Electrical Engineering Department

BRCM COLLEGE OF ENGINEERING & TECHNOLOGY

BAHAL – 127028 (Distt. Bhiwani) Haryana, India

ELECTRICAL MACHINES-II Laboratory

(PCC- EE-208G**)**

Prepared By.

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Electrical Machines-II Laboratory

Class Work: 25
Exam : 25
Total : 50

Course Code	**PCC-EE-208G**		
Category	**Engineering Science Course**		
Course title	**Electrical Machines-II** (Laboratory)		
Scheme	**L**	**T**	**P**
	-	**-**	**2**

Notes:
(i) At least 10 experiments are to be performed by students in the semester.
(ii) At least 7 experiments should be performed from the list, remaining three experiments may either be performed from the above list or designed and set by the concerned institution as per the scope of the syllabus

LIST OF EXPERIMENTS:

1. To perform the open circuit test and block rotor test on 3 phase induction motor and draw the circle diagram.
2. To study the speed control of induction motor by rotor resistance control.
3. To conduct the load test to determine the performance characteristics of the I.M.
4. To compute the torque v/s speed characteristics for various stator voltages.
5. To perform the open circuit test and block rotor test on single-phase induction motor and determine equivalent circuit parameters.
6. To perform O.C. test on synchronous generator and determine the full load regulation of a three phase synchronous generator by synchronous impedance method.
7. To Study and Measure Synchronous Impedance and Short circuit ratio of Synchronous Generator .
8. Study of Power (Load) sharing between two Three Phase alternators in parallel operation Condition.
9. To plot V- Curve of synchronous motor.
10. Synchronization of two Three Phase Alternators by
    a) Synchroscope Method
    b) Three dark lamp Method
    c) Two bright one dark lamp Method
11. Determination of sequence impedances of synchronous machine for various stator voltages.

Note:

1. Each laboratory group shall not be more than about 20 students To allow fair opportunity of practical hands on experience to each student, each experiment may either done by each student individually or in group of not more than 3-4 students. Larger groups be strictly discouraged/disallowed.

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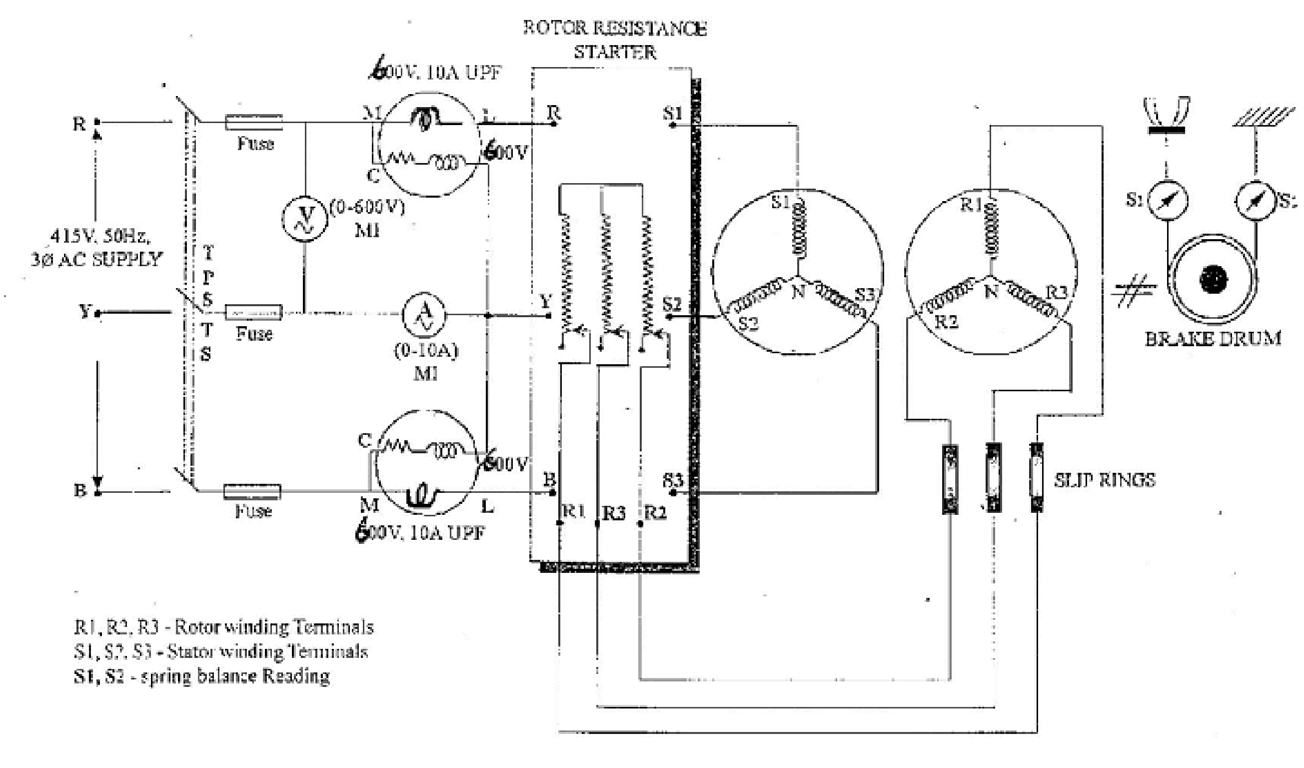
EXPERIMENT NO: 01

AIM:- STUDY OF THE NO LOAD AND BLOCK ROTOR TEST IN A THREE PHASE SLIP RING INDUCTION MOTOR & DRAW ITS CIRCLE DIAGRAM

APPARATUS:- 3 phase Induction motor with belt and pulley arrangement , three phase supply, wattmeters , ammeter and voltmeter

Diagram

LOAD TEST ON THREE PHASE SLIP RING INDUCTION MOTOR



FORMLULAE

$\cos\phi_o = W_o / \sqrt{3}\, V_o I_o$

$\cos\phi_r = W_{br} / \sqrt{3}\, V_{br} I_{br}$

$I_{bm} = I_{br} (V_o/V_{br})$

$W_{bm} = W_{br} (V_o/V_{br})^2$

Stator copper loss = $3\, I_{br}^2 R_s$

PRECAUTION

1. The 3φ autotransformer should be kept at initial position.
2. Initially the machine should be under no load condition.

PROCEDURE

NO LOAD TEST

1. Connections are made as per the circuit diagram.
2. 3φ AC supply is increased gradually using 3φ autotransformer till rated voltage is applied.
3. Readings of voltmeter and wattmeter are noted.

BLOCKED ROTOR TEST

1. Connections are made as per the circuit diagram and rotor is blocked from rotating.
2. Applied voltage is increased until rated load current flows.
3. Readings of all meters are noted.

