G.PULLA REDDY ENGINEERING COLLEGE (AUTONOMOUS): KURNOOL
ELECTRICAL & ELECTRONICS ENGINEERING DEPARTMENT
V Semester B.Tech. - E.E.E. (Scheme-20)
ELECTRICAL MACHINES-2 LAB (EMC2 (P))

List of Experiments

1. Regulation of an alternator using EMF Method and MMF method.
2. Regulation of an alternator using ZPF Method.
3. Brake test on three phase squirrel-cage induction motor.
4. No – load test and Rotor blocked tests on three phase squirrel-cage induction motor.
5. No – load test and Rotor blocked tests on single phase induction motor.
6. Slip test on alternator to determine the X_d and X_q reactances.
7. Synchronization of alternators and V & ʌ curves of synchronous machine.
8. Load test on Alternator.
9. Performance characteristics of Induction Generator.
10. Performance characteristics of Universal Motor.
11. Regulation of salient pole Alternator.
12. Load test on single phase squirrel-cage induction motor.
13. Simulation of 1-phase induction motor.
14. Simulation of 3-phase induction motor.
15. Simulation of Torque Vs Speed characteristics of 3- phase induction motor.

TITLE: **REGULATION OF ALTERNATOR USING EMF & MMF METHOD**	GPRECD/EEE/EMCP-II- EXPT - 1
SCHEME-20	DATE: 01-07-2022

OBJECTIVE:

To determine regulation of an alternator by conducting OC and SC test on 3-Φ alternator by Synchronous impedance method and MMF method.

APPARATUS:

NAME PLATE DETAILS:

FUSE RATINGS:

THEORY:

Alternator is a machine, which converts mechanical energy to electrical energy. Regulation of an Alternator can be calculated by synchronous impedance method. In OC test the terminals of the alternator are kept opened and a voltmeter is connected. Keeping speed constant, a relation b/w field current & open circuit voltage are obtained. In SC test, the terminals are short circuited with a suitable ammeter & a relation b/w field current & short circuit Current is obtained.

Voltage regulation:

It is defined as the rise in terminal voltage of an isolated Machine when full load is thrown off w.r.t voltage on the full load, when speed & excitation remaining constant.

EMF Method:

Now, Syn.Impedance (Z_S) = OC voltage / SC current

$X_S = \sqrt{(Z^2_S - R^2_a)}$

$E_O = \sqrt{(V\cos\phi + IR_a)^2 + (V\sin\phi + IX_s)^2}$

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

MMF Method:

Steps:

1. By suitable tests plot OCC and SCC
2. From the OCC find the field current I_{f1} to produce rated voltage, V.
3. From SCC find the magnitude of field current I_{f2} to produce the required armature current.
4. Draw I_{f2} at an angle (90+Φ) from I_{f1}, where Φ is the phase angle of current from voltage (for lagging loads). If current is leading, take the angle of I_{f2} as (90-Φ) (for leading loads).

5. Find the resultant field current, I_f and mark its magnitude on the field current axis.
6. From OCC. find the voltage corresponding to I_f, which will be E_0.

PROCEDURE:

O.C TEST:

1. Connections are made as per circuit diagram. Keep the motor side rheostat in minimum position and generator side rheostat in maximum position.
2. DC supply is given to the motor and it is started.
3. The speed of motor is adjusted to its rated speed by using motor field rheostat.
4. The field current of alternator is varied with exciter circuit rheostat.
5. At different field currents, voltmeter readings are noted up to 120% of rated voltage.
6. And then exciter rheostat is brought to original position.

S.C. TEST:

1. After O.C. test, rheostat of exciter is brought to minimum position.
2. TPST switch is closed.
3. The field rheostat is varied until full load current is obtained, and then I_f and I_{sc} are noted.
4. Graphs between I_f and V_{oc} , I_f and I_{sc} from O.C and S.C test are plotted respectively.

OBSERVATIONS:

O.C.TEST:

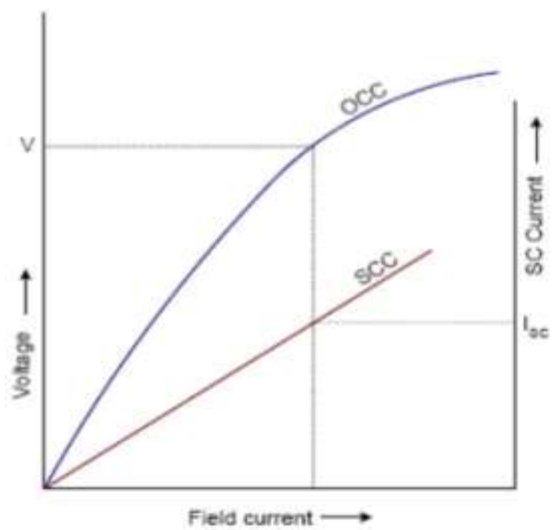
I_f	V_o

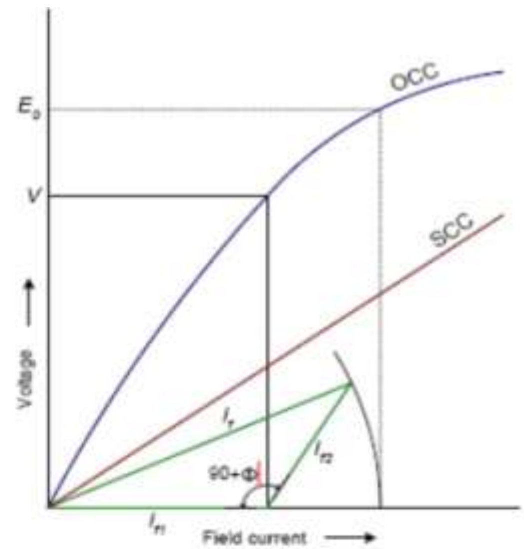
S.C TEST:

I_f	I_{sc}

TITLE: **REGULATION OF ALTERNATOR USING EMF & MMF METHOD**	GPRECD/EEE/EMCP-II- EXPT - 1
SCHEME-20	DATE: 01-07-2022

GRAPHS:





SAMPLE CALCULATIONS:

RESULT:

REMARKS IF ANY:

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CIRCUIT DIAGRAM:

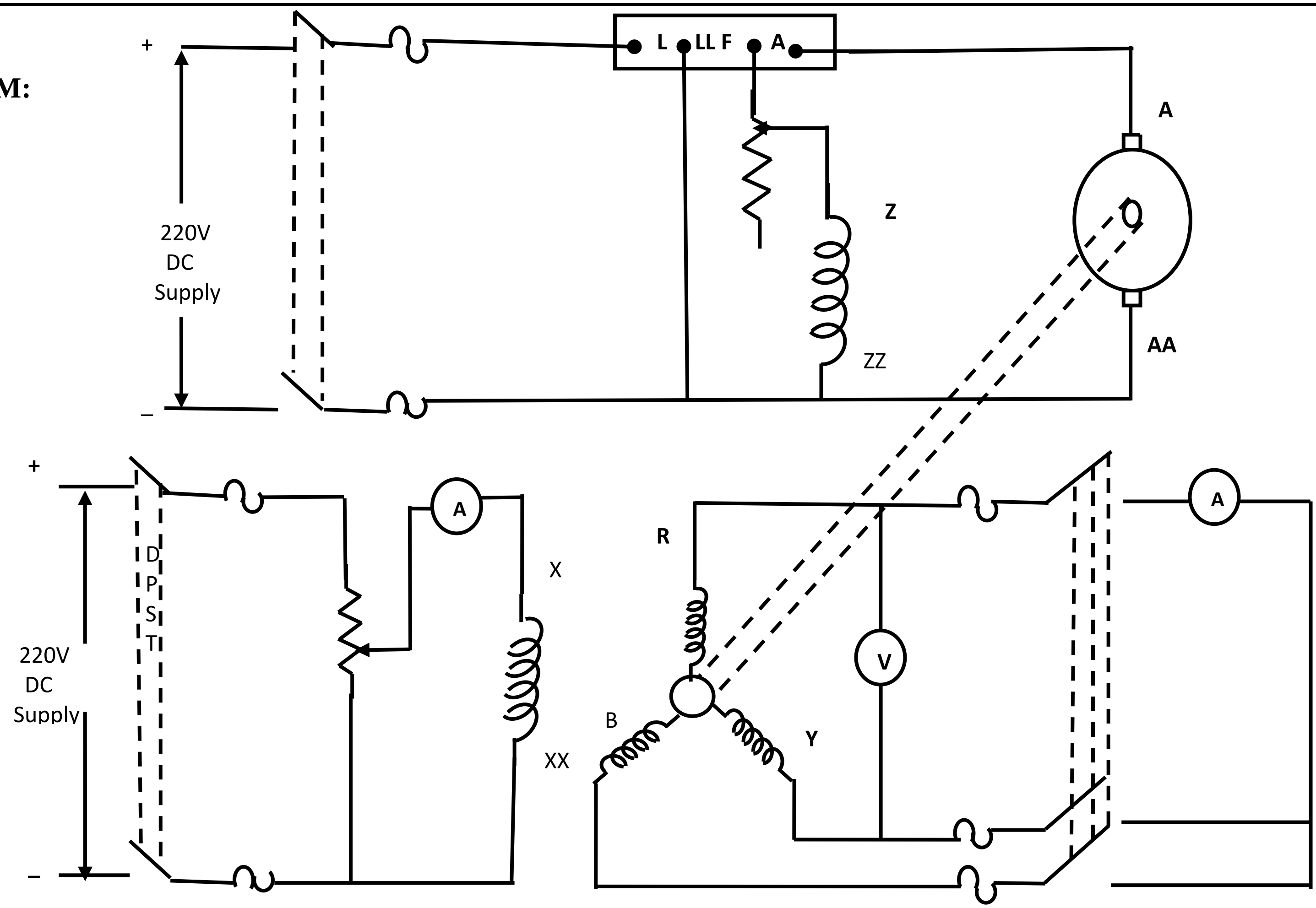
O.C & S.C TESTS:

Viva Questions:

1. What is an alternator?
2. What are the types of an alternator?
3. Define voltage regulation of an alternator?
4. Mention the methods by which voltage regulation of an alternator can be measured?
5. Which method gives the result nearer to actual value?

CIRCUIT DIAGRAM:

O.C & S.C TESTS:



G.PULLA REDDY ENGINEERING COLLEGE (AUTONOMOUS): KURNOOL
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ELECTRICAL MACHINES-II (EMC-II (P)) LABORATORY

TITLE: **REGULATION OF ALTERNATOR USING ZPF METHOD**	GPRECD/EEE/EMCP-II- EXPT - 2
SCHEME-20	DATE: 01-07-2022

OBJECTIVE:

To determine regulation of an alternator by conducting ZPF load test on 3-ϕ alternator by Potier's Triangle method or Zero Power Factor method.

APPARATUS:

NAME PLATE DETAILS:

FUSE RATINGS:

THEORY:

Alternator is a machine, which converts mechanical energy to electrical energy. Regulation of an Alternator can be calculated by synchronous impedance method. In OC test the terminals of the alternator are kept opened and a voltmeter is connected. Keeping speed constant, a relation b/w field current & open circuit voltage are obtained. In SC test, the terminals are short circuited with a suitable ammeter & a relation b/w field current & short circuit Current are obtained.

Voltage regulation:

It is defined as the rise in terminal voltage of an isolated Machine when full load is thrown off w.r.t voltage on the full load, when speed & excitation remaining constant.

ZPF Method:

Steps:

1. By suitable tests plot OCC and SCC
2. Draw tangent to OCC (air gap line)
3. Conduct ZPF test at full load for rated voltage and fix the point B.
4. Draw the line BH with length equal to field current required to produce full load current at short circuit.
5. Draw HD parallel to the air gap line so as to touch the OCC

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ZPF Method:

Steps:

6. Draw DE parallel to voltage axis. Now, DE represents voltage drop IX_L and BE represents the field current required to overcome the effect of armature reaction.
Triangle BDE is called Potier triangle and X_L is the Potier reactance
7. Find E from V, IX_L and Φ. Consider Ra also if required. The expression to use is
$$E = \sqrt{(V\cos\phi + IR_a)^2 + (V\sin\phi + IX_s)^2}$$
8. Find field current corresponding to E.
9. Draw FG with magnitude equal to BE at angle (90+Ψ) from field current axis, where Ψ is the phase angle of current from voltage vector E (internal phase angle).
10. The resultant field current is given by OG. Mark this length on field current axis.
11. From OCC find the corresponding E_0.
12. % Regulation = [(E_0-V) / V]x 100

PROCEDURE:

O.C TEST:

1. Connections are made as per circuit diagram. Keep the motor side rheostat in minimum position and generator side rheostat in maximum position.
2. DC supply is given to the motor and it is started.
3. The speed of motor is adjusted to its rated speed by using motor field rheostat.
4. The field current is varied with exciter circuit rheostat.
5. At different field currents, voltmeter readings are noted up to 120% of rated voltage.
6. And then exciter rheostat is brought to original position.

S.C. TEST:

1. After O.C. test, rheostat of exciter is brought to minimum position.
2. TPST switch is closed.
3. The field rheostat is varied until full load current is obtained, I_f and I_{sc} are noted.
4. Graphs between I_f and V_{oc} , I_f and I_{sc} from O.C and S.C test are plotted respectively.

ZERO POWER FACTOR METHOD:

1. Circuit is connected as shown in figure.
2. The inductive load and field excitation of alternator is varied gradually until rated stator current and rated voltage is obtained.
3. The meter readings are noted.

OBSERVATIONS:

O.C.TEST:

I_f	V_o

S.C TEST:

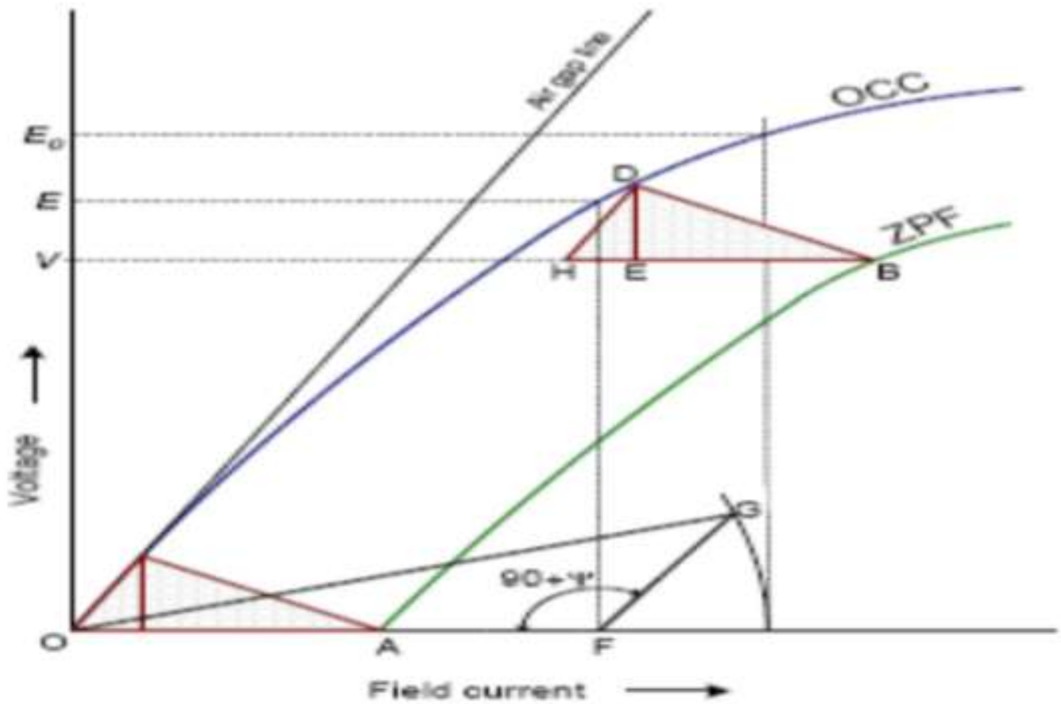
I_f	I_{sc}

ZPF LOAD TEST:

