILS:

S.NO.	MOTOR		3 PHASE ALTERNATOR	
	PARAMETER	UNITS	PARAMETER	UNITS
1				
2				
3				
4				

APPARATUS REQUIRED:

S.NO	EQUIPMENT	TYPE	RANGE	QUANTITY
	3-Phase alternator	-	-	1
1	Ammeter	MC	(0-1.5A/3A)	1
3	Voltmeter	MC	(0-600)V	1
4	Wattmeter	-	(0-5)A/600V	1
5	Tachometer	Digital	-	1

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Ensure that motor field Rheostat is minimum and alternator field rheostat is maximum
3. Start the motor as with the help of starter and by adjusting motor field rheostat if rated speed synchronous speed of machine.

4. By smooth variation the field rheostat of the alternator is set at rated V/g(415V) across any two phases.
5. Apply the different load current upto the rated current of the alternator of each step each load current. Notedown the readings of V_{ac} ,I_{dc} , $V_{ac,}$ I_{ac},W_1 , W_2
6. By changing the rheostat get the rated voltage in alternator voltmeter.
7. By applying different loads note down the V_{ac} ,I_{dc} , V_{ac} ,W_1 , W_2

CALCULATION:

Input Power = (V_{dc} * I_{dc}*0.82)

Output Power = (W_1 + W_2)

Efficiency = (Output Power/ Input Power)

OBSERVATION TABULAR FORM:

S.No.	Load	V_{dc}(V)	I_{dc}(A)	I/P	V_{ac}(V)	I_{ac}(A)	W_1	W_2

CALCULATION TABULAR FORM:

S.NO.	INPUT POWER	OUTPUT POWER	EFFICIENCY

RESULT: