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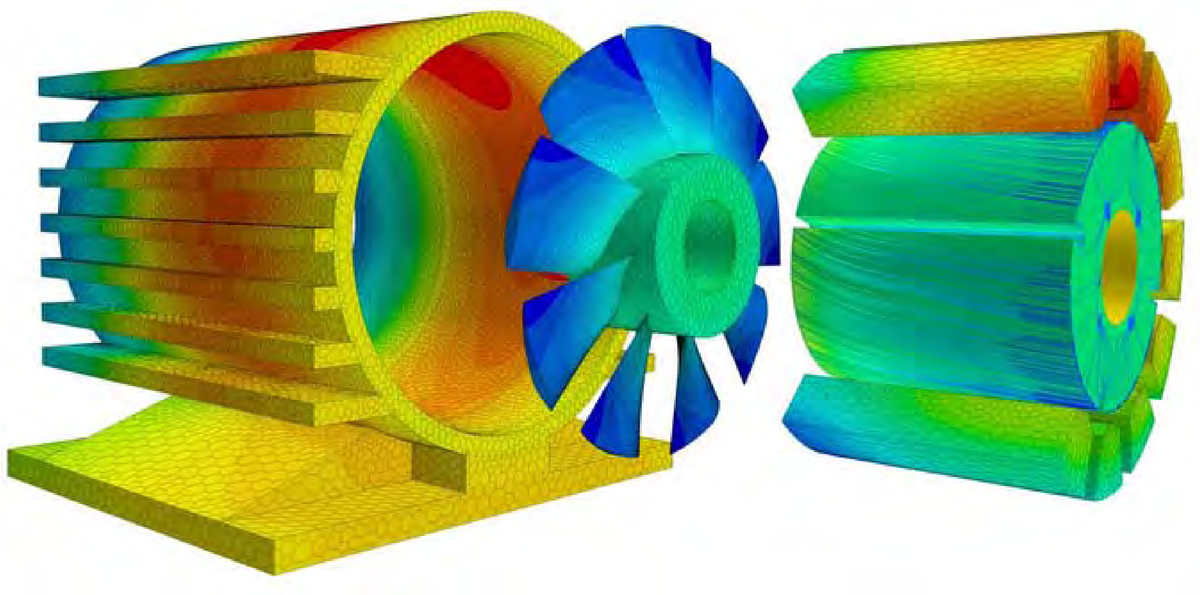


DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

ELECTRICAL MACHINES LAB II

CLASS : III YEAR (EEE)

SEMESTER : VIth SEM (EEE)

SUBJECT CODE : EE09 607 (P)

SUBJECT : ELECTRICAL MACHINES LAB II

Ammini College of Engineering

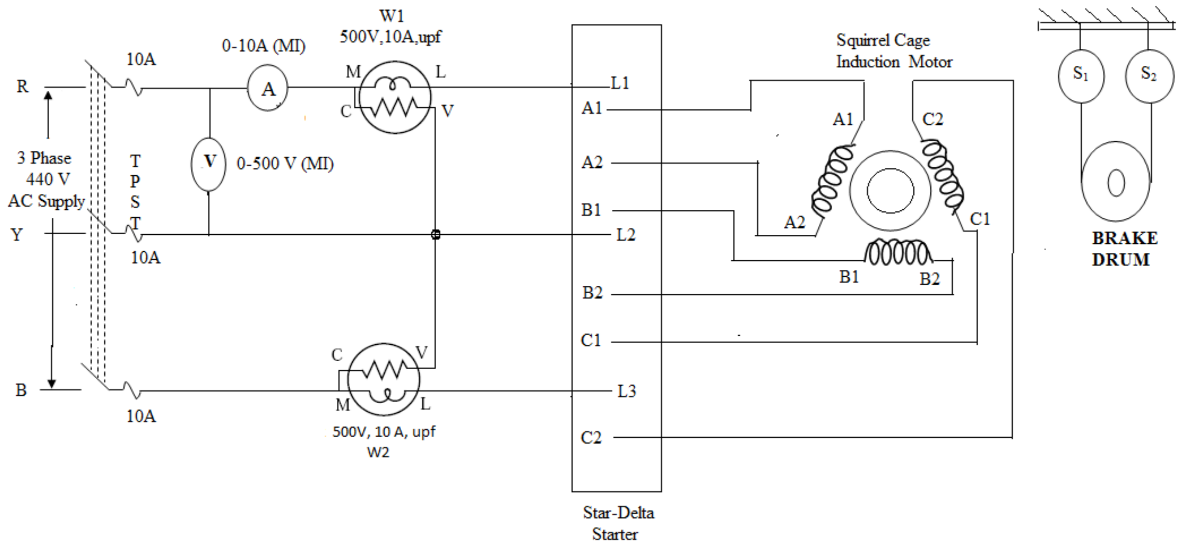
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PREPARED BY : ***SUNIL TP (ASSISTANT PROFESSOR E.E.E)***

OUR SINCER THANKS TO ALL THE STAFF IN EEE DEPARTMENT WHO HELPED US FOR THE PERFECTION OF THIS MANUAL

List of Experiments in AC machines Laboratory

CIRCUIT DIAGRAM:-



Ex No: 1

LOAD TEST ON 3-PHASE SQUIRREL CAGE INDUCTION MOTOR

AIM:-

To obtain following performance characteristics.

1. Line current, torque, power factor, efficiency, speed and slip Vs output.
2. Torque Vs slip.

APPARATUS REQUIRED:-

S.No	Name of apparatus	Range	Type	Qty.
1.	Ammeter	(0-10)A	MI	1
2.	Voltmeter	(0-500)V	MI	1
3.	Wattmeter	(500V,10A)	UPF	2
4.	Tachometer	-	Digital	1

THEORY:

A 3-phase induction motor consists of stator and rotor with the other associated parts. In the stator, a 3-phase winding is provided. The windings of the three phase are displaced in space by 120°.A 3-phase current is fed to the 3-phase winding. These windings produce a resultant magnetic flux and it rotates in space like a solid magnetic poles being rotated magnetically.

SAFETY PRECAUTIONS:-

1. There must be no load when starting the motor.

PROCEDURE:-

1. Connections are made as per circuit diagram.
2. The rotor was made very much free to rotate.
3. Pour some water inside the brake drum so as to cool the rotor belt.
4. 3-Φ induction motor started using star-delta starter by pressing green switch of starter.
5. Adjusted the load till current was made to rated value of motor.
6. Decrease the load step by step and note corresponding speed, load, current, voltage and wattmeter readings.
7. At certain load, wattmeter W2 will show negative reading. Note down the line current at this point.
8. Interchange the connection of current coil of wattmeter W2 which was reading negative after switching off supply by pressing red switch of starter.

OBSERVATION :-

V_L (V)	I_L (A)	Input (W)	Load (kg)		Torque (Nm)	Speed (N) (rpm)	Output (W)	%Slip	$\%\eta$	PF
			S1	S2						

SAMPLE CALCULATION:-

Radius of Brake drum R=……………m

N_s= Synchronous speed in rpm

N =Rotor speed in rpm

S1&S2= Load of brake drum in kg

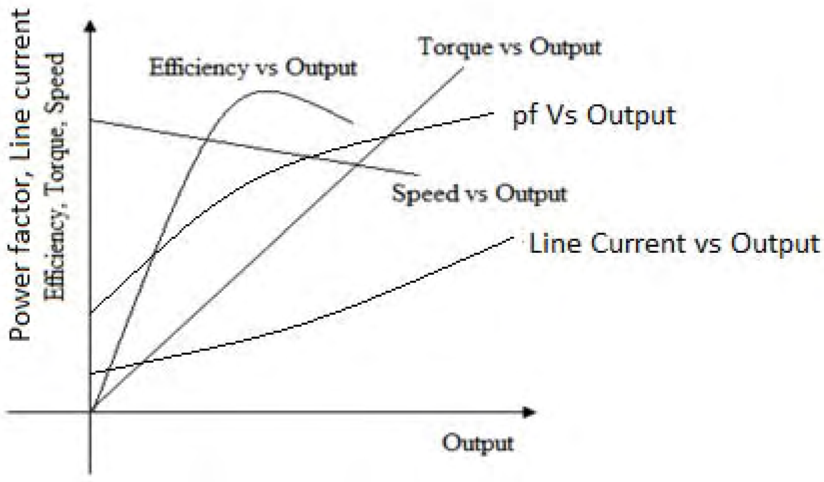
V_L=Line voltage in Volts

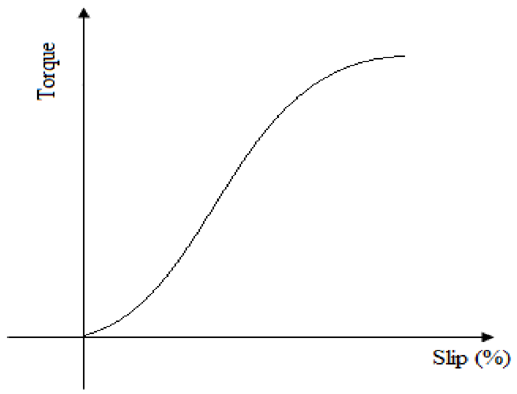
I_L= Line current in Amps

1) % slip= [(Ns-N)/Ns]*100=……….%
2) Input Power(W)= (W1+W2)=…………. watts
3) Torque(T) = 9.81*(S1-S2)*R =…………….. N-m
4) Output Power = 2πNT/60=……………… watts
5) % efficiency =[output/input]* 100=……………..%
6) Power Factor(PF) = Input Power/($\sqrt{3}V_L I_L$)=………………

9. Rotor was made free to rotate by removing the load completely.
10. 3-Φ induction motor started using star-delta starter by pressing black switch of starter.
11. Adjust the line current to a value in step 7.
12. Note down corresponding speed, load, current, voltage, wattmeter readings. Take the reading of wattmeter W2 as negative.
13. Finally switch off supply.

MODEL GRAPHS:-



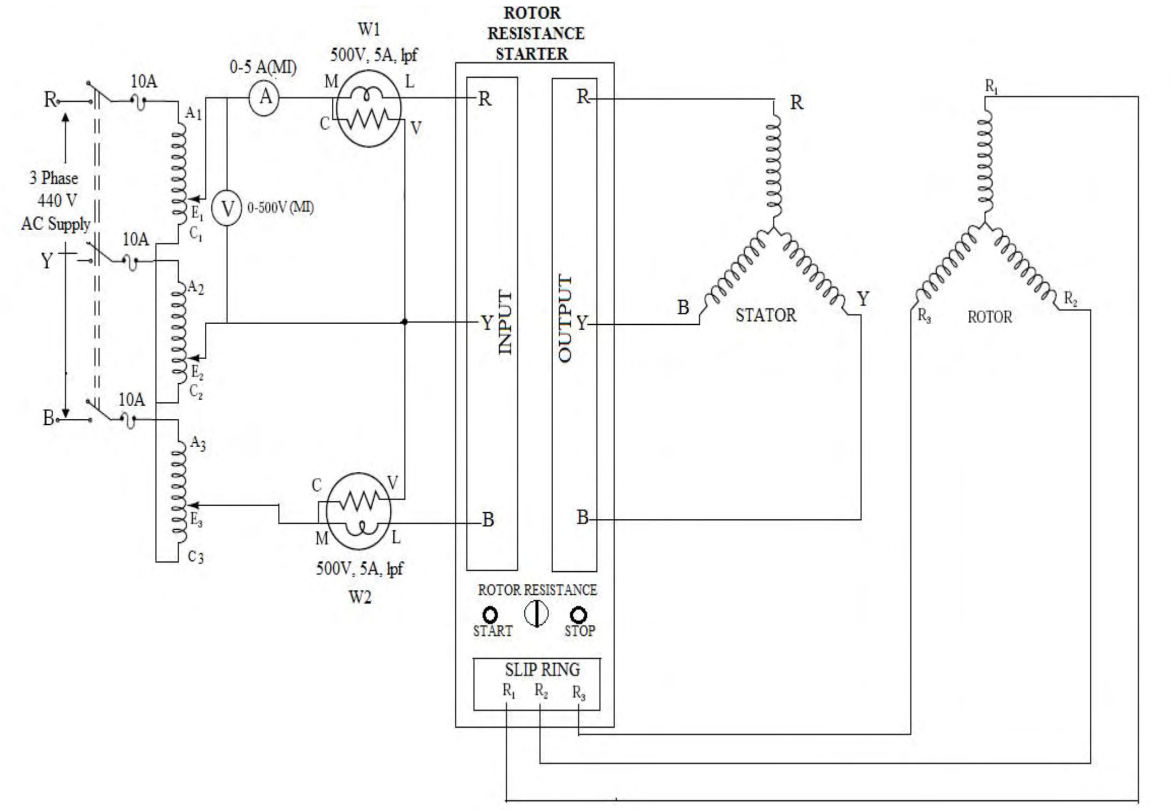


RESULT:-

The load test was conducted and the performance characteristics and torque-slip characteristics of given 3-phase induction motor were plotted.

CIRCUIT DIAGRAM:-

FOR NO LOAD:-



Ex No: 2

NO LOAD AND BLOCKED ROTOR TEST ON SLIP RING INDUCTION MOTOR.

AIM:-

1) To determine the equivalent circuit parameters.
2) To draw the performace characterestics using data obtained from the circle diagram

APPARATUS REQUIRED:-

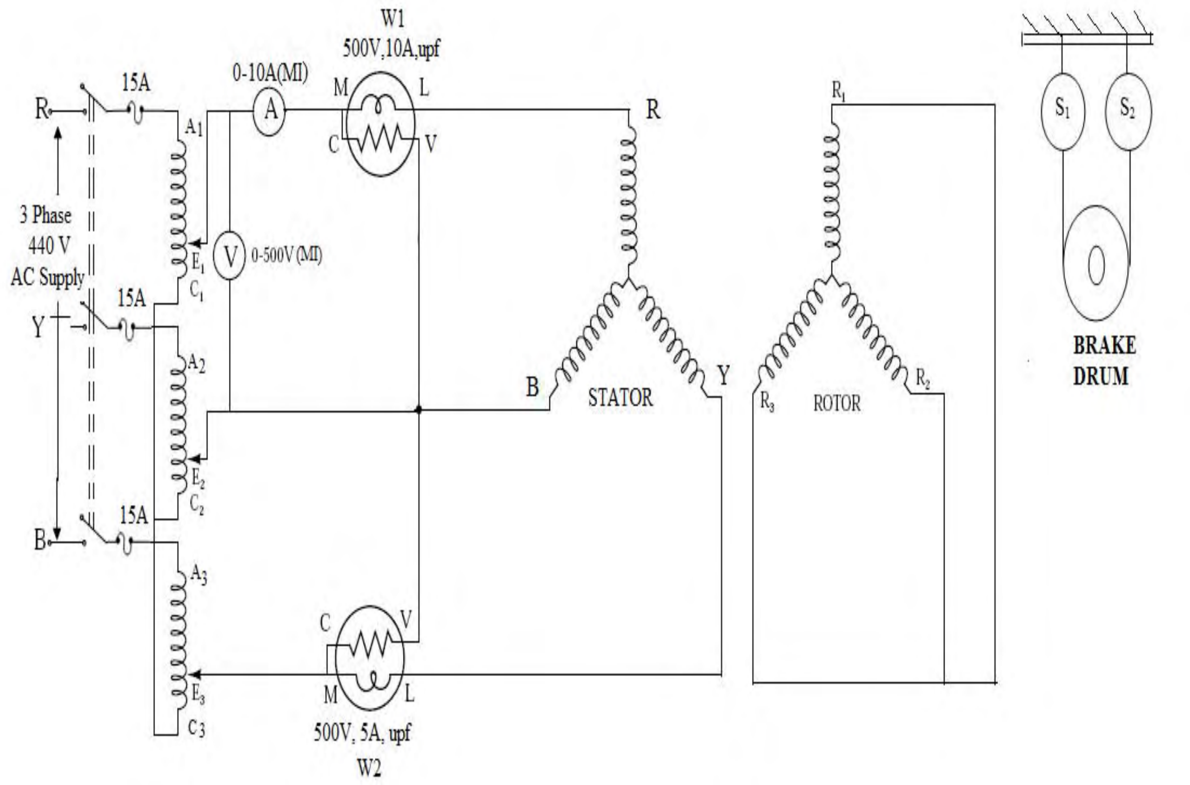
S.No	Apparatus	Range	Type	Qty
1.	Voltmeter	(0-500)V, (0-300)V	MI MC	1 1
2.	Ammeter	(0-10)A (0-5)A	MI MC	1 1
3.	Wattmeter	(500V,5A), (500V,10A)	LPF UPF	2 2
4.	Rheostat	45Ω, 5A	Wire wound	1
5.	Auto transformer	440V, 3phase		1
6.	Rotor resistance STARTER			
7.	Connecting wire	1/18	-	As required

THEORY :-

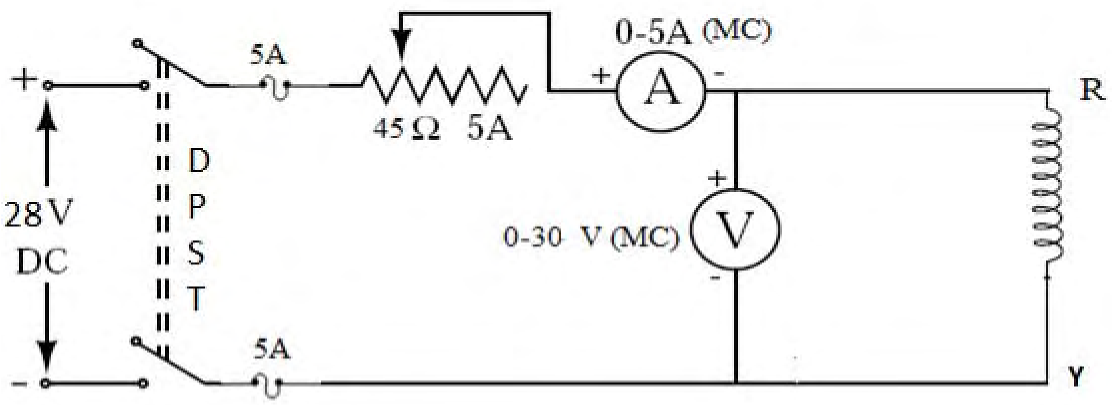
A 3-phase induction motor consists of stator, rotor & other associated parts. In the stator, a 3- phase winding (provided) are displaced in space by 120. A3- phase current is fed to the winding so that a resultant rotating magnetic flux is generated. The rotor starts rotating due to the induction effect produced due the relative velocity between the rotor winding & the rotating flux.

Slip ring motors are always started with full line voltage applied across the stator terminals. The value of starting current is adjusted by introducing a variable resistance in the rotor circuit.The controlling resistance is in the form of resistances connected in star. The resistance is gradually cut out of the rotor circuit as the motor gathers speed.

FOR BLOCKED TOTOR:-



FOR STATOR RESISTANCE:



No load test:-

If the motor is run at rated voltage and frequency without any mechanical load, it will draw power necessary to supply the no load losses. The no load current will have two components. The active component and the magnetizing component, the former being very small as the no load losses are small. The power factor at no load is therefore very low. The no load power factor is always less than 0.5 and hence at no load one of the wattmeter at input side reads negative.

The no load input W_0 to the stator consists of

1. Small stator copper loss
2. Core losses
3. The loss due to friction and windage.

The rotor copper loss can be neglected, since slip is small at no load.

Blocked rotor test :-

The stator is supplied with a low voltage of rated frequency just sufficient to circulate rated current through the stator with the rotor blocked and short circuited. The power input, current and the voltage applied are noted down. The power input during the blocked rotor test is wholly consumed in the stator and rotor copper losses. The core loss is low because the applied voltage is only a small percentage of the normal voltage. Again since the rotor is at stand still the mechanical losses are absent. Hence the blocked rotor input can be taken as approximately equal to the copper losses.

PROCEDURE FOR NO LOAD TEST:-

1. Connections are made as shown in the diagram for no load test.
2. Brake drum is made free to rotate by loosening the belt.
3. The autotransformer is placed in zero position. Then the supply is switched on and the auto transformer is adjusted to supply the rated voltage to the machine.
4. Press green switch on the starter. The handle of the starter resistance switch is rotated three times in clockwise direction to cut out the rotor resistance.
5. Readings of the two wattmeter, voltmeter and ammeter are noted and tabulated.
6. Press red switch on starter and then switch off supply.

OBSERVATIONS:-

NO LOAD TEST:-

S. No	Voltage (V_{oc})	Current (I_{oc})	Wattmeter readings (W1)	Watt meter readings (W2)	W_{OC} =W1+W2
	(V)	(A)	(W)	(W)	(W)

V_{oc}= open circuit voltage

I_{oc} = open circuit current

BLOCKED ROTOR TEST:-

S. No	Voltage (V_{sc})	Current (I_{sc})	Wattmeter readings (W1)	Watt meter readings (W2)	W_{SC} =W1+W2
	(V)	(A)	(W)	(W)	(W)

Vsc = short circuit voltage

Isc = short circuit current

STATOR RESISTANCE:-

S.No	**Voltage (V)**	**Current(A)**	**Resistance R_S (Ω)**
1 **2** **3** **4** **5**			
		R_S mean =	……..Ω

PROCEDURE FOR BLOCKED ROTOR TEST :-

1. Connections are made as shown in the diagram for blocked rotor test.
2. The rotor is blocked by tightening the belt on the brake drum.
3. The auto transformer is set to the zero voltage position.
4. Short circuit the terminals of rotor.
5. Then the three phase supply is switched on.
6. By adjusting the autotransformer, the ammeter reading is made equal to rated current of the machine.
7. Readings of the two wattmeter, voltmeter and the ammeter are noted and tabulated.
8. Switch off supply.

PROCEDURE TO DRAW CIRCLE DIAGRAM:-

1. Set current scale = …………..A
2. Draw Y axis (voltage axis) and X axis.
3. Calculate $I_{sn} = \frac{I_{sc}*230}{\frac{V_{sc}}{\sqrt{3}}}$
4. Calculate Φ_{OC} and Φ_{SC}
5. Draw $OP_0 = \frac{I_{OC}}{current\ scale}$ With an angle Φ_{OC} from voltage axis.
6. Draw OA=$\frac{I_{sn}}{current\ scale}$ with an angle $\Phi_{SC}$from voltage axis.
7. Join point P_0 and point A.
8. Draw line P_0F parallel to X axis.

   Calculation of AE & EF

9. Measure AF from circle diagram using scale.
10. AE+EF=AF=…………cm
11. (AE/EF)=$\frac{R_2'}{R_{S(eff)}}$ =……………..
12. EF=AF/(1+$\frac{R_2'}{R_{S(eff)}}$)=……………………cm
13. AE=$\frac{R_2'}{R_{S(eff)}} * EF$=……………………….cm

OBSERVATIONS FROM CIRCLE DIAGRAM

Operating point	Line current	Pf angle	Pf	Speed	Input power	Output power	Slip	% η	Torque
P_0									
P_1									
P_2									
P_3									
P_5									

SAMPLE CALCULATIONS:-

***DETERMINATION OF EQUIVALENT CIRCUIT PARAMETERS*:**

FROM NO LOAD TEST:

1. Wattmeter reading W_{OC}=....................W
2. Voltmeter reading V_{OC}=........................V
3. Ammeter reading I_{OC}=...........................A
4. $W_{OC}=\sqrt{3}\, V_{OC}\, I_{OC} \cos oc$
5. $\cos \Phi_{OC} = \frac{W_{OC}}{\sqrt{3} V_{OC} I_{OC}}$ =...................
6. $\Phi_{OC} = \cos^{-1} \Phi_{OC}$=................................degree
7. $\sin \Phi_{OC}$=..........................
8. $R_O\ per\ phase = \frac{\left(V_{OC}/\sqrt{3}\right)}{I_{OC} \cos \Phi_{OC}} =$ ... ... Ω
9. $X_O\ per\ phase = \frac{\left(V_{OC}/\sqrt{3}\right)}{I_{OC} \sin \Phi_{OC}} =$ ... ... Ω

FROM BLOCKED ROTOR TEST:

1. Wattmeter reading W_{sc} =......................W
2. Voltmeter reading V_{SC}=........................V
3. V/phase = $\frac{440}{\sqrt{3}}$=....................................V
4. Ammeter reading I_{SC}=...........................A
5. $\cos \Phi_{SC} = \frac{W_{SC}}{\sqrt{3} V_{SC} I_{SC}}$ =...................

6. $\Phi_{SC} = \cos^{-1} \Phi_{SC}$=...............................degree
7. Mean stator resistance R_{Smean}=..................... Ω
8. Total winding resistance as referred to the stator side R_{o1} (per phase)= $\frac{Wsc}{3Isc^2}$ =......................Ω
9. $Z_{01} = \frac{\left(V_{SC}/\sqrt{3}\right)}{I_{SC}}$ =.................... Ω.
10. Total leakage reactance as referred to the stator side X_{o1} =$\sqrt{(Zo1^2 - Ro1^2)}$ =..............Ω

11. $R_{S(eff)=(}$1.2xR_{Smean})/2=.......................Ω
12. Rotor resistance as referred to the stator side $R'_2 = R_{01} - R_{S(eff)} = \ldots\ldots\ldots\ldots\ldots\ldots..\Omega$
13. Electrical equivalent of the mechanical load $R_L = R'_2\left(\frac{1-S}{S}\right)$=........................... Ω

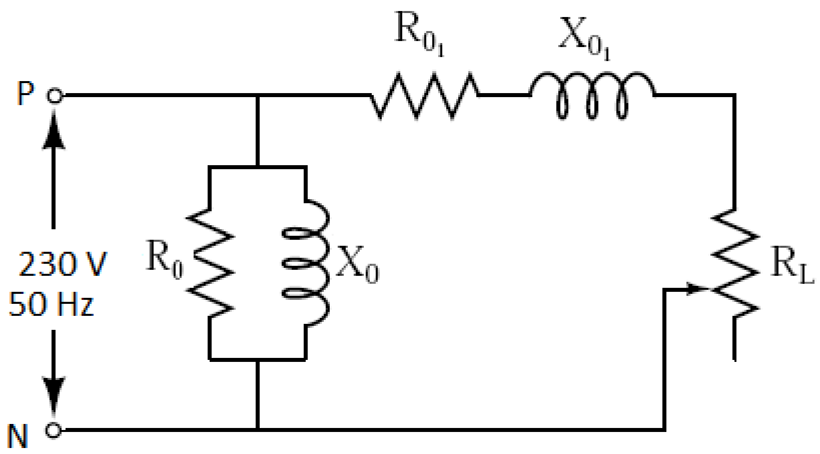
FROM CIRCLE DIAGRAM:-

Calculation of performance curresponding to point OP_X on the circumference of the Circle diagram

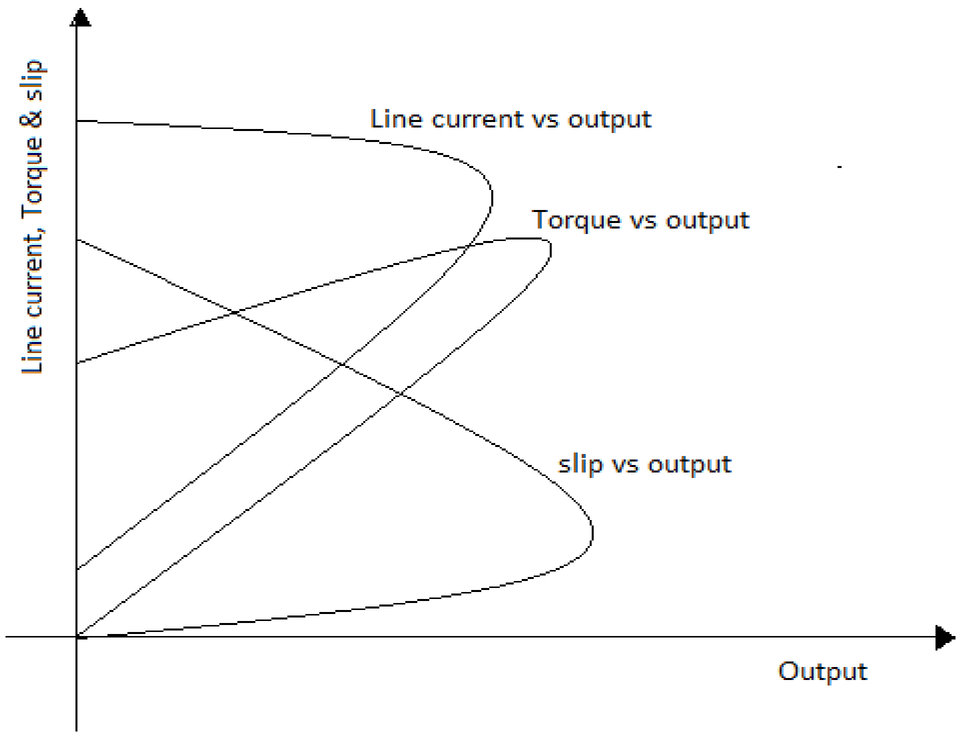
1. P_X is the point on the circumference of the circle diagram.
   Where *x*=0,1,2…..n (we can choose ay value for n. Here n=5)
2. For an example, consider x=2. Then the point on the circle diagram is $P_X = P_2$
   Current scale 1cm=…… A
3. OP_X=………… (If x=2, Then $0P_X=OP_2$)
4. Line current=OP_X* Current scale=…………A
5. Power Scale==√3 V_{OC}* Current Scale=………..W
6. Input= (P_XK)* Power Scale=…………W
7. Output=(P_XM)* Power Scale=…………W
8. Synchronous speed(N_S)=……………….rpm
9. Torque Scale=(60*Power Scale)/(2*3.14*N_S)=……………..N-m
10. Torque=(P_XN)*Torque Scale=……………N-m
11. Efficiency= (Output/Input)*100=…………..%
12. Slip(S)=[(P_XN-P_XM)/P_XN]*100=…………%

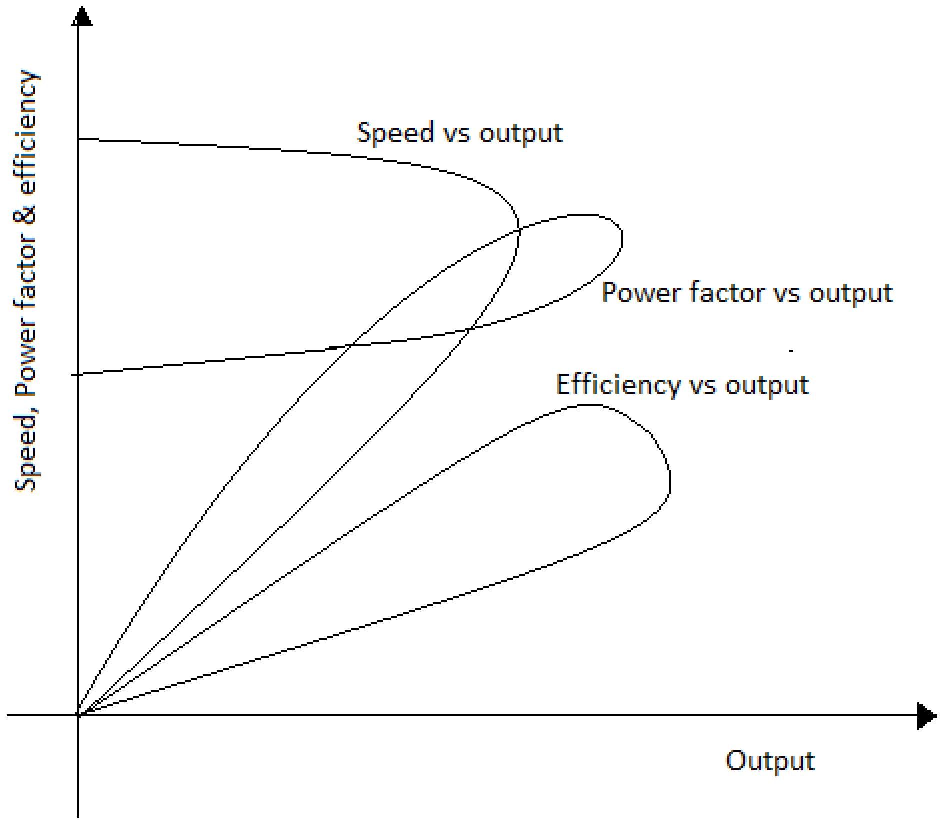
13. Power Factor (PF) =(P_XK)/(OP_X)=…………….
14. Speed= N_S (1-S) =………….rpm