MEASUREMENT OF STATOR RESISTANCE

1. Connections are made as per the circuit diagram.
2. Supply is given by closing the DPST switch.
3. Readings of voltmeter and ammeter are noted.
4. Stator resistance in ohms is calculated as

$R_{a/phase} = (V x 1.5) / 2I$

PROCEDURE FOR CONSTRUCTING THE CIRCLE

1. Vector OO' is drawn at an angle of phase with respect to OY represents the output line.
2. O'X' is drawn parallel to OX.
3. Vector OA is I_{br} plotted at an angle of phasor with respect to OY. O'A is joined which represents the output line.

4. A perpendicular bisector from output line which cuts O'Y at C. With C as centre and O'C as radius draw a semi-circle passing through A.
5. From A, a perpendicular is drawn meeting O'X' at E and OD at D.
6. AD represents W_{br} in CM.
EF represents stator copper loss in CM.
AD represents rotor copper loss in CM.
7. Join OF' which represents the torque line.
8. Line AD is extended and points S is marked, where AS is equal to rated output power.
9. Line PS is drawn parallel to output line.
10. From P, perpendicular line is drawn meeting OX at y.
11. Join OP.

MEASUREMENT OF PARAMETER AT FULL LOAD

Stator current = OP x X

%η = (PQ/PV)x 100

%Slip = (QR/PR)x 100

Torque = (PRxV/(2ΠNT/60))
Pf = PV/OP

MAXIMUM OUTPUT
The perpendicular at O'A' line cuts the circle at P and O'A' at PQ'.
Maximum output = P_1Q_1x power scale (W)

MAXIMUM TORQUE
The perpendicular bisector of line cuts the circle at PR and OF' at Q_2.
Maximum torque = (PFx power scale)/T Nm

NO LOAD TEST

S.N.O	Vo (V)	Io (A)	Wo (W)		$W_o=(W_1+W_2)$ W
			W1	W2	

BLOCKED ROTOR TEST

S.N.O	Vo (V)	Isc (A)	Wsc (W)		$W_{SC}=(W_1+W_2)$ W
			W1	W2	

PRECAUTION:
1. TPST switch should be at open position.
2. 3-phase autotransformer should be at minimum voltage position.
3. There should be no-load at the time of starting(Loosen the belt on the brake drum)
4. Brake drum should be filled with water.

PROCEDURE:
1. The connections are made as per the circuit diagram.
2. Power supply is obtained from the control panel.
3. The TPST switch is closed.
4. Rated voltage of 3-phase induction motor, is applied by adjusting autotransformer
5. The initial readings of ammeter, voltmeter and wattmeter are noted.
6. By increasing the load step by step, the reading of ammeter, voltmeter and wattmeter
7. Step1 to 6 is repeated till the ammeter shows the rated current of 3-phase induction motor.
8. Decrease the load, bring auto-transformer to its minimum voltage position.
9. Switch off the supply

S.NO	V (volt)	I (A)	Speed (rpm)	Spring Balance		Torque =(($S_1 - S_2$) * 9.81 * R) N-m	I/P($V*I_L$) Watt	O/P 2 ?NT/60(Watt)	Efficiency = Output Power Input Power 100%?	% slip
				S1	S2					

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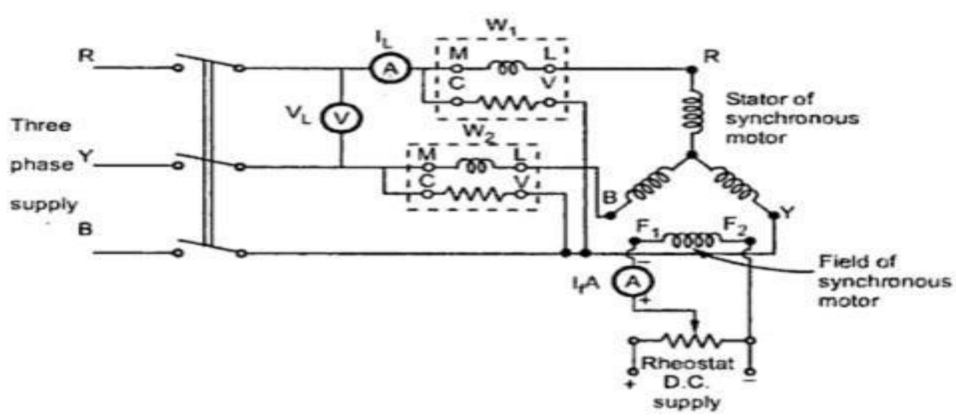
EXPERIMENT NO: 02

AIM: - TO PLOT V & INVERTED V CURVES OF A SYNCHRONOUS MOTOR.

APPARATUS:-

1) Synchronous motor 3 Phase, 3 HP, 440V, 8.2A ,1500 rpm,
2) DC shunt Generator 220V, 9A, 1500 rpm
3) Power factor meter-600V, 10A
4) Voltmeter AC- (0-600V), DC- (0-300V)
5) Ammeter AC- (0-10A)
6) Ammeter DC (0-2A), DC (0-10A)
7) Rheostat-470 ohm, 1.2A,
8) Resistive load bank, tachometer, connecting wires, etc.

CIRCUIT DIAGRAM:-



THEORY:-

Theory should cover the following points

1. Significance of V and inverted V curves of synchronous motors.
2. Phasor diagram of a synchronous motor showing effect of change in excitation
3. Necessary condition for obtaining V & inverted V curves
4. Explanation about circuit diagram

PROCEDURE:-

1) Make the connections as shown in circuit diagram.
2) Adjust the field rheostat of DC generator at maximum position, the potential divider at zero output position and the load at off condition.
3) Switch on the 3-ph. supply, start the synchronous motor and let it run at its rated speed.
4) Switch on the DC supply and adjust the generator field current to a suitable value so that it generates rated voltage.
5) Increase the alternator field current and note down corresponding power factor and armature current covering a range from low lagging to low leading power factor through a unity power factor. Note that armature current is minimum when the p.f. in unity.
6) Repeat step No.5 for some constant load on the Generator.

OBSERVATIONS:-

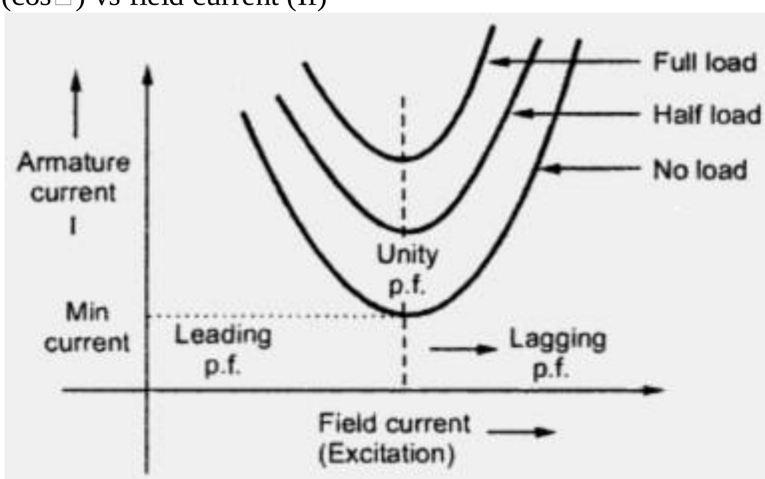
[A] AT NO LOAD

Sr. No.	If	Power Factor(cos□)	Ia

[B] AT LOAD

Sr. No.	If	Power Factor(cos□)	Ia

GRAPH: Plot the curves between armature current (Ia) vs field current (If) and power factor (cos□) vs field current (If)



CONCLUSION:

1. The variation of armature current (line current) and its power factor due to field current variation at load and at no load are shown. The armature current is minimum when the PF is unity.
2. As load increases the V curve shifts upward and the inverted V curve shift towards right.

