1. PREAMBLE:

The significance of the Electrical Machines Lab-II, is renowned in the various fields of engineering applications. For an Electrical Engineer, it is obligatory to have the practical ideas about the Electrical Machines . By this perspective we have introduced a Laboratory manual cum Observation for Electrical Machines Lab-II.

The manual uses the plan, cogent and simple language to explain the fundamental aspects of Electrical Machines in practical. The manual prepared very carefully with our level best. It gives all the steps in executing an experiment.

2 OBJECTIVE & RELEVANCE:

This Machines-2 Laboratory is to expose the students to the concepts of synchronous and asynchronous machines and analyze their performance. Also impart knowledge on Construction and performance of salient and non – salient type synchronous generator, Principle of operation and performance of synchronous motor, Construction, principle of operation and performance of induction machines, Starting and speed control of three-phase induction motors, Construction, principle of operation and performance of single phase induction motors and special machines. This lab consists of machines such as reluctance machine, induction motor, induction generator, alternators, synchronous motors etc., all mounted in industrial type of assembly to give the students industrial feel.

OUTCOME:

- After the completion of this course student may able to find the efficiency of alternators ,transformers and induction motors.
- Understanding of conversion of 3-phase to 2-phase by using scott connection .
- Design parameters of single phase induction motors.
- Separation of losses in transformers.
  Parallel operation of transformer

3 List of Experiments:

1. O.C. & S.C. Tests on Single phase Transformer
2. Sumpner's or back to back test
3. Scott connections of transformers
4. No-load on three phase Induction motor
5. Blocked rotor tests on three phase Induction motor
6. Regulation of an Alternator by synchronous Impedance Method
7. V and Inverted V curves of a three-phase synchronous motor
8. Determination of Xd and Xq of a salient pole synchronous machine
9. Brake test on three phase Induction Motor
10. Parallel operation of two single phase Transformer
11. Equivalent Circuit of Single Phase Induction Motor

4 Text and Reference Books

1 I.J.Nagrath & D.P.Kothari, Tata Mc Graw-Hill "***Electric Machines"*** Publishers, 1997

2 P.S.Bimbra, "***Electric Machines"***, Khanna Publishers

3 M.G.Say, ELBS and Pitman & Sons ***"The performance and design of A.C Machines"***.

4 A.E.Fitgerald, C.Kingsley and S.Umans "***Electric Machinary"*** Mc Graw-Hill Companies, 5thEdition , 1990.

5 Mukerjee & Chakravarthi "***Electrical Machines"*** Khanna Publishers
Langsdorf, "***Theory of Alternating Current Machinery***" 2nd Edition.

6 S.Kamakashiah "***ElectroMachines-III (Synchrnous and Single – phase machines)"***,
Hitech Publishers.

7 Additional Books Referred by the Faculty :
J.B.Gupta ***" Theory and Performance of Electrical Machines",*** Tata Mc. Graw-Hill.

5. SESSION PLAN

Sl.No	Name of the Experiment	Week of Experiment
1	O.C. & S.C. Tests on Single phase Transformer	Week #1
2	Sumpner's or back to back test	Week #2
3	Scott connections of transformers	Week #3
4	No-load on three phase Induction motor	Week #4
5	Blocked rotor tests on three phase Induction motor	Week #5
6	Regulation of an Alternator by synchronous Impedance Method	Week #6
7	V and Inverted V curves of a three-phase synchronous motor	Week #7
8	Determination of Xd and Xq of a salient pole synchronous machine	Week #8
9	Brake test on three phase Induction Motor	Week #9
10	Parallel operation of two single phase Transformer	Week #10
11	Equivalent Circuit of Single Phase Induction Motor	Week #11

6 Experiment write up

6.1 OC & SC TESTS ON SINGLE PHASE TANSFORMER

AIM : To determine the Efficiency, Regulation and to determine the equivalent circuit.

NAME PLATE DETAILS :

1. Voltage : 230 / 115 V
2. Current :
3. KVA Rating : 3 KVA
4. Frequency : 50 Hz

APPARATUS REQUIRED:

S.No	Name of the equipment	Range	Type	Quantity
1	Transformer	115u / 300V	Single Phase	1

THEORY:

The performance of Transformer can be calculated on the basis of its equivalent circuit, which contains four main parameters, the equivalent resistance (R_{01} or R_{02}), the equivalent leakage reactance (X_{01}or X_{02}), the core loss resistance R_0 and the magnetizing reactance X_0. These parameters can be determined by two tests i). O.C Test ii). SC test.

O.C. Test :

The purpose of this test is to determine no-load losses or core losses and no-load primary current I_o , which is helpful in finding out X_o and R_o .

One winding, usually the high voltage winding is left open and the other is connected to the supply of normal voltage and frequency. With normal voltage applied normal flux will be setup in the core. Hence normal iron losses will occur which are recorded by the watt meter. As primary no-load current I_0 is small, copper loss is negligibly small in primary and nil in secondary. Hence watt meter reading represents practically the core losses under no-load conditions.No-load primary current = I_o

Input = V_1

Core losses under no-load = $W_o = V_1 I_O \cos \phi_o$

$\cos \phi = W/ V_1 I_O$

Magnetizing current $I\mu = I_o \sin \phi_o$

Working component current $I_w = I_o / \cos \phi_o$

Core loss resistance $R_o = V_1 / I_w$

Magnetizing reactance $X_o = V_1 / I\mu$

S.C. test :

The purpose of this test is to determine the Equivalent Impedance (Z_{01}orZ_{02}), Total resistance (R_{01}or R_{02}), leakage reactance (X_{01}or X_{02}), Efficiency and Regulation.

In this test one winding usually low voltage winding is short circuited by a thick conductor or through a low resistance ammeter.

Since, the applied voltage is a small percentage of the normal voltage, the mutual flux Φ produced is also a small percentage of its normal value. Hence, core losses are very small with the result that the watt meter reading represents the full load copper loss or I^2R loss for the whole transformer.

If V_{sc} is the voltage required to circulate rated load currents, then

$Z_{01} = V_{sc} / I_1$

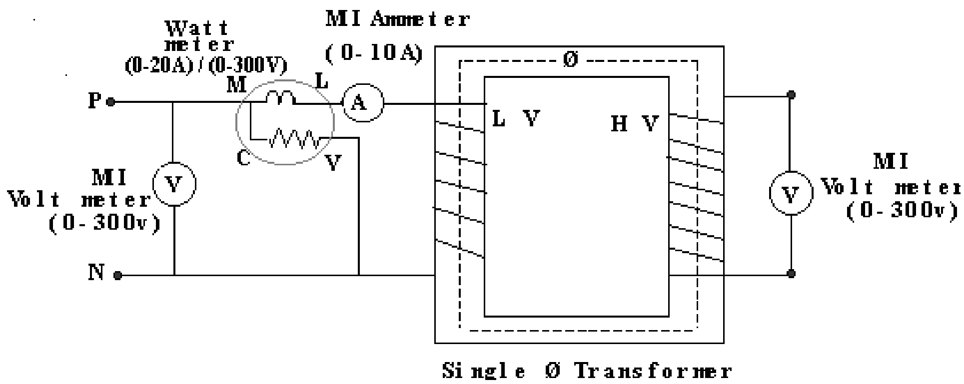
Also,

Copper losses = W = $I_1^2 R_{01}$

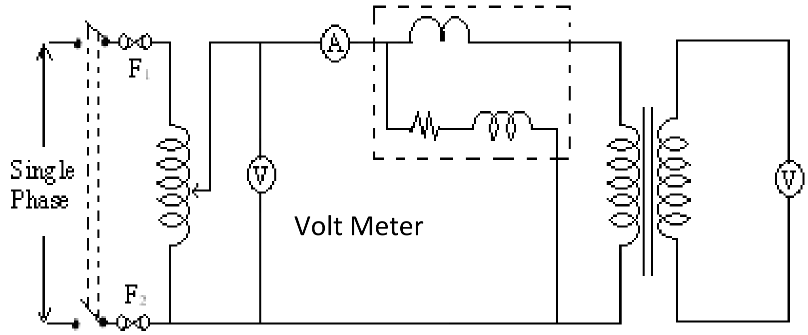
There fore
$R_{01} = W/ I_1^2$

$X_{01} = \sqrt{(Z_{01}^2 - R_{01}^2)}$
Efficiency = Output/ (Output + Total losses)

CIRCUIT DIAGRAM:

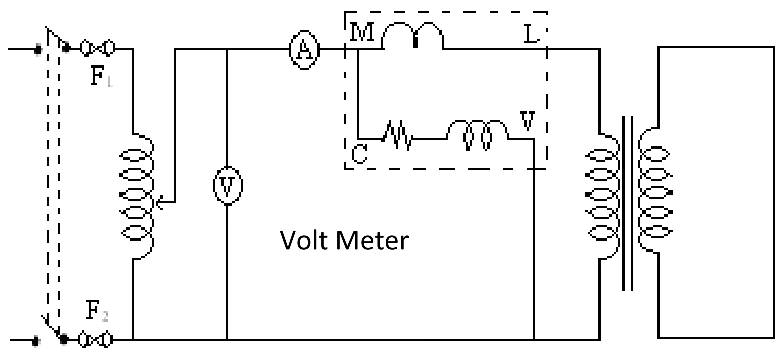


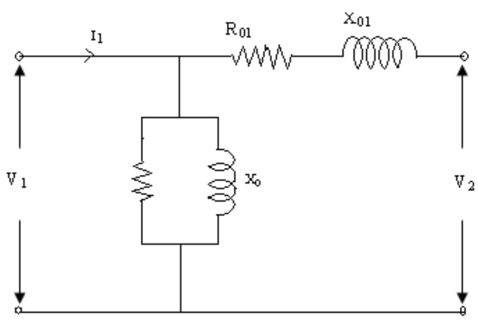
OC Test : [0-5A]



SC Test :

[0-20A]





EQUIVALENT CIRCUIT FOR OC AND SC TEST

PROCEDURE:

a. O.C. Test.

1. Connect the circuit as shown in circuit diagram.
2. Switch on the supply
3. Apply the rated voltage to the L.V. side with the help of variac by varying the knob gradually.
4. Note down the readings of Ammeter, Voltmeter and wattmeter.
5. Adjust the variac output to zero value with the help of variac knob.
6. Switch off the supply and remove the connections

S.C. Test.

1. Connect the circuit as shown in figure
2. Switch on the supply
3. Apply the voltage by varying the variac knob gradually drawn is equal to the rated current of HV side this will occur usually at 5-10% of rated voltage.
4. Note down the readings of voltmeter Ammeter and wattmeter.
5. Adjust the o/p voltage of variac to zero value with the help of variac knob.
6. Switch off the supply and remove the connections.

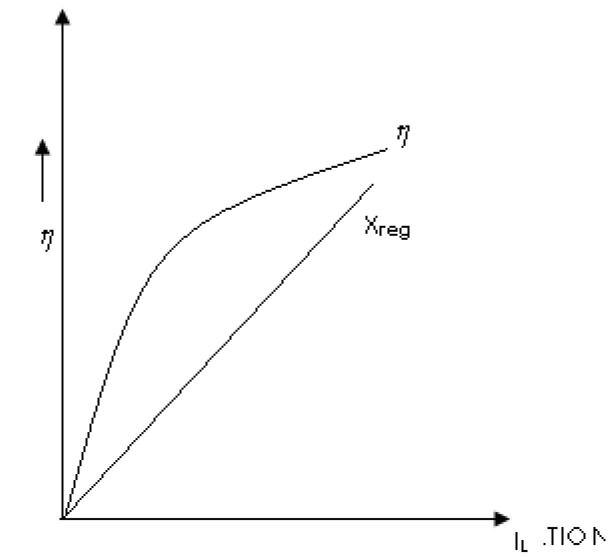
OBSERVATIONS:

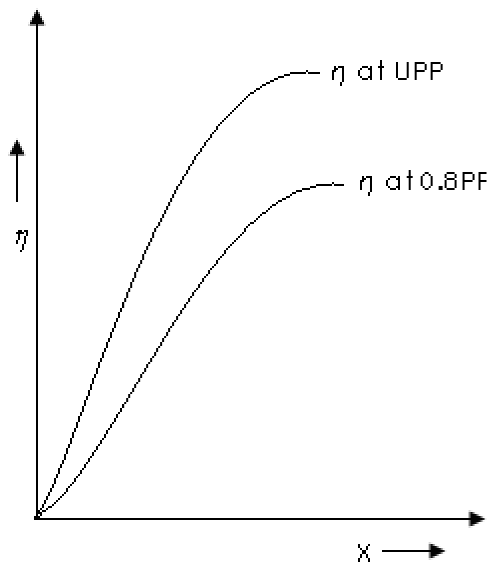
S. No		V (volts)	I (amps)	W (watts)
1	OC TEST	115V	0.75A	30W – Iron Loss
2	SC Test	12.5	9A	100W – Copper loss

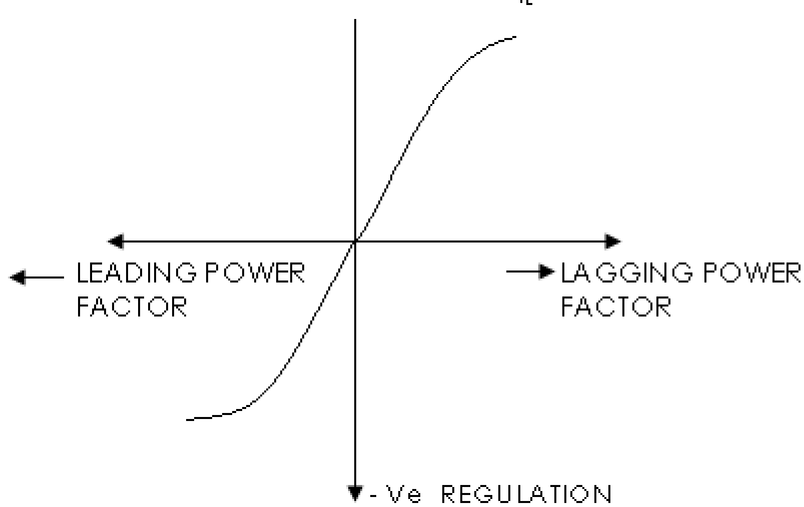
Tabular Form

Friciti on of Load	Output xp Power (kw)	Iron loss P_1 (w)	Copper Loss P_{SC} (w)	Input P_I+x^2 P_{sc} +x_p	η at UPF %	Output at 0.8 PF log	η at 0.8PF	Cos Ø	Sin Ø	Regulation of Log PF	Regulation of Load PF

EXCEPTED GRAPHS:







RESULTS & CONCLUSIONS:

6.2 SUMPNER OR BACK TO BACK TEST

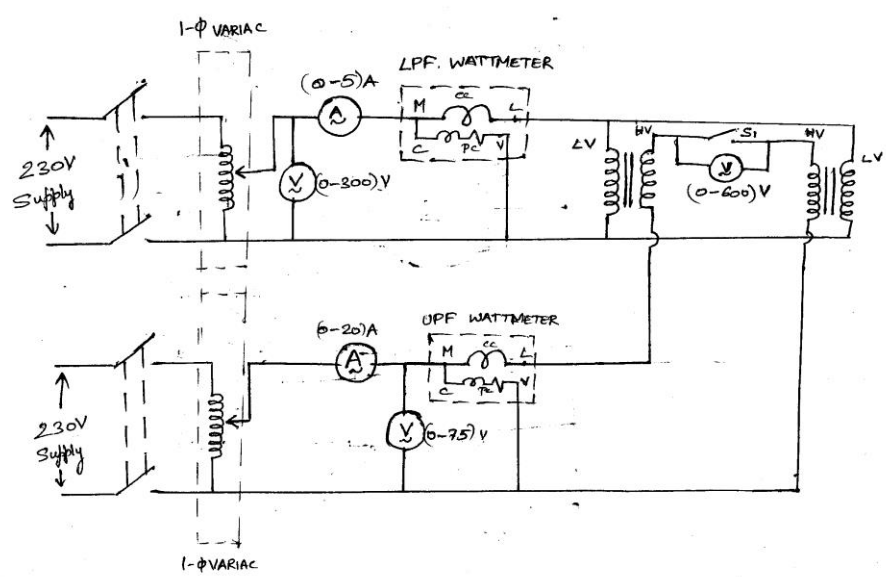
AIM :

To find the Efficiency, Regulation of a single phase transformer by conducting Sumpner test.

APPARATUS REQUIRED:

1. Two identical single phase transformers
2. Watt meters – 2 No.s
3. Voltmeter - 2 No.s
4. Ammeter - 1 No.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Connect the circuit as per circuit diagram
2. Keep the various in minimum position open the switch which is connected between secondary windings, used to test the polarity.
3. Switch ON the supply and slowly increase the input voltage by using variac knob til rated voltage is present at input side.
4. Close the switch connected between secondary windings if the voltmeter connected across switch shows zero reading then they are in phase opposition if it is nol. Showing the zero reading then open the switch adjust to initial conditions. Switch OFF the suppky and interchange the secondary winding connections.
5. After closing the switch, note down the readings of meters.
6. Vary the second variac which is connected to the secondary winding until rated current flows in the winding. (usually it requires 15-20% of rated voltage.
7. Once the circuit is operating in rated conditions note down the readings.
8. Once the circuit is operating in rated conditions note down the readings
9. Bring the circuit to its initial state by slowly varying the variac knob.
10. Switch OFF the supply.