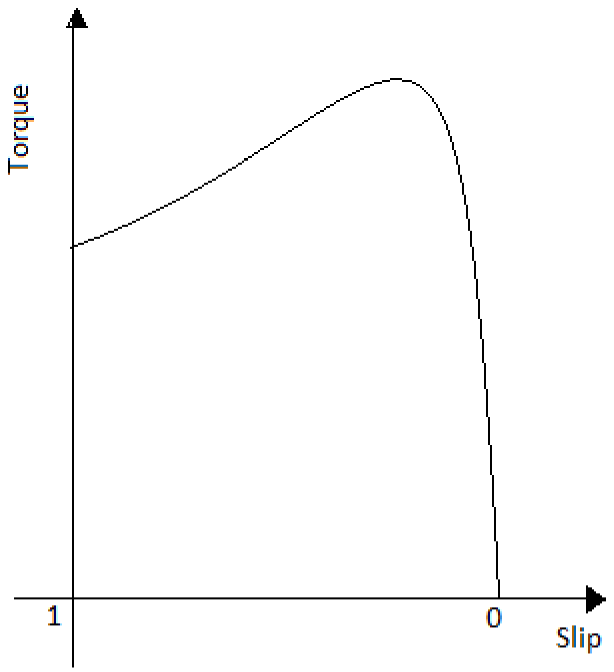
EQUIVALENT CIRCUIT:



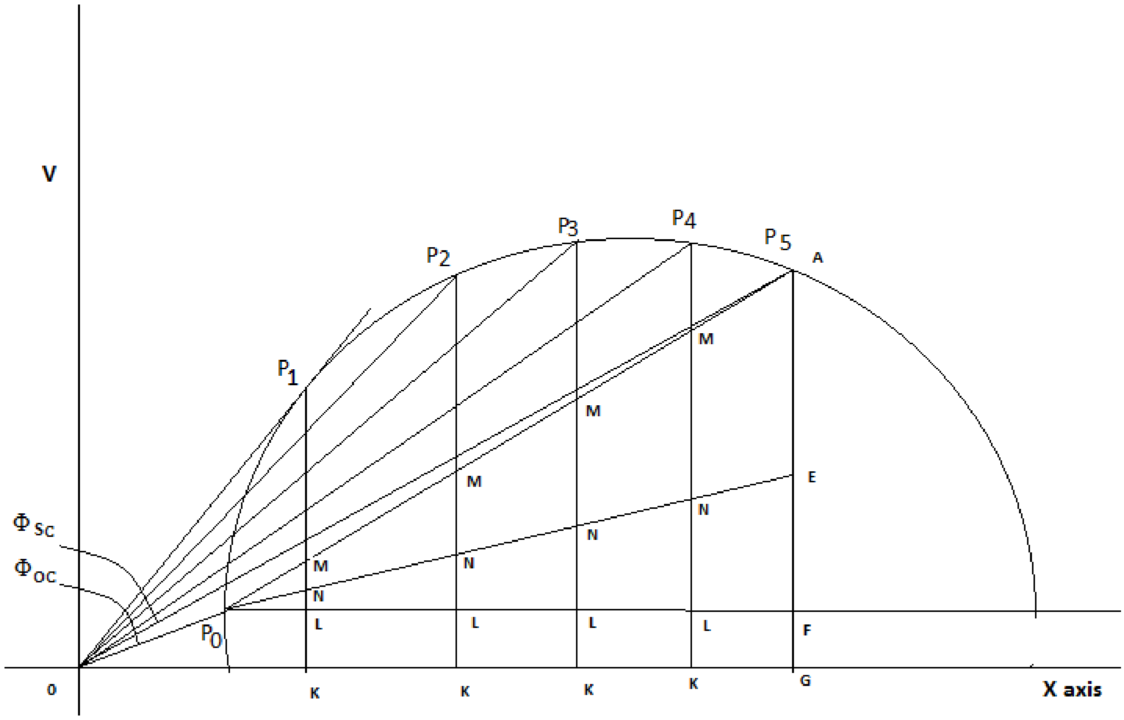
MODEL GRAPHS:-




Speed, Power factor & efficiency
Speed vs output
Power factor vs output
Efficiency vs output
Output


Torque
1
0
Slip

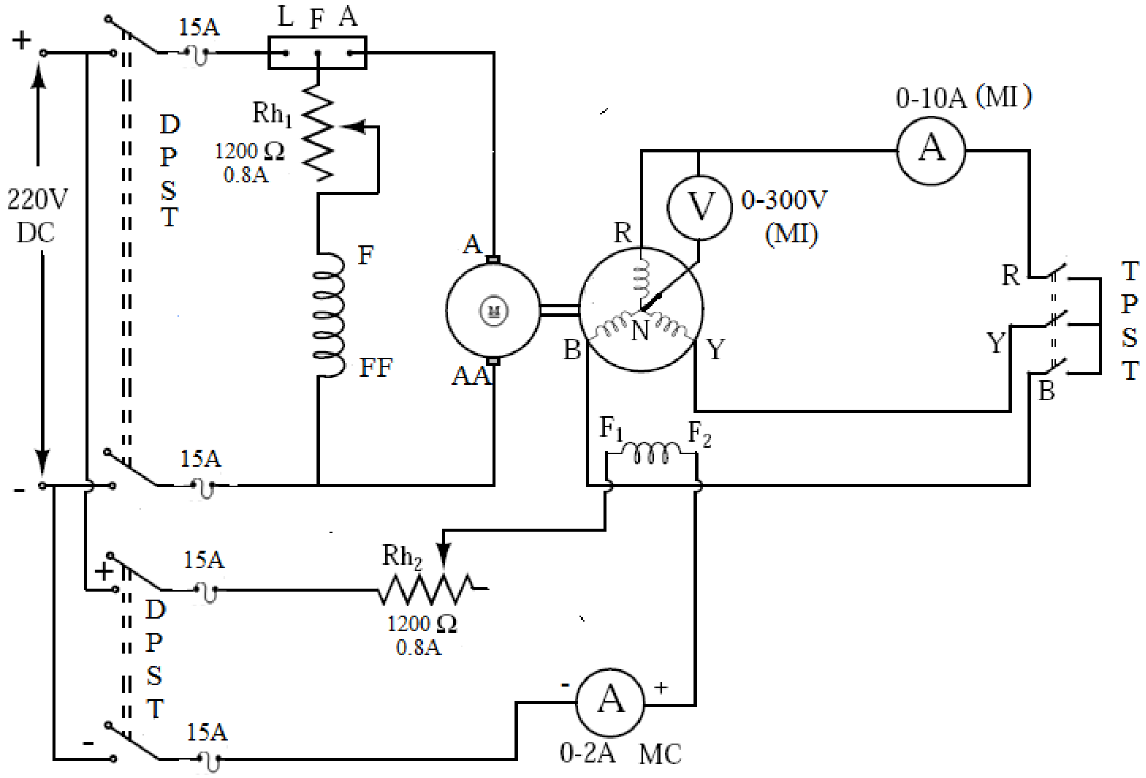
CIRCLE DIAGRAM:-



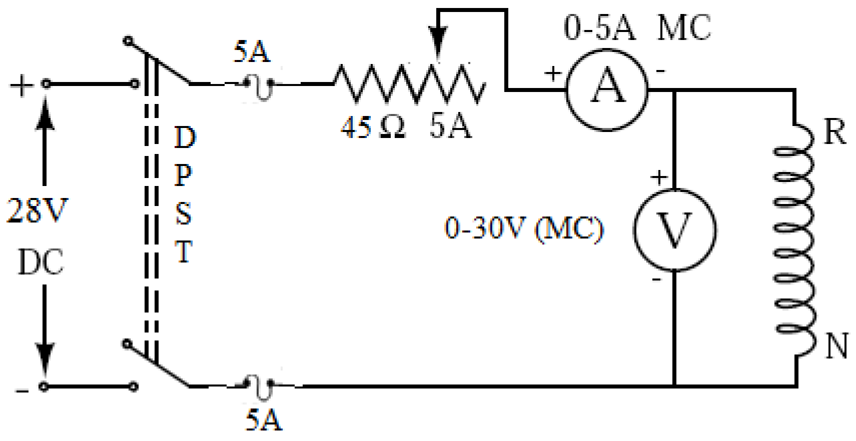
RESULT:-

Performed the no load and blocked rotor test on 3 phase slip ring induction motor for calculating equivalant circuit parameter and plotted the performance curve fom the circle diagram.

CIRCUIT DIAGRAM:-



CIRCUIT FOR RESISTANCE MEASURMENT:-



Ex No: 3

REGULATION OF ALTERNATOR BY EMF AND MMF METHODS

AIM:-

To conduct OC and SC tests to obtain OCC and SCC for predetermining regulation at various loads and power factor by EMF and MMF methods.

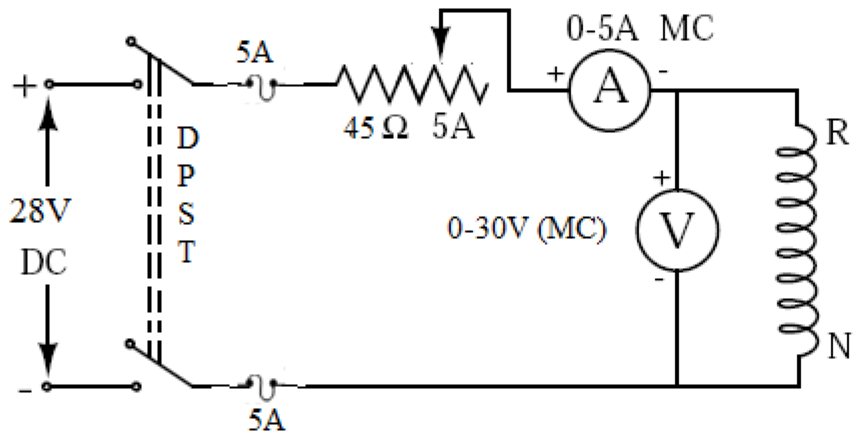
APPARATURS REQUIRED:

SL.NO	Name of the Apparatus	Type	Range	Quantity
1	Ammeter	MC	0 – 2 A	1
2	Ammeter	MI	0 – 10 A	1
3	Ammeter	MC	0-5A	1
3	Voltmeter	MC	0 – 30 V	1
4	Voltmeter	MI	0 – 500 V	1
5	Rheostat	Wire wound	45 Ω, 5 A	1
6	Rheostat	Wire wound	1200Ω, 0.8 A	2
7	Tachometer	Digital	---	1
8	TPST knife switch	--	--	1

THEORY:

The regulation of a 3-phase alternator may be predetermined by conducting the Open Circuit (OC) and the Short Circuit (SC) tests. These methods are employed for determination of regulation of *EMF or synchronous impedance* method, *MMF or Ampere Turns* method and the ZPF or Potier triangle method. In this experiment, the EMF and MMF methods are used. The OC and SC graphs are plotted from the two tests. The synchronous impedance is found from the OC test. The regulation is then determined at different power factors by calculations using vector diagrams. The EMF method is also called *pessimistic* method as the value of regulation obtained is much more than the actual value. The MMF method is also called *optimistic* method as the value of regulation obtained is much less than the actual value. In the MMF method the armature leakage reactance is treated as an additional armature reaction. In both methods the OC and SC test data are utilized.

CIRCUIT FOR RESISTANCE MEASURMENT:-



OPEN CIRCUIT TEST:

S.No.	Field Current (If)	Open Circuit Line Voltage (V_{oL})	Open circuit Phase Voltage (V_{oph})
	(A)	(V)	(V)

SHORT CIRCUIT TEST:

S.No.	Field Current (I_f)	Short Circuit Current (120% to 150% of rated current) (I_{SC})
	(A)	(A)

PRECAUTIONS:

(i) The motor field rheostat should be kept in the minimum resistance position.

(ii) The alternator field potential divider should be kept in the minimum voltage position.

(iii) Initially all switches are in open position.

PROCEDURE:-

OCC:

1. Connections are made as shown in the connection diagram.
2. The motor field rheostat Rh1 is kept in minimum position and the alternator field rheostat Rh2 in the maximum position.
3. Open TPST switch.
4. Supply is switched on.
5. The dc motor is started using the 3-point starter. The motor field rheostat Rh1 is varied till the speed becomes equal to the rated speed.
6. Rh2 is varied in steps and the field current and voltmeter reading are noted down.
7. The experiment is repeated for different values of field current till the voltmeter reading shows the rated voltage of the alternator.
8. Rheostat Rh2 is brought back to the maximum resistance position and switch off supply.

SCC:

1. Connections are made as shown in the connection diagram.
2. The motor field rheostat Rh1 is kept in minimum position and the alternator field rheostat Rh2 in the maximum position.
3. Close TPST switch.
4. Supply is switched on.
5. The dc motor is started using the 3-point starter. The motor field rheostat Rh1 is varied till the speed becomes equal to the rated speed.

9 Adjust Rh2 till the ammeter reading in the alternator armature reads the rated current of the machine. The corresponding value of field current is noted down.

10 Rheostat Rh2 is brought back to the maximum resistance position and switch off supply

RESISTANCE CALCULATION:

S.No	Voltage (V)	Current (A)	$R = \frac{V}{I}\ \Omega$
		Mean R=R_m	……. Ω

R_a=1.2 R_m=...........................

DATA PROCESSING(EMF)

S.No	Load	Current I_a (A)	Power factor cosΦ	Open circuit voltage,$E_O(V)$	%Regulation
1	Full load	4.2 4.2 4.2 4.2 4.2	upf 0.8 lag 0.8 lead 0.6 lag 0.6lead		
2	(1/2) of Full load	2.1 2.1 2.1 2.1 2.1	upf 0.8 lag 0.8 lead 0.6 lag 0.6lead		

PROCEDURE TO PLOT OCC AND SCC:

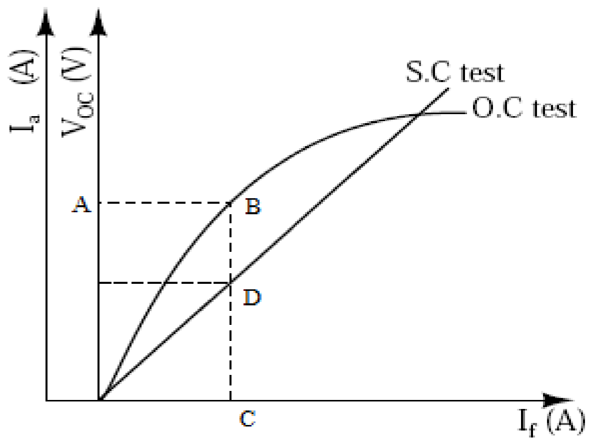
1. Draw the Open Circuit Characteristic curve (Generated Voltage per phase VS Field current).
2. Draw the Short Circuit Characteristics curve (Short circuit current VS Field current)

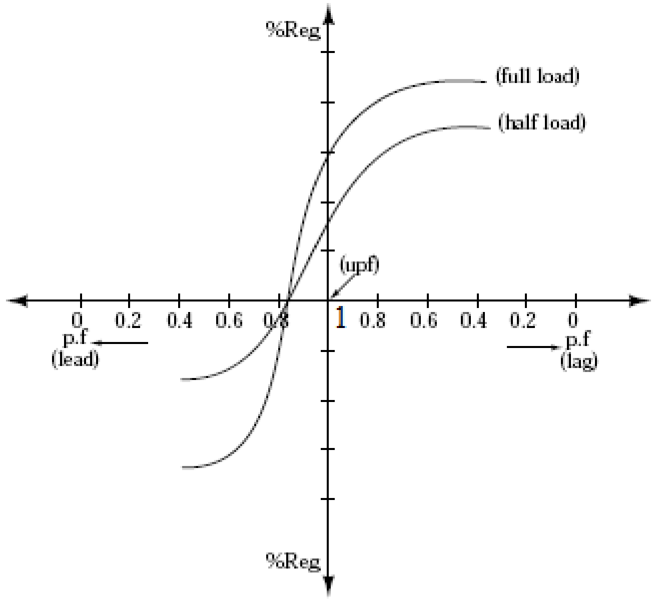
DATA PROCESSING(MMF)