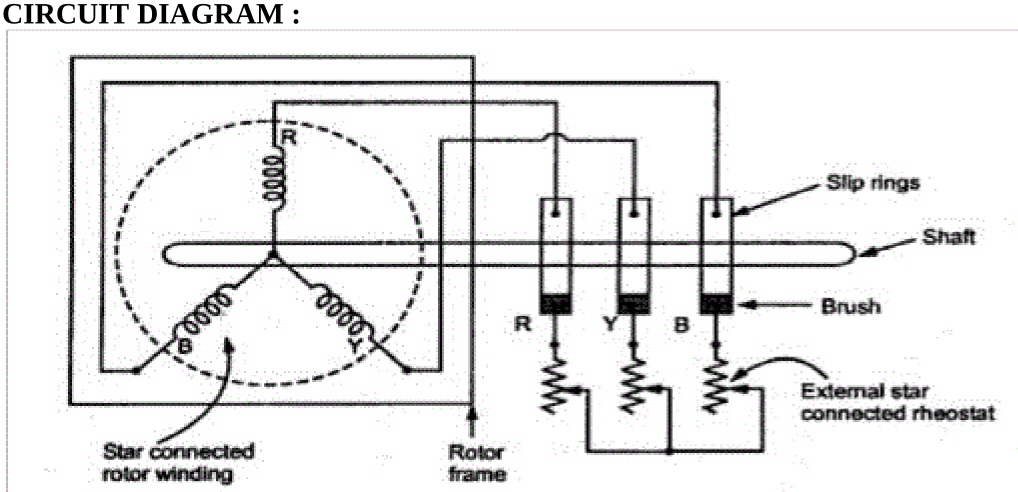
EXPERIMENT NO: 03

AIM: - TO STUDY THE STARTING OF SLIP RING INDUCTION MOTOR BY ROTOR RESISTANCE STARTER.

APPARATUS:- 1 3-phase slip ring asynchronous motor,1 Magnetic power brake,1 Control unit for brake,1 Rubber Coupling sleeve,1 Coupling guard,1 Shaft end guard,1 Rotation reversing switch,1 Start for slip ring motors,1 Cut out switch, 3 pole 1 Multimeter,1 Set of connection cables.

THEORY :- Squirrel cage induction motors draw 500% to over 1000% of full load current (FLC) during starting. While this is not a severe problem for small motors, it is for large (10's of kW) motors. Placing resistance in series with the rotor windings not only decreases start current, locked rotor current (LRC), but also increases the starting torque, locked rotor torque (LRT). Figure below shows that by increasing the rotor resistance from R_0 to R_1 to R_2, the breakdown torque peak is shifted left to zero speed.Note that this torque peak is much higher than the starting torque available with no rotor resistance (R_0) Slip is proportional to rotor resistance, and pullout torque is proportional to slip. Thus, high torque is produced while starting.

CIRCUIT DIAGRAM :



OBSERVATION TABLE :-

Sr. No	Variable Resister	Speed

PROCEDURE :

1. Study the construction and the various parts of the 3-phase induction motor.
2. For rotor resistance starting, connect the slip-ring motor. Start the motor with full starting resistance and then decrease the resistance in steps down to zero. Take observations of the stator & rotor currents.
3. For direct-on -line starting , connect the cage motor.
4. For star-delta starting , connect the cage motor to the terminals of the star delta.
5. For autotransformer starting, connect the cage motor. Take care at starting that the "Run" switch is open and that it is not closed before the "Start" switch is opened.
6. In each case observe the starting currents by quickly reading the maximum indication of the ammeters in the stator circuit.
7. Reverse the direction of rotation of the motor by reversing of two phases at the terminal box. The reversal has to be made when the motor is stopped and the supply switched off.

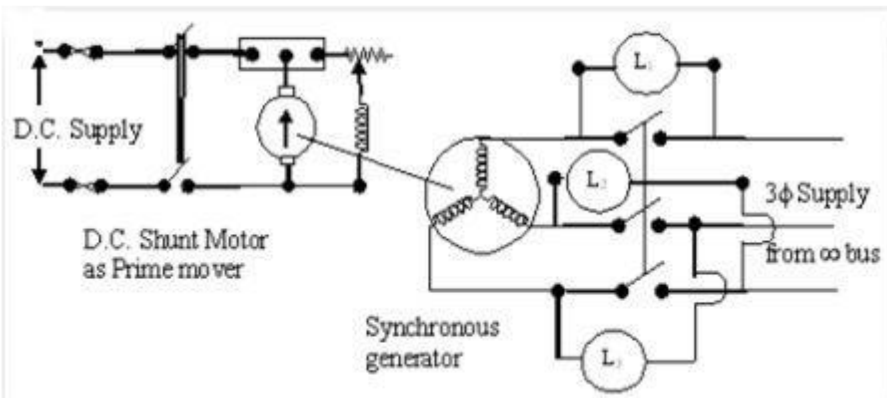
EXPERIMENT NO: -04

AIM: - TO STUDY THE SYNCHRONIZATION OF ALTERNATOR WITH INFINITE BUS BY BRIGHT LAMP METHOD.

APPARATUS:-

3 phase alternator: - 1 KW , 4.2A, 1500 rpm , 3 phase , 440 V
DC shunt motor - 1.5 Kw , shunt , 8 A , 220V , 1500 rpm , self excited . Voltmeter 0-600 V AC
Lamp bank, rheostats, 400 ohms - 1.7 A, A knife switches, connecting wires.

CIRCUIT DIAGRAM:-



THEORY:

Following conditions must be satisfied for the synchronization of alternator with infinite bus.
1) The terminal voltage of the incoming alternator must be equal to the bus voltage.
2) The frequency of incoming alternator must be equal to the bus frequency.
3) The voltage of incoming alternator and bus must be in the same phase with respect to the external load.
A voltmeter can be used to check the voltage of bus and incoming alternator for frequency and phase lamps are used.
Following are the advantages of parallel operation of alternators.
2) Repairs and maintenance of individual generating unit can be done by keeping the continuity of supply.
3) Economy
4) Additional sets can be connected in parallel to meet the increasing demand.