CALCULATIONS:

Input Voltage = V_1

Core loss for a single phase transformer = $W_1 / 2$

OBSERVATIONS:

S.No.	V_1(V)	I_1 (A)	W_1 (W)	V_2 (V)	W_2 (W)	I_2 (A)

1	230V	1.2	36 x 2	7.5	75 x 1	8

CALCULATIONS:

Fraction of Load (x)	Output (P_i)	Power factor	Iron losses W_i	Copper losses $Wc=X^2w$	Input $P=P_i+W_i+W_c$	% η

Copper loss for a single phase transformer= W_2 / 2

Total losses = $(W_1 + W_2) / 2$

η = Output/ (Output + Total losses)

Regulation of a transformer = $[(V_{NO\ LOAD} - V_{FULL\ LOAD})/ V_{FULL\ LOAD}] \times 100$

RESULT:

6.3 Scott Connection of Transformers

AIM : To obtain a balanced 2 phase supply from 3-phase supply by using scott connection.

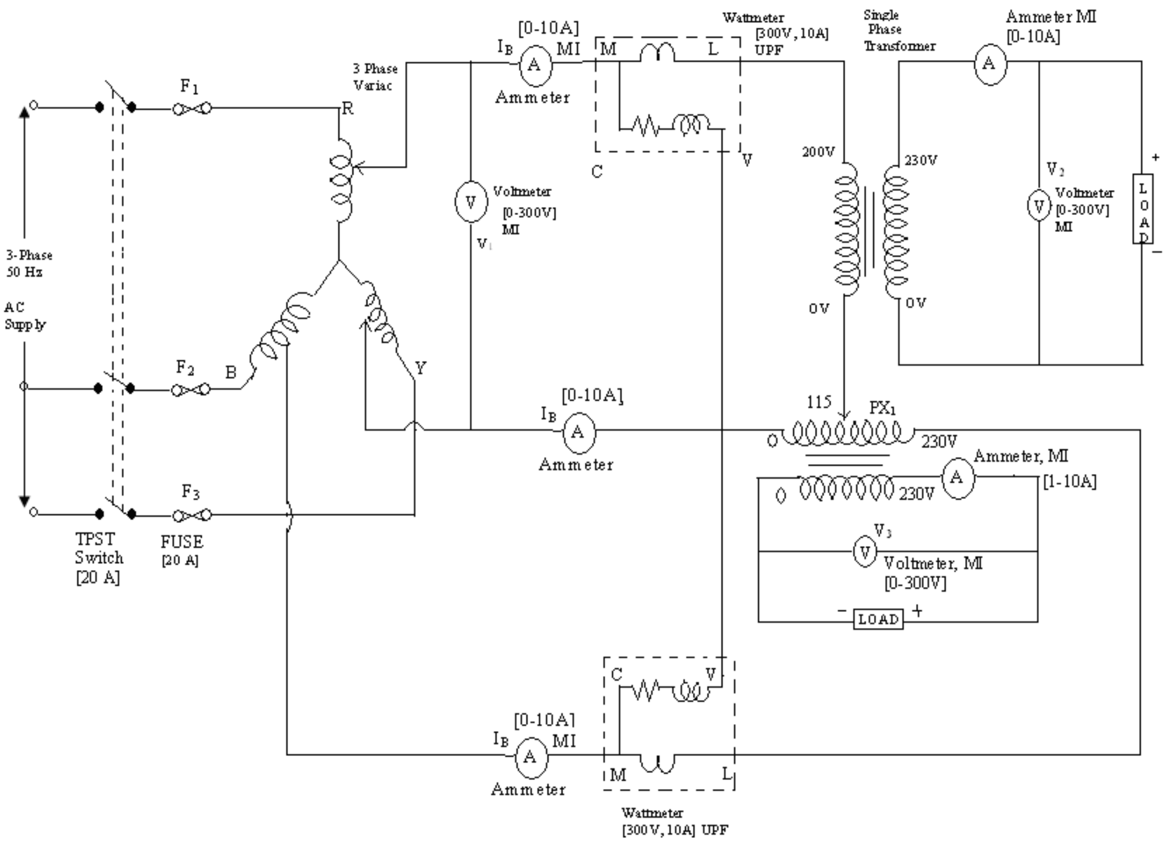
APPARATUS REQUIRED:

S.NO	COMPONENTS	TYPE	RANGE	Qty
1	3phase variac	15A, 400V A C	0-470V	1
2	3 pole MCB		25A	1
3	TPST Switch	MI	(0-10)A	5
4	Ammeter	MI	(0-300)A	2
5	Voltmeter	MI	(0-600)V	1
6	Load	Resistive		2

THEORY:

In some cases such as for electric furnaces, it is derived to work with 2-phase current. Now a days 3-phase AC supply is available. Therefore it is necessary to convert 3-phase to 2-phase. This is achieved by means of scott connections.

CIRCUIT DIAGRAM:



PROCEDURE:

1 Make the connections as per circuit diagram

2 Adjust the value & 3-phase variac to zero position and open the switches of loads connected at output side.

3 Ensure that all the switches of load will be in OFF position.

4 Switch ON the supply and slowly adjust the value of input voltage by varying variac knob.

5 Switch ON the switches of load and gradually apply the load and note down the readings at each and every load in the tabular column.

6 The above sty will be carried out for both balanced and unbalanced loads.

7 After, remove all the loads and bring the circuit to its initial conditions by varying the variac knob.

8 Switch OFF the supply

LOAD	AT_L(A)	AM_L(A)	V1(V)	V2(V)

OBSERVATIONS:

S.NO	V1	V2	V3

RESULT:

Three phase to two phase conversion is obtained by using scott connection.

6.4. No-load & Blocked rotor tests on three phase Induction motor

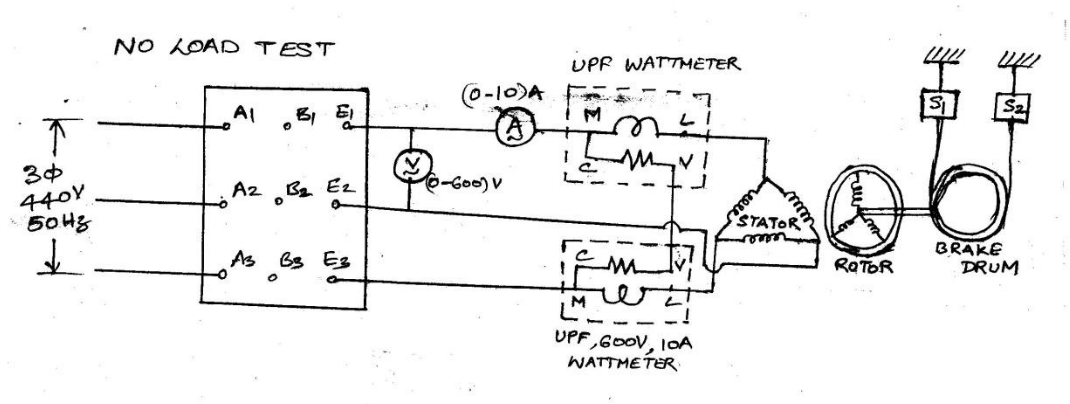
NO-LOAD TEST

AIM : To perform No-load test on 3- phase Induction motor and to find the magnetizing resistance and Reactance.

APPARATUS REQUIRED:

1. 3- Phase slip ring induction motor.
2. 3- phase Auto transformer.
3. Watt meter(LPF) - 2 No.s
4. M.I. Ammeter (0-10A) - 2 No.s
5. Voltmeter(0-600v)
6. Tacho meter

CIRCUIT DIAGRAM:



PROCEDURE:

1. Make the circuit as per the given circuit diagram.
2. Close the main switch and gradually increase the voltage applied to the stator through the auto transformer.
3. At each value of applied voltage, take the values of the two watt meters, stator current I_0, Stator voltage V, rotor current I_r and speed.
4. Tabulate the observations and calculate the power input and power factor for each reading.
5. Measure the stator resistance and make the necessary temperature correction.