I_f	V_a	I_{sc}

TITLE: **REGULATION OF ALTERNATOR USING ZPF METHOD**	GPRECD/EEE/EMCP-II- EXPT - 2
SCHEME-20	DATE: 01-07-2022

GRAPHS:



SAMPLE CALCULATIONS:

RESULT:

REMARKS IF ANY:

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TITLE: **REGULATION OF ALTERNATOR USING ZPF METHOD**	GPRECD/EEE/EMCP-II- EXPT - 2
SCHEME-20	DATE: 01-07-2022

CIRCUIT DIAGRAM:

ZPF LOAD TEST:

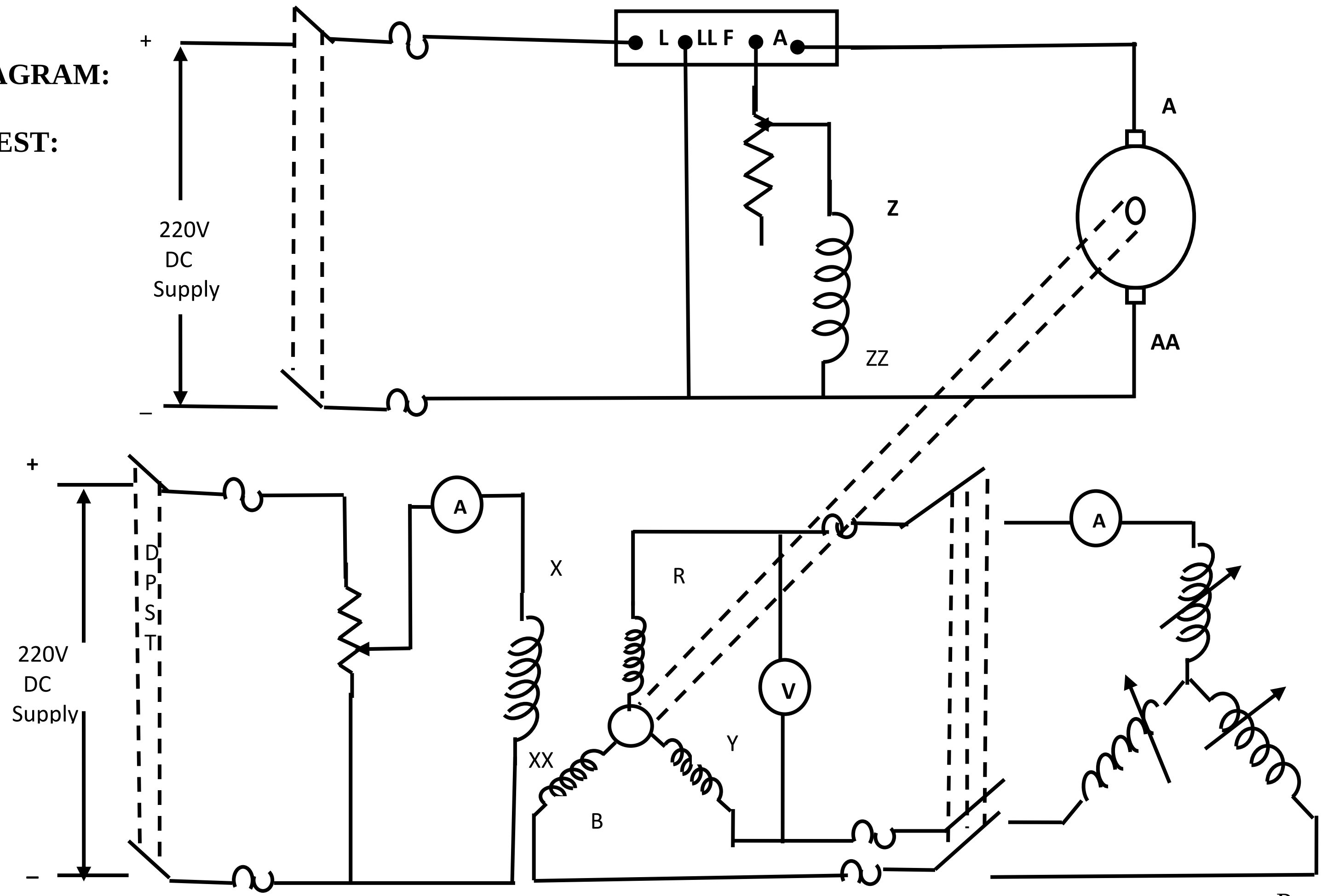
Viva Questions:

1. Is Alternator double excited (or) single excited machine? Explain?
2. The voltage regulation of an alternator at 1000 rpm is 20% then what will happen in the voltage regulation if you operate alternator at 1300 rpm.
3. What are the different type's voltage regulation methods? Give the order of voltage regulation.
4. For which type of alternator voltage regulation is maximum? Why?
5. Define Synchronous impedance and short circuit ratio of an alternator.

TITLE: **REGULATION OF ALTERNATOR USING ZPF METHOD**	GPRECD/EEE/EMCP-II- EXPT - 2
SCHEME-20	DATE: 01-07-2022

CIRCUIT DIAGRAM:

ZPF LOAD TEST:



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TITLE: **BRAKE TEST ON 3-ϕ SQUIRREL CAGE INDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT-3 DATE: 01-07-2022 SCHEME-20

OBJECTIVE:

To draw the performance characteristics of a 3-ϕ squirrel cage Induction motor by conducting brake test.

APPARATUS:

NAME PLATE DETAILS:

FUSE RATINGS:

THEORY:

As a general rule, conversion of electrical energy to mechanical energy takes place in to the rotating part on electrical motor. In DC motors, electrical power is conduct directly to the armature, i.e, rotating part through brushes and commutator. Hence, in this sense, a DC motor can be called as 'conduction motor'. However, in AC motors, rotor does not receive power by conduction but by induction in exactly the same way as secondary of a two winding Transformer receives its power from the primary. So, these motors are known as Induction motors. In fact an induction motor can be taken as rotating Transformer, i.e, one in which primary winding is stationary and but the secondary is free.

The 3-phase induction motors are of two types based on construction of the rotor. i.e. Squirrel cage rotor type and Wound rotor type (Slip ring) induction motors. The squirrel cage induction motor consists of stator and rotor. The stator carries 3-phase winding while the rotor is made up of bars short circuited by end rings. When the stator of this induction motor is connected to 3-phase supply, a rotating magnetic field is produced that will rotate at constant speed (Synchronous speed Ns) which will cut the rotor conductors. Hence emf is induced in rotor conductors ans icne conductors are shorted, the current will flow through he conductors. The current should oppose the main cause and hence the rotor rotates in the direction of RMF. The starting torque is nearly 1.5 times of full load torque. The performance of squirrel cage induction motor can be determined by conducting the brake test.

TITLE: **BRAKE TEST ON 3-ϕ SQUIRREL CAGE INDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT-3 DATE: 01-07-2022 SCHEME-20

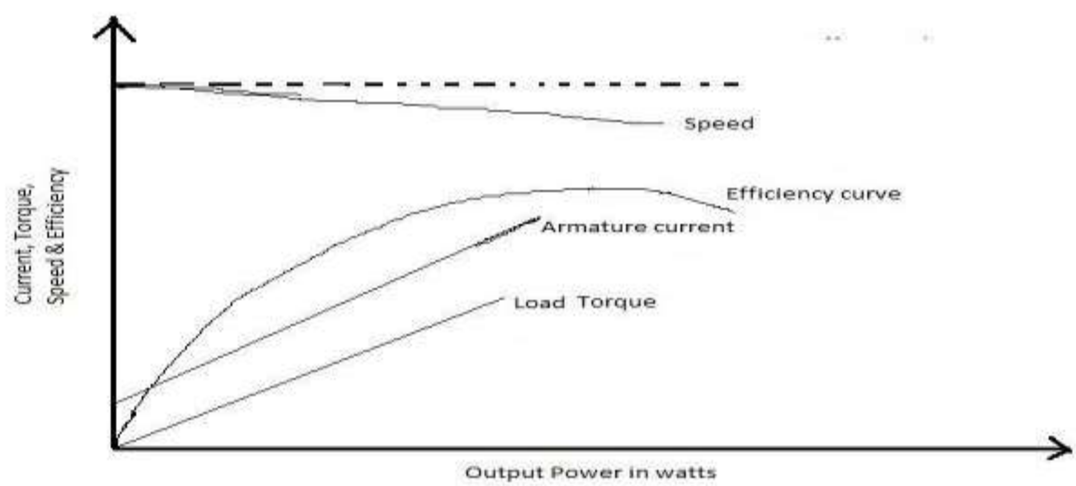
PROCEDURE:

1. Connections are made as per the circuit diagram.
2. With the help of 3-ϕ auto transformer, the voltage is applied and with star delta starter, the squirrel cage induction motor is started under no load condition, at this moment all the no load readings are noted.
3. With the help of spring balances the motor is mechanically loaded till maximum load current is reached in steps.
4. For different load currents up to rated value, all the meter readings are noted.

OBSERVATIONS:

Speed Rpm (N)	V	I_L	Input Power (WxWc)	Spring Balance		Torque in N-m	Output Power	% slip	cosϕ	%η
				T_1	T_2					

GRAPHS:



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TITLE: **BRAKE TEST ON 3-ϕ SQUIRREL CAGE INDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT-3 DATE: 01-07-2022 SCHEME - 20

SAMPLE CALCULATIONS:

Input voltage (V_L) = Volts

Input current (I_L) = Amps

Input Power (W*Wc)= watts

Power factor = CosΦ= (W * Wc)/(√3$V_L I_L$) =
where Wc is Wattmeter multiplying factor and W is 3-phase wattmeter reading.

Torque = (T1~T2)rg where r= 0.114 m, g= 9.8m/s^2
= Nm

Speed = N= rpm

% Slip =[(N_s- N)/ N_s] * 100

Output Power = (2ΠNT) / 60 Watts

Efficiency (%η) = (Output power / Input power) x 100 =

RESULT:

REMARKS IF ANY:

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TITLE: **BRAKE TEST ON 3-ϕ SQUIRREL CAGE INDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT-3 DATE: 01-07-2022 SCHEME-20

CIRCUIT DIAGRAM:

TITLE: **BRAKE TEST ON 3-ϕ SQUIRREL CAGE INDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT-3 DATE: 01-07-2022 SCHEME-20

Viva Questions:

1. Write the classification of 3-phase induction motor?
2. State the condition for maximum torque of 3-phase induction motor?
3. Give the different methods of speed control of I.M.
4. State the condition when induction motor acts as induction generator?
5. Give the other name for induction generator

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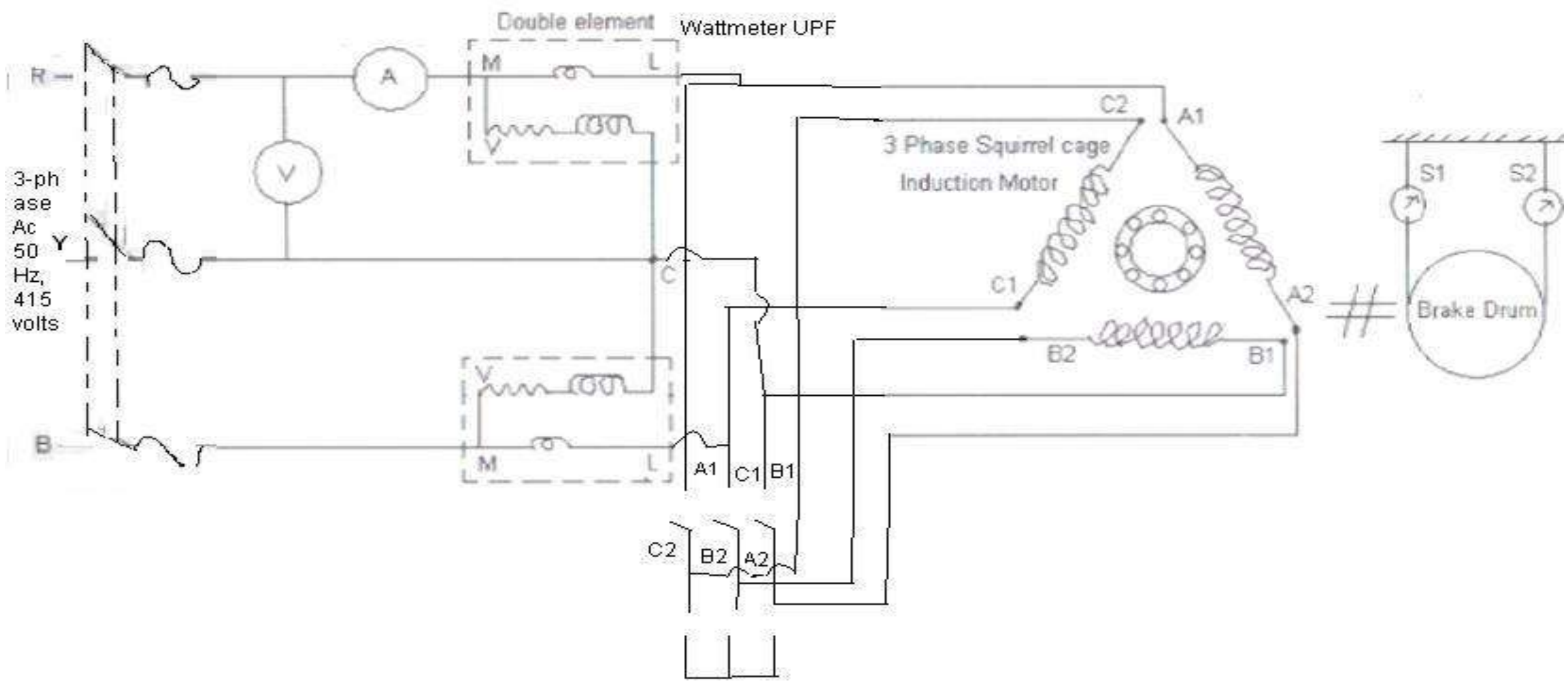
TITLE: **BRAKE TEST ON 3-ϕ SQUIRREL CAGE INDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT-3
SCHEME-20	DATE: 01-07-2022

CIRCUIT DIAGRAM:



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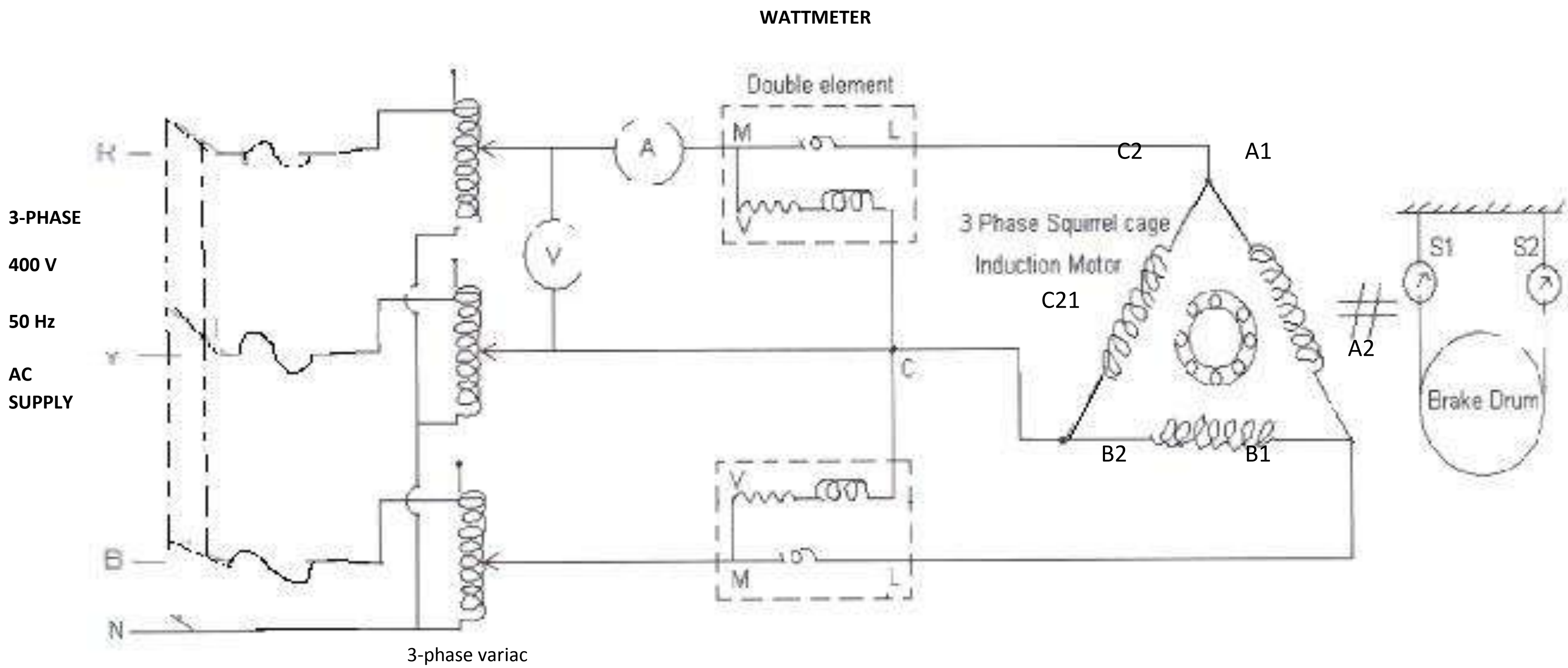
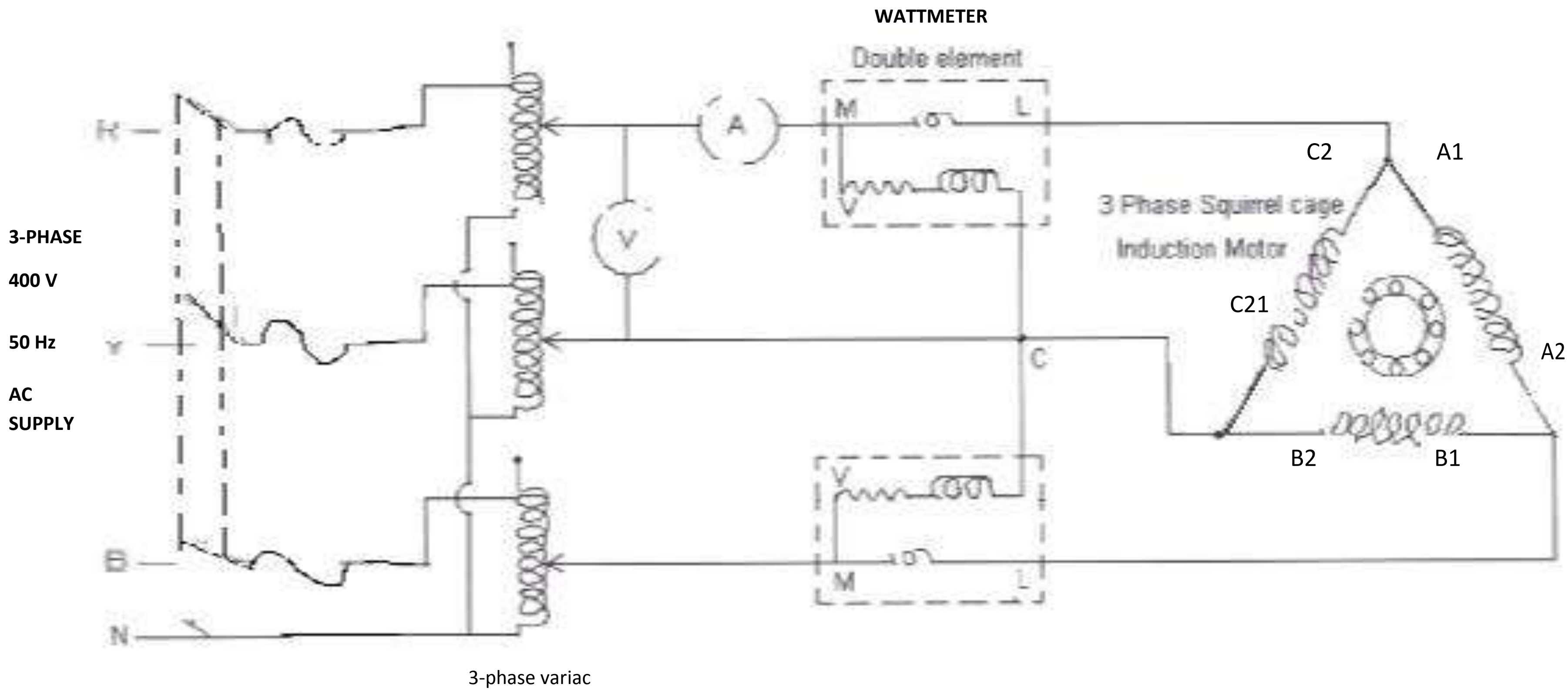
TITLE: **NO LOAD TEST AND ROTOR BLOCK TEST ON 3-φ SQUIRREL CAGE INDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT-4
SCHEME-20	DATE :01-07-2022

CIRCUIT DIAGRAM: BLOCKED ROTOR TEST



TITLE: **NO LOAD TEST AND ROTOR BLOCK TEST ON 3-ϕ SQUIRREL CAGE NDUCTION MOTOR** SCHEME-20	GPRECD/EEE/EMCP-II- EXPT-4 DATE :01-07-2022

CIRCUIT DIAGRAM: NO LOAD TEST



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TITLE: **NO LOAD TEST AND ROTOR BLOCK TEST ON 3-ϕ SQUIRREL CAGE INDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT-4 DATE : 01-07-2022 SCHEME-20

OBJECTIVE:

To conduct no load test and rotor block test on 3 ϕ slip ring induction motor and to draw the circle diagram and determine efficiency, slip, power factor from graph.

APPARATUS:

NAME PLATE DETAILS:

FUSE RATINGS:

THEORY:

The current locus of an Induction motor is a circle diagram. With the help of circle diagram, the behaviour of the Induction motor under various load conditions i.e. the characteristics can be studied. Apart from that the max torque and max O/P that is developed by the motor can be predetermined. Efficiency, slip, p.f, rotor cu losses, stator cu losses, no-load losses, full load O/P, stable region of operation etc. can also be predetermined. To draw a circle diagram, it is necessary to conduct two tests on the motor. a) No-load test and b) blocked rotor test.

No-load Test

Run the induction motor on no-load at rated supply voltage. Observe the supply line voltage V_0, No-load line current I_0 and no-load power P_0.

Phase angle for no-load condition $\phi_o = \frac{P_o}{\sqrt{3}V_o I_o}$

Blocked Rotor Test

Block the rotor firmly and apply a reduced voltage to obtain rated current at the motor terminals. Observe the supply line voltage V_{SC}, No-load line current I_{sc} and no-load power P_{sc}.

Phase angle for blocked rotor condition = $\phi_{sc} = \frac{P_{sc}}{\sqrt{3}V_{sc} I_{sc}}$

Current drawn if rated voltage is applied at blocked rotor condition = $I_{SN} = I_{sc}\left(\frac{V_o}{V_{sc}}\right)$

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Power input at rated voltage and motor in the blocked rotor condition = $P_{SN} = P_{sc}\left(\frac{V_o}{V_{sc}}\right)^2$

Resistance Test

By voltmeter-ammeter method determine per phase equivalent stator resistance, R_1. If the machine is wound rotor type, find the equivalent rotor resistance R_2' also after measuring rotor resistance and required transformations are applied.

Construction of Circle Diagram

1. Draw horizontal axis OX and vertical axis OY. Here the vertical axis represents the voltage reference.
2. With suitable scale, draw phasor OA with length corresponding to I_0 at an angle Φ_0 from the vertical axis. Draw a horizontal line AB.
3. Draw OS equal to I_{SN} at an angle Φ_{sc} and join AS.
4. Draw the perpendicular bisector to AS to meet the horizontal line AB at C.
5. With C as center, draw a semi-circle passing through A and S. This forms the circle diagram which is the locus of the input current.
6. From point S, draw a vertical line SL to meet the line AB.
7. Fix the point K as below.
   For wound rotor machines where equivalent rotor resistance R_2' can be found out:
   Divide SL at point K so that SK: KL = equivalent rotor resistance : stator resistance.
   For squirrel cage rotor machines:
   Find Stator copper loss using I_{SN} and stator winding resistance R_1.
   Rotor copper loss = total copper loss – stator copper loss.
   Divide SL at point K so that SK : KL = rotor copper loss : stator copper loss

Note: If data for separating stator copper loss and rotor copper loss is not available then assume that stator copper loss is equal to rotor copper loss. So divide SL at point K so that SK= KL

8. For a given operating point P, draw a vertical line PEFGD as shown.
   Then, PD = input power, PE = output power, EF = rotor copper loss, FG = stator copper loss, GD = constant loss (iron loss + mechanical loss)
9. Efficiency of the machine at the operating point P, η = PE/ PD
10. Power factor of the machine at operating point P = $\cos\Phi_1$
11. Slip of the machine at the operating point P, s = EF/ PF
12. Starting torque at rated voltage (in syn. watts) = SK
13. To find the operating points corresponding to maximum power and maximum torque, draw tangents to the circle diagram parallel to the output line and torque line respectively. The points at which these tangents touch the circle are respectively the maximum power point (T_{max}) and maximum torque point (P_{max})

TITLE: **NO LOAD TEST AND ROTOR BLOCK TEST ON 3-ϕ SQUIRREL CAGE INDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT-4 DATE : 01-07-2022 SCHEME-20

PROCEDURE:

No Load Test :

1. The circuit is connected as shown in the circuit diagram.
2. The main switch is closed and voltage is applied with the help of auto transformer and voltage is gradually increased up to rated voltage.
3. Voltmeter , Ammeter and wattmeter readings are noted.

Rotor Block Test :

1. Rotor is blocked manually in such a way that it does not rotate.
2. Initially no voltage is applied and is gradually increased until the current reaches its full load value. Readings of ammeter, voltmeter and wattmeter are noted down.
3. From no load test, rotor block test, the circle diagram is drawn
4. Power factor, slip, efficiency are calculated using the circle diagram.

OBSERVATIONS:

No Load Test:

V_o(V)	I_o(A)	W_o(W)

Rotor Block Test:

V_{sc}(V)	I_{sc} (A)	W_{sc} (W)

GRAPHS:

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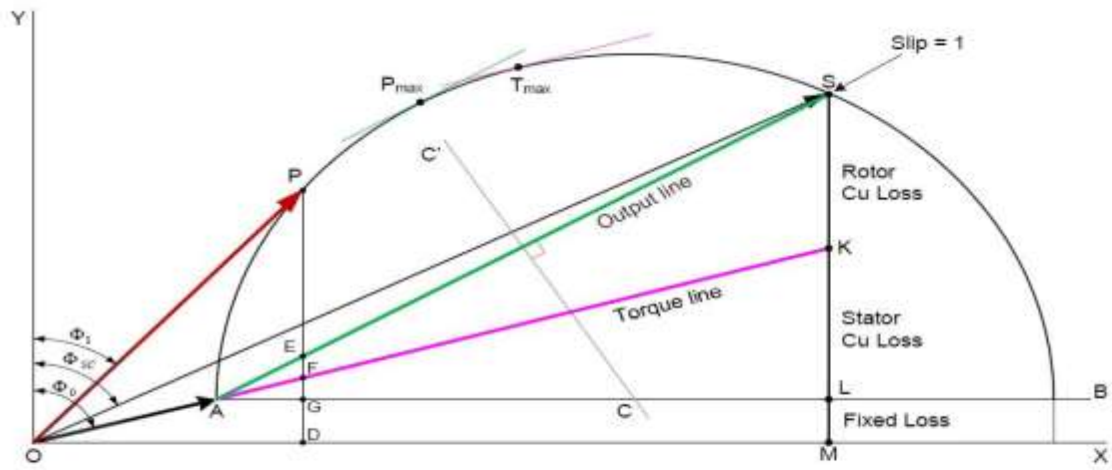
TITLE: **NO LOAD TEST AND ROTOR BLOCK TEST ON 3-ϕ SQUIRREL CAGE NDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT-4 DATE : 01-07-2022 SCHEME-20



SAMPLE CALCULATIONS:

From the circle Diagram the following data is acquired.

PD = input power,

PE = output power,

EF = rotor copper loss,

FG = stator copper loss,

Φ_1 = Angle between load current at operating point P and Voltage

GD = constant loss (iron loss + mechanical loss)

Maximum power = P_{max} = Watts

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Maximum Torque = T_{max} = Syn Watts

Power factor of the machine at operating point P = cos Φ_1 Slip of the machine at the operating point P, s = EF/ PF Efficiency of the machine at the operating point P, η = PE/ PD

RESULT:

REMARKS IF ANY:

TITLE: **NO LOAD TEST AND ROTOR BLOCK TEST ON 3-ϕ SQUIRREL CAGE INDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT-4 DATE : 01-07-2022 SCHEME-20

CIRCUIT DIAGRAM:

ROTOR BLOCK TEST:

TITLE: **NO LOAD TEST AND ROTOR BLOCK TEST ON 3-ϕ SQUIRREL CAGE INDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT-4 DATE : 01-07-2022 SCHEME-20

CIRCUIT DIAGRAM:

NO-LOAD TEST:

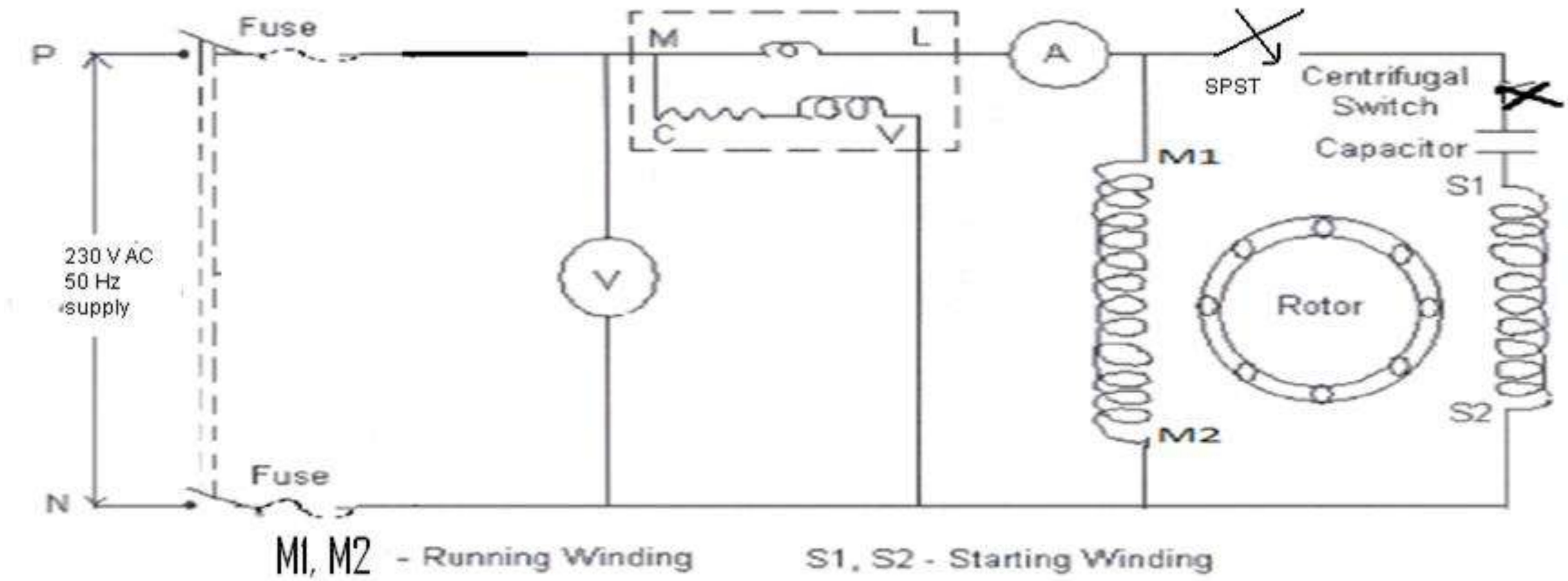
Viva Questions:

1. Is 3-ø induction motor self starting? If yes (or) No explain briefly?
2. Transformer and 3-ø induction motor are almost similar. So why we are drawing circle diagram in 3-ø induction motor but where it is not necessary in transformer?
3. Why we are using LPF meters in No load test and UPF in blocked rotor test? Can’t we interchange?
4. No load test is conducting at rated voltage and Blocked rotor test is conducting at rated current. Why it is so? Can’t we conduct vice-versa?
5. What happens to the power factor when load on 3-ø induction motor is varied? Explain?