S.No	Load	Current I_a (A)	Power factor cosΦ	I_{f1}	I_{f2}	I_f	Open circuit voltage, $E_O(V)$	%Regulation
1	Full load	4.2 4.2 4.2 4.2 4.2	upf 0.8 lag 0.8 lead 0.6 lag 0.6lead					
2	(1/2) of Full load	2.1 2.1 2.1 2.1 2.1	upf 0.8 lag 0.8 lead 0.6 lag 0.6lead					

SAMPLE GRAPH:

OCC and SCC Curve:





SAMPLE CALCULATION:-

EMF METHOD (for current **Ia** and power factor **cos ϕ**)

From graph,

1. Rated open circuit voltage per phase V=............................V
2. short circuit current (Isc) for rated open circuit voltage per phase=..................A
3. Mean Resistance R_m=.........................Ω
4. Armature Resistance Ra=1.2* R_m =--------- Ω
5. Synchronous Impedance Zs = $\frac{Rated\ O.C\ phase\ Voltage}{Curresponding\ S.C\ Current} = \frac{BC}{DC} = \frac{V}{I_{SC}}$.....................Ω
6. Synchronous Reactance Xs = $\sqrt{Z_S^2 - R_a^2}$ Ω
7. Open circuit voltage E_0 for lagging Pf = $\sqrt{(Vcos\phi + IaRa)^2 + (Vsin\phi + IaXs)^2}$
8. Open circuit voltage E_0 for leading Pf. = $\sqrt{(Vcos\phi + IaRa)^2 + (Vsin\phi - IaXs)^2}$
9. Open circuit voltage E_0 for unity Pf = $\sqrt{(V + IaRa)^2 + (IaXs)^2}$
10. Percentage regulation = $\frac{Eo - V}{V} * 100$

MMF METHOD (for current **Ia** and power factor **cos ϕ**)

From graph,

1. Voltage behind armature resistance $E^1 = \sqrt{(Vcos\phi + IaRa)^2 + (Vsin\phi)^2}$
2. Calaculate Field current I_{f1} curresponding to E^1
3. Calcuate field current I_{f2} curresponding to armature current Ia

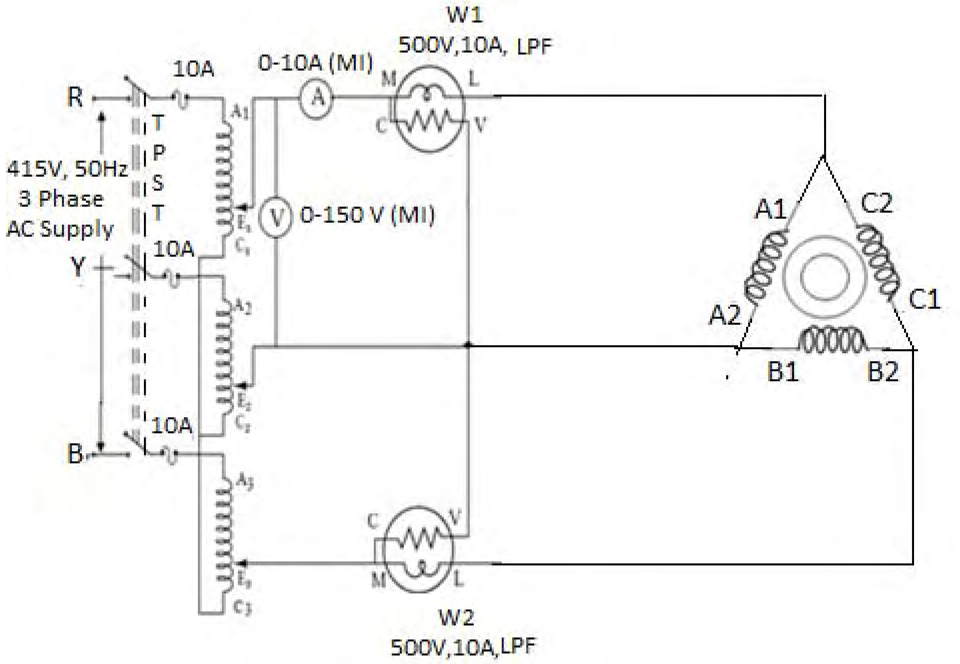
4. Calculate $I_f = \sqrt{I_{f1}^2 + I_{f2}^2 + 2I_{f1}I_{f2}\cos(90+\phi)}$ for lag
5. Calculate $I_f = \sqrt{I_{f1}^2 + I_{f2}^2 + 2I_{f1}I_{f2}\cos(90-\phi)}$ for lead
6. Calculate $I_f = \sqrt{I_{f1}^2 + I_{f2}^2 + 2I_{f1}I_{f2}\cos(90)}$ for unity power factor.
7. Calculate E_0 curresponding to I_f from OCC and SCC graphs.
8. Percentage regulation = $\frac{Eo - V}{V} * 100$

RESULT:

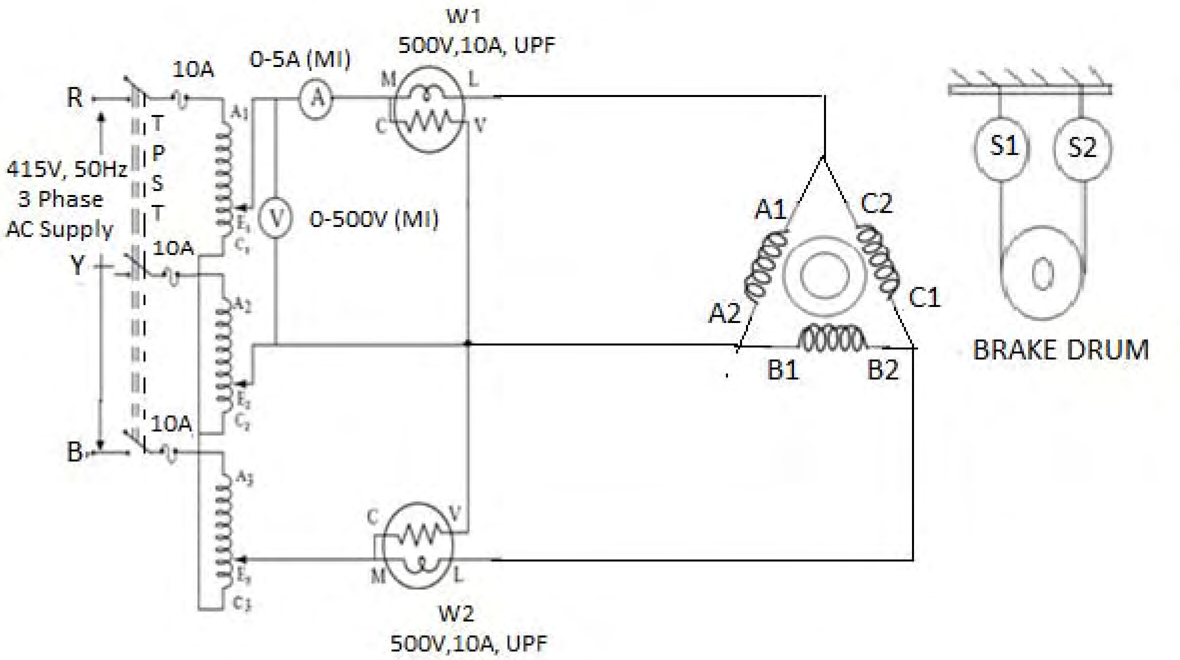
The regulation of 3-phase alternator has been predetermined by the EMF and MMF methods.

CIRCUIT DIAGRAM:-

FOR NO LOAD:-



FOR BLOCKED TOTOR:



Ex No: 4

NO LOAD AND BLOCKED ROTOR TEST ON 3 PHASE SQUIRREL CAGE INDUCTION MOTOR.

AIM:-

1) To draw the equavalant circuit pararmeters.
2) Draw the circle diagram and obtain performance characteristics

APPARATUS REQUIRED:-

S.No	Apparatus	Range	Type	Qty
1.	Voltmeter	(0-500)V, (0-300)V	MI MC	1 1
2.	Ammeter	(0-10)A (0-5)A	MI MC	1 1
3.	Wattmeter	(500V,5A), (500V,10A)	LPF UPF	2 2
4.	Rheostat	45Ω, 5A	Wire wound	1
5.	Auto transformer	440V, 3phase		1
6.	Connecting wire	1/18	-	As required

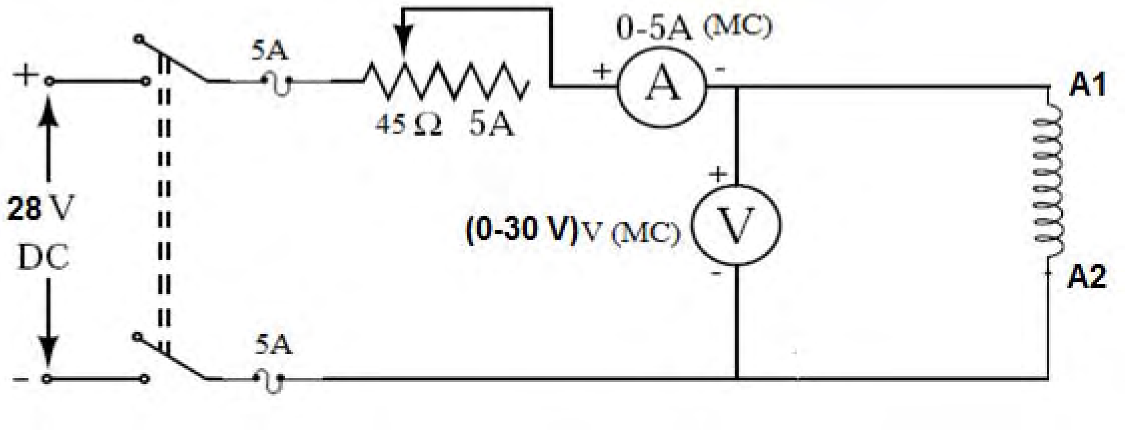
THEORY :-

A 3-phase induction motor consists of stator, rotor & other associated parts. In the stator, a 3- phase winding (provided) are displaced in space by 120. A3- phase current is fed to the winding so that a resultant rotating magnetic flux is generated. The rotor starts rotating due to the induction effect produced due the relative velocity between the rotor winding & the rotating flux.

No load test:-

If the motor is run at rated voltage and frequency without any mechanical load, it will draw power necessary to supply the no load losses. The no load current will have two components. The active component and the magnetizing component, the former being very small as the no load losses are small. The power factor at no load is therefore very low. The no load power factor is always less than 0.5 and hence at no load one of the wattmeter at input side reads negative.

FOR STATOR RESISTANCE:



TABULAR COLUMNS:-

NO LOAD TEST:-

S. No	Voltage (V_{oc})	Current (I_{oc})	Wattmeter readings (W1)	Watt meter readings (W2)	W_{OC}=W1+W2
	(V)	(A)	(W)	(W)	(W)

V_{oc}= open circuit voltage

I_{oc} = open circuit current

BLOCKED ROTOR TEST:-

S. No	Voltage (V_{sc})	Current (I_{sc})	Wattmeter readings (W1)	Watt meter readings (W2)	W_{sC}= W1+W2
	(V)	(A)	(W)	(W)	(W)

Vsc = short circuit voltage

Isc = short circuit current

The no load input W_0 to the stator consists of

1. Small stator copper loss
2. Core losses
3. The loss due to friction and windage.

The rotor copper loss can be neglected, since slip is small at no load.

Blocked rotor test :-

The stator is supplied with a low voltage of rated frequency just sufficient to circulate rated current through the stator with the rotor blocked and short circuited. The power input, current and the voltage applied are noted down. The power input during the blocked rotor test is wholly consumed in the stator and rotor copper losses. The core loss is low because the applied voltage is only a small percentage of the normal voltage. Again since the rotor is at stand still the mechanical losses are absent. Hence the blocked rotor input can be taken as approximately equal to the copper losses.

PROCEDURE FOR NO LOAD TEST:-

7. Connections are made as shown in the diagram for no load test.
8. Brake drum is made free to rotate by loosening the belt.
9. The autotransformer is placed in zero position. Then the supply is switched on and the auto transformer is adjusted to supply small voltage to the machine. Initially current will rise to high value. Wait until the current reaches to low current. Then increase the voltage to rated value.
10. Readings of the two wattmeter, voltmeter and ammeter are noted and tabulated.
11. If the wattmeter reads negative, interchange current coil terminals and take wattmeter reading as negative.
12. Switch off supply.

PROCEDURE FOR BLOCKED ROTOR TEST :-

9. Connections are made as shown in the diagram for blocked rotor test.
10. The rotor is blocked by tightening the belt on the brake drum.
11. The auto transformer is set to the zero voltage position.
12. Then the three phase supply is switched on.

STATOR RESISTANCE:-

S.No	Voltage (V)	Current(A)	Resistance R_S (Ω)
1 2 3 4 5			
		R_S mean =	……..Ω

$R_{S(eff)=}(1.2xR_{Smean})$

OBSERVATIONS FROM CIRCLE DIAGRAM

Operating point	Line current	Pf angle	Pf	Speed	Input power	Output power	Slip	% η	Torque
P_0									
P_1									
P_2									
P_3									
P_5									

13. By adjusting the autotransformer, the ammeter reading is made equal to rated current of the machine.
14. Readings of the two wattmeter, voltmeter and the ammeter are noted and tabulated.
15. If the wattmeter reads negative, interchange current coil terminals and take wattmeter reading as negative.

Switch off supply

PROCEDURE TO DRAW CIRCLE DIAGRAM:-

1. Set current scale=……………..A
2. Draw Y axis (voltage axis) and X axis.
3. Calculate $I_{sn} = \frac{\frac{I_{sc}}{\sqrt{3}}*415}{V_{sc}}$
4. Calculate Φ_{OC} and Φ_{SC}
5. Draw $OP_0 = \frac{\frac{I_{sc}}{\sqrt{3}}}{Current\ scale}$ With an angle Φ_{OC} from voltage axis.
6. Draw OA=$\frac{I_{sn}}{current\ scale}$ with an angle $\Phi_{SC}$from voltage axis.
7. Join point P_0 and point A.
8. Draw line P_0F parallel to X axis.