CALCULATIONS:

The input Power= $W_1 + W_2 = P_0$

Stator copper loss = $3I_0^2 R_1$

We have $P_0 = \sqrt{3} VI_0 \cos\Phi_0$

$\cos\Phi_0 = P_0 / (\sqrt{3} VI_0)$

In phase component of load current = $I_0 \cos\Phi_0$

Magnetizing component of load current = $I_0 \sin\Phi_0$

Resistance in Magnetising circuit = voltage per phase/ $I_0 \cos\Phi_0$

Magnetising reactance = voltage per phase/ $I_0 \sin\Phi_0$

OBSERVATIONS :

No-Load test:

V (Vats)	I (ANPS)	W_1 (Watts)	W_2 (Watts)

Blocked rotor test:

V (Vats)	I (AMPS)	W_1 (Watts)	W_2 (Watts)

GRAPHS:

Plot

1. Speed V_S Applied voltage
2. Rotor current V_S Applied voltage
3. Stator current I_S V_S V
4. Power factor V_S V
5. Power input P_0 V_S V

RESULT:

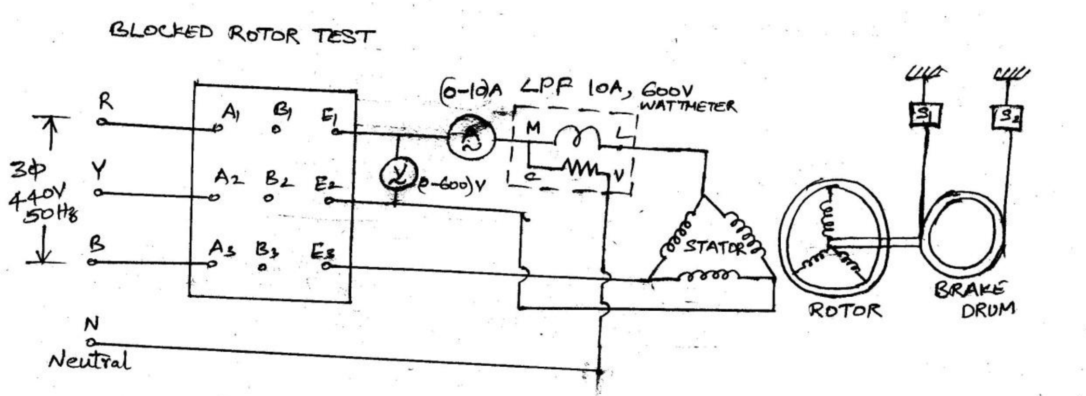
6.5. Blocked rotor tests on three phase Induction motor

AIM: To conduct blocked rotor test on a 3-phase Induction motor and find the series branch resistance and reactance.

APPARATUS REQUIRED:

1. 3- Phase slip ring induction motor.
2. 3- phase Auto transformer.
3. Watt meter(LPF) - 2 No.s
4. M.I. Ammeter (0-10A) - 2 No.s
5. Voltmeter(0-600v)
6. Tacho meter

CIRCUIT DIAGRAM:



PROCEDURE:

1. Make the connections as per circuit diagram.
2. Block the rotor properly so that it cannot rotate.
3. Apply very low voltage to the stator and gradually increase the voltage in small steps.
4. At each step note down the values of stator voltage V, stator current I_S, rotor current I_r, Watt meter readings and calculate Power input.
5. Repeat the step 3 and 4 till 30% above normal rotor current.
6. Decrease the stator voltage and Switch OFF the supply.

CALCULATIONS:

Short circuit current at test voltage = I_{Se} (test)

Short circuit current at rated voltage = I_{Se} (rated)

I_{Se} (rated) = [I_{Se} (test) x V (rated)]/ V (test)

Input = √3. V (test). I_{Se} (test). $\text{Cos}\Phi_S$

= $W_1 + W_2$

$\text{Cos}\Phi_S$ = $(W_1 + W_2)$/ [√3. V (test). I_{Se} (test)].

Equivalent Impedance Z_e = Rated voltage per phase / I_{Se} (rated)

Equivalent resistance R_e = $Z_e \text{Cos}\Phi_S$.

Let Stator resistance per phase = R_1.

Equivalent rotor resistance per phase = $R_e - R_1 = R_2^I$.

Equivalent Leakage reactance X_e = $\sqrt{[Z_e^2 - R_e^2]}$

Stator reactance X_1 = $X_e / 2$

Rotor reactance X_2^I = $X_e / 2$

GRAPHS:

1. Input Power V_S V
2. I_r V_S V
3. I_S V_S V

RESULT:

6.6 REGULATION OF AN ALTERNATOR BY SYNCHRONOUS IMPEDANCE METHOD

AIM : To determine the regulation of an alternator by synchronous impedance method.

NAME PLATE DETAILS :

1. Voltage :
2. Current :
3. H.P/KW Rating :
4. Speed :
5. Frequency :

S.No	Name of the equipment	Range	Type	Quantity

APPARATUS REQUIRED:

THEORY :

It is clear that change in load, there is a change in terminal voltage of an alternator. The magnitude of this change depends not only on the load, but also on the p.f.

VOLTAGE REGULATION:

It is defined as "the rise in voltage when full load is removed (field excitation and speed remaining same) devided by rated terminal voltage.

$$\% \text{ Regulation up} = [(E_0 - V)/ V] \times 100$$

Note : In case of leading p.f terminal voltage will fall on removing the full load. Hence regulation is negative in that case.

SYNCHRONOUS IMPEDANCE METHOD:

This is the indirect method used in the case of large machines when the cost of finding the regulation by direct loading become prohibitive.

This method requires :-

i). Armature (or Stator) resistance R_a

ii). Open circuit/ No load characteristics

iii). Short circuit characteristics.

i) Value of Armature Resistance R_a, per phase can be measured by voltage and ammeter method. However, under working conditions the effective value of R_a is increased due to 'skin effect'. The value of R_a so obtained is increased by 60% or so to allow for this test. Generally a value 1.6 times the d.c. value is taken.

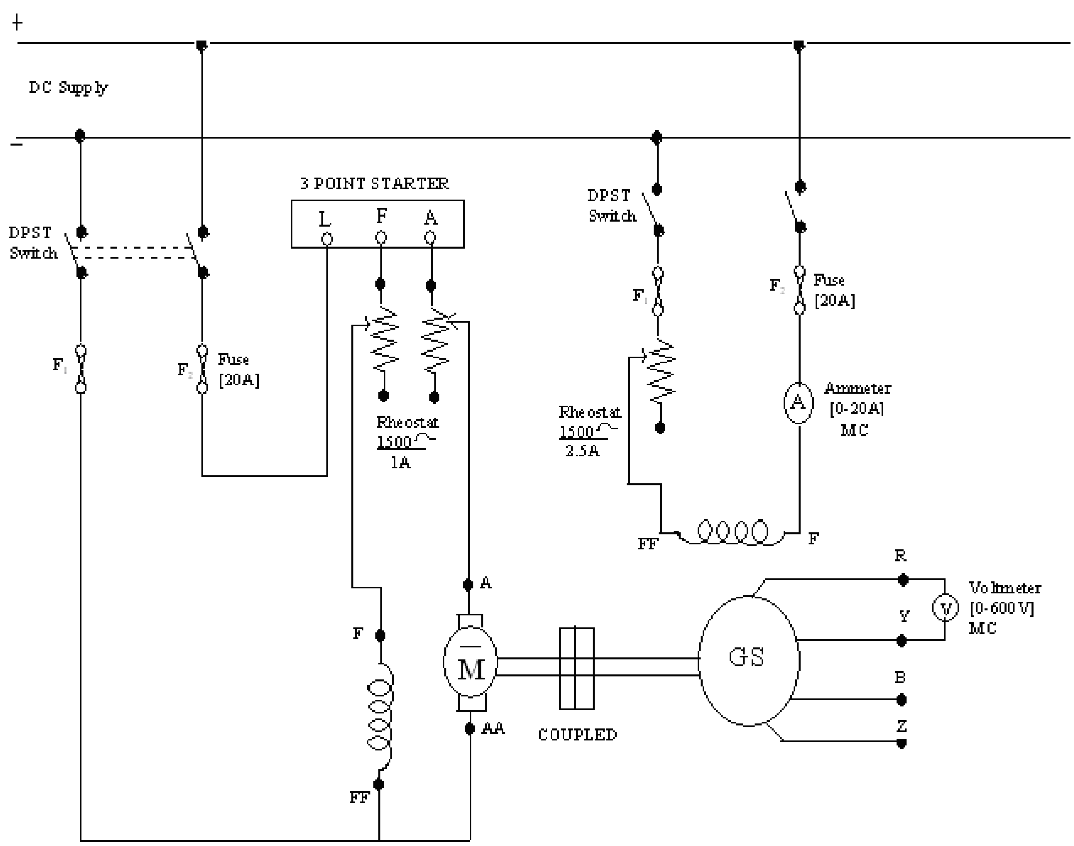
ii). O.C characteristics:

This is the curve plotted by running the machine on no load and by noting the values of induced voltage and field excitation current.

iii). S.C. characteristics:

It is obtained by short circuiting the armature windings through a low resistance ammeter. The excitation is so adjusted as to give 1.5 to 2 times the value of full load current. During this test speed is kept constant.