TITLE: **NO LOAD TEST AND ROTOR BLOCK TEST ON 1-ϕ INDUCTION MOTOR** SCHEME-20	GPRECD/EEE/ EMCP-II-EXPT-5 DATE: 01-07-2022

CIRCUIT DIAGRAM:

NO-LOAD TEST:



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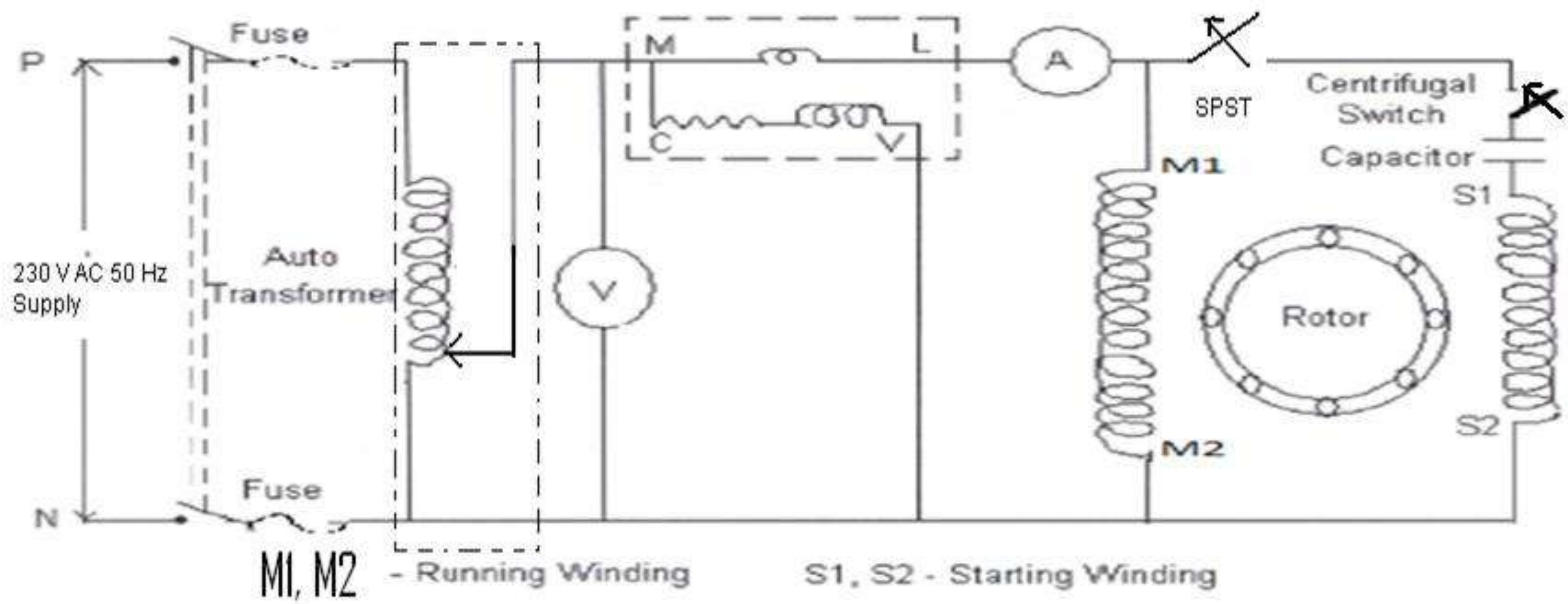
ROTOR BLOCKED TEST:



M1, M2 - Running Winding S1, S2 - Starting Winding

TITLE: **NO LOAD TEST AND ROTOR BLOCK TEST ON 1-ϕ INDUCTION MOTOR**	GPRECD/EEE/ EMCP-II- EXPT-5 DATE: 01-07-2022 SCHEME-20

OBJECTIVE:

To conduct no load test, rotor block test on 1-ϕ Induction motor and to draw its equivalent circuit from obtained data.

APPARATUS:

NAME PLATE DETAILS:

FUSE RATINGS:

THEORY:

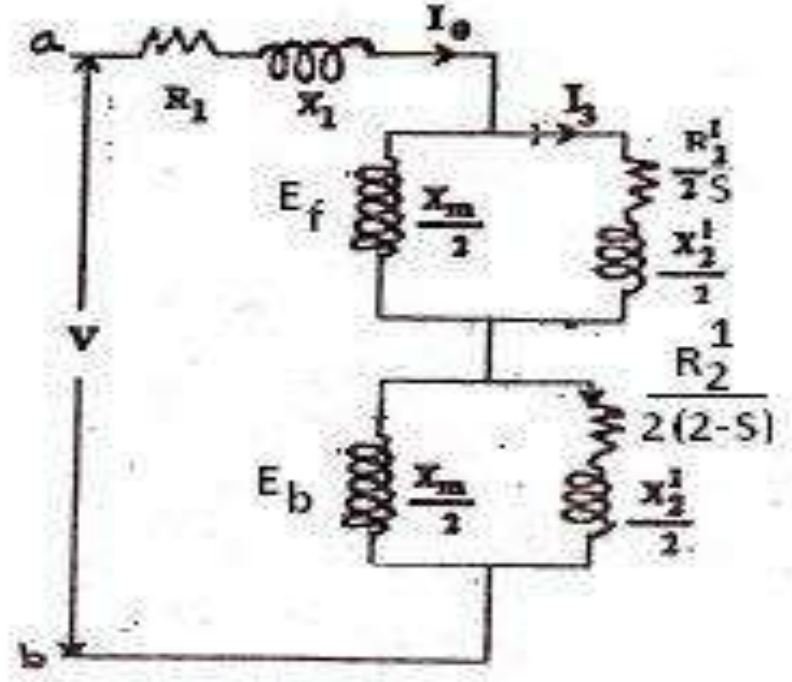
Single phase induction motor also woks on the principle of 'Faraday's laws of electromagnetic induction. The equivalent Circuit of such motor is based on double field revolving theory i.e, an alternating uniaxial quantity can be represented by two oppositely rotating vectors of half magnitude. So here the single phase motor has been imagined to be made up of one stator winding and two imaginary rotors. Each rotor will be assigned half the actual value of resistance. In order to find the equivalent circuit parameters, it is need to conduct OC & SC tests on it. In OC test, rated voltage will be given to motor with out any load on it. In SC test, the rotor is blocked and a reduced voltage will be given upto the rated load current.

Blocked rotor test

- This test is performed with main winding and starting winding separately and input voltage, amperes, and watts are measured in each case.
- This test is sometimes performed at reduced voltage (about 40% of rated voltage) to avoid excessive short circuit current and heating.

No-load test

This test is performed at rated voltage, exciting the main winding only and input current, voltage are measured.



Equivalent circuit of
1-ϕ induction motor

PROCEDURE:

No Load test:

1. The circuit is connected as shown in figure.
2. The switch is closed and rated voltage is applied to stator side.
3. The ammeter, voltmeter and wattmeter readings are noted.

TITLE: **NO LOAD TEST AND ROTOR BLOCK TEST ON 1-ϕ INDUCTION MOTOR**	GPRECD/EEE/ EMCP-II- EXPT-5 DATE: 01-07-2022 SCHEME-20

Rotor Blocked test:

1. The circuit is connected as shown in figure.
2. The rated current is obtained by increasing the voltage with autotransformer.
3. Ammeter, voltmeter, wattmeter readings are noted.

OBSERVATIONS:

No load test:

No load voltage (V_0)	No load Current (I_0)	No load power (W_0)

Blocked rotor test:

S.C. voltage (V_{sc})	S.C Current (I_{sc})	S.C power (W_{sc})

SAMPLE CALCULATIONS:

Parameters from No Load and Blocked rotor tests:
No load Test:
Rated Voltage = ; Current I_0 = Amps ; Power W_0 = Watts
$Z_0 = V_0/I_0$; $R_0 = W_0/I_0^2$ $X_0 = \sqrt{(Z_0^2 - R_0^2)}$
Blocked Rotor Test:
V_{sc}= V ; I_{sc}= A ; W_{sc}= W
$Z_{SC} = V_{sc}/I_{sc}$; $R_{sc} = W_{sc}/I_{sc}^2$; $X_{sc} = \sqrt{(Z_{sc}^2 - R_{sc}^2)}$
$X_{sc} = X_1+X_2$; $X_1=X_{sc}/2 = X_2$ (assumed)
$X_0= X_1+X_m+X_2/2$;
Therefore Xm =
$R_{sc} = R_1+R_2$; $R_1 = R_{sc}/2 = R_2$

RESULT:

REMARKS IF ANY:

TITLE: **NO LOAD TEST AND ROTOR BLOCK TEST ON 1-ϕ INDUCTION MOTOR**	GPRECD/EEE/ EMCP-II- EXPT-5 DATE: 01-07-2022 SCHEME-20

CIRCUIT DIAGRAM:

NO-LOAD TEST:

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TITLE: **NO LOAD TEST AND ROTOR BLOCK TEST ON 1-ϕ INDUCTION MOTOR**	GPRECD/EEE/ EMCP-II- EXPT-5 DATE: 01-07-2022 SCHEME-20

CIRCUIT DIAGRAM:

ROTOR BLOCK TEST:

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TITLE: **NO LOAD TEST AND ROTOR BLOCK TEST ON 1-ϕ INDUCTION MOTOR**	GPRECD/EEE/ EMCP-II- EXPT-5 DATE: 01-07-2022 SCHEME-20

Viva Questions:

1. Why we are conducting No load and blocked rotor test on 1-ø induction motor. Explain?
2. Is 1-ø induction motor self starting? If yes (or) No explain briefly?
3. Why we are using LPF in no load and UPF in blocked rotor test? Can't we interchange?
4. No load test is conducting at rated voltage and Blocked rotor test is conducting at rated current. Why it is so? Can't we conduct vice-versa?
5. Copper losses are almost double the no load losses why it is so. Explain?

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TITLE: **SLIP TEST ON SALIENT POLE ALTERNATOR TO DETERMINE THE X_d AND X_q REACTANCES**	GPRECD/EEE/EMCP-II-EXPT-6 Date: 1-07-2022 Scheme-20

OBJECTIVE:

To determine the values of X_d (Direct Axis reactance) & X_q (Quadrature Axis reactance) of the given salient pole synchronous machine.

APPARATUS:

NAME PLATE DETAILS:

FUSE RATINGS:

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

Because of saliency, the reactance measured at the terminals of a salient-pole synchronous machine as opposed to a cylindrical-rotor machine varies as a function of the rotor position. The effects of saliency are taken into account by the two-reactance theory.

TITLE: **SLIP TEST ON SALIENT POLE ALTERNATOR TO DETERMINE THE X_d AND X_q REACTANCES**	GPRECD/EEE/EMCP-II-EXPT-6 Date: 1-07-2022 Scheme-20

PROCEDURE:

1) The circuit is connected as shown in the diagram.
2) Run the machine with the help of a prime mover (DC Motor)
4) Field winding is to be kept open and run the machine slightly above or below the rated speed.
5) Apply approximately 25% of the balanced three phase rated voltage is to be applied across the armature terminals of the synchronous machine.
6) Observe the oscillations in ammeter & voltmeter and note the maximum & minimum voltages and currents.
7) Calculate the values of X_d and X_q

OBSERVATIONS:

S.No.	Speed (Rpm)	V_{MIN} (Volts)	V_{MAX} (Volts)	I_{MIN} (Amps)	I_{MAX} (Amps)	X_d (Ohms)	X_q (Ohms)

$$X_d = \frac{\text{Maximum Voltage}}{\text{Minimum Current}}\ ;\ X_q = \frac{\text{Minimum Voltage}}{\text{Maximum Current}}$$

GRAPHS: The following are expected wave forms that can be observed from the Oscilloscope

RESULT:

REMARKS IF ANY:

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

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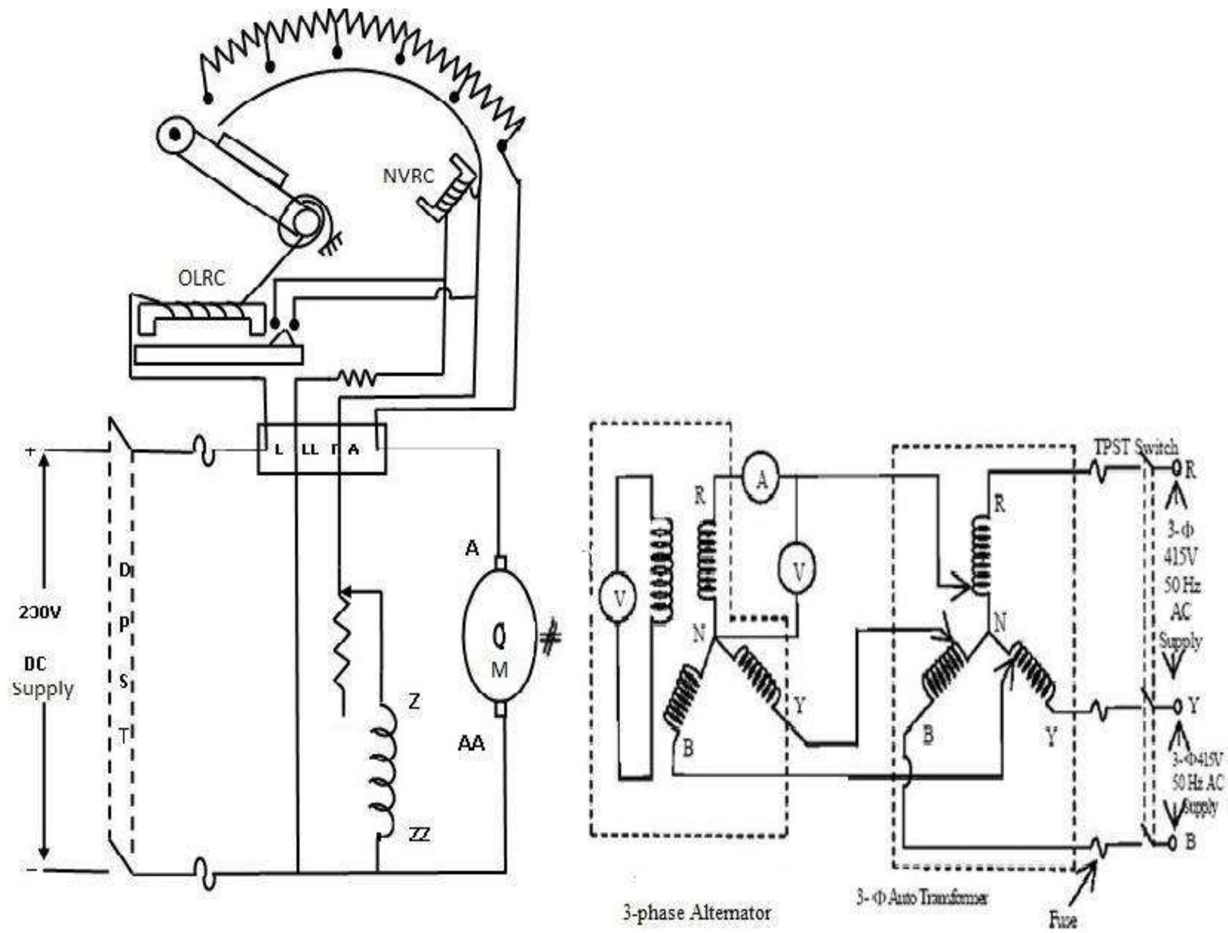
TITLE: **SLIP TEST ON SALIENT POLE ALTERNATOR TO DETERMINE THE X_d AND X_q REACTANCES**	GPRECD/EEE/EMCP-II-EXPT-6 Date: 1-07-2022 Scheme-20

CIRCUIT DIAGRAM:



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Viva Questions:

1. Which of these reactance Xd and Xq is having greater value why?
2. How will you distinguish between two types of large alternator from their appearance?
3. What is total power in salient pole synchronous machine? Give the expression and explain?
4. During the slip test for determining the direct and quadrature axis synchronous reactances of an alternator, what is frequency of the voltage across the open circuited field terminals?
5. Draw the phasor diagram of salient pole synchronous machine?