PROCEDURE:

1) Connect the circuit as shown in the diagram.
2) Keep all the switches S1, S2, SL1, SL2, and SL3 in open position and put on the DC supply.
3) Start the DC motor and bring the speed very near to synchronous speed of the alternator.
4) Put on AC supply and measure its voltage by keeping the position of switch S2 online side.
5) Now keep the switch S2 on alternator side and adjust its field current such that it gives voltage equal to the line voltage.
6) Now put on the switches SL1, SL2, SL3 watch the changes in the glow of three sets of lamps. At one instant two will be equally bright while the third set will be fully dark. . Then the set which is fully dark slowly starts becoming bright and one set from the to which were bright starts dimming. A position will come when this set will become fully dark while other two will be equally bright.
7) Make small adjustment in speed and excitation of alternator to get long dark and bright periods.
8) At an instant when pair IR -IR is dark and IB-IB are equally bright, close switch S-1 to synchronize the alternator to bus. Observe the reading of ammeter which should be minimum.

RESULT & CONCLUSION:

An alternator can be synchronized with the bus. At the time of synchronization voltage and frequency of the incoming alternator should be equal to the bus voltage and frequency and also the voltage of incoming alternator should be in phase with the bus with respect to external load .

EXPERIMENT NO: -05

To perform the open circuit test and block rotor test on Three-phase induction motor

APPARATUS REQUIRED:

No.	Equipment	Type	Range	Quantity
1	Voltmeter	MI	(0-600)V	1 no
2	Ammeter	MI	(0-10)A	1 no
			10A/600V UPF	1 no
3	Wattmeter	Electro dynamo meter type	10A/600V LPF	1 no
4	Tachometer	Digital	0-9999 RPM	1 no
5	Connecting Wires	*****	*****	Required

3- ϕ Auto transformer Det ails:

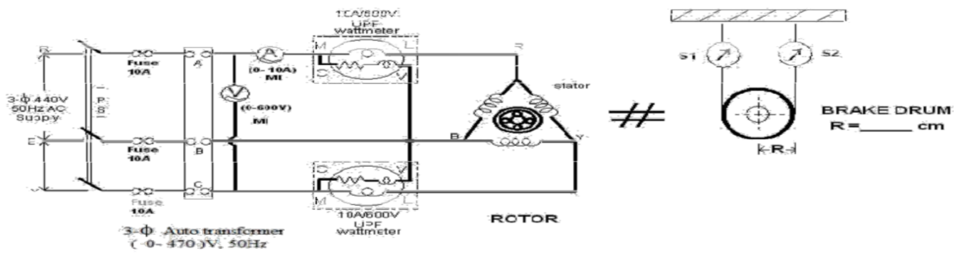
Input Voltage: _________415_________ (Volt)

Output Voltage: ________(0-470)_________ _(Volt)

Current:_________________ _______(Amp.)

Freq.:_____________50Hz______________(Hz)

CIRCUIT DIAGRAM:



PROCEDURE:

NO- LOAD TEST:

1. **Connections are mad e as per the circuit diagram.**

2. **Ensure that the 3- ϕ variac is kept at minimum output voltage position and belt is freely suspended.**

3. **Switch ON the supply. Increase the variac output voltage gradually until rated voltage is observed in voltmeter. Note that the induction motor takes large current initially, so, keep an eye on the ammeter such that the starting current current should not exceed 7 Amp.**

4. **By the time speed gains rated value, note down the readings of voltmeter, ammeter, and wattmeter.**

5. **Bring back the variac to zero output voltage position and switch OFF the supply.**

BLOCKED ROTOR TEST:

1. **Connections are as per the circuit diagram.**
2. **The rotor is blocked by tightening the belt.**
3. **A small voltage is applied using 3- ϕ variac to the stator so that a rated current flows in the induction motor.**
4. **Note down the readings of Voltmeter, Ammeter and Wattmeter in a tabular column.**
5. **Bring back the Variac to zero output voltage position and switch OFF the supply.**

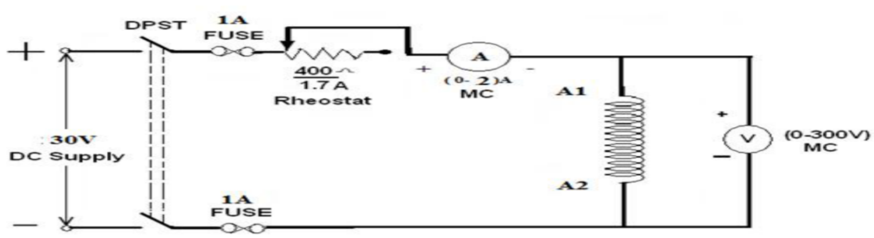
OBSERVATIONS:

No Load Test:

S No.	Voltmeter reading V_{nl} (V)	Ammeter reading I_{nl} (A)	Wattmeter reading W_1 (W)	W_2 (W)	W_{nl} (P_{nl}) (W) W_1+W_2
1	420	1	60	98	158*2=316

Blocked Rotor Test

S No.	Voltmeter Reading V br	Ammeter reading Ibr	Wattmeter reading W_1 (W)	W_2 (W)	W_{br} (P_{br}) W1+W2
1	38.5	8	56	64	120*2=240



Procedure to find r_1:

1. **Connections are made as per the circuit diagram**
2. **Switch ON the supply. By varying the rheostat, take different readings of ammeter and voltmeter in a tabular column.**
3. **From the above readings, average resistance r_1 of a stator is found**

Measurement of Stator resistance

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

MODEL CALCULATIONS:

$G=W_0/3V_2$, $Y_0=I_0/V$, $B_0=Y_{02}-G_{02}$

$Z_{01}=V_{sc}/I_{sc}$, $R=W_{sc}/3xI_{sc2}$, $X_{01}=\sqrt{Z_{012}-R_{012}}$

For circle diagrm:

$\cos\Phi_0=W_0/\sqrt{3}\ V_0I_0$, $\Phi_0=\cos_{-1}(W_0/\sqrt{3}\ V_0I_0)$

$\cos\Phi_{sc}=W_{sc}/\sqrt{3}\ V_{sc}I_{sc}$

$I_{sn}=I_{sc}(V/V_{sc})$;

PRECAUTIONS:

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

RESULT:

No load and blocked rotor tests are performed on 3-Φ Induction motor.

Experiment No. 6

LOAD TEST ON SINGLE PHASE INDUCTION MOTOR

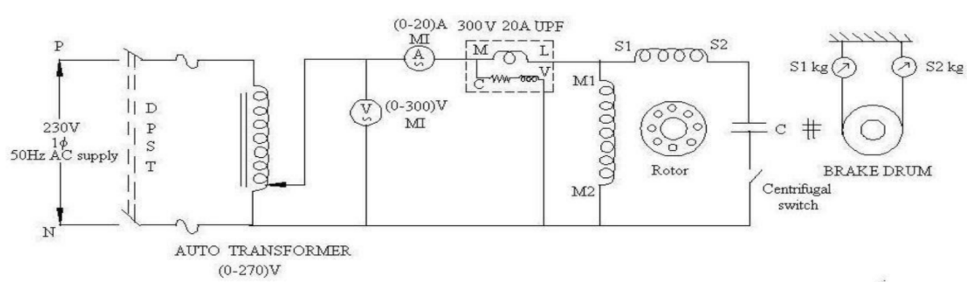
AIM:

To conduct load test on the given single phase induction motor and to plot its performance characteristics.