CIRCUIT DIAGRAM:



PROCEDURE :

OCC:

1. Connections are made as per the circuit diagram.
2. Kept the field rheostat in maximum position.
3. Switch ON the motor and gradually increase the field to the alternator.
4. In each step note down the values of I_f and E_0.
5. Continue step-5 till alternator reaches the rated current.

SCC:

1. Connections are made as per the circuit diagram.
2. Kept the field rheostat in maximum position.
3. Switch ON and run the motor at rated rpm.
4. kept the field current zero and short circuit the stator terminals as shown in figure.
5. Increase the field current and note down the values.
6. Continue step-5 till alternator reaches the rated current.

$E_0 = \sqrt{[(V\cos\Phi + I R_a)^2 + (V \sin\Phi + IX_S)^2]}$

% of Regulation up = $[(E_0 - V)/ V] \times 100$

OBSERVATIONS:

Speed of the M-G set = rpm

OCC

S.No	I_f	E_0

SCC

S.No	I_f	I_{sh}

Following procedure steps are involved in this method:

1. O.C.C is plotted from the given data.
2. Similarly S.C.C. is drawn from the given data.

Both these curves are drawn on a common field current base. Consider a field current I_f . The O.C voltage corresponding to this field current is E_1. when winding is short circuited, the terminal voltage is zero. Hence it may be assumed that the whole of this voltage E_1 is being used to circulate the armature short circuit current I, against synchronous impedance Z_S.

$E = I_1 Z_S$ $Z_S = E_1$ (Open circuit)/ I_1 (Short circuit)

$X_S = \sqrt{(Z_s^2 - R_a^2)}$

Residual Voltage = 15V

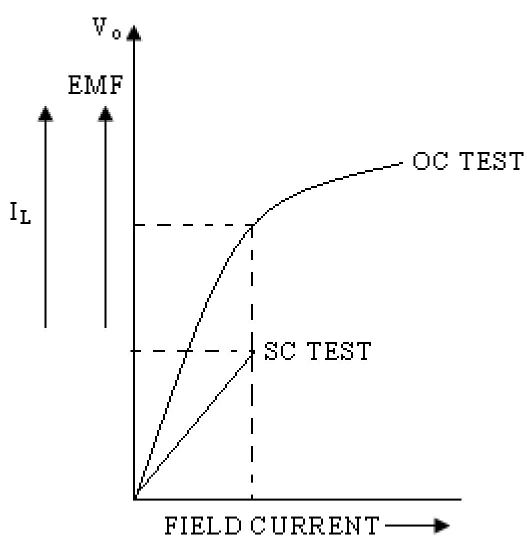
OC Test:

S.No.	Field current I_f (A)	V_o (V)

SC Test:

S.No.	Field current I_f (A)	Load current (I_L)

EXCEPTED GRAPH:



RESULTS & CONCLUSIONS :

6.7. 'V' AND "INVERTED 'V" CURVES OF A SYNCHRONOUS MOTOR.

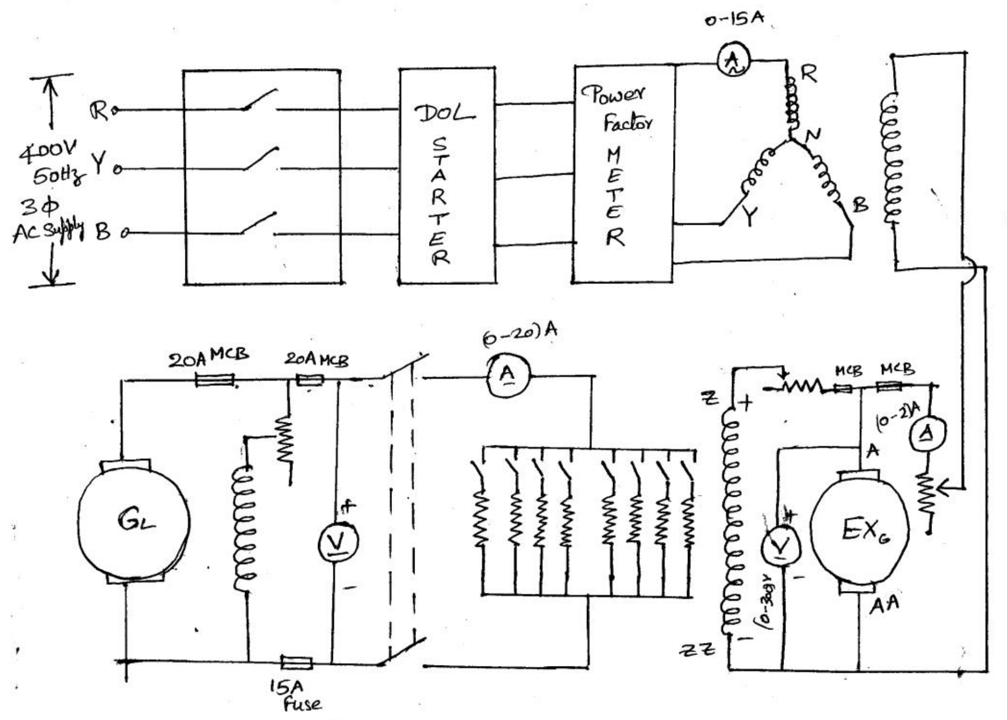
AIM :

To determine V and Inverted V curves of a Synchronous motor at constant output or constant input.

APPARATUS REQUIRED:

1. MC Ammeter (0-20A)
2. MI Ammeter (0-20A)
3. MI Volt meter (0-600v)
4. Watt meters [(0-20A)/ (0-600v)] - 2 No.s
5.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Make the connections as per circuit diagram.
2. Starts the motor on no-load without field excitation.
3. Switch ON DC excitation.
4. Vary the field excitation through the rheostat and note down the values of Field excitation current I_f, Armature current I_a, Input voltage V and Input Power (i.e. W_1 & W_2) at different steps.
5. Find out the power factor in each step.
6. Repeat the steps 4 and 5 at different load conditions i.e. 1/4th load, ½ load and 3/4th load.

TABULAR FORM:

Sl.No	W_1	W_2	$W_1 + W_2$	I_F	I_a	V	$\cos\Phi = \frac{W}{\sqrt{3}VI_a}$

CALCULATIONS:

Input voltage = V

Input power = √3. V.I. cosΦ

= $W_1 + W_2$

cosΦ = ($W_1 + W_2$)/ √3. V.I.

GRAPHS:

Plot

1. Field current I_f V_S Armature current I_a
2. Power factor V_S Field current I_f.

RESULT:

6.8. Determination of Xd and Xq of a Salient Pole Synchronous Machine

AIM: To determine direct axis (Xd) and quadrant axis (Xq) of an alternator.

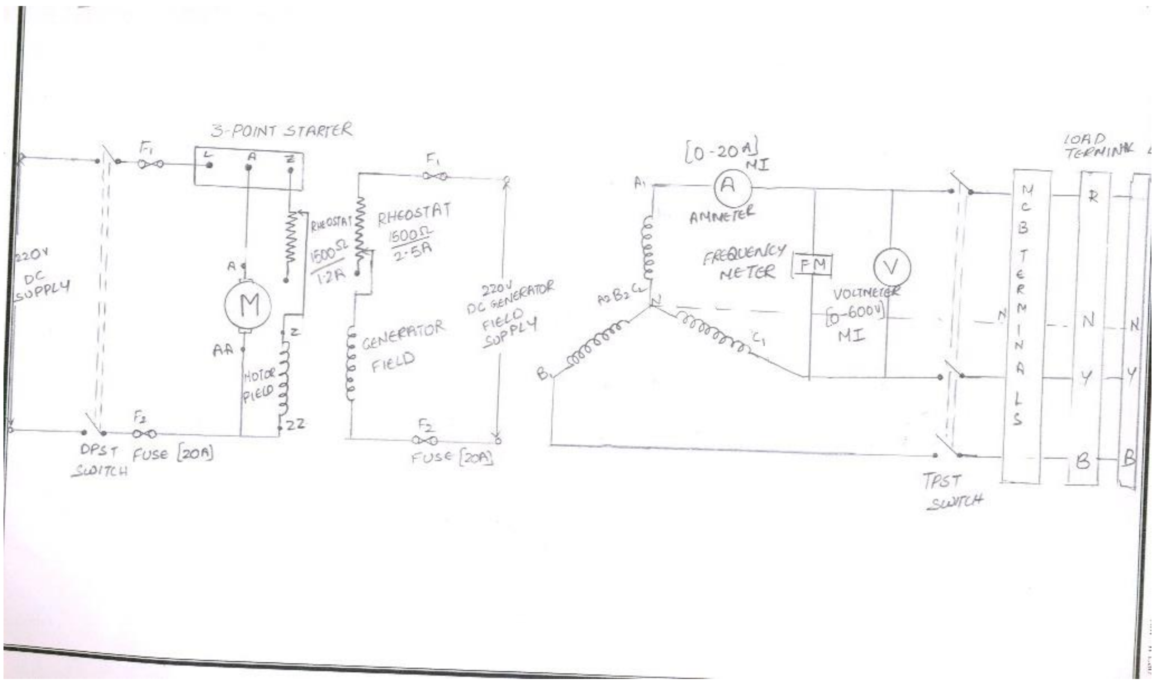
APPARATUS:

S.NO	COMPONENTS	RANGE	TYPE	QTY
1	VOLTMETER	(0-600)V	MI	1
2	AMMETER	(0-20)V	MI	1
3	AMMETER	(0-2)A	MC	1
4	RHEOSTAT	100 OHMS/5A 1500 OHMS/1.2A	WIRE WOUND	1
5	TACHOMETER	(0-3000)rpm	DIGITAL	1

THEORY:

The synchronous machine with salient pole has non uniform airgap. Due to its vactance varies with the rotor position. The salient pole machine posses two axes of geometry symmetry (i) field axis, called direct axis (or) d- Axis and (ii) axis passing through the centre of inter polar space called the quadrant axis (or) Q-axis.

CIRCUIT DIAGRAM:



PROCEDURE:

a. Connect the diagram as shown.

b. Run the alternator with the help of DC motor to the nearest synchronous speed keeping AC supply off.

c. Keep the variac output voltage minimum.

d. Connect the variac output to rated voltage so that dc motor runs at rated speed.

e. check the voltmeter of alternator so that a reasonable voltage develops, if not set the direction of rotation of rotor and stator field such that they are same ,then a slight adjustment of speed causes the significant oscillations in ammeter.

f. Set the field rheostat to minimum and armature rheostat at max position of the DC shunt motor. Switch ON the supply at the field current.

g. Note the frequency from the frequency meter.

h. Note down the stator voltage &stator current by varying the field rheostat at synchronous machine.

CALCULATIONS:

Xd= (Maximum stator terminal voltage/phase)/(Minimum stator current / phase)

RESULT:

6.9. BRAKE TEST ON A THREE- PHASE INDUCTION MOTOR

AIM :

To determine the performance characteristic of a 3-phase induction motor by load test.

NAME PLATE DETAILS :

1. Voltage : 415 Volts
2. Current : 7.5 Amps
3. H.P/KW Rating : 3.7 KW
4. Speed : 4430 rpm – 1500 rpm
5. Frequency : 50Hz
6. Efficiency : 84%

S.No	Name of the equipment	Range	Type	Quantity
1	VARIAC (Auto transformer)	415/470V 15A, 50HZ	3-Phase	1

APPARATUS REQUIRED:

THEORY :

During this test, the motor is operated at rated voltage, frequency and is loaded mechanically by brake drum and belt arrangement. From the observed data, the performance can be calculated as follows:

1). SLIP (s):

The difference between the synchronous speed N_S and the actual speed N of the rotor is known as *slip*.

The speed of the rotor (N), drops as load on the motor is increased. The synchronous speed (N_s) of the rotating magnetic field is calculated and hence slip.

$$N_S = (120\ f) / P \quad \text{rpm}$$

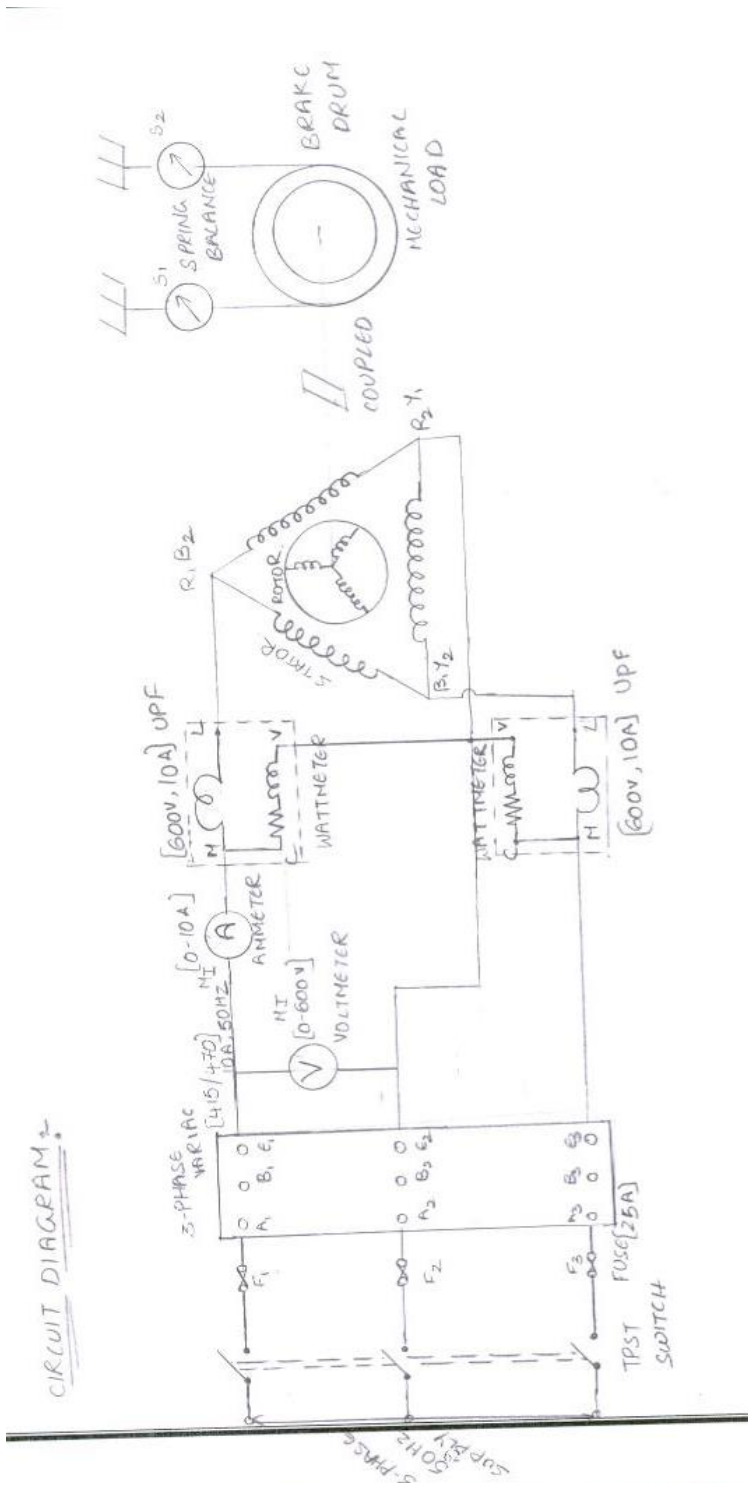
$$\text{Slip, } S = \frac{(N_S - N)}{N_S} \times 100$$

2). Power Factor:

Power factor can also be calculated from the readings of two-watt meters for balanced load. If 'ϕ', power factor 'Cos ϕ' can be calculated.

It should be noted that the PF of the Induction Motor is low at no load, (of about 0.1 to 0.3 lagging). As such one of the watt meters will record a negative reading, till the PF is less than 0.5, which may be measured by reversing the connection of either current coil or pressure coil of this watt meter.

Circuit diagram:



PROCEDURE :

1. Connections are made as per the circuit diagram.
2. Ensure minimum voltage position of the variac and free rotation of the brake drum and switch ON the supply.
3. Slowly increase the voltage using the variac till rated voltage is impressed across the stator winding of the motor.
4. Note down readings of W_1, W_2, V, S1, S2, speed and I.
5. Increase the load by tightening the brake belt in steps and note down readings as of step–4
6. Continue step-5 till 110% of the rated current of the motor.
7. Release the load on 3-ϕ I.M. and reduce the voltage using the variac and switch OFF the supply.