TITLE: **SLIP TEST ON SALIENT POLE ALTERNATOR TO DETERMINE THE X_d AND X_q REACTANCES**	GPRECD/EEE/EMCP-II-EXPT-9 Date: 1-07-2019 Scheme-17

OBJECTIVE:

To determine the values of X_d (Direct Axis reactance) & X_q (Quadrature Axis reactance) of the given salient pole synchronous machine.

APPARATUS:

NAME PLATE DETAILS:

FUSE RATINGS:

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

Because of saliency, the reactance measured at the terminals of a salient-pole synchronous machine as opposed to a cylindrical-rotor machine varies as a function of the rotor position. The effects of saliency are taken into account by the two-reactance theory. The armature current a I is resolved into two 16 components: d I in time quadrature with, and q I in time phase with the excitation voltage E f , Figures 1-a and 1-

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b, in which δ is the torque angle or the power angle, is the power factor angle, and (ϕ+) δ is the internal power angle .ψ

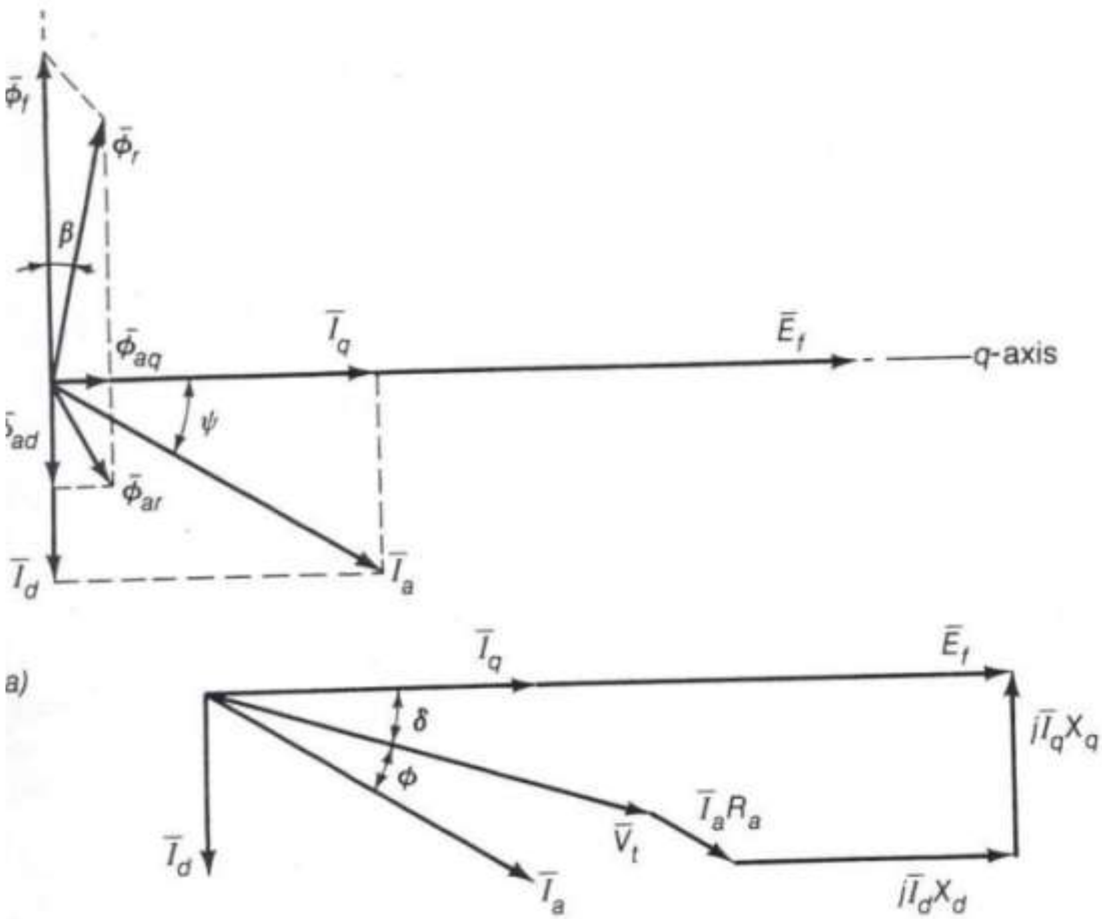

Fig. 1: Phasor diagram of an unsaturated salient pole synchronous generator operating at lagging power factor. Referring to figure 1-b, the terminal current a I may be expressed as follows, while taking the terminal voltage Vt as a reference:

$$\vec{I_a} = V_t \frac{X_d + X_q}{2X_d X_q} e^{j\Pi/2} + V_t \frac{X_d - X_q}{2X_d X_q} e^{j(2\delta - \Pi/2)} + \frac{E_f}{X_d} e^{j(\delta - \Pi/2)} \quad (1)$$

Thus the salient-pole synchronous machine delivers three components of current to the bus. The second term on the right side of equation 1 vanishes for a round-rotor synchronous machine, because X d equals X q . Even for no excitation (E f =0), as for a salient-pole synchronous machine, it can be seen that the 17 current has an active component. With sufficient excitation, the current can be made equal to zero. For example, at no-load, for δ=0 and E f = Vt , a I becomes zero. Further, it can be seen that, for E f = 0,

$$I_a = I_{max} = \frac{V_t}{X_q} \text{ for } \delta = \frac{\Pi}{2} \quad (2)$$

and

$$I_a = I_{min} = \frac{V_t}{X_d} \text{ for } \delta = 0 \quad (3)$$

q t a max X V for I I = 2 (2) and d t a min X V for I I = 0 (3) The current wave is an amplitude-modulated wave, provided is varied slowly. This analysis suggests a method of determining the direct-axis and quadrature axis steady state (or synchronous) reactances of a synchronous machine by a test known as the slip test. The machine is unexcited, and balanced voltages are applied at the armature terminals. The rotor is driven at a speed differing slightly from synchronous speed (which is calculated from the frequency of the applied voltage and the number of poles of the machine). The armature currents are then modulated at slip frequency by the machine, having maximum amplitude when the quadrature axis is in line with the mmf wave and minimum amplitude when the direct axis aligns with the mmf wave. The armature voltages are also usually modulated at slip frequency because of impedences in the supply lines, the amplitude being greatest when the current is smallest, and vice versa. Such variations of voltage and current are illustrated in the oscillograms of Figure 2. The maximum and minimum values of the voltage and current can also be read on a voltmeter and an ammeter, provided the slip is small. The field winding should be kept open in the slip test so that the slipfrequency current is not induced in it. 18 Fig.2: Slip test oscillogram. (a) Armature voltage variation. (b) Armature current variation The direct axis reactance X d can now be calculated from the ratio of maximum voltage to minimum current: min max d I V / X 3 (4) On the other hand, the quadrature axis reactance X q is given by the ratio of minimum voltage to maximum current. max min q I V / X 3 (5) =

PROCEDURE:

1) The circuit is connected as shown in the diagram.
2) Run the machine at synchronous speed with the help of a prime mover (DC Motor)
4) Field winding is to be kept open and run the machine slightly above or below the rated speed.
5) Apply approximately 25% of the balanced three phase rated voltage and frequency across the armature terminals of the synchronous machine.
6) Observe the oscillations in ammeter & voltmeter and note the maximum & minimum voltages and currents.
7) Calculate the values of X_d and X_q

OBSERVATIONS:

S.No.	Speed (Rpm)	V_{MIN} (Volts)	V_{MAX} (Volts)	I_{MIN} (Amps)	I_{MAX} (Amps)	X_d (Ohms)	X_q (Ohms)

$$X_d = \frac{\text{Maximum Voltage}}{\text{Minimum Current}} \; ; \; X_q = \frac{\text{Minimum Voltage}}{\text{Maximum Current}}$$

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GRAPHS: The following are expected wave forms that can be observed from the Oscilloscope

RESULT:

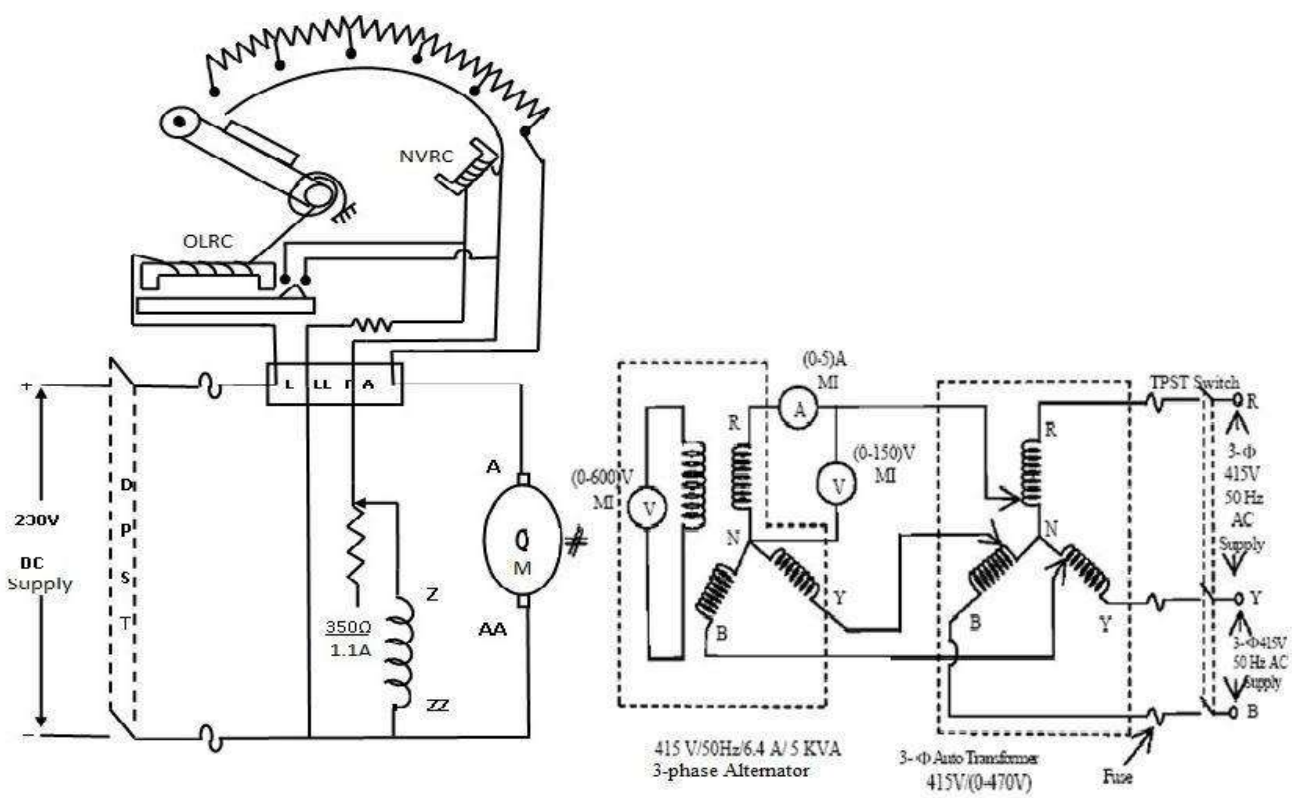
REMARKS IF ANY:

Precautions:

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

TITLE: **SLIP TEST ON SALIENT POLE ALTERNATOR TO DETERMINE THE X_d AND X_q REACTANCES**	GPRECD/EEE/EMCP-II-EXPT-9 Date: 1-07-2019 Scheme-17

CIRCUIT DIAGRAM:



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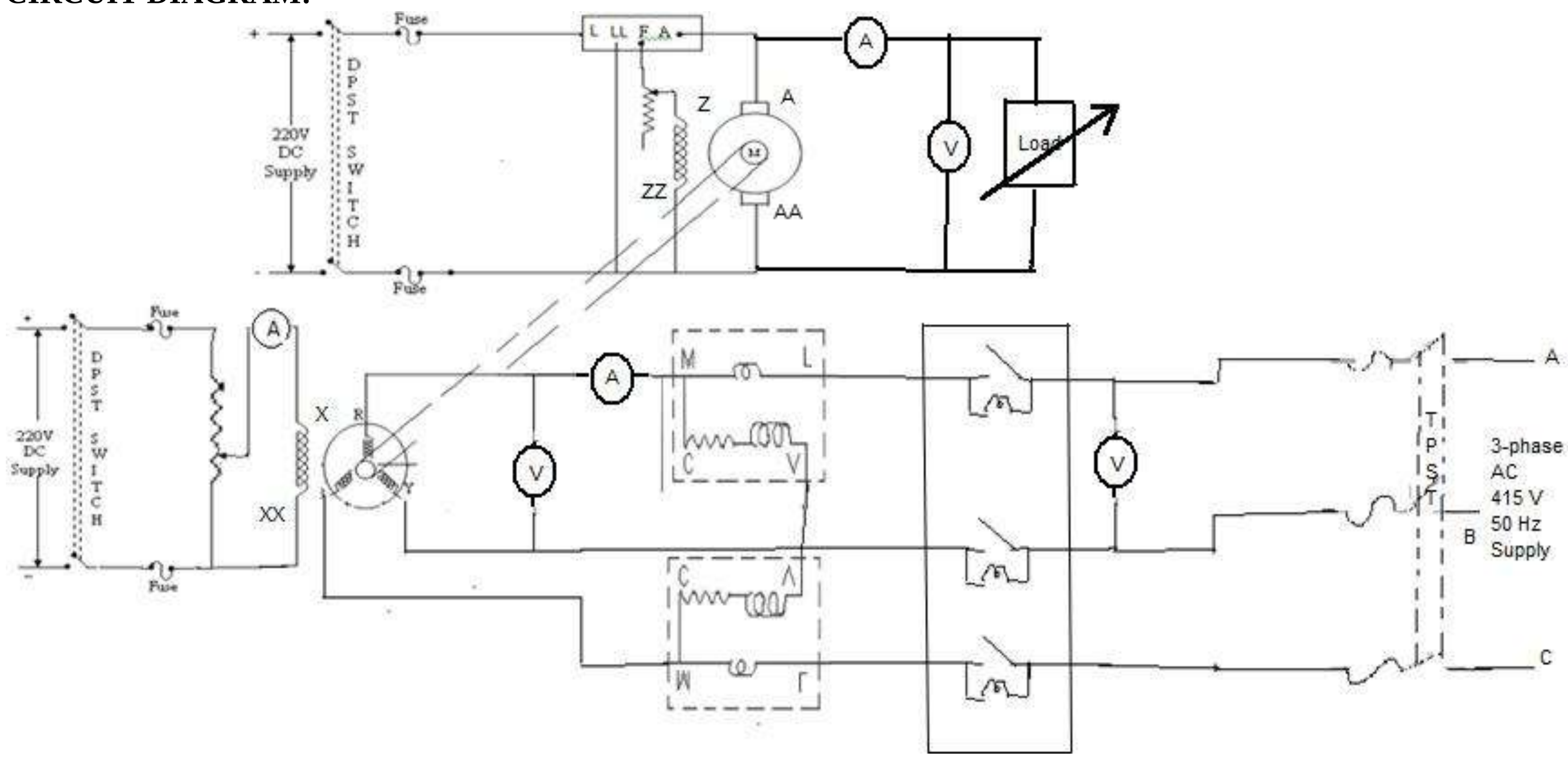
TITLE: **SYNCHRONIZATION OF ALTERNATORS AND V & Λ CURVES OF SYNCHRONOUS MACHINE**
SCHEME-20

GPRECD/EEE/EMCP-II-EXPT-7
DATE: 01-07-2022

CIRCUIT DIAGRAM:



TITLE: **SYNCHRONIZATION OF ALTERNATORS AND V & Λ CURVES OF SYNCHRONOUS MACHINE**	GPRECD/EEE/EMCP-II-EXPT-7 DATE: 01-07-2022 SCHEME-20

OBJECTIVE:

To determine the effect of variation of excitation on armature current (Ia) and on power factor of a given synchronous motor.