   Calculation of AE & EF

9. Measure AF from circle diagram using scale.
10. AE+EF=AF=…………cm
11. (AE/EF)=$\frac{R_2'}{R_{S(eff)}}$ =……………..
12. EF=AF/(1+$\frac{R_2'}{R_{S(eff)}}$)=……………………cm
13. AE=$\frac{R_2'}{R_{S(eff)}} * EF$=……………………….cm

SAMPLE CALCULATIONS:-

***DETERMINATION OF EQUIVALENT CIRCUIT PARAMETERS*:**

FROM NO LOAD TEST:

1. Wattmeter reading W_{OC}=.....................W
2. Voltmeter reading V_{OC}=.........................V
3. Ammeter reading I_{OC}=............................A
4. $W_{OC}=\sqrt{3}\ V_{OC}\ I_{OC} \cos oc$
5. $\cos \Phi_{OC} = \frac{W_{OC}}{\sqrt{3} V_{OC} I_{OC}}$ =...................
6. $\Phi_{OC} = \cos^{-1} \Phi_{OC}$=.................................degree
7. $\sin \Phi_{OC}$=...........................
8. $R_O\ per\ phase = \frac{\left(V_{OC}/\sqrt{3}\right)}{I_{OC} \cos \Phi_{OC}} =$ ……… Ω
9. $X_O\ per\ phase = \frac{\left(V_{OC}/\sqrt{3}\right)}{I_{OC} \sin \Phi_{OC}} =$ ……… Ω

FROM BLOCKED ROTOR TEST:

1. Wattmeter reading W_{sc} =.......................W
2. Voltmeter reading V_{SC}=.........................V
3. V/phase = $\frac{440}{\sqrt{3}}$=....................................V
4. Ammeter reading I_{SC}=............................A
5. $\cos \Phi_{SC} = \frac{W_{SC}}{\sqrt{3} V_{SC} I_{SC}}$ =...................
6. $\Phi_{SC} = \cos^{-1} \Phi_{SC}$=.................................degree
7. Mean stator resistance R_{Smean}=...................... **Ω**
8. Total winding resistance as referred to the stator side R_{o1} (per phase)= $\frac{Wsc}{3Isc^2}$ =.......................**Ω**
9. $Z_{01} = \frac{\left(V_{SC}/\sqrt{3}\right)}{I_{SC}}$ =..................... **Ω**.
10. Total leakage reactance as referred to the stator side X_{o1} =$\sqrt{(Zo1^2 - Ro1^2)}$ =..............**Ω**

11. $R_{S(eff)}$=(1.2xR_{Smean})/2=........................**Ω**

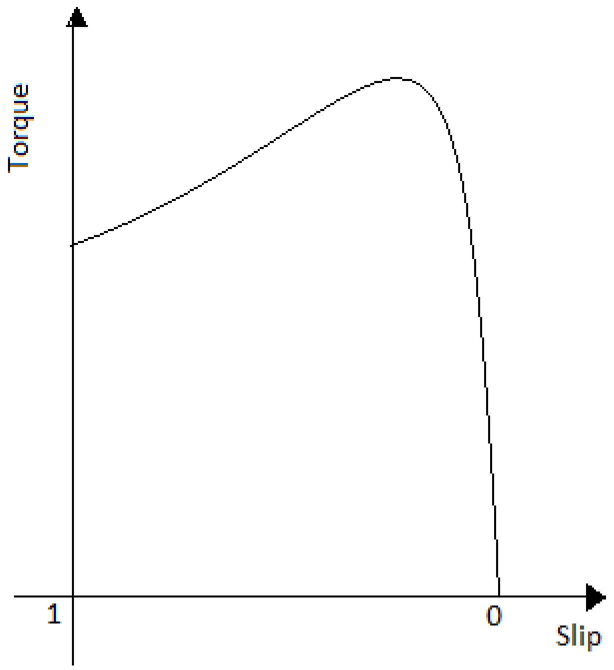
12. Rotor resistance as referred to the stator side $R'_2 = R_{01} - R_{S(eff)} = \ldots\ldots\ldots\ldots\ldots\ldots..\Omega$
13. Electrical equivalent of the mechanical load $R_L = R'_2\left(\frac{1-S}{S}\right)$=………………………. Ω

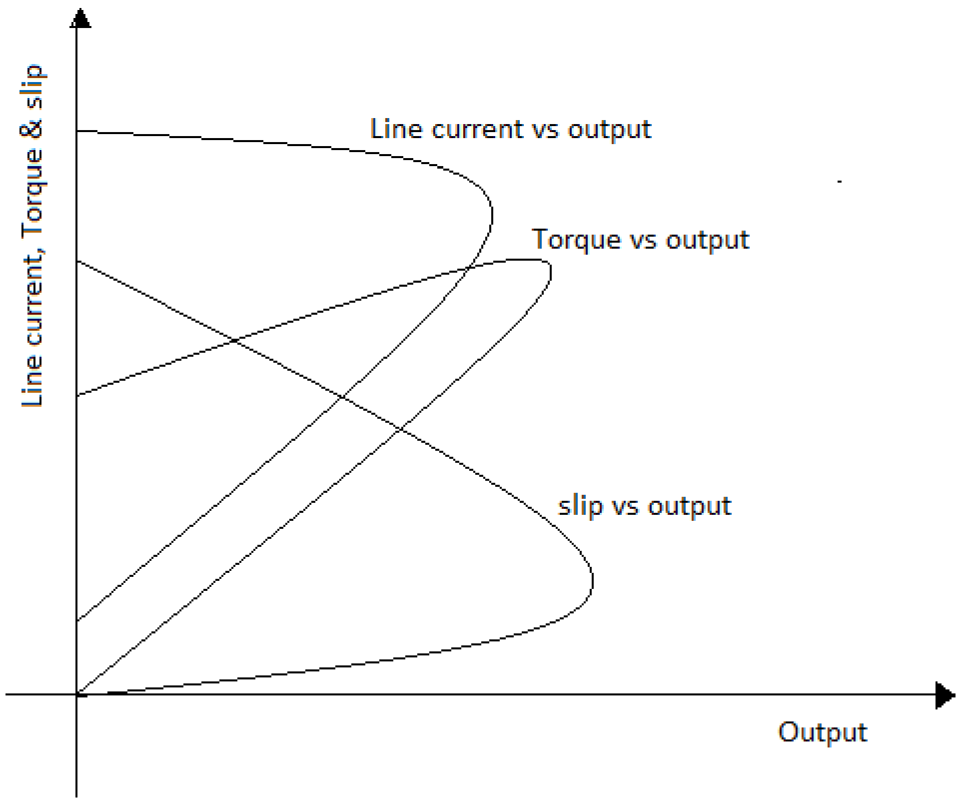
FROM CIRCLE DIAGRAM:-

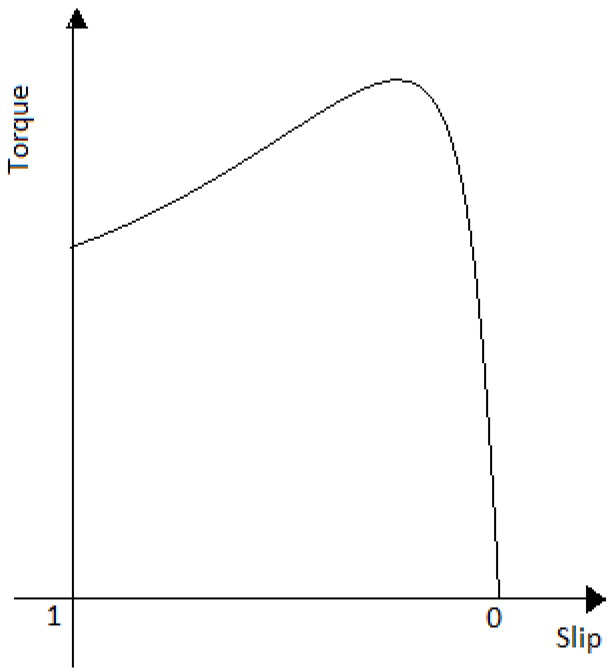
Calculation of performance curresponding to point OP_X on the circumference of the Circle diagram

1. P_X is the point on the circumference of the circle diagram.
   Where *x*=0,1,2…..n (we can choose ay value for n. Here n=5)
2. For an example, consider x=2. Then the point on the circle diagram is $P_X = P_2$
   Current scale 1cm=…… A
3. OP_X=………… (If x=2, Then $0P_X = OP_2$)
4. Line current=√3 OP_X* Current scale=…………A
5. Power Scale==√3 V_{OC}* Current Scale=………..W
6. Input= ($P_X K$)* Power Scale=…………W
7. Output=($P_X M$)* Power Scale=…………W
8. Synchronous speed(N_S)=……………….rpm
9. Torque Scale=(60*Power Scale)/(2*3.14*N_S)=……………..N-m
10. Torque=($P_X N$)*Torque Scale=……………N-m
11. Efficiency= (Output/Input)*100=…………..%
12. Slip(S)=[($P_X N$-$P_X M$)/$P_X N$]*100=…………%
13. Power Factor (PF) =($P_X K$)/(OP_X)=…………….
14. Speed= N_S (1-S) =………….rpm

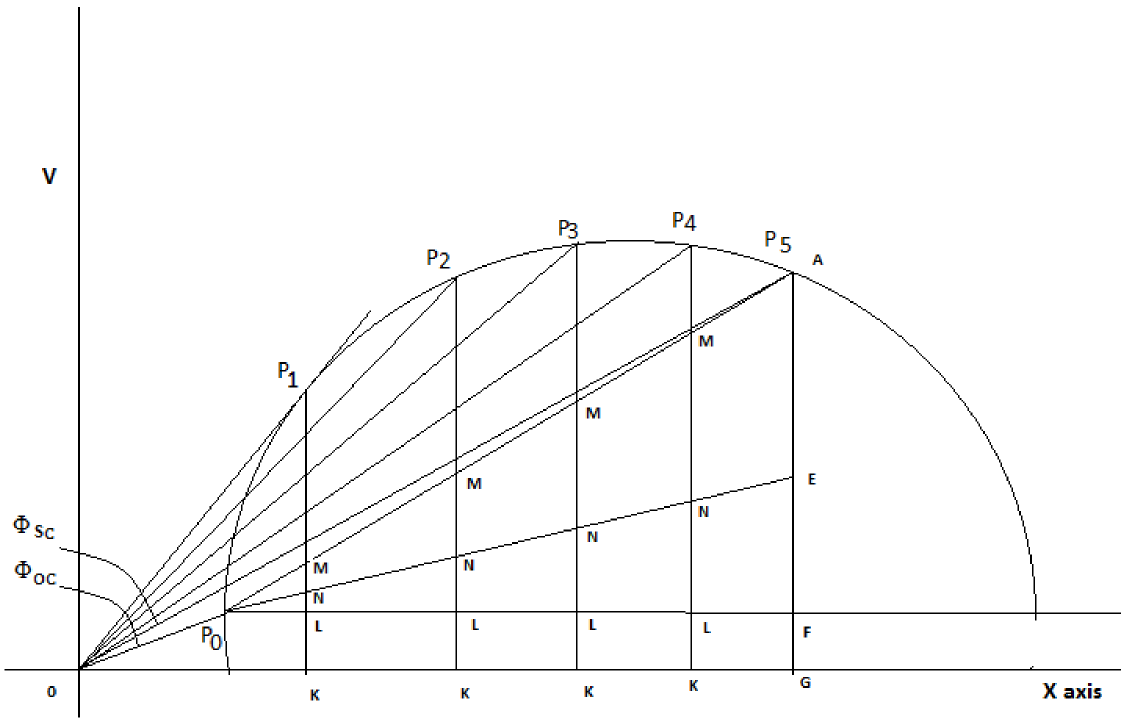
MODEL GRAPHS:-







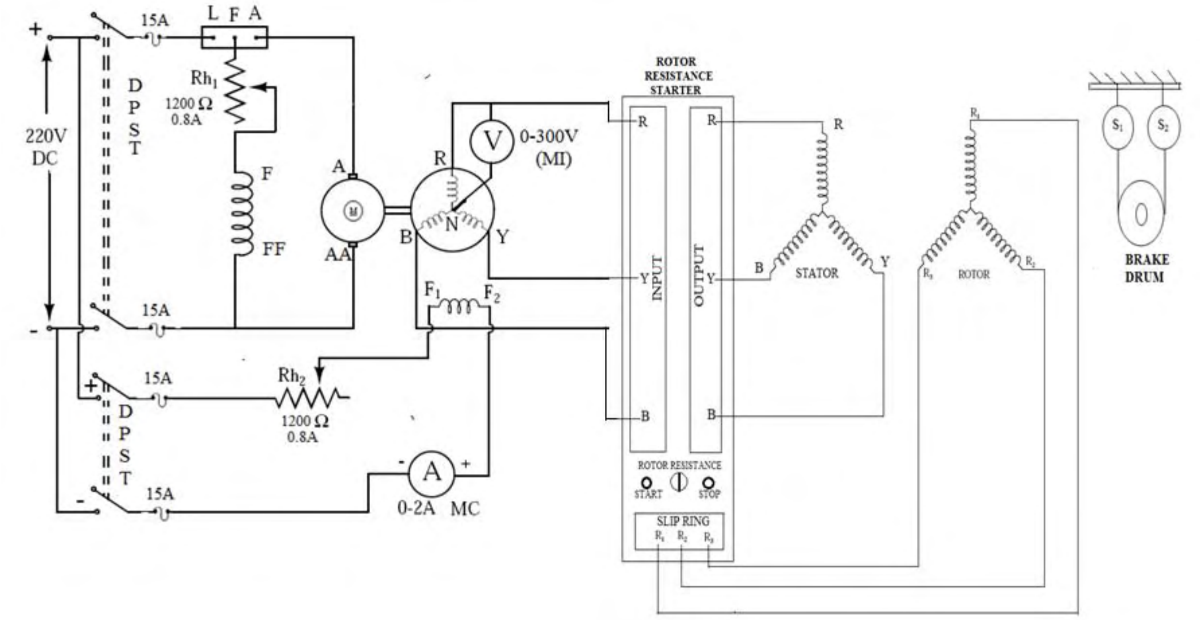
CIRCLE DIAGRAM:-



RESULT:-

Performed the no load and blocked rotor test on 3 phase squirrel cage induction motor for calculating equivalant circuit parameter and plotted the performance curve fom the circle diagram.

CIRCUIT DIAGRAM:-



Ex No: 5

SPEED CONTROL OF 3 PHASE INDUCTION MOTOR BY VARIABLE FREQUENCY METHOD

AIM:-

To plot the speed Vs frequency curve of 3 phase slip ring induction motor using variable frequency speed control method at no load and constant load method.

APPARATUS REQUIRED:-

SL.NO	Name of the Apparatus	Type	Range	Quantity
1	Ammeter	MI	0 – 10 A	1
2	Voltmeter	MI	0 – 500 V	1
3	Rheostat	Wire wound	1200Ω, 0.8 A	2
4	Tachometer	Digital	---	1

THEORY :-

The synchronous speed of induction motor is given by $N_S = \frac{120f}{P}$, where f is frequency of supply and P is number of poles. The synchronous speed and thereby the speed of induction motor can be controlled by controlling the supply frequency. We know that V/f is proportional to flux, therefore if we decrease the frequency while keeping voltage constant the flux in the air-gap will increase thereby causing saturation. To avoid this frequency is not decreased beyond a particular value. The frequency of the alternator output can be varied by varying the prime mover's (dc motor) speed.

PROCEDURE:-

1. Connections are done as shown in the figure.
2. The motor field rheostat Rh1 is kept in minimum position and the alternator field rheostat Rh2 in the maximum position.
3. Supply is switched on.
4. The dc motor is started using the 3-point starter. The motor field rheostat Rh1 is varied till the required frequency (48-52) Hz is obtained.
5. Rh2 is varied till the rated voltage of induction motor is obtained.

TABULAR COLUMN

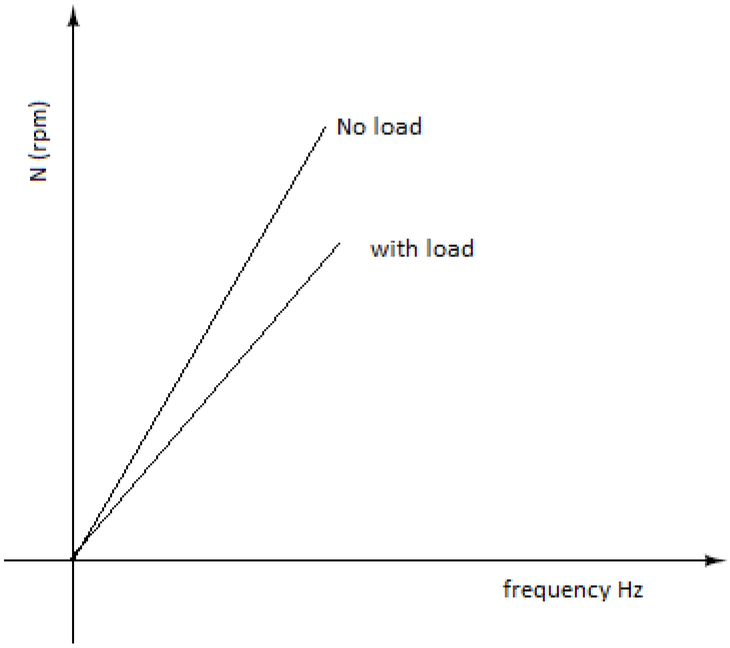
Load	S.No.	V (volt)	I (A)	F (Hz)	N (rpm)	Ns (rpm)
No Load						
With Load						

SAMPLE CALCULATION:-

1) Voltage V=……………V
2) Frequency f=…………….Hz
3) Current I=……………..A
4) Speed N=………………..rpm
5) Total number of pole P=
6) $N_S = \frac{120f}{P}$=……………….rpm

6. The experiment is repeated for different values of frequency keeping the supply voltage to induction motor constant at rated value.
7. Each time the speed and input current of induction motor is noted.
8. The induction motor is loaded and repeat step2 to step 7..
9. Rheostat Rh2 is brought back to the maximum resistance position and switch off supply.