OBSERVATIONS:

S.No	V (volts)	I (amps)	W_1	W_2	S_1	S_2	N (rpm)	Cosϕ	T	I/P	O/P	Efficiency

MODEL CALCULATIONS :

Torque (T) = $(S_1-S_2) \times 9.81$

Output $= \frac{2\pi NT}{60} \times 0.102$

Efficiency = Output/ Input

$\cos\phi = 1/\sqrt{(1+\tan^2\phi)}$

GRAPHS :

1. Speed V_S Output
2. power factor V_S Output
3. Efficiency V_S Output

RESULTS & CONCLUSIONS :

6.10. Parallel Operation of Two Single Phase Transformer

AIM : To Perform parallel operation of two single phase transformer and to verify

$V_1I_1 + V_2I_2 > V_LI_L$

Load va SHARED < va Capacity

Load VA shared < 1/Z

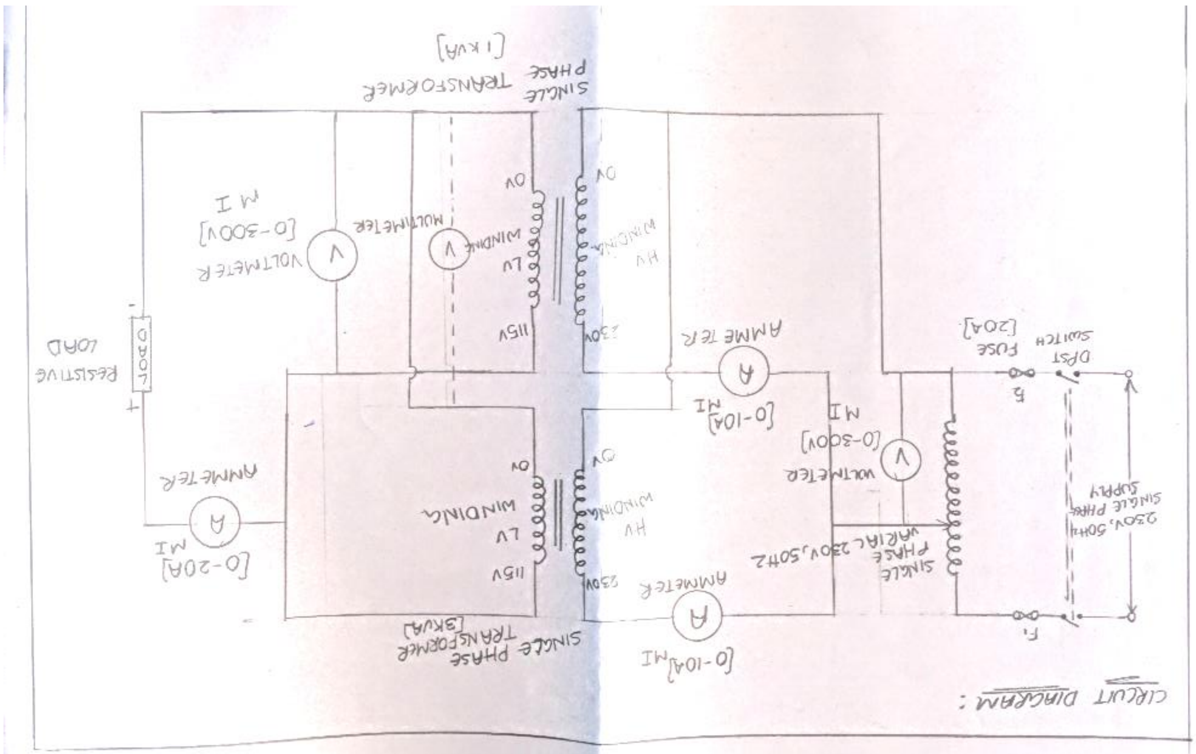
Apparatus Required:

S.No.	Name of the Equipment	Type	Range	Quantity
1	Ammeter	MI	0-10A	2
2	Voltmeter	MI	0-300V	2
3	Ammeter	MI	0-20A	1
4	Variac			1

Theory :

For supplying a load in excess of the rating of an existing transformer and 2^{nd} may be connected in parallel with it. It is seen that primary windings are conncted to the supply bus bars and secondary windings are connected to the load bus bars. It is essential that their terminals of similar polarities are joined to the same bus bars.

CIRCUIT DIAGRAM:



Procedure:

1. Connect the circuit as per circuit diagram without connecting load
2. Apply voltage 230V by using variav
3. To check the polarity
    a. Connect the voltmeter accors OV and OV of secondary side of two transformer and voltmeter show zero reading
    b. Connect the voltmeter accors 115V and OV of secondary side here the voltmeter should same voltage as applied voltage.
4. After checking the polarity connect the load and as per circuit diagram and apply voltage 230V by using variac.
5. Increase the load in steps of 2A and note down the readings of voltmeter and ammeter of I_1, I_2, I_L, V and V_L
6. Calculate V_1 I_1, V_2 I_2 and V_L I_L

Observations:

Load	$V_1 = V_2$	I_1	I_2	V_L	I_L

Calculations:

S.No.	V_1I_1(w)	V_2I_2(w)	$V_1I_1+V_2I_2$ (w)	V_LI_L(w)

Result :

6.11. EQUIVALENT CIRCUIT OF SINGLE PHASE INDUCTION MOTOR

AIM: To conduct the no load and blocked rotor test on single phase squirrel cage induction motor to draw the equivalent circuit

NAME PLATE DETAILS:

-

	Induction motor	Auto transformer
Power:	2HP	3600 VA
Speed:	1440 RPM	-
Current:	15 AMPS	15 AMPS
Voltage:	220 Volts	240 Volts

APPARATUS REQUIRED:

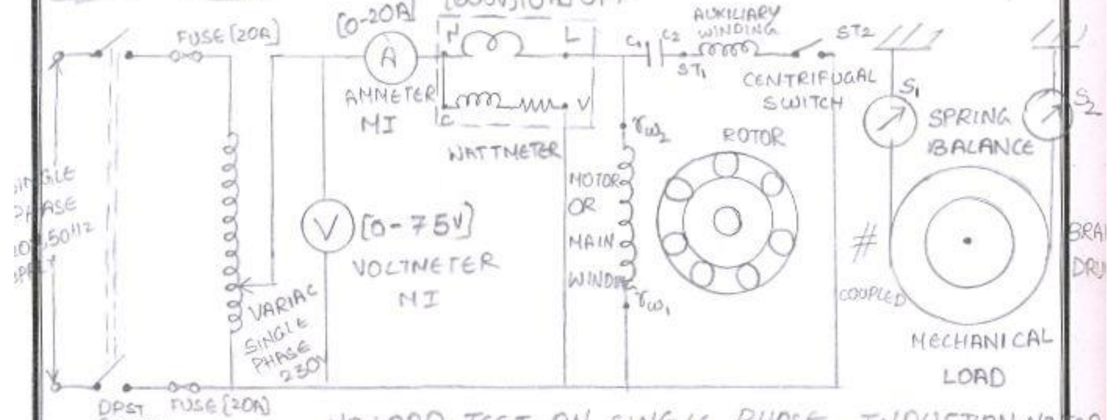
S.No	NAME OF APPARATUS	TYPE	RANGE	QTY
1	Volt meter	MI	0-300 V	1 No
2	Ammeter	MI	0-20 A	1 No
3	Wattmeter	LPF	600V, 20A	1 No
4	Wattmeter	UPF	300V, 10A	1 No

THEORY:

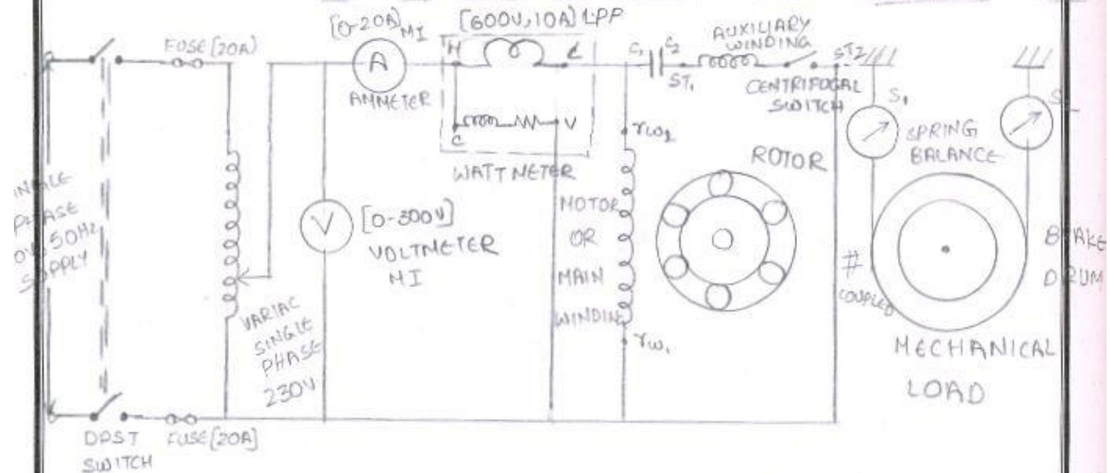
In order to find the equivalent circuit parameters of the motor this test will be conducted. The complete parameters of the motor will be achieved in two stages by performing the no load test and blocked rotor test, in which motor will operates under open circuit and short circuit conditions respectively.