APPARATUS:

NAME PLATE DETAILS:

FUSE RATINGS:

THEORY:

Using an isolated synchronous generator to supply its own load independently is very rare (such a situation is found only a few out-of-the –way applications such as emergency generators). For all usual generator applications, there is more than one generator operating in parallel to supply the power demanded by the load. It is possible to connect a synchronous generator, which has already been excited and is being driven at its nominal speed, to three-phase power lines. To accomplish this, there are three conditions that must be met:

1. The magnitude and phase angle of generated voltage must be equal to voltage and phase of the main power line.
2. The frequency of the voltage generated by the generator must be equal or slightly higher than the frequency of the main power line.
3. The phase sequence of both the generated voltage and the power line must be the same.

The simplest way to match the power lines and the generated voltage is done with the help of special synchronizing lamp placed between the power lines and the generator. Since it is possible that during the synchronizing process an unfavorable phase relationship may exist between power lines and generator that could place as much as twice the phase voltage across the lamps, two lamps are connected in series to form a

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pair. In the "dark-lamp circuit" method, lamps are placed between the same phase of the power lines and the generator. The machine can be connected to the power lines at the time when all lights are simultaneously off. The parallel connection may be made only if the illumination rotation stops and the lamps are dark.

A synchronous motor is a double-excited machine, its armature winding is energized from an a.c source and its field winding from d.c source. When synchronous motor is working at constant applied voltage, the resultant air gap flux demanded by applied voltage remains constant. This resultant air gap flux is established by both a.c in armature winding and d.c in the field winding. If the field current is sufficient enough to set up the air-gap flux, as demanded by constant applied voltage then magnetizing current or lagging reactive VA required from the a.c source is zero and therefore motor operates at unity power factor. This field current, which causes unity power factor operation of the synchronous motor, is called normal excitation or normal field current. If the current less than the normal excitation, i.e the motor is under excited, then the deficiency in flux must be made up by the armature winding m.m.f. In order to do the needful, the armature winding draws a magnetizing current or lagging reactive VA from the a.c source and as a result of it, the motor operates at a lagging power factor.
In case the field current is made more than its normal excitation, i.e the motor is over-excited, operates at leading power factor.

PROCEDURE:

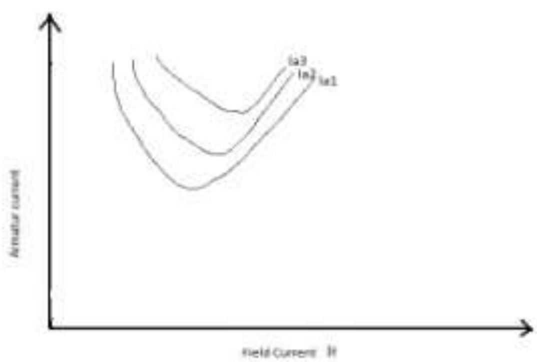
1. The DC motor is started and adjusted to around rated speed.
2. The DC excitation switch is closed and excitation is given.
3. 3- supply is given, if two bulbs glow and one darkens alternatively , the phase sequence is to be changed.
4. Speed of DC motor is adjusted to get flickering of lamps at a slower rate.
5. Excitation is adjusted to get the intensity of lamps low, gradually made dark and the point at which they become dark, the switch is closed.
6. The dc supply to dc motor is disconnected.
7. AC machine functions as a synchronous motor. At constant load, the excitation of synchronous machine is varied initially from zero to its maximum for about a minute and then again gradual increase in field current is to be applied.

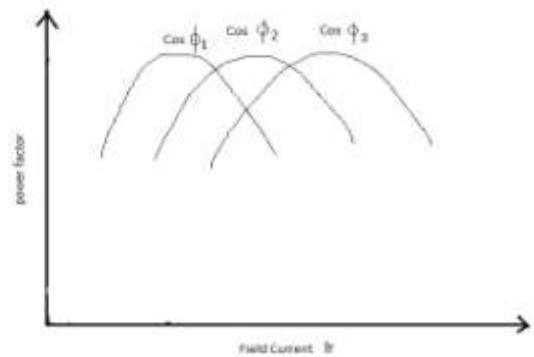
8. Armature current and wattmeter readings are noted at various values of excitation.
9. The experiment is repeated for different loads.

OBSERVATIONS:

I_f(A)	I_L(A)	V_L(V)	P=(W_1+W_2)	cosϕ

GRAPHS:





SAMPLE CALCULATIONS:

RESULT:

REMARKS IF ANY:

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TITLE: **SYNCHRONIZATION OF ALTERNATORS AND V & Λ CURVES OF SYNCHRONOUS MACHINE**	GPRECD/EEE/EMCP-II-EXPT-7 DATE: 01-07-2022 SCHEME-20

CIRCUIT DIAGRAM:

Viva Questions:

1. What is the difference between the alternators one is isolated and the other is connected to the infinite bus.
2. What is Synchronous Condenser?
3. An Alternator is floating on bus bar if excitation increases then what is the operating power factor?
4. What is the significance of "V" and "Λ" curves?
5. What will happen when the DC supply of an alternator removes while it is in running?

TITLE: **LOAD TEST ON ALTERNATOR**	GPRECD/EEE/EMCP-II- EXPT - 8
SCHEME-20	DATE: 01-07-2022

OBJECTIVE:

To conduct load test and to draw the performance characteristics of an alternator.

APPARATUS:

NAME PLATE DETAILS:

FUSE RATINGS:

THEORY:

Alternator is a machine, which converts mechanical energy to electrical energy. Alternators is used in generating plants. It generates voltage and thereby supplies power. While drawing power, the terminal voltage of an alternator is reduced due to the following reasons.

1) Voltgae drop due to armature resistance
2) Voltgae drop due to armature leakage reactance
3) Voltgae drop due to armature reaction

PROCEDURE:

1. Connections are made as per circuit diagram. Keep the motor side rheostat in minimum position and generator side rheostat in maximum position.
2. DC supply is given to the motor and it is started.
3. The speed of motor is adjusted to its rated speed by using motor field rheostat.
4. The field current is varied with exciter circuit rheostat till rated voltage is obtained.
5. Ensure that load is in minimum position initially before closing TPST switch
6. Once the TPST switch is closed, apply different loads and note down the meter readings.
7. Continue the process till rated load current.

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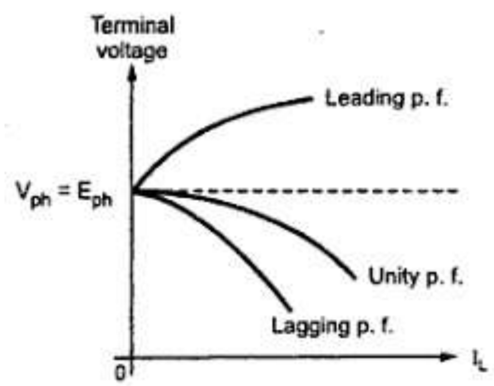
PROCEDURE:

8. Graphs between I_L and V are plotted respectively.
9. The above steps are repeated for inductive load.

OBSERVATIONS:

S.No	Load Voltage	Load Current	Type of Load

GRAPHS:



SAMPLE CALCULATIONS:

RESULT:

REMARKS IF ANY:

CIRCUIT DIAGRAM:

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CIRCUIT DIAGRAM:

Viva Questions:

1. What are the various methods to determine the voltage regulation of the large alternators?

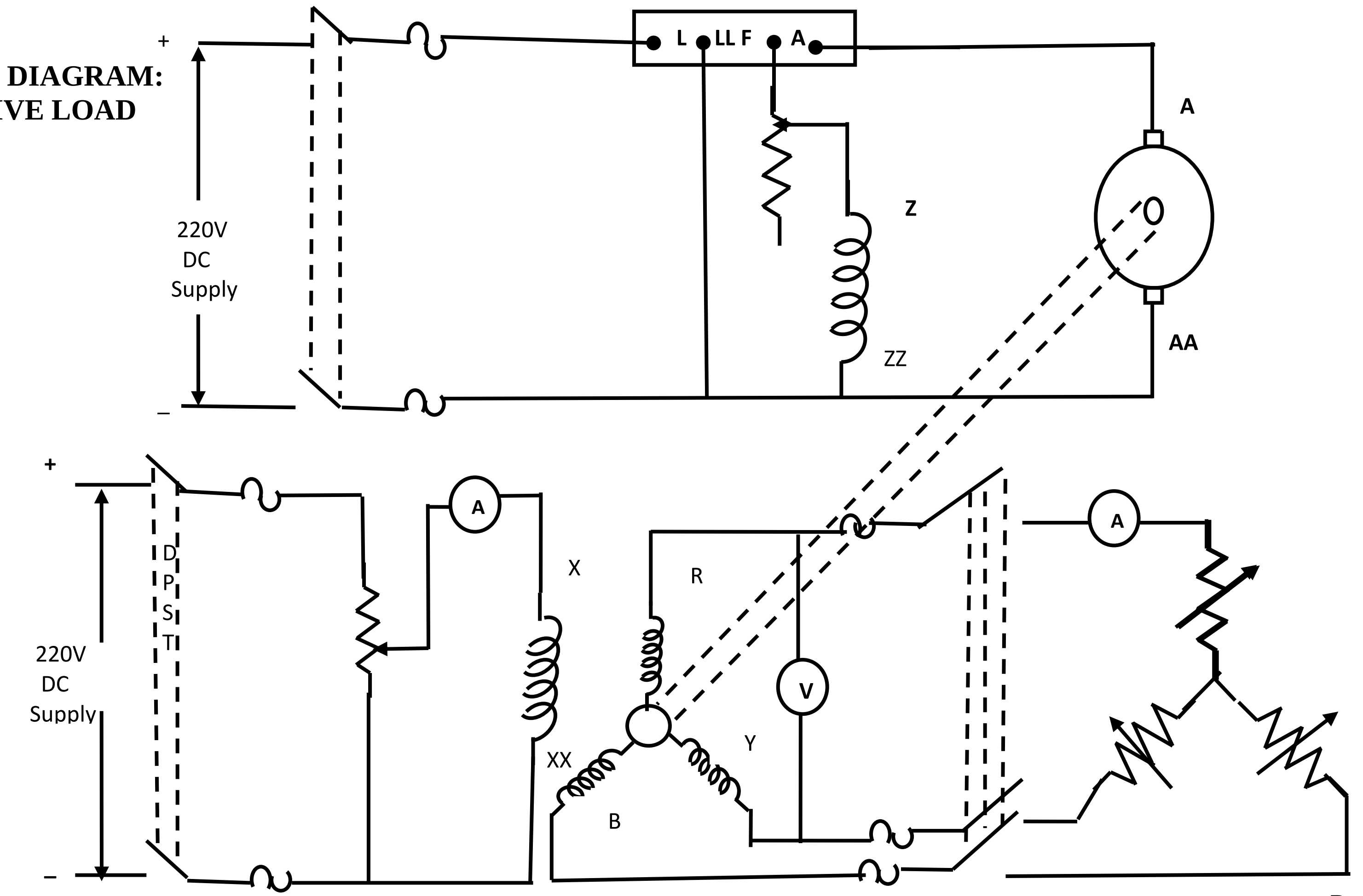
2. What is the general system requirement of an alternator?

3. What is the basic principle of alternators?

4. What is meant by turbo alternators?

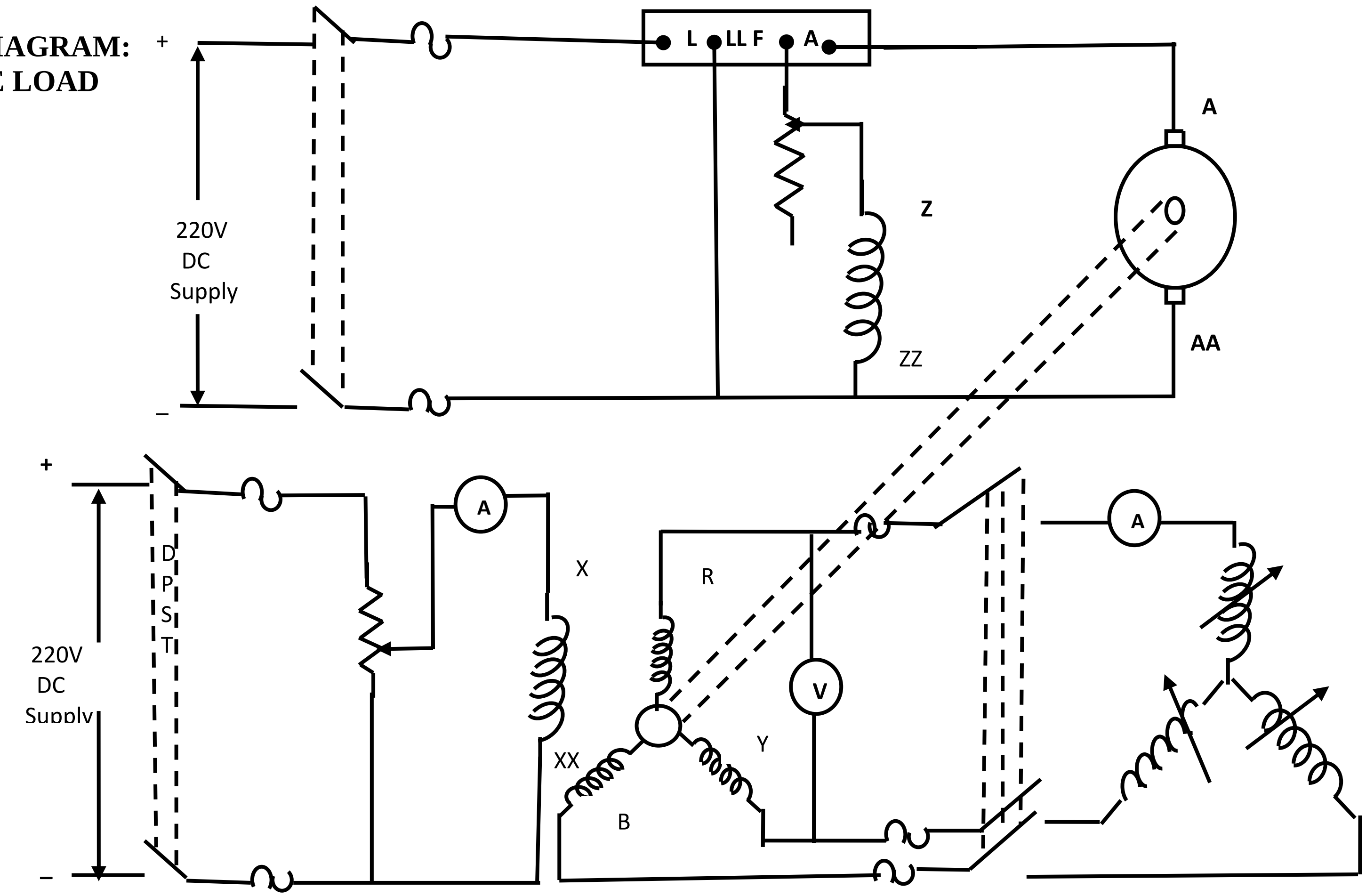
5. What are types of rotors used in alternators?