(i) Electrical characteristics – speed, torque, slip, power factor and efficiency vs. output power

APPARATUS REQUIRED: S.NO	APPARATUS	SPECIFICATIONS	QUANTITY
1	VOLTMETER	(0-300V) MI	1
2	AMMETER	(0-10A) MI	1
3	WATTMETER	(300V,10A,UPF)	1
4	TACHOMETER	(0-10000 RPM)	1

Diagram:-



S. No	V_L Volts	I_L Amps	S_1 kg	S_2 kg	S kg	W watts	Speed rpm	Torque Nm	Po watts	%η
1	220	2	0	0	0	480	1480	0	0	0
2	220	4	2	0.5	1.5	680	1460	1.65	252.142	37.09
3	220	5	4.5	1.5	2	960	1448	2.197	332.97	34.68
4	220	6	6.5	2	4.5	1120	1440	4.94	745.15	65.53
5	220	7	8.3	2.5	5.8	1440	1430	6.372	953.71	66.23

PRECAUTIONS:

1. The auto transformer is kept at minimum voltage position.
2. The motor is started at no load condition.

PROCEDURE:

1. Connections are as per the circuit diagram

2. The DPST switch is closed and the single phase supply is given

3. By adjusting the VARIAC the rated voltage is applied and the corresponding no load values of speed, spring balance and meter readings are noted down. If any of the wattmeter readings shows negative on no load or light loads, switch of the supply & interchange the terminals of pressure coils/current coils (not both) of that wattmeter. Now, again starting the motor (follow above procedure for starting), take readings.

4. The procedure is repeated till rated current of the machine.

5. The motor is unloaded, the auto transformer is brought to the minimum voltage position, and the DPSTS is opened.

6. The radius of the brake drum is measured.

RESULT:

Thus load test on the single phase induction motor has been conducted and its performance characteristics determined.

Experiment No. 7

AIM:

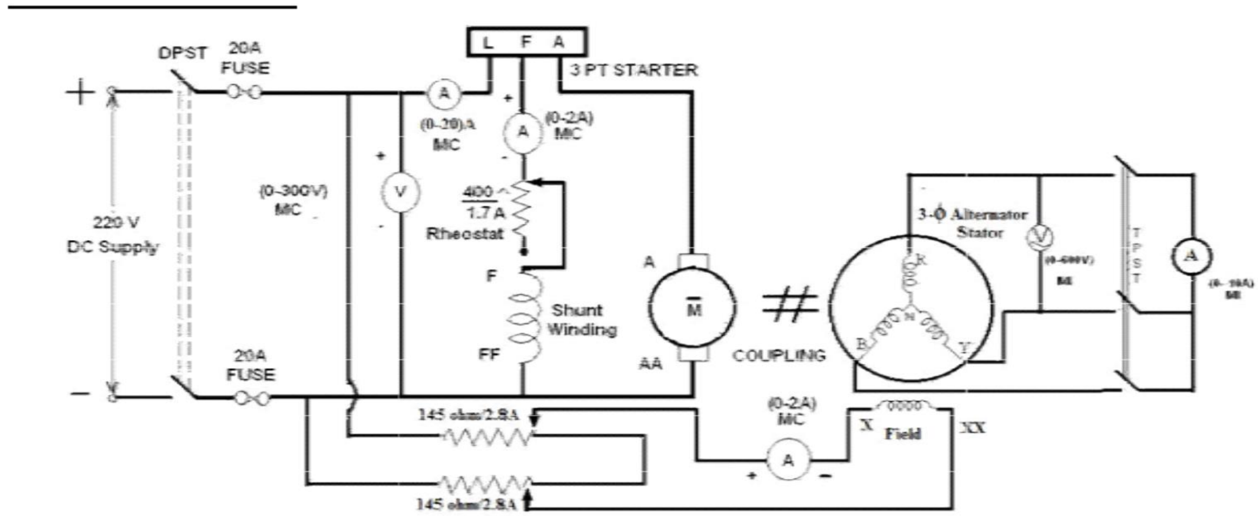
To find the regulation of a 3 - ϕ using synchronous impedance method.

APPARATUS REQUIRED:

Sl. No.	Equipment	Type	Range	Quantity
1	Voltmeter	MI	(0-300/600)V	1 no
2	Ammeter	MI	(0-5/10)A	1 no
3	Ammeter	MI	(0-2.5/5)A	1 no
			400 Ω /1.7A	1 no
3	Rheostat	Wire-wound	145Ω /2A	2 no
4	Tachometer	Digital	(0-100000)RPM	1 no
5	Connecting Wires	*****	(0-20)A	Required

NAME PLATE DETAILS:

DC Motor(prime mover)			3- ϕ Alternator		
Power rating	:	5HP	Power Rating	:	3KVA
Armature Voltage	:	220V	Voltage	:	415 V
Current	:	19A	Rated Current	:	3.8A
Speed	:	1500rpm	Speed	:	1500rpm
Excitation	:	Shunt	Excitation	:	DC Generator



PROCEDURE:

Open Circuit Test:

1. **Make the connection s as per the circuit diagram.**
2. **Before starting the e xperiment, the potential divider network in the alternator field circuit and field regulator rheostat of motor circuit is set minim um resistance position.**
3. **Switch ON the suppl y and close the DPST switch. The DC motor is s tarted by moving starter handle .**
4. **Adjust the field rheostat of DC motor to attain rated speed (equal to synchronous speed of alternator)**
5. **By decreasing the fie ld resistance of Alternator, the excitation current of alternator is increased gradually in steps.**
6. **Note the readings of f ie ld current, and its corresponding armature voltage in a tabular column.**
7. **The voltage readings are taken up to and 10% beyond the rated voltage of the machine.**

Short Circuit Test:

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

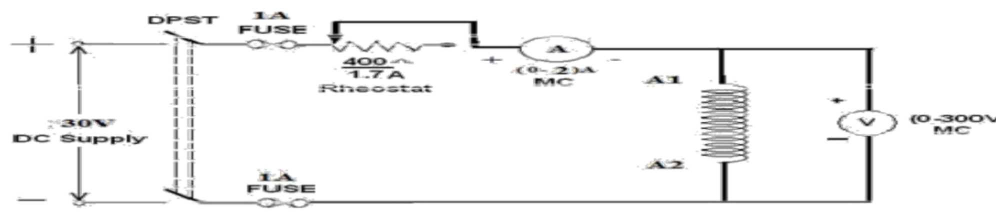
OBSERVATIONS:

	OC test			S.C. test	
SL. No.	Field current in Amp.(I f)	OC voltage per phase (Vo)	SL. No.	Field current I_f(Amp.)	SC current I_{SC} Amp.
1	0.25	140	1	0.24	0.5
2	0.3	160	2	0.3	1
3	0.35	175	3	0.35	1.2
4	0.4	205	4	0.4	1.6
5	0.45	228	5	0.45	1.9
6	0.5	250	6	0.5	2.15
7	0.55	270	7	0.55	2.4
8	0.6	265	8	0.6	2.8
9	0.7	320	9	0.65	3.1
10	0.75	335	10	0.7	3.4

Procedure to find Armature resistance of Alternator:

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

Connection diagram to find Ra



OBSERVATIONS:

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

Procedure to find synchron ous impedance from OC and SC tests:

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

4. The voltage regulation is calculated at rated terminal voltage.

MODEL CALCULATIONS:

Zs= Voc/Isc for the same If and speed : Xs = $\sqrt{Zs^2 - Ra^2}$ (Ra=Rdc)

Generated e.m.f. of alternator on no loa d is

$$E_0 \quad \sqrt{} \; v\cos \quad I_a \; R_a \quad ^2 \quad v\sin \quad I_a \; X_S \quad ^2$$

+ for lagging

p.f. - for leading

p.f.

The percentage regulation of alternator for a given p.f. is

$$1.\ \text{Re g} \quad \frac{E_0 \quad V}{V} \; x\ 1\ 00$$

Where

E_0 – generated emf of alternator (or excitation voltage per ph ase)

V – full load, rated terminal voltage per phase.

MODEL GRAPHS:

Draw the graph betw een I_f VS E_0 per phase and I_f VS I_{SC}

PRECAUTIONS:

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

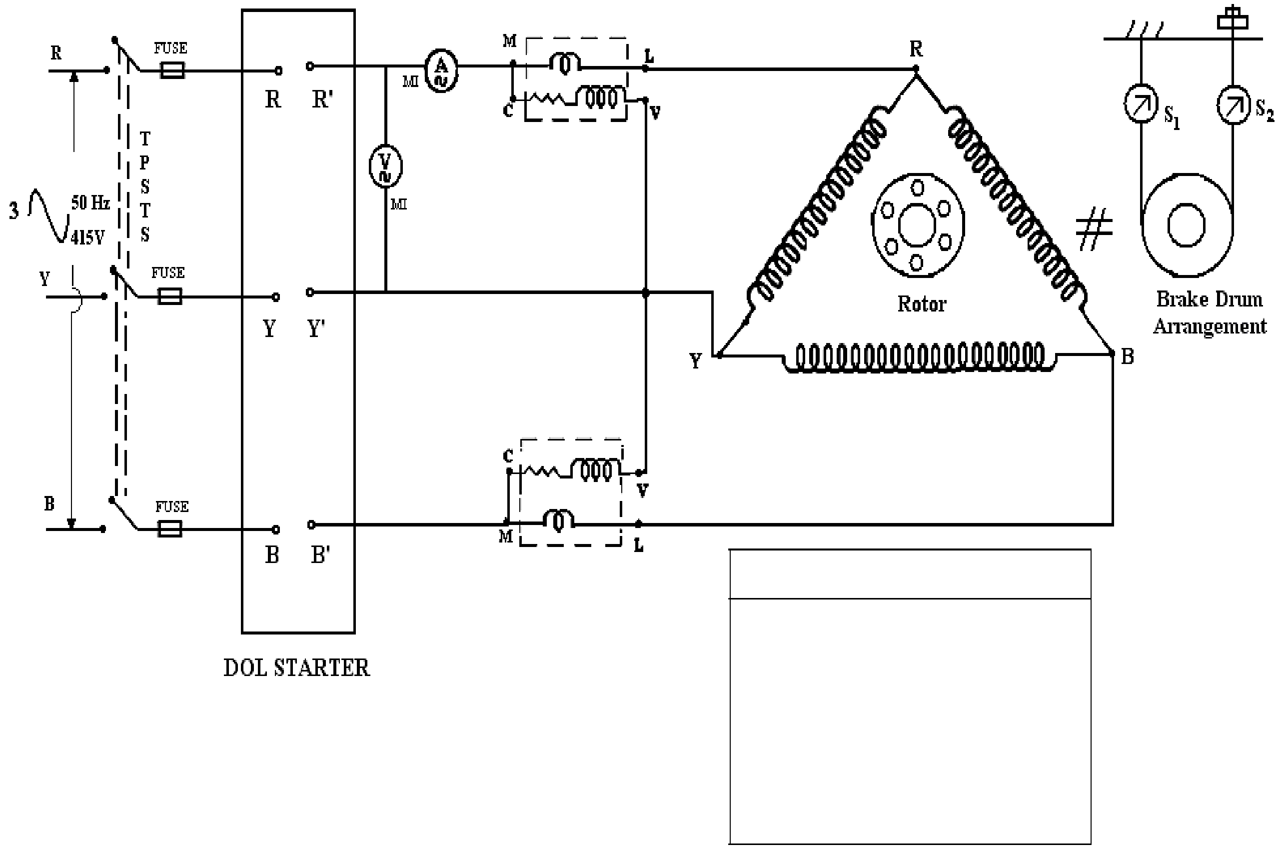
RESULT:

The O.C. and S.C. tests were conducted on the given 3-Φ Alternator and the regulation of Alternator was predetermined by e.m.f. and m.m.f. method.

Experiment NO. 8

LOAD TEST ON 3-PHASE INDUCTION MOTOR AIM: To draw the performance characteristics of 3-phase squirrel cage induction motor by conducting load test. APPARATUS REQUIRED:
Apparatus

Range Type Qty
THEORY: Induction motor is one of the most important machines, which is used in Industrial and Domestically applications. These motors are classified in to different types namely (i). Squirrel cage Induction motor (ii). Slip ring Induction motor. Where the first one is most preferable because of its simple construction and its performance characteristics. This motor has normal starting torque and adjustable speed so that speed control can be achieved easily. Normally direct on-line starter, star-delta starter and autotransformer starter are used to start the motor. It works under the principle of Faraday’s law of electromagnetic induction. Induction motor is simply an electric transformer whose magnetic circuit is separated by an air gap into two relatively movable portions, one carrying the primary and the other secondary winding. Alternating current supplied to the primary winding from an electric power system induces an opposing current in the secondary winding, when latter short-circuited or closed through external impedance. Relative motion between the primary and secondary is produced by the electromagnetic forces corresponding to the power thus transferred across the air gap by induction. 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^o.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.