CIRCUIT DIAGRAM:

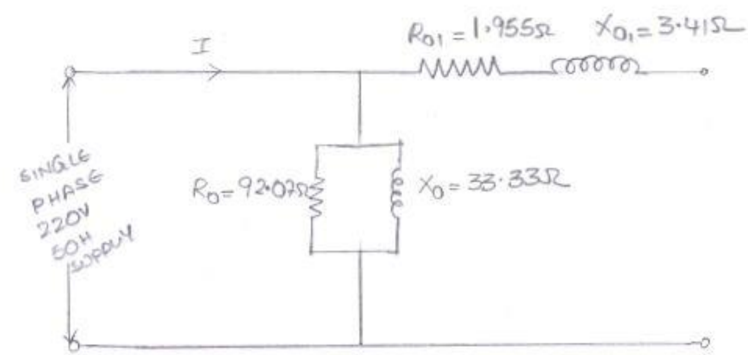
CIRCUIT DIAGRAM:



NO LOAD TEST ON SINGLE PHASE INDUCTION MOTOR



BLOCKED ROTOR TEST ON SINGLE PHASE INDUCTION MOTOR



EQUIVALENT CIRCUIT OF SINGLE PHASE INDUCTION MOTOR

PROCEDURE:

a. No. load test :

1. Connect the circuit as shown in fig.
2. Adjust the value of i/p or supply voltage to 220V by slowly varying the knob of the variac
3. Switch on the supply make sure that motor is not loaded.
4. At rated voltage take the readings of all the meters with out applying any load
5. Switch off the supply & adjust the position of variac knob to initial position.

b. Blocked rotor test :

1. Connect the ckt as per the circuit diagram.
2. Apply full load on the motor such that rotor should be blocked.
3. Adjust the variac position to zero & switch on the supply.
4. Slowly increase the supply voltage such that the motor has to take rated current. (Usually 15% to 20% of rated voltage is required)
5. Note down the readings of all the meters tabular form.
6. Slowly bring the variac knob to its initial position
7. Switch of the supply & remove the load on the motor.

TABULAR COLUMN:

No load test:

S. No	voltage	current	power	
			Actual	Observed

Blocked rotor test:

S. No	voltage	current	power	
			Actual	Observed

PRECAUTIONS:

1. Avoid loose connections
2. Vary the voltage slowly with the help of variac

RESULT:

7. Content beyond syllabus

1) Parallel operation on three phase transformer
2) No load and block rotor test on single phase induction motor
3) On load and blocked rotor test on special machines

8. Sample Viva Voce Questions

Exp:1

1. what is oc test?
2. What is SC test
3. What are the applications of OC test?
4. What are the applications of OC test?
5. Where we will use this test?
6. Applications of OC and SC test?

Exp:2

1. what is back to back test?
2. What is the importance of this test
3. What are the applications of sumperner test?
4. Where we will use this test?

Exp:3

1. what is scott connection ?
2. What is transformer
3. What are importance of scott connection test
4. What are the applications scott connection?
5. Where we will use this test?

Exp:4

1. what is no load test?
2. What is block rotor test
3. What are the applications of no load test?
4. What are the applications of block rotor test?
5. Where we will use this test?

Exp:5

1. what is no load test?
2. What is block rotor test
3. What are the applications of no load test?
4. What are the applications of block rotor test?
5. Where we will use this test?

Exp:6

1. what is regulation?
2. What is alteranator
3. What are the applications of synchronous impedance method test?
4. Why is regulation of rated synchronous motor?
5. Where we will use this test?

Exp:7

1. what is V curve?
2. What is inverted V curve
3. What are the applications of V curve?
4. What are the applications of inverted V curve?
5. Where we will use this test?

Exp:8

1. what is Xq?
2. What is Xd
3. What are the applications of salient pole machine ?
4. What are the applications of squirrel gauge motor?
5. Where we will use this test?

Exp:9

1. what is break test?
2. What is SC test
3. What are the applications of break test?
4. What are the applications of sC test?
5. Where we will use this test?
6. Applications of thistest?

Exp:10:

1. what is transformer?
2. What is parallel operation
3. What are the applications of transformer ?
4. What are the applications of parallel operation
5. Where we will use this test?

Exp:11

1. what is the circuit diagram of single phase induction machine ?
2. What is working principle of SIM
3. What are the applications of salient pole machine ?
4. What are the applications of squirrel gauge motor?
5. Where we will use this test?

9. Sample Question paper of the lab external:

1 perform the O.C. & S.C. Tests on Single phase Transformer

2 perform the back to back test

3 perform the Scott connections of transformers

4 perform the No-load on three phase Induction motor

5 perform the Blocked rotor tests on three phase Induction motor

6 find the Regulation of an Alternator by synchronous Impedance Method

7 draw the V and Inverted V curves of a three-phase synchronous motor

8 Determine the Xd and Xq of a salient pole synchronous machine

9 perform the Brake test on three phase Induction Motor

10 **perform the** Parallel operation of two single phase Transformer

11 calculate the parameters of Equivalent Circuit of Single Phase Induction Motor

10. Applications of the laboratory .

1 with the healp of this lab the students can able to learn the different testing of the transformers

2 with the healp of this lab the students can able to learn the different testing of the single phase induction motor.

3 with the healp of this lab the students can able to learn the different testing of the synchronous motor

4 with the healp of this lab the students can able to learn the different testing of the synchronous generator

This lab healps to learn all the other AC machines.

11. Precautions to be taken while conducting the lab

- Power must be switched-OFF while making any connections.
- Do not come in contact with live supply.
- Power should always be in switch-OFF condition, EXCEPT while you are taking readings.
- The Circuit diagram should be approved by the faculty before making connections.
- Circuit connections should be checked & approved by the faculty before switching on the power.
- Keep your Experimental Set-up neat and tidy.
- Check the polarities of meters and supplies while making connections.
- Always connect the voltmeter after making all other connections.
- Check the Fuse and it’s ratify.
- Use right color and gauge of the fuse.
- All terminations should be firm and no exposed wire.
- Do not use joints for connection wire.
- While making 3-phase motor ON, check its current rating from motor name plate details and adjust its rated current setting on MPCB(Motor Protection Circuit Breaker) by taking approval of the faculty.
- Before switch-ON the AC or DC motor, verify that the Belt load is unloaded.
- Before switch-ON the DC Motor-Generator set ON, verify that the DC motor field resistance should be kept in minimum position. Where as the DC generator / AC generator field resistance should be kept in Maximum position.
- Avoid loose connections. Loose connections leads to heavy sparking & damage for the equipments as well as danger for the human life.
- Before starting the AC motor/Transformer see that their variacs or Dimmerstats always kept in zero position.

- For making perfect DC experiment connections & avoiding confusions follow color coding connections strictly. Red colour wires should be used for positive connections while black color wires to be used for Negative connections.
- After making DPST switch/ICTPN switch-OFF see that the switch in switched-OFF Perfectly or not. Open the switch door & see the inside switch contacts are in open. If in-contact inform to faculty for corrective action.
- For safety protection always give connections through MCB (Miniature circuit breaker) while performing the experiments.

SAFETY – II

1. The voltage employed in electrical lab are sufficiently high to endanger human life.
2. Compulsorily wear shoes.
3. Don’t use metal jewelers on hands.
4. Do not wear loose dress
5. Don’t switch on main power unless the faculty gives the permission4 Do not start the series motor without load.
6. Keep the armature rheostat in maximum position

12. Code of Conduct

1 Students should report to the labs concerned as per the timetable.

2. Students who turn up late to the labs will in no case be permitted to perform the experiment scheduled for the day.

3. After completion of the experiment, certification of the staff in-charge concerned in the observation book is necessary.

4. Students should bring a notebook of about 100 pages and should enter the readings/observations/results into the notebook while performing the experiment.

5. The record of observations along with the detailed experimental procedure of the experiment performed in the immediate previous session should be submitted and certified by the staff member in-charge.

6. Not more than three students in a group are permitted to perform the experiment on a set up.

7. The group-wise division made in the beginning should be adhered to, and no mix up of student among different groups will be permitted later.

8. The components required pertaining to the experiment should be collected from Lab-in-charge after duly filling in the requisition form.

9. When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.

10. Any damage of the equipment or burnout of components will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for the semester/year.

11. Students should be present in the labs for the total scheduled duration.

12. Students are expected to prepare thoroughly to perform the experiment before coming to Laboratory.

13. Procedure sheets/data sheets provided to the students' groups should be maintained neatly and are to be returned after the experiment.

13. Graphs if any.