CIRCUIT DIAGRAM:
RESISTIVE LOAD



TITLE: **LOAD TEST ON ALTERNATOR**	GPRECD/EEE/EMCP-II- EXPT - 8
SCHEME-20	DATE: 01-07-2022

CIRCUIT DIAGRAM:
INDUCTIVE LOAD



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TITLE: **PERFORMANCE CHARACTERISTICS OF INDUCTION GENERATOR**	GPRECD/EEE/EMCP-II-EXPT-9
SCHEME-20	DATE: 1-07-2022

OBJECTIVE: To study rotor rheostat starter for slip ring induction motor and to determine load characteristics of a 3-phase induction generator.

APPARATUS:

NAME PLATE DETAILS:

FUSE RATINGS:

THEORY:

An induction generator or asynchronous generator is a type of alternating current (AC) electrical generator that uses the principles of induction motors to produce power. Induction generators operate by mechanically turning their rotors faster than synchronous speed. A regular AC asynchronous motor usually can be used as a generator, without any internal modifications. Induction generators are useful in applications such as mini hydro power plants, wind turbines, or in reducing high-pressure gas streams to lower pressure, because they can recover energy with relatively simple controls. An induction generator usually draws its excitation power from an electrical grid

- An AC supply is connected to the stator terminals of an induction machine. Rotating magnetic field produced in the stator pulls the rotor to run behind it (the machine is acting as a motor).
- Now, if the rotor is accelerated to the synchronous speed by means of a prime mover, the slip will be zero and hence the net torque will be zero. The rotor current will become zero when the rotor is running at synchronous speed.
- If the rotor is made to rotate at a speed more than the synchronous speed, the slip becomes negative. A rotor current is generated in the opposite direction, due to the rotor conductors cutting stator magnetic field.

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- This generated rotor current produces a rotating magnetic field in the rotor which pushes (forces in opposite way) onto the stator field. This causes a stator voltage which pushes current flowing out of the stator winding against the applied voltage. Thus, the machine is now working as an induction generator (asynchronous generator).

Induction generator is not a self-excited machine. Therefore, when running as a generator, the machine takes reactive power from the AC power line and supplies active power back into the line. Reactive power is needed for producing rotating magnetic field. The active power supplied back in the line is proportional to slip above the synchronous speed.

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. SPST switch is kept at open position & field rheostat is kept at maximum position.
3. Start the 3-phase slip ring induction machine with starter.
4. Close DPST switch and decrease the field resistance until the voltmeter reading shows zero position (value).
5. Close SPST switch.
6. By increasing the field resistance in steps and take all meter readings.
7. Then meter reading are tabulated and draw the necessary graphs.

OBSERVATIONS:

Slip Ring Induction Motor

Slip Ring Induction Motor					Dc Machine			T_1	T_2	$T=(T_1 \sim T_2)rg$	Speed (N) in RPM	(Input) I/P= $2\pi NT/60$	%S= (Ns-Nr) *100/N_s	%η= output /input
V_1	I_1	W_1	W_2	Output Power (W_1+W_2)	V	I	I_f							

SAMPLE CALCULATIONS:

Input voltage (V_L) =

Input current (I_L) = Amps

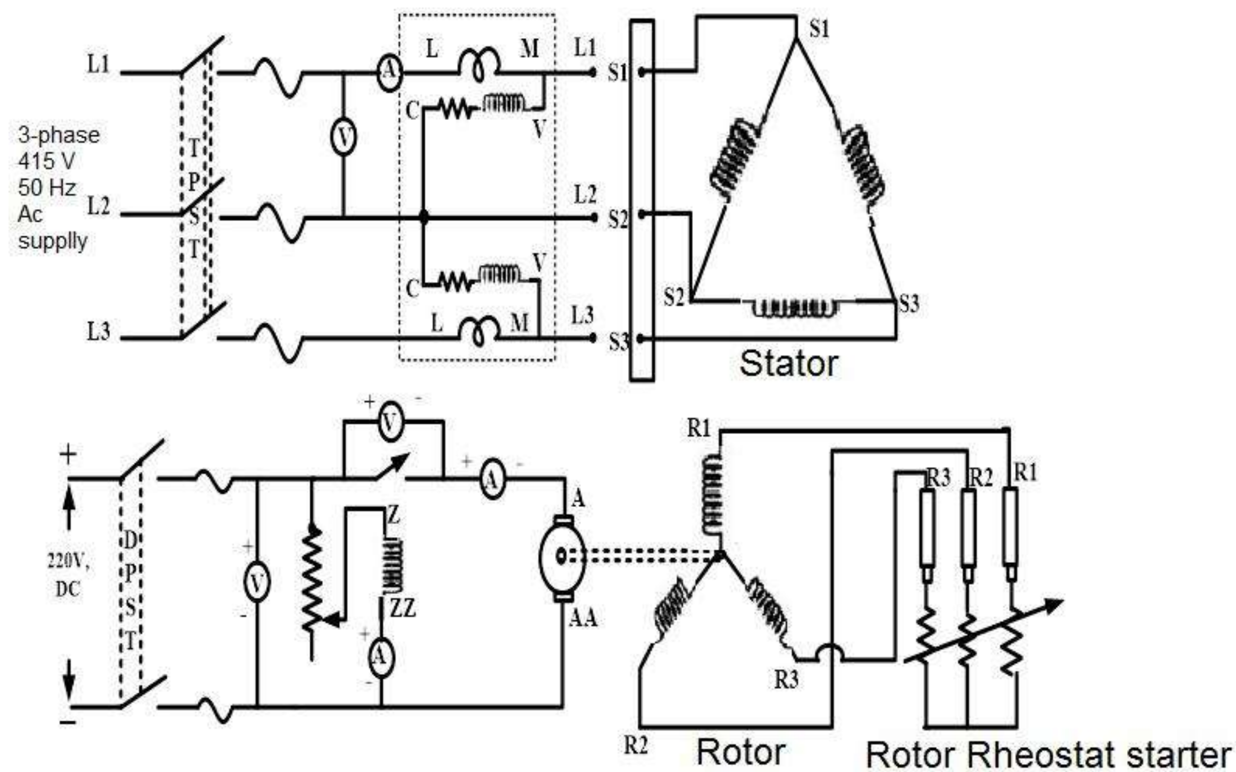
Input Power = (2ΠNT) / 60 watts =
Torque = (T1~T2)rg where r= 0.114 m, g= 9.8m/s^2
= Nm
Speed = N = rpm
Output Power = (W_1+W_2) = Watts
Efficiency (%η) = (Output power / Input power) x 100 =

RESULTS:

REMARKS IF ANY:

TITLE: **PERFORMANCE CHARACTERISTICS OF INDUCTION GENERATOR**	GPRECD/EEE/EMCP-II-EXPT-9
SCHEME-20	DATE: 1-07-2022

CIRCUIT DIAGRAM:



Prepared by:
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Associate Professor

Approved by:
Dr.K.Sri Gowri
HOD, EEE Dept

Viva Questions:

1. What is an Induction Generator?
2. Justify "Reactive power is must for an Induction Generator in order to generate electricity" through proper explanation.
3. Why slip is negative for an Induction Generator?
4. Draw the circle diagram for an Induction Generator?
5. Write few applications of an Induction Generator?

TITLE: **PERFORMANCE CHARACTERISTICS OF UNIVERSAL MOTOR**	GPRECD/EEE/EXPT-EMC2-10
SCHEME-20	DATE: 01-07-2022

Objective:
To conduct load test on Universal Motor and draw the performance characteristics with dc and ac voltages.

Apparatus:

Universal Motor, Voltmeter, Ammeter, Tachometer, Required number of connecting wires

Name plate details:

Fuse ratings:

Theory:
A universal motor is a commutator motor with series field winding. The performance of operation is almost same for ac/dc supply. Speed of a universal motor is controlled either connecting the field winding in parallel or in series with the armature. Most of the universal motors include a compensating winding for operation in ac voltage. It improves the commutation quality and power factor by neutralizing the armature mmf and thereby reducing the armature reactance and improving speed regulation.

Procedure:

1) Circuit is connected as per the circuit diagram(Fig.1) for dc operation.
2) Ensure that initially there is minimum load on the motor.
3) Rated dc voltage is applied to the machine
4) Load the motor by tightening the belt on the pulley and record the readings of all the meters, speed and the readings of both the spring balances.
5) Repeat step 4 by increasing the load on the motor in steps, till the rated current of the motor is obtained.
6) Remove the load gradually and then stop the motor by switching off the supply.

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7) In the next step, the motor is connected as shown in Figure (2) and the steps of dc voltages test are repeated but with ac input voltages.

Observations:

(i) **Machine with dc test**:

Voltage (V)	I_L (A)	Speed (N) (RPM)	Balance		Torque $T=(F_1 \sim F_2)\ rg$	O/p=$\frac{2\pi NT}{60}$	I/P= V I_L	% η= [(O/p) / (I/p)]*100
			F_1	F_2				

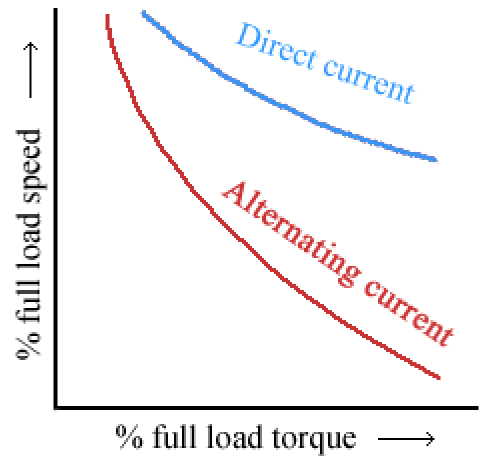
r = radius of brake drum g = acceleration due to gravity

(ii) **Machine with ac test**:

Voltage (V)	I_L (A)	Speed (N) (RPM)	Balance		Torque $T=(F_1 \sim F_2)\ rg$	O/p=$\frac{2\pi NT}{60}$	I/P= V I_L	% η= [(O/p) / (I/p)]*100
			F_1	F_2				

r = radius of brake drum g = acceleration due to gravity

Graphs:



Result:

Remarks if any:

TITLE: **PERFORMANCE CHARACTERISTICS OF UNIVERSAL MOTOR**	GPRECD/EEE/EXPT-EMC2-10
SCHEME-20	DATE: 01-07-2022

Circuit Diagram:

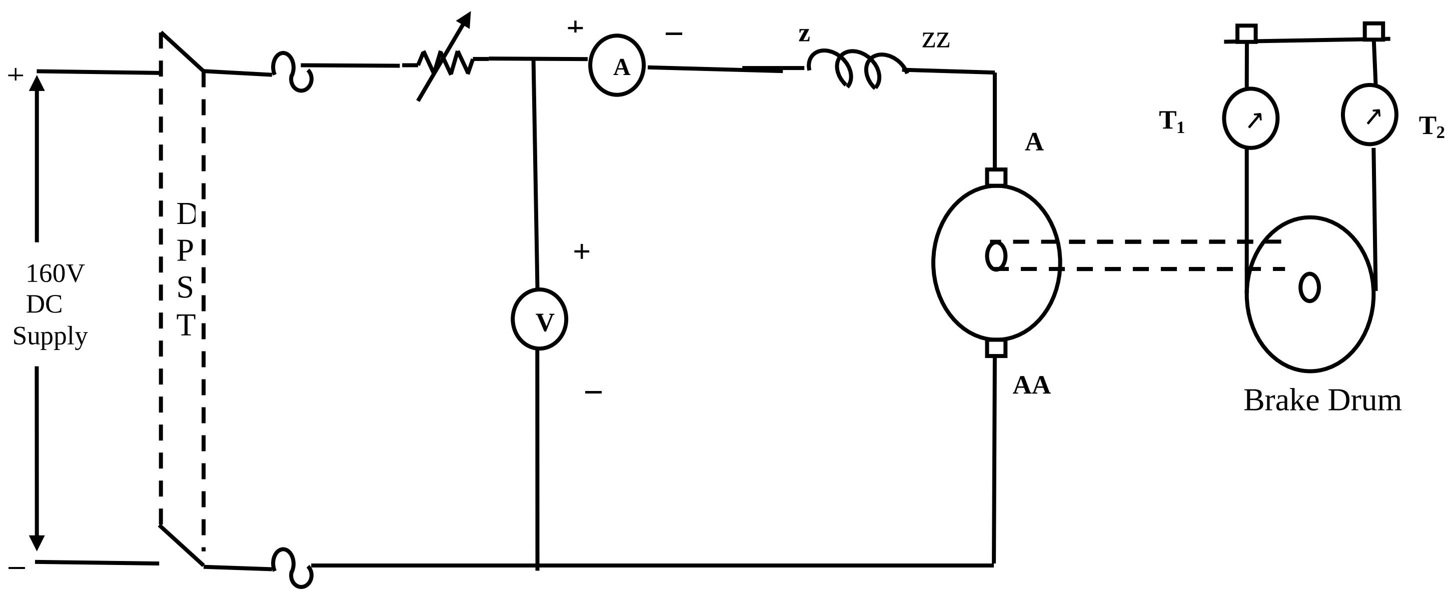


Figure.1

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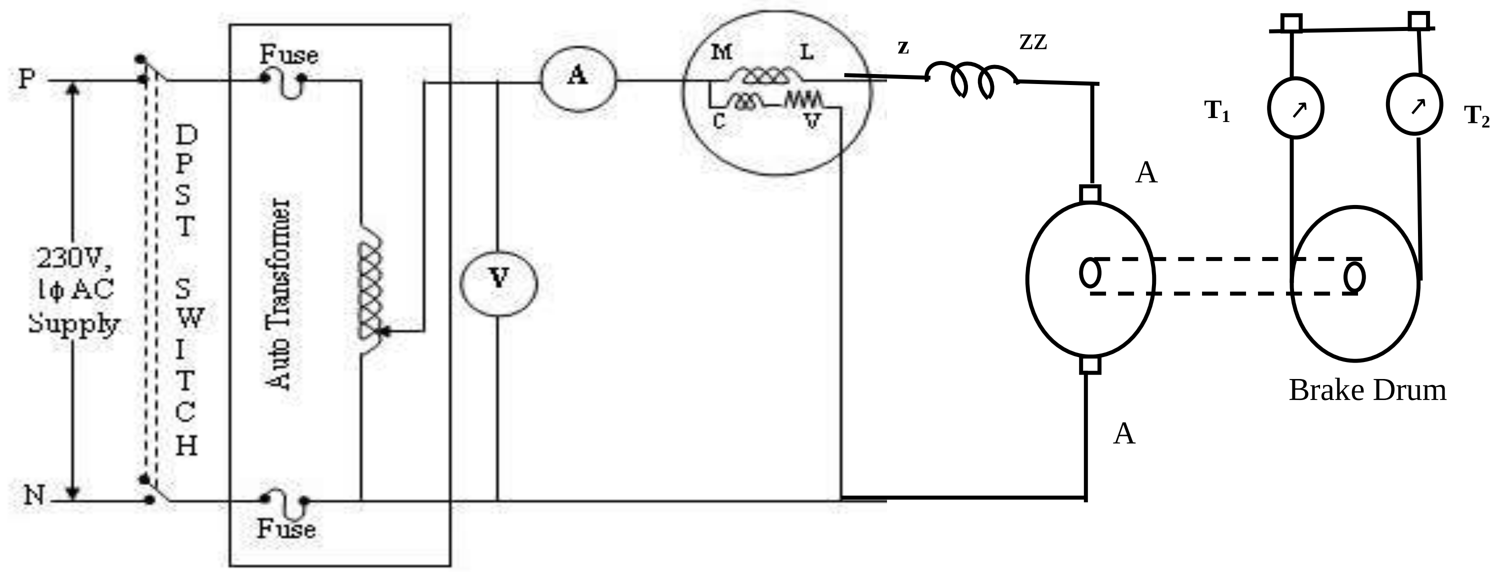

Figure.2

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Dr.K.Sri Gowri
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Viva Questions:

1. Why universal motor works with DC and AC?
2. What is universal motor ?
3. How do you control the speed of a universal motor?
4. What are the applications of universal motor?
5. What is the difference between induction motor and universal motor?