R
FUSE
R R'
A
MI
M
L
R
C
V
V
MI
T
P
S
T
S
3
50 Hz
415V
S1
S2
Rotor
Brake Drum Arrangement
Y
FUSE
Y Y'
Y
B
C
V
B
FUSE
M
L
B B'
DOL STARTER

Tabulation for Load Test on Three phase squirrel cage induction motor

Circumference of brake drum =

Radius of the brake drum =

Thickness of the belt =

S.No.	Line Voltage (V_L)	Line Current (I_L)	Input Power		Spring Balance Readings			Torque (T)	Speed (N)	Slip (S)	Output Power	Efficiency (η)	Power factor
			W_1	W_2	S_1	S_2	S_1~S_2						
	V	A	W	W	Kg	Kg	kg	Nm	rpm	%	W	%	

PRECAUTIONS:

- TPST switch is kept open initially.
- Autotransformer is kept at min. voltage position.
- There must be no load when starting the load.

PROCEDURE:

1. Connections are given as per circuit diagram.
2. 3-Φ induction motor is started with DOL starter.
3. If the pointer of one of the wattmeter readings reverses, interchange the current coil terminals and take the reading as negative.
4. The no load readings are taken.
5. The motor is loaded step by step till we get the rated current and the readings of the voltmeter, ammeter, wattmeter, spring balance are noted.

FORMULAE USED:

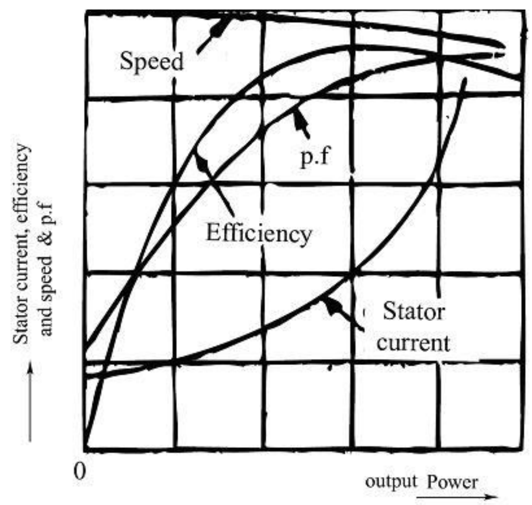
1) % slip= (Ns-N/Ns)*100

2) Input Power = (W1+W2)watts

3) Output Power = 2∏NT/60 watts

4) Torque = 9.81*(S1-S2)*R N-m

5) % efficiency = (o/p power/i/p power)* 100



MODEL CALCULATION

GRAPHS:

1) Output Power vs Efficiency
2) Output Power vs Power factor
3) Output Power vs Speed
4) Output Power vs stator current

RESULT:

Thus the performance characteristic of a 3-Φ squirrel cage induction motor by conducting load test has been drawn.

EXP.NO. 9

SEPARATION OF LOSSES IN THREE PHASE SQUIRREL CAGE INDUCTION MOTOR

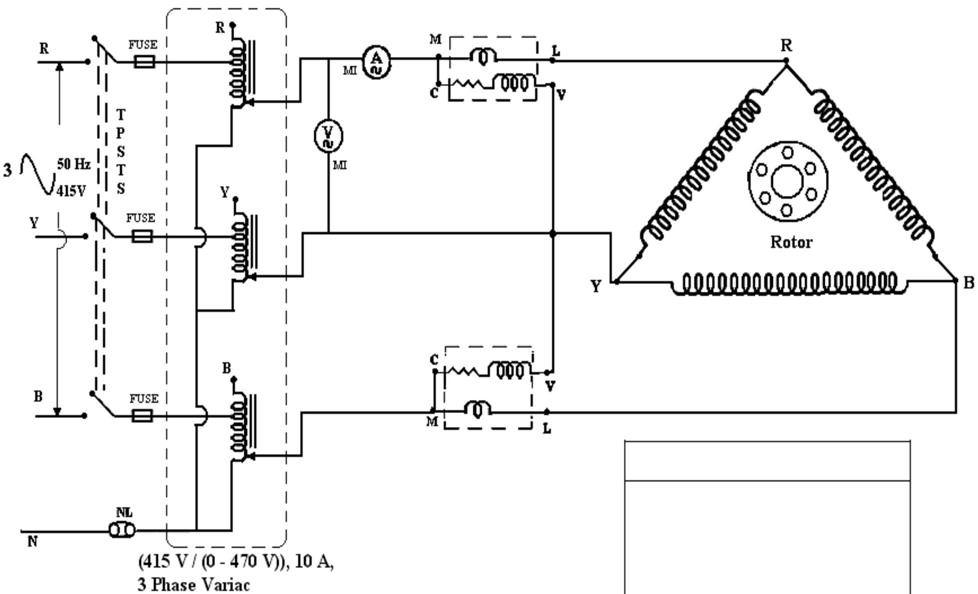
AIM:

To separate the no load losses of a 3 phase squirrel cage induction motor as iron losses and mechanical losses.

APPARATUS REQUIRED:

SI. NO.	Apparatus	Range	Type	Qty

SEPARATION OF LOSSES IN THREE PHASE SQUIRREL CAGE INDUCTION MOTOR



THEORY:

We find the losses in the single-phase induction motor using this experiment. we separate the losses from the induction motor using the test. the losses are classified as (i) constant losses and (ii) Variable losses.

CONSTANT LOSSES:

These can be further classified as core losses and mechanical losses. We using this experiment only find out the constant losses.

Core losses occur in stator core and rotor core. These are also called iron losses. These losses include eddy current losses and hysteresis losses. The eddy current losses are minimized by using laminated construction while hysteresis losses are minimized by selecting high-grade silicon steel as the material for stator and rotor.

The iron losses depend on the frequency. The stator frequency is always supply frequency hence stator iron losses are dominant. As against this in rotor circuit, the frequency is very very small which is slip times the supply frequency. Hence, rotor iron losses are very small and hence generally neglected, in the running condition.

The mechanical losses include frictional losses at the bearings and windage losses. The friction changes with speed but practically the drop in speed is very small hence, these losses are assumed to be the part of the constant losses.