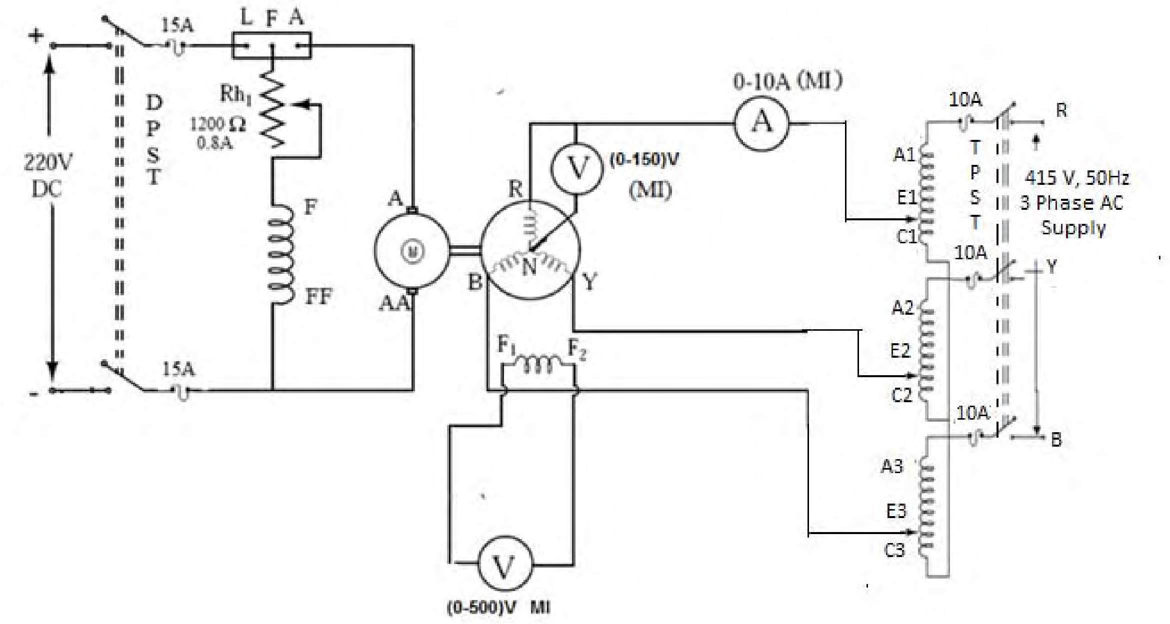
MODEL GRAPHS:-



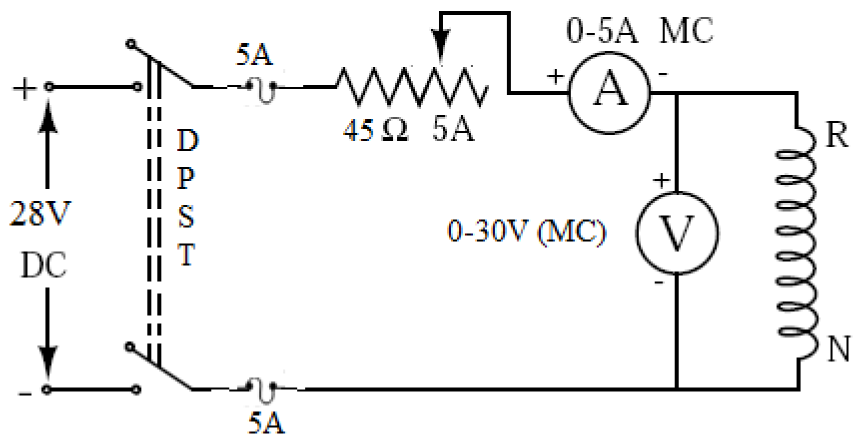
RESULT:-

Speed of 3 phase induction motor was controlled by varying the frequency and speed Vs frequency curve was plotted for both no load and constant load.

CIRCUIT DIAGRAM:-



Stator resistance measurement:



Ex No: 6

SLIP TEST ON SALIENT POLE ALTERNATOR

AIM:-

1) To determine X_d and X_q by conducting slip test.
2) To pre-determine the regulation at upf different powerfactor and load
3) To plot power Vs load angle graph

APPARATUS REQUIRED:-

S.No	Name of apparatus	Range	Type	Qty.
1.	Ammeter	(0-10)A (0-5)A	MI MC	1
2.	Voltmeter	(0-500)V, (0-150)V	MI	1
3.	Voltmeter	(0-30)V	MC	2
4.	Rheostat	1200 Ω, 0.8A 45 Ω, 5A		1
5.	Tachometer	-	Digital	1

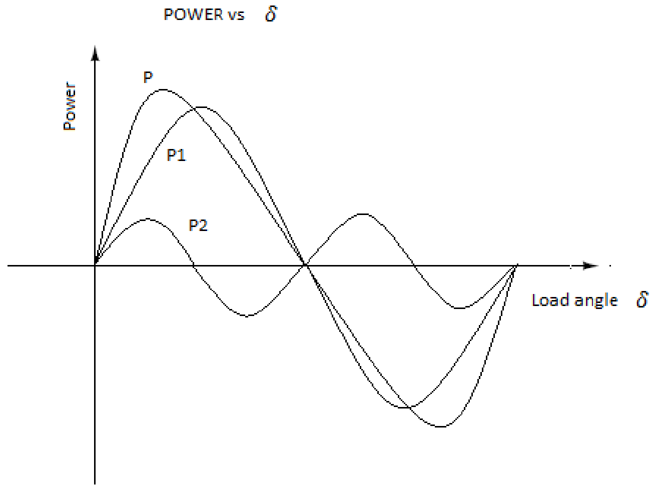
THEORY:-

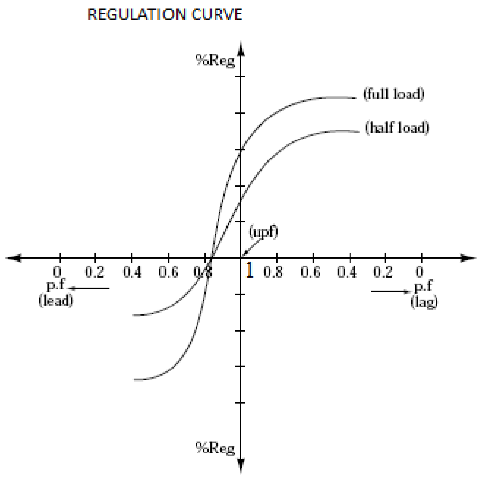
If a synchronous machine runs at a slightly less than the synchronous speed, the field structure is exposed to the rotating mmf of armature reaction. Hence the poles and armature reaction mmf fall in phase and out of phase at slip frequency. Where the axis of two coincides, the armature acts through the field magnetic circuit, including maximum voltage in the field. The direct axis reactance X_d (and hence the impedance Z_d) is maximum resulting in the armature current being minimum. Where the field poles are in quadrature with armature mmf, quadrature axis reactance X_q (and hence the impedance Z_q) will be minimum resulting in the armature current maximum. Hence,

Z_d = Max. voltage / min. current

Z_q = Min. voltage / max. current

MODEL GRAPHS:-





OBSERVATION :-

Slip test reading:

Voltmeter reading (V)		Ammeter reading (A)	
Min.	**Max.**	**Min.**	**Max.**

RESISTANCE CALCULATION:

S.No	Voltage (V)	Current (A)	$R = \frac{V}{I}\ \Omega$
		Mean R=R$_m$	**……. Ω**

R_a=1.2 R$_m$=…………………………..Ω

PROCEDURE:-

1. Make connections as shown in circuit diagram.
2. Start the set and bring it to near synchronous speed keeping the field of the alternator open.
3. Apply an AC voltage of reduced magnitude (about 25% of the rated value). The field poles and armature mmf should rotate in same direction this can be verified by measuring the voltage across the field winding (It should be nearly equal to zero) Otherwise interchange the stator terminals.
4. Adjust the speed of the alternator to get sufficient oscillations (Maximum deflection) in the meter.
5. Note down the maximum and minimum value of ammeter and voltmeter.

Data for plotting power Vs power angle:

δ	sinδ	sin2δ	Excitation power, P_1	Reluctance power, P_2	Total power P $P_1 + P_2$
30					
60					
90					
120					
150					
180					
210					
240					
270					
300					

Data for regulation:

Power factor cosφ	**% Regulation**	
	Full load	**Half load**
0.6 lead		
0.8 lead		
Unity		
0.6 lag		
0.8 lead		

SAMPLE CALCULATION:-

For calculating X_d and X_q:

1) Ra=1.2 R_m=……………………Ω
2) $Z_d=\frac{Maximum\ voltage}{Minimum\ current}$=…………….Ω
3) $Z_q=\frac{Minimum\ voltage}{Maximum\ current}$=…………….Ω
4) $X_d = \sqrt{(Z_d^2 - R_a^2)}$ =………………Ω
5) $X_q = \sqrt{(Z_q^2 - R_a^2)}$ =…………..Ω

For calculating voltage regulation(For any load and power factor$cos\varphi$):

1) $\tan\beta = \frac{V\sin\varphi \mp I_a X_q}{V\cos\varphi + I_a R_a}$=………………degree (+ for lag and – for lead pf)
2) $\delta = \beta \mp \varphi$=……………degree (+ for lag and – for lead pf)
3) $E_0 = V\cos\delta + I_q R_a \cos\beta \mp I_d X_d \sin\beta$ (+ for lag and – for lead pf)
4) % Regulation = $\frac{E_0 - V}{V} \times 100$.

Calculation of excitation and reluctance power:

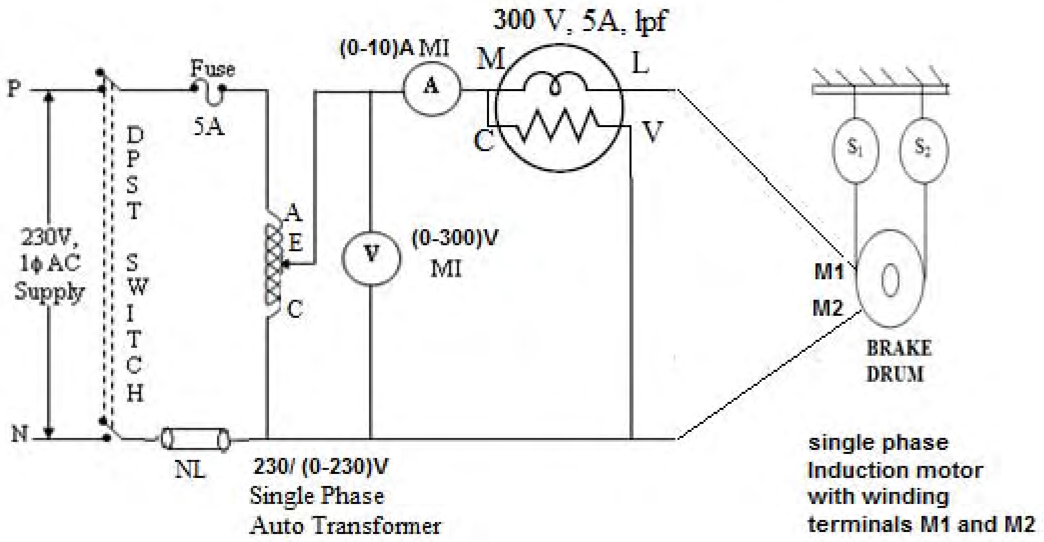
1) Excitation power, $P_1 = \frac{EV\sin\delta}{X_d}$=…………………watts
2) Reluctance power, $P_2 = \frac{V^2}{2} * \frac{(X_d - X_q)\sin 2\delta}{X_d X_q}$=…………watts
3) Total power P=P1+P2=…………..watts

RESULT:-

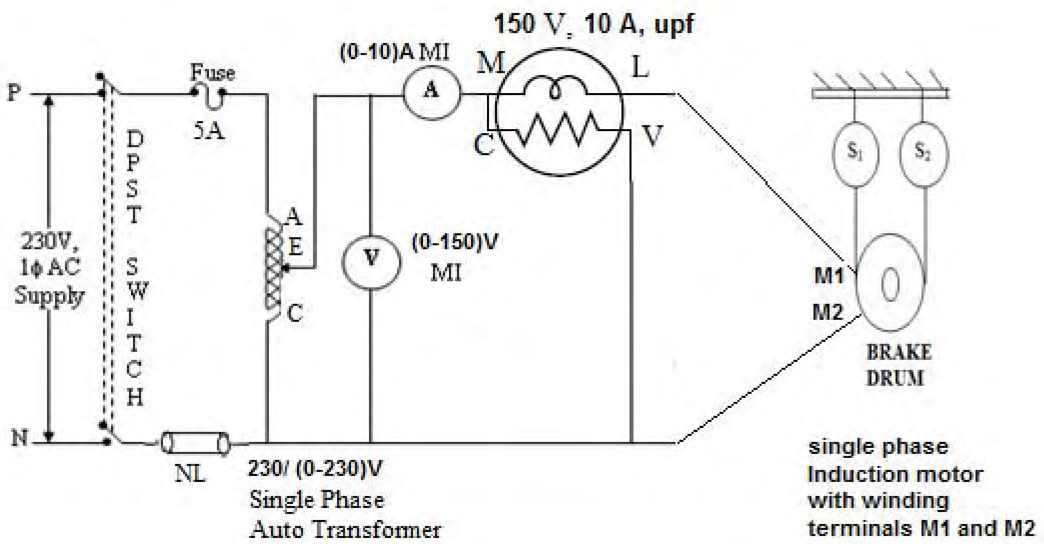
Performed slip test, calculated d axis and q axis synchronous reactance and plotted the graphs

CIRCUIT DIAGRAM:-

FOR NO LOAD:-



FOR BLOCKED TOTOR:-



Ex No: 7

NO LOAD AND BLOCKED ROTOR TEST ON SINGLE PHASE INDUCTION MOTOR

AIM:

1) To obtain the equivalent circuit parameter of the single phase induction motor.
2) To pre determine the line current, power factor, efficiency and the torque developed at 4% slip.

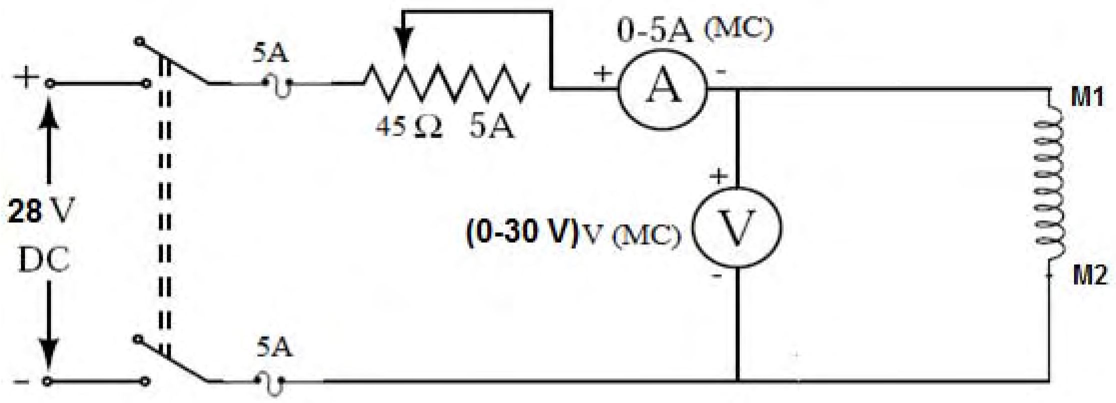
APPARATUS REQUIRED:-

S.No	Apparatus	Range	Type	Qty
1.	Voltmeter	(0-300)V, (0-30)V	MI MC	1 1
2.	Ammeter	(0-10)A (0-5)A	MI MC	1 1
3.	Wattmeter	(300V,5A), (300V,10A)	LPF UPF	1 1
4.	Rheostat	45Ω, 5A	Wire wound	1
5.	Auto transformer	230V, 1phase		1
6.	Connecting wire	1/18	-	As required

PRINCIPLE:-

Single phase motors are similar in construction to poly phase squirrel cage induction motor with exception that the stator has single phase winding. Therefore in single phase motors rotating magnetic field if not produced, but only a pulsating field is produced. The torque is also pulsating and hence single phase motors are not self starting. In order to make them self starting, they are converted to two phase motors at starting. A centrifugal switch is used to cut off the starting winding after motor picks up full speed.

FOR STATOR RESISTANCE:-



OBSRVATION:-

No load Test Readings			**Blocked Rotor Test Readings**		
Power W_O	**Voltage** V_O	**Current** I_O	**Power** W_{sc}	**Voltage** V_{sc}	**Current** I_{sc}

STATOR RESISTANCE:-

S.No	**Voltage (V)**	**Current(A)**	**Resistance R_S (Ω)**
1 **2** **3** **4** **5**			
		R_S mean =	……..Ω

$R_a = R_{Smean}$

PROCEDURE:-

FOR NO LOAD TEST:-

1. Connections are done as shown in the diagram.
2. Supply is switched on with dimmerstat in the minimum position.
3. A low voltage is applied at starting.
4. Gradually as motor picks up speed, the rated voltage is applied.
5. The corresponding meter readings are noted.

FOR BLOCKED ROTOR TEST:-

1. For this test, starting winding is disconnected.
2. A small voltage is applied so that the rated current of the motor flows.
3. Corresponding meter readings are noted. (No physical blocking is required since starting windings is not connected).
4. The resistance of stator winding is also measured.

SAMPLE CALCULATION:-

FROM NO LOAD TEST

Wattmeter reading W_O=…………………W

Voltmeter reading V_O=……………………V

Ammeter reading I_O=………………………A

$W_O= V_O I_O \cos$ o

$\cos \Phi_O = \frac{W_O}{V_O I_O}$ =………………..

Φ_O =…………………degree,

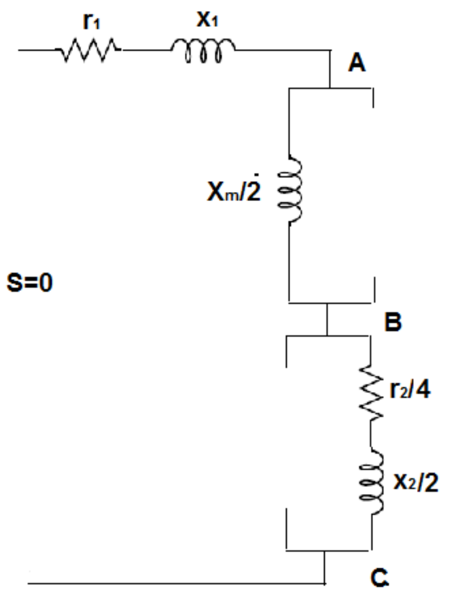
$Z_0 = \frac{V_0}{I_0}$=……………Ω

$X_0 = Z_0 . sin\varphi_0$=……………Ω

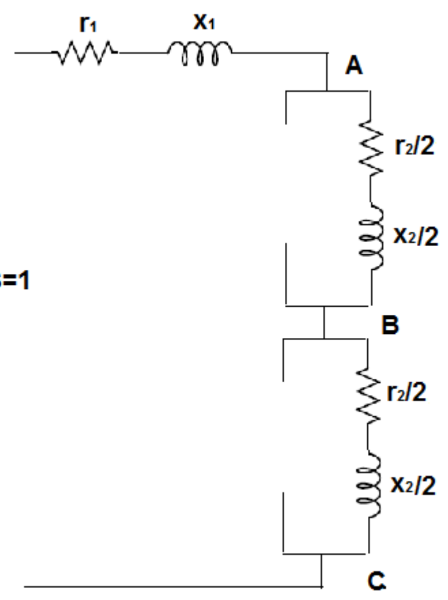
From No-load equivalent circuit, X_0 can be written as

$X_0 = X_1 + \frac{X_m}{2} + \frac{X_2}{2}$ (Note: $X_1 = X_2$)

$X_m = 2X_0 - 3X_1$



No load equivalent circuit



Blocked rotor equivalent circuit

FROM BLOCKED ROTOR TEST

Wattmeter reading W_{sc} =…………………..W

Voltmeter reading V_{SC}=……………………V

Ammeter reading I_{SC}=………………………A

$W_{SC}=V_{SC} I_{SC} \cos$ sc

$\cos\Phi_{SC} = \frac{W_{SC}}{V_{SC}I_{SC}}$ =....................

Φ_{SC} =....................degree

$Z_{sc} = \frac{V_{sc}}{I_{sc}}$=..............Ω

$R_{sc} = Z_{sc}.cos\varphi_{sc}$=...........Ω

$X_{sc} = Z_{sc}.sin\varphi_{sc}$=..............Ω

From blocked rotor equivalent circuit; R_{sc} and X_{sc} can be written as

$R_{sc} = r_1 + (2 * r_2/2) = r_1 + r_2$

$r_2 = R_{sc} - r_1$

Where $r_1 = 1.2R_a$

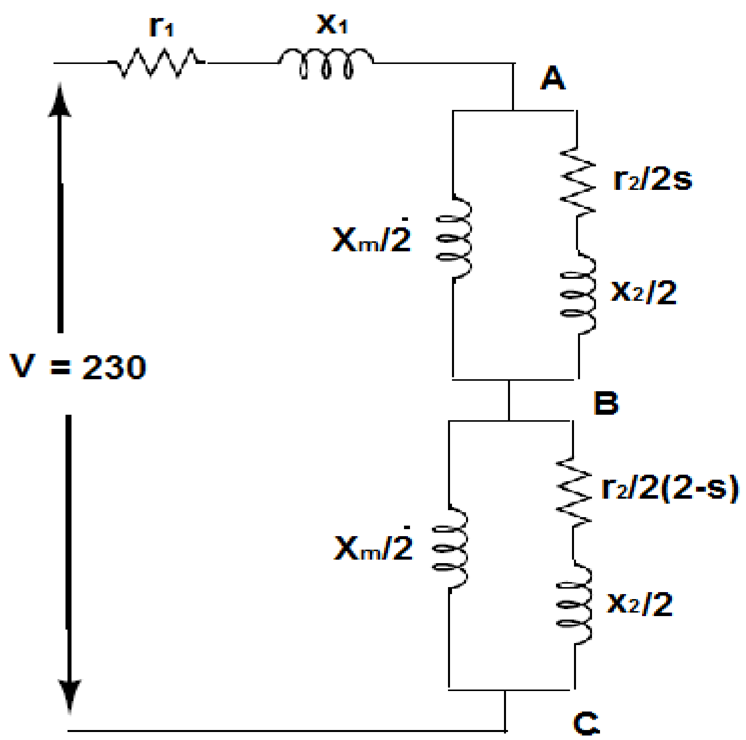
$X_{sc} = x_1 + x_2$

Assuming $x_1 = x_2$, we get

$x_1 = x_2 = X_{sc}/2.$

Thus all the equivalent circuit parameters have been determined.

The final equivalent circuit is given below.



Current, power factor, efficiency and torque at slip = 5%

Impedance between A & B = forward impedance

$$Z_f = \frac{\frac{jX_m}{2} * \left(\left(\frac{r}{2s}\right) + jx_2/2\right)}{\frac{jX_m}{2} + \left(\left(\frac{r}{2s}\right) + jx_2/2\right)}$$

R_f=Real part of forward impedance

X_f=imaginary part of forward impedance

Impedance between B & C = Backward impedance

$$Z_b = \frac{\frac{jX_m}{2} * \left(\left(\frac{r}{2(2-s)}\right) + jx_2/2\right)}{\frac{jX_m}{2} + \left(\left(\frac{r}{2(2-s)}\right) + jx_2/2\right)}$$

R_b=Real part of backward impedance

X_b=imaginary part of backward impedance.

Total impedance Z_T = $\left(r_1 + R_f + R_b\right) + j(x_1 + X_f + X_b)$ = X$< \theta$ (in polar form)

Stator current I = V/Z_T

Power factor = cosθ

Power input $P_i = VIcos\theta$

Constant losses (friction, windage and iron loss), W_c= $W_0 - I_0^2[r_1 + r_2/4]$.

Net torque in synchronous watts = $T_f - T_b$ = $I^2\left(R_f - R_b\right)$

Torque in Nm = $\frac{torque\ in\ synch\ watts}{2\pi N_s/60}$

Mechanical power delivered = P_m = $(T_f - T_b)(1 - s)$ W

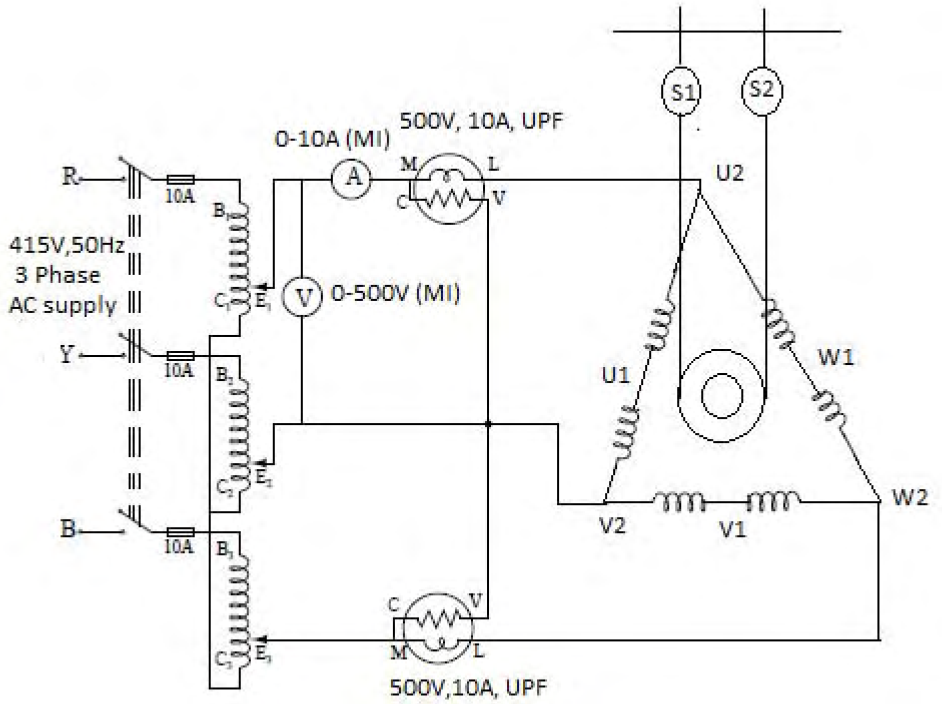
Shaft output = P_s = $P_m - W_c$ W

Efficiency =$(P_s/P_i) * 100$

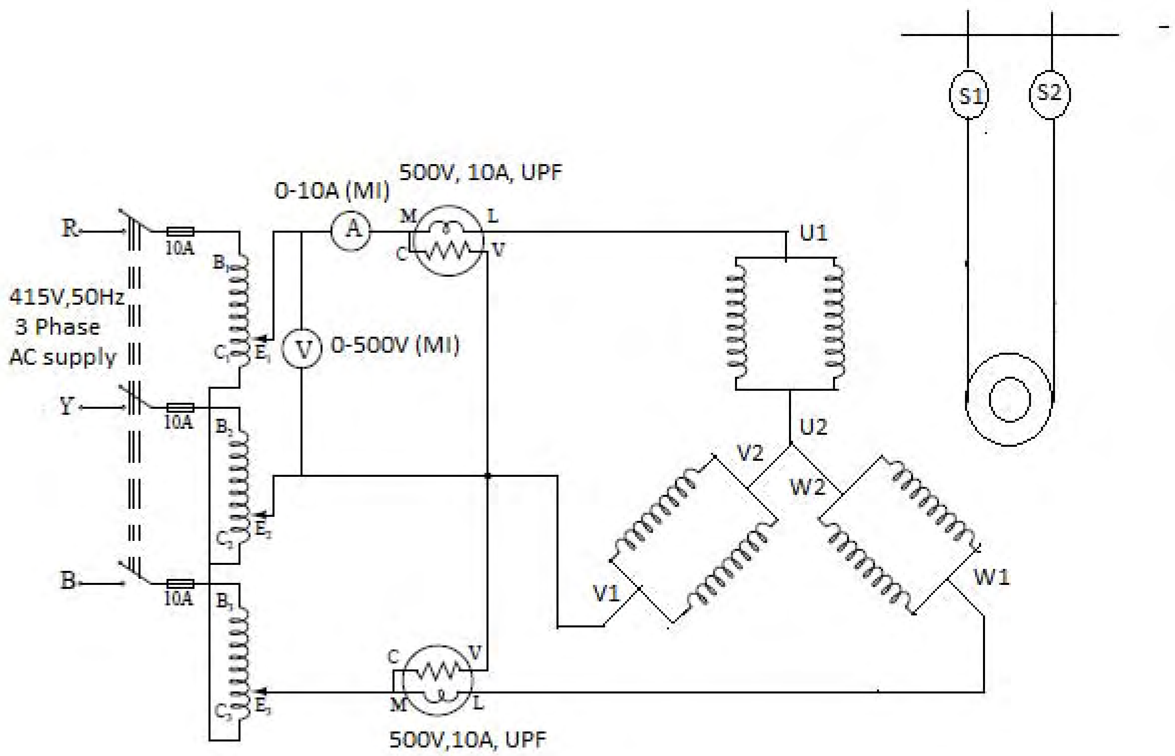
RESULTS

a. The equivalent circuit parameters of the single phase induction motor are obtained and the same is drawn..
b. At slip = 5%, the following were predetermined using the equivalent circuit,
   1. Stator current, I =
   2. Efficiency =
   3. Torque =
   4. Power factor =

CIRCUIT DIAGRAM (Low Speed):-



CIRCUIT DIAGRAM (High Speed):-



Ex No: 8

LOAD TEST ON POLE CHANGING INDUCTION MOTOR

AIM:

1) To study different modes of operation of three phase pole changing induction motor.
2) Perform load test and obtain performance characteristics and compare the results obtained for different pole combination at different load condition.

APPARATUS REQUIRED:-

S.No	Name of apparatus	Range	Type	Qty.
1.	Ammeter	(0-10)A	MI	1
2.	Voltmeter	(0-500)V	MI	1
3.	Wattmeter	(500V,10A)	UPF	2
4.	Tachometer	-	Digital	1

THEORY:

Pole changing motor is similar in construction when compared to standard squirrel cage induction motor because of it's simple construction and low cost. The only disadvantage is it's single speed of running. But pole changing induction motor gives two speeds using a single stator winding. The reliability and operating characteristics are identical to that of standard squirrel cage induction motor.

In pole changing induction motor each phase winding is usually divided into equal parts provided with tappings. The direction in which current is passed through them can be reversed by switching, thereby number of pole becomes halved and will consequently lead to double synchronous speed. In practice switch over from series to parallel connection is accomplished by changing either from delta to double star or from single star to double star.

SAFETY PRECAUTIONS:-

1. There must be no load when starting the motor.

OBSERVATION:-

For low speed:

V_L (V)	I_L (A)	W1 (W)	W2 (W)	W (W)	Load(kg)		Torque (Nm)	N (rpm)	Output (W)	%Slip	%η	PF
					S1	S2						

For high speed:

V_L (V)	I_L (A)	W1 (W)	W2 (W)	W (W)	Load(kg)		Torque (Nm)	N (rpm)	Output (W)	%Slip	%η	PF
					S1	S2						

PROCEDURE:-

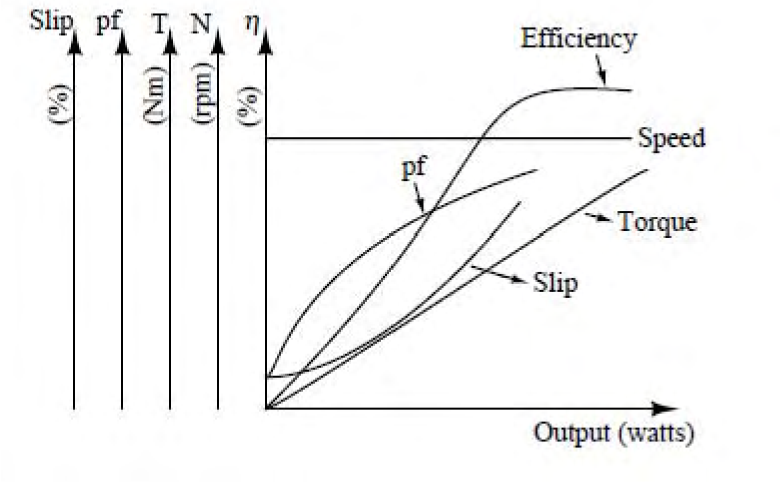
1. For low speed, connections are made as per circuit diagram. Connect U2,V2 and W2 to R, Y and B respectively. Make U1, V1 and W1 free.
2. The rotor was made very much free to rotate. Adjust the autotrnsformer to zero position.
3. Pour some water inside the brake drum so as to cool the rotor belt.
4. 3-Φ induction motor started using auto transformer. Apply rated voltage slowly.
5. Adjusted the load till current was made to rated value of motor.
6. Decrease the load step by step and note corresponding speed, load, current, voltage and wattmeter readings.
7. At certain load, wattmeter W2 will show negative reading. Note down the current at his load. Interchange the connection of current coil of wattmeter W2 which was reading negative after switching off supply by pressing red switch of starter.
8. Rotor was made free to rotate by removing the load completely.
9. 3-Φ induction motor started using autotransformer. Adjust the current to value in step7
10. Note down corresponding speed, load, current, voltage, wattmeter readings. Take the reading of wattmeter W2 as negative.
11. Finally switch off supply.
12. For high speed, connections are done as per the circuit diagram. Connect U1, V1 and W1 to R,Y and B respectivey. Short U2, V2 and W2.
13. Repeat step 2 to step 11.