TABULAR COLUMN

S.No.	Voltage (V)		Current	W_1	W_2	$W_0=W_1 \pm W_2$	Copper	W_0-W_i
	V_L	V_{Ph}	(I)				Loss	
	V	V	A	W	W	W	W	W

PRECAUTIONS:

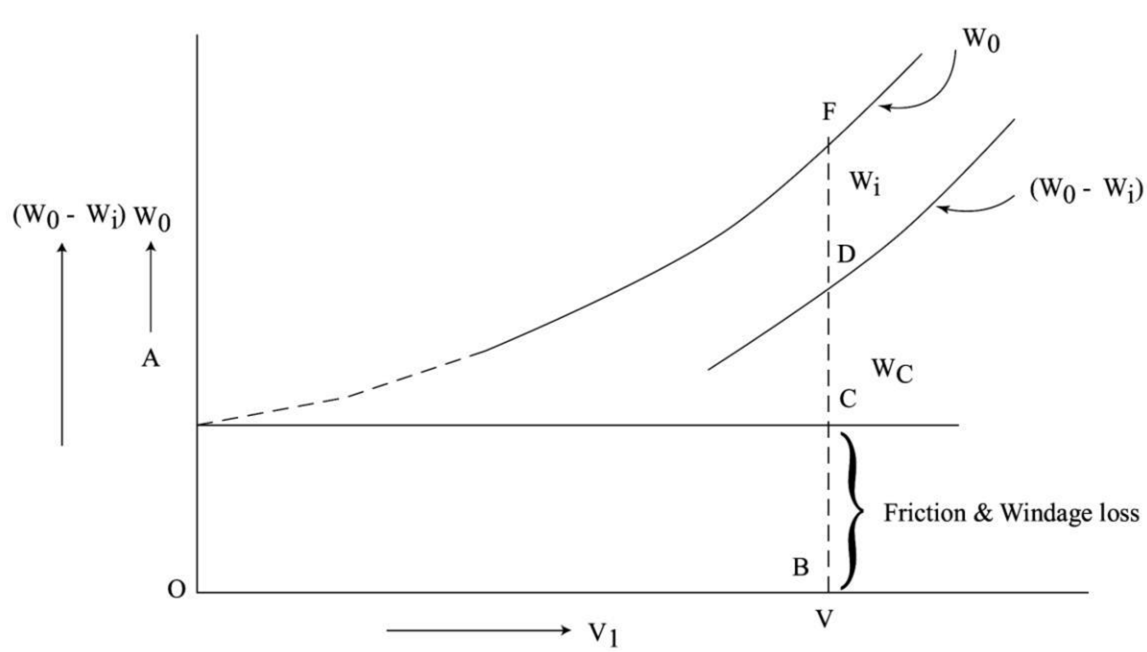
1. The autotransformer should be kept in minimum voltage position.
2. The motor should not be loaded throughout the experiment.

PROCEDURE:

1. Connections should be made as per the circuit diagram.
2. By giving three phase supply, start the motor.
3. Vary the autotransformer till rated speed and note the input power, voltage and current.
4. Repeat the same procedure and tabulate the reading.
5. Find the stator copper loss and constant loss by respective formulas.
6. Draw the suitable graph to find the mechanical losses.
7. Obtain the core loss by separating the mechanical loss from constant losses.

FORMULA REQUIRED:

1. Input power (W) =(W1+W2)in watts
2. Stator copper loss =3I2Rs in watts
3. Constant loss/phase (Wc)= (W-3I2Rs)/3 in watts
4 Core loss/phase (Wi)= (constant loss/phase)-mechanical loss



RESULT:

Thus the no load losses of 3-phase squirrel cage induction motor was separated as core losses and mechanical losses

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ELECTRICAL MACHINES-II Laboratory

(PCC- EE-208G**)**

EXP.NO. 10 **DATE :**

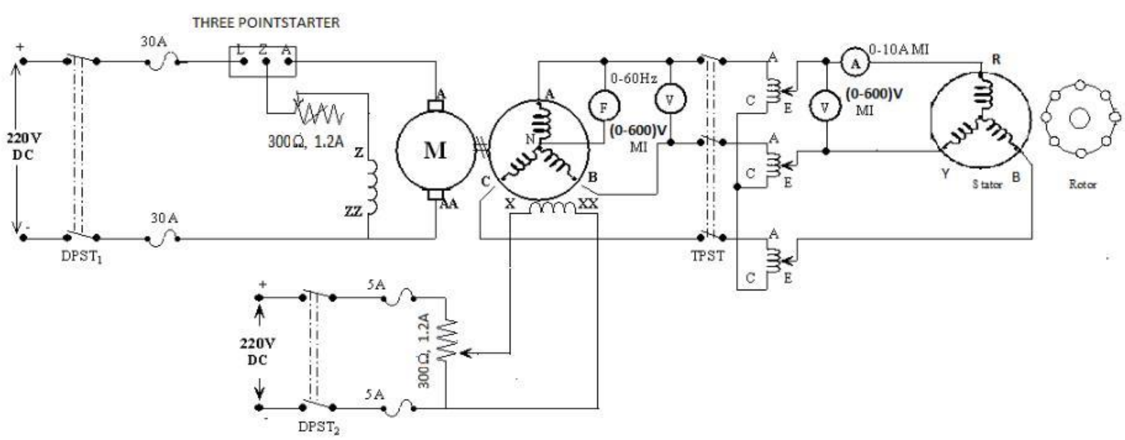
SPEED CONTROL OF THREE PHASE INDUCTION MOTOR

AIM :

To control the speed of the 3 phase induction motor by changing the supply frequency and to plot the speed Vs frequency curve.

APPARATUS REQUIRED:

Diagram;-



THEORY :

The synchronous speed of induction motor is given by $N_s=120\ fP$
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.

PRECAUTIONS:

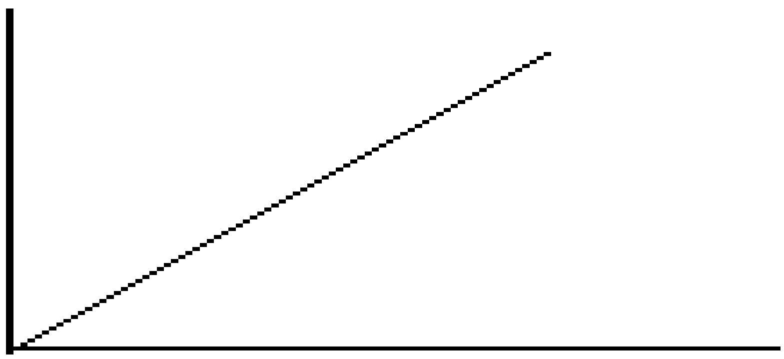
1. TPST in open position
2. DPST1 and DPST2 in open position
3. Motor field rheostat in minimum position
4. Potential divider in minimum voltage position
5. Autotransformer at minimum voltage position

Induction motor on no load

Line voltage

In volts
Frequency
In Hz
Speed of IM
In rpm

MODEL GRAPH :



PROCEDURE:

1. Make the connections as shown in diagram.
2. Switch on the DC supply to the DC motor by closing the switch DPST1. Start the DC shunt motor using 3-point starter. Adjust the field rheostat of the alternator and bring it to rated speed.(1500rpm).
3. Now, DC supply is given to the alternator field winding and adjust the potential divider so that the generated voltage is rated value (410V).
4. Close the TPST switch. Increase the autotransformer. Induction motor starts running on no load. Apply rated voltage by adjusting autotransformer. Note down the frequency, voltage and speed of the induction motor. Now, decrease the frequency. Decrease the voltage and frequency in proportion and note down the frequency, voltage and speed of the induction motor each time. This procedure is continued till frequency decreases to 48Hz.Switch off the supply after bringing the motor to no load.

RESULT :

Thus the speed control characteristics of three phase Induction motor by V/f control method are done.