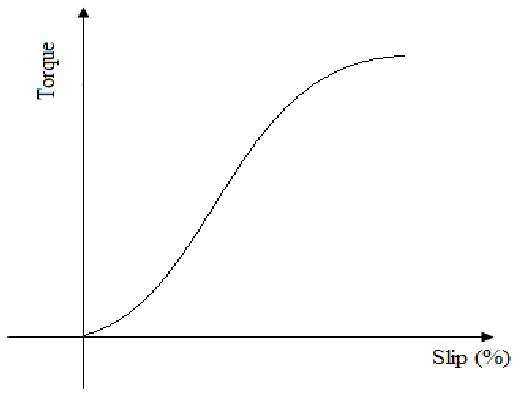
SAMPLE CALCULATION (For low and high speed):-

1. Line voltage V_L=…………………….V
2. Line current I_L=……………….A
3. Radius of brake drum R=………………m
4. Synchronous speed, Ns =……………….rpm
5. Rotor speed, N =……………….rpm
6. % slip= [(Ns-N)/Ns]*100=…………..%
7. Input Power W = (W1+W2)=…………….. watts
8. Torque T = 9.81*(S1-S2)*R=……………. N-m
9. Output Power = 2πNT/60=……………. watts
10. % efficiency =[output/input]* 100=……………%
11. Pf = W/($\sqrt{3}V_L I_L$)=………………..

MODEL GRAPHS:-

Performance Characterestics:

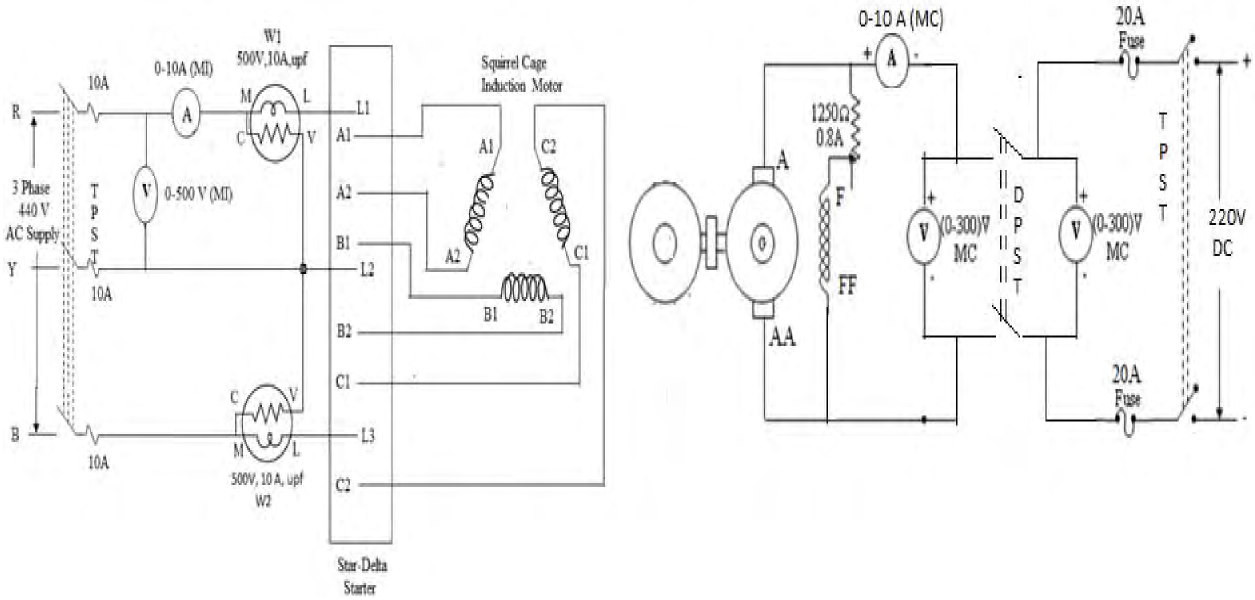




RESULT:-

The load test on pole changing induction motor has been conducted and performance characteristics were plotted.

CIRCUIT DIAGRAM:-



Ex No: 9

INDUCTION MACHINE AS MOTOR AND GENERATOR

AIM:-

1. To operate the given 3 phase induction machine as i)induction motor and ii) induction generator.
2. To obtain the overall efficiency vs. output charactereristics.

APPARATUS REQUIRED:-

S.No	Name of apparatus	Range	Type	Qty.
1.	Ammeter	(0-50)A (0-15)A	MI	Each 1
2.	Voltmeter	(0-500)V	MI	1
3.	Voltmeter	(0-150)V	MC	2
4	Wattmeter	500V,15A	UPF	1
4.	Rheostat	1200 Ω, 0.8A		1

THEORY:-

An induction motor running above its synchronous speed (super synchronous speed) has negative slip and will act as a generator if the stator magnetizing current is supplied either from the synchronous mains or from a set of capacitors connected across its terminal. It's seldom used for the purpose of generator operation but finds application in the electrical braking purpose.

OBSERVATION :-

For motor:

Operating mode	I_{ac} (A)	V_{ac} (V)	Wattmeter reading		Input	I_{dc}	V_{dc}	Output	%η
			W1	W2					
Motoring Action									

For generator:

Operating mode	I_{ac} (A)	V_{ac} (V)	Wattmeter reading		Output (W)	I_{dc} (A)	V_{dc} (V)	Input (W)	%η
			W1	W2					
Generating Action									

DATA PROCESSING:-

Motor Action

Input power =W1+W2=………..watts

Output power =I_{dc}*V_{dc}=…………..watts

% efficiency = (output/input)*100 =………%

Generator Action

Input power =I_{dc}*V_{dc} =…………….watts

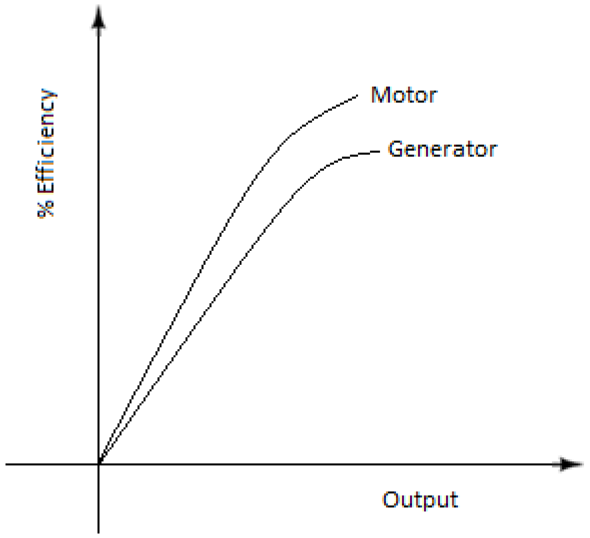
Output power = W1+W2=………..watts

% efficiency = (output/input)*100 =…………%

PROCEDURE:-

1. Connections are done as shown in the diagram.
2. Keeping DPST in open position, start the set from the ac side using Y/Δ starter. If the direction of rotation is opposite to the marked direction for the DC machine, restart the induction motor after interchanging any two phases.
3. With the DPST open, the DC supply is switched on. Adjust the field rheostat such that the generated voltage and the DC supply voltage are equal in magnitude (check readings on V_2 and V_3). Also confirm that polarity is the same and if not interchange any two leads.
4. Now close the DPST switch to bring the DC machine in floating condition. Adjust the excitation in such a way that the DC machine acts as a generator and the induction machine continues to run as a motor. For this effect reduce the field rheostat resistance.
5. For different values of field current note all the meter readings. Now bring the field rheostat again to the floating condition and continue to decrease the excitation to make the DC machine run as a motor and the induction machine as a generator. The meter readings are noted for different values of field current.

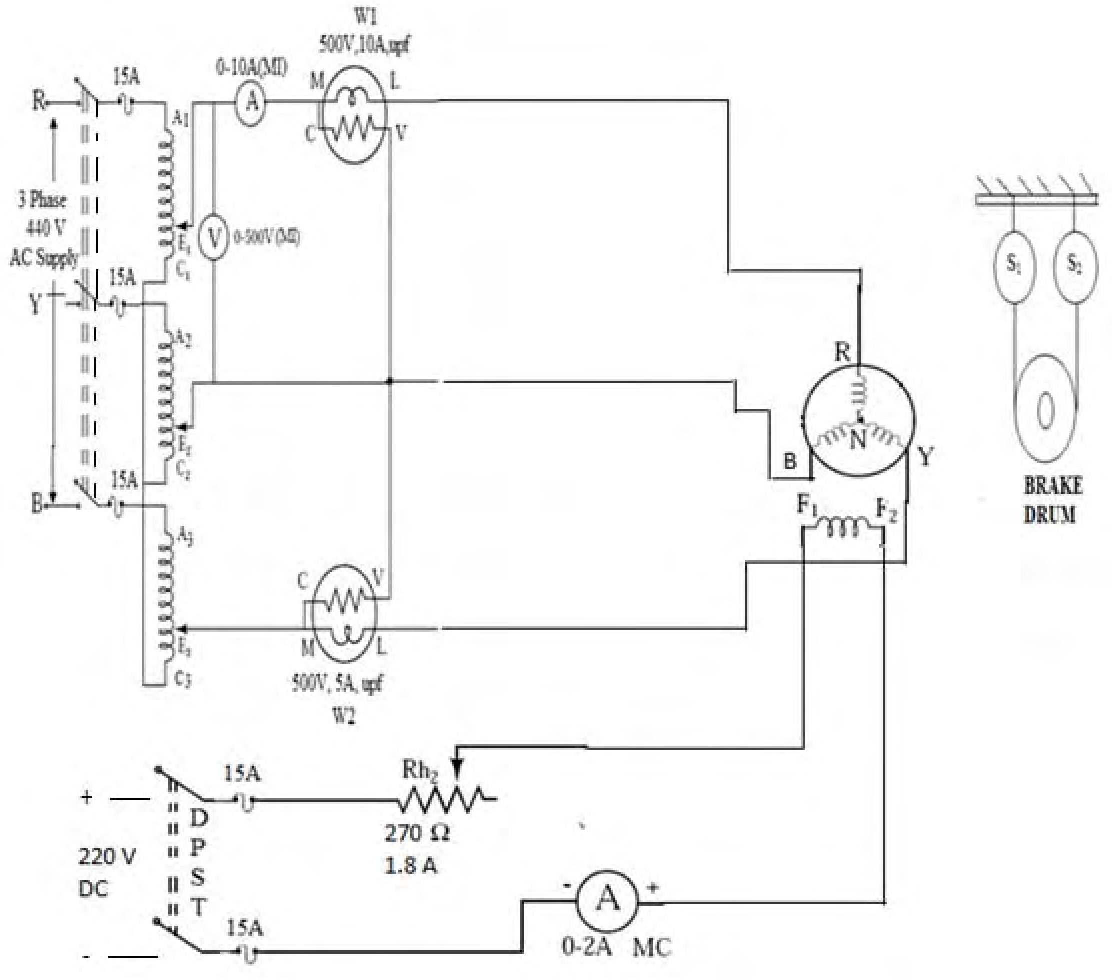
MODEL GRAPH:-



RESULT:-

The performance characteristics of induction machine running in motoring and generating is plotted

CIRCUIT DIAGRAM:-



Ex No: 10

LOAD TEST ON THREE PHASE SYNCHRONOUS MOTOR

AIM:

To draw the V and inverted V curves of synchronous motor at different loads.

APPARATUS REQUIRED:-

S.No	Apparatus	Range	Type	Qty
1.	Voltmeter	(0-500)V	MI	1
2.	Ammeter	(0-10)A (0-2)A	MI MC	1 1
3.	Wattmeter	(500V,10A)	UPF	2
4.	Rheostat	270 Ω, 0.8A	Wire wound	1

PRINCIPLE:

A synchronous machine can be used as an alternator, when driven mechanically or as a motor when driven electrically. Most synchronous motors are rated between 150kW to 15MW and run at speed ranging from 150 to 1800 rpm. Based on the construction synchronous motor can be classified in to two types, 1.Cylindrical rotor type and 2. Salient pole type.

In salient pole type, the rotor poles are projecting out from the rotor core. But what we are using is the other. The cylindrical rotor machine has its rotor slots. This type provides greater mechanical strength and permits more accurate dynamic balancing. It is particularly adopted for use in high speed turbo generators.

Some characteristic features of a synchronous motor are:

1. It runs either at synchronous speed or not at all. The only way to change its speed is to vary the supply frequency.
2. It is not inherently self starting.
3. It is capable of being operated under a wide range.

TABULAR COLUMNS:-

Load	Sl.No	Armature Current I_a(A)	Field current I_f(A)	Wattmeter Reading		Power factor
				W1	W2	
No load						
50% load						
75% load						

DATA PROCESSING:-

1. Power factor (PF) = cos =………………..

   Where, $=\tan^{-1}\frac{\sqrt{3}(w2-w1)}{w1+w2}$

PROCEDURE:-

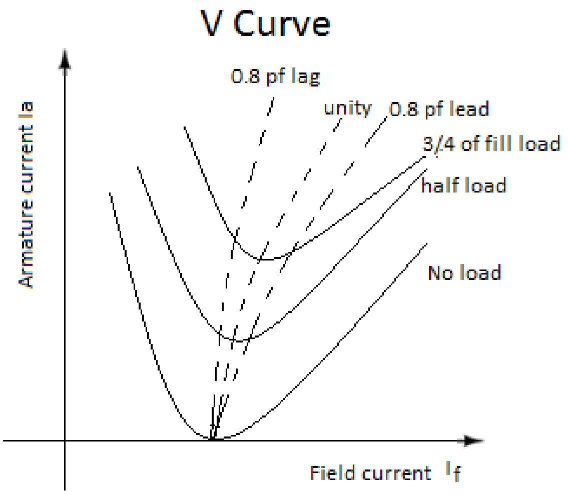
FOR DETERMINATION OF V AND INVERTED V CURVES:

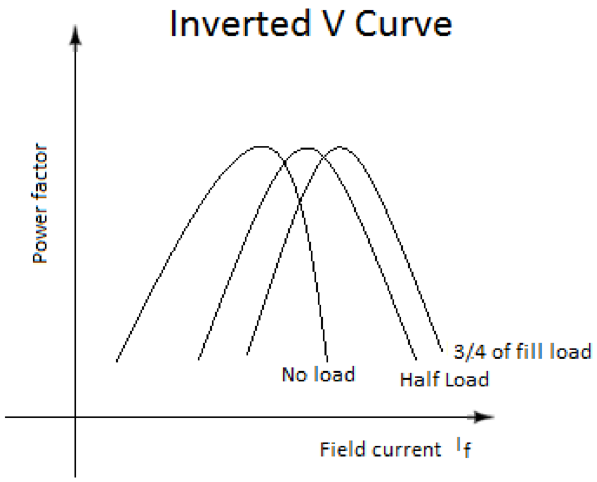
1. Connections are given as per the circuit diagram.
2. The auto transformer is adjusted such that it reads the rated voltage.
3. At no-load condition, the field excitation was varied and the corresponding line current and the wattmeter readings are noted.
4. Then by keeping 75% load, the excitation was adjusted by varying the field rheostat and the above readings are noted.
5. Same procedure was followed for full load.

FOR LOAD TEST:-

1. Connections are given as per the circuit diagram.
2. By varying the auto-transformer, rated voltage was kept across the voltmeter.
3. At no-load, the line current, the line current, wattmeter readings and the spring balance readings were noted down.
4. Then by adding the load in steps, the above said readings were noted.
5. The above procedure was followed until it reaches the rated current.

SAMPLE GRAPHS:-





RESULT:-

The V curves and inverted V-curve for different load condition are drawn.