TITLE: **REGULATION OF SALIENT POLE ALTERNATOR**	GPRECD/EEE/EMCP-II-EXPT-11 Date: 1-07-2022 Scheme-20

OBJECTIVE:

To determine the regulation of salient pole synchronous machine.

APPARATUS:

NAME PLATE DETAILS:

FUSE RATINGS:

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

Because of saliency, the reactance measured at the terminals of a salient-pole synchronous machine as opposed to a cylindrical-rotor machine varies as a function of the rotor position. The effects of saliency are taken into account by the two-reactance theory.

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TITLE: **REGULATION OF SALIENT POLE ALTERNATOR**	GPRECD/EEE/EMCP-II-EXPT-11 Date: 1-07-2022 Scheme-20

OBJECTIVE:

PROCEDURE:

1) The circuit is connected as shown in the diagram.
2) Run the machine with the help of a prime mover (DC Motor)
4) Field winding is to be kept open and run the machine slightly above or below the rated speed.
5) Apply approximately 25% of the balanced three phase rated voltage and frequency is to be applied across the armature terminals of the synchronous machine.
6) Observe the oscillations in ammeter & voltmeter and note the maximum & minimum voltages and currents.
7) Calculate the values of X_d and X_q
8) Calculate δ, I_{ad} and E_0 and regulation.

OBSERVATIONS:

S.No.	Speed (Rpm)	V_{MIN} (Volts)	V_{MAX} (Volts)	I_{MIN} (Amps)	I_{MAX} (Amps)	X_d (Ohms)	X_q (Ohms)

$$X_d = \frac{\text{Maximum Voltage}}{\text{Minimum Current}} \; ; \; X_q = \frac{\text{Minimum Voltage}}{\text{Maximum Current}}$$

Neglecting armature resistance

$$V\cos\delta = E_0 - I_{ad} * X_d$$

$$V\sin\delta = I_{aq} * X_q$$

$$V\sin\delta = I_{aq} * X_q(\cos\delta\cos\varphi - \sin\delta\sin\varphi)$$

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TITLE: **REGULATION OF SALIENT POLE ALTERNATOR**	GPRECD/EEE/EMCP-II-EXPT-11 Date: 1-07-2022 Scheme-20

OBJECTIVE:

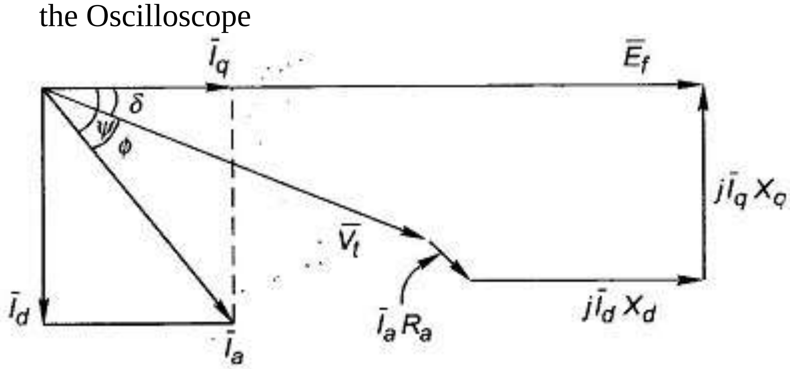
$I_a\cos\varphi = I_{aq}\cos\delta + I_{ad}\sin\delta$

$I_{ad} = (I_a\cos\varphi - I_{aq}\cos\delta)/\sin\delta$

$E_0 = V\cos\delta + I_{ad}*X_d$

% Regulation =[(E – V) / V]*100

GRAPHS: The following are expected wave forms that can be observed from the Oscilloscope



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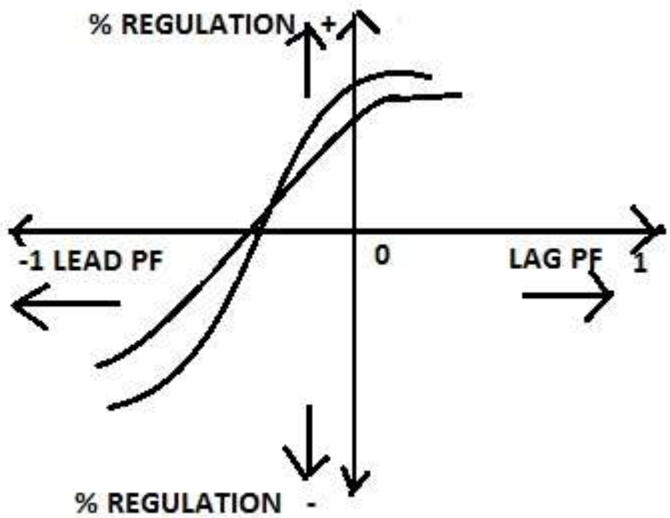


GRAPHS:

RESULT:

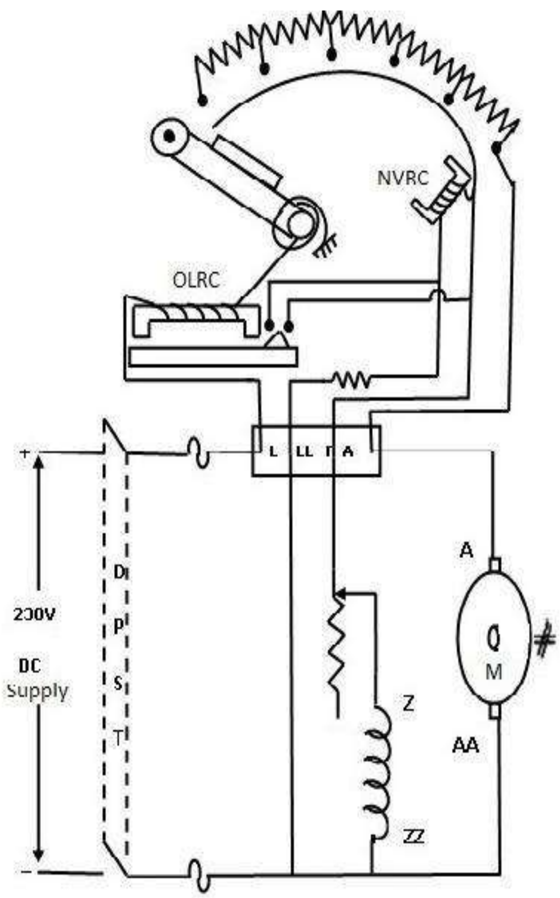
REMARKS IF ANY:

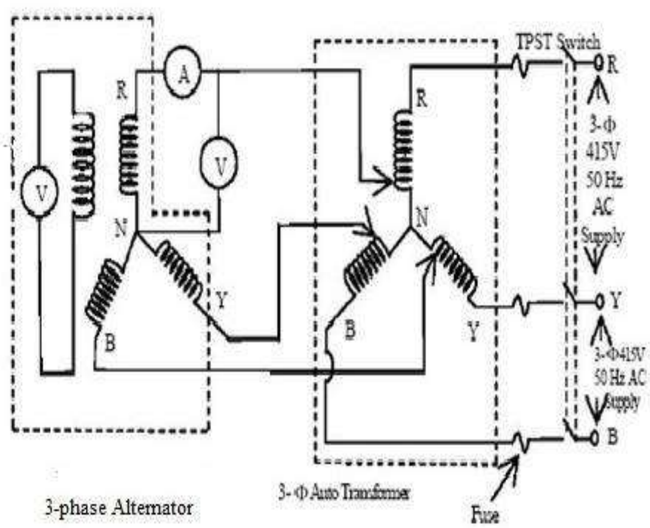
Precautions:

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

TITLE: **REGULATION OF SALIENT POLE ALTERNATOR**	GPRECD/EEE/EMCP-II-EXPT-11 Date: 1-07-2022 Scheme-20

CIRCUIT DIAGRAM:





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TITLE: **REGULATION OF SALIENT POLE ALTERNATOR**	GPRECD/EEE/EMCP-II-EXPT-11 Date: 1-07-2022 Scheme-20

Viva Questions:

1. Is Alternator double excited (or) single excited machine? Explain?
2. The voltage regulation of an alternator at 1000 rpm is 20% then what will happen in the voltage regulation if you operate alternator at 1300 rpm.
3. What are the different type's voltage regulation methods? Give the order of voltage regulation
4. For which type of alternator voltage regulation is maximum? Why?
5. Define voltage regulation?

TITLE: **LOAD TEST ON 1-φ SQUIRREL CAGE INDUCTION MOTOR**	GPRECD/EEE/ EMCP-II- EXPT-12 DATE: 01-07-2022 SCHEME-20

OBJECTIVE:

To conduct load test on 1-ϕ Induction motor and to draw its performance characteristics

APPARATUS:

NAME PLATE DETAILS:

FUSE RATINGS:

THEORY:

Single phase induction motor also woks on the principle of 'Faraday's laws of electromagnetic induction. The equivalent circuit of such motor is based on double field revolving theory i.e, an alternating uniaxial quantity can be represented by two oppositely rotating vectors of half magnitude. So here the single phase motor has been imagined to be made up of one stator winding and two imaginary rotors. Each rotor will be assigned half the actual value of resistance.

PROCEDURE:

Load test:

1. The circuit is connected as shown in figure.
2. The switch is closed and rated voltage is applied to stator side.
3. The ammeter, voltmeter and wattmeter readings are noted.
4. Now by applying load on the motor ammeter, voltmeter and wattmeter readings are noted.

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TITLE: **LOAD TEST ON 1-ϕ SQUIRREL CAGE INDUCTION MOTOR**	GPRECD/EEE/ EMCP-II- EXPT-12 DATE: 01-07-2022 SCHEME-20

OBSERVATIONS:

S.No	Voltage (V)	Current (A)	Speed in R.P.M	Spring Balance		Torque In N-m	Output power in Watts	Power factor	% Efficiency
				S_1	S_2				

SAMPLE CALCULATIONS:

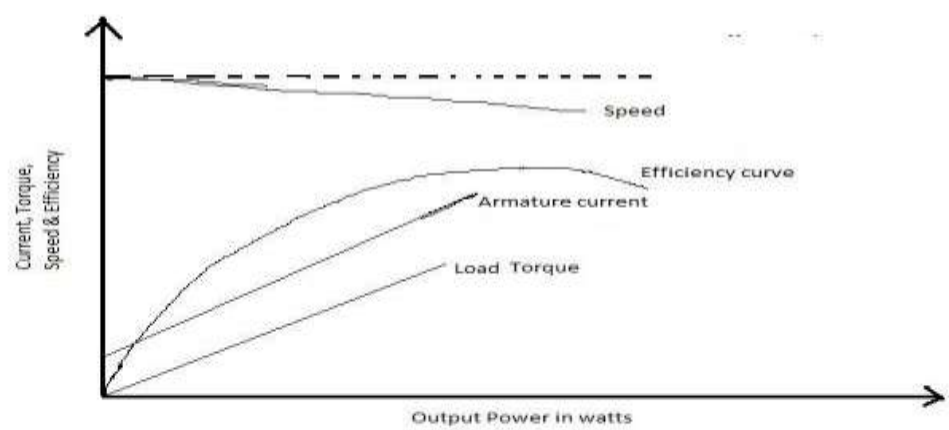
Output Power = (2ΠNT) / 60 Watts

Torque = (T1~T2)rg N-m, where r= 0.114 m, , g= 9.8m/s^2

Efficiency (%η) = (Output power / Input power) x 100

Cosφ = W/VI

GRAPH:



RESULT:

REMARKS IF ANY:

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TITLE: **LOAD TEST ON 1-ϕ SQUIRREL CAGE INDUCTION MOTOR**	GPRECD/EEE/ EMCP-II- EXPT-12 DATE: 01-07-2022 SCHEME-20

CIRCUIT DIAGRAM:

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TITLE: **LOAD TEST ON 1-ϕ SQUIRREL CAGE INDUCTION MOTOR**	GPRECD/EEE/ EMCP-II- EXPT-12 DATE: 01-07-2022 SCHEME-20

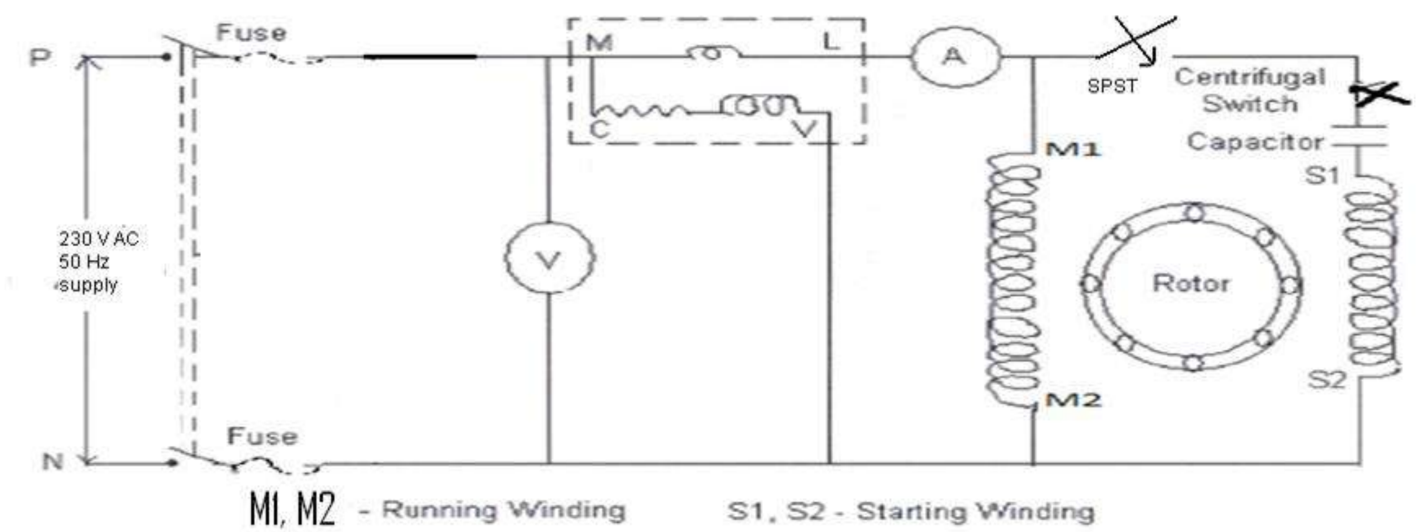
Viva Questions:

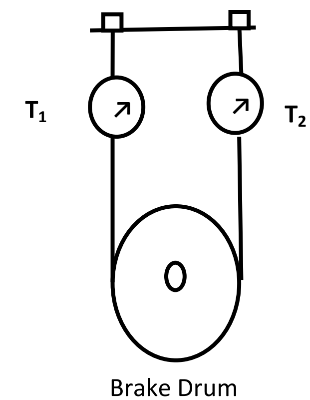
1. What are the two types of induction motors?
2. What are the methods of starting of an induction motor?
3. How can the directions of rotation of the motor be reversed?
4. Whether a single phase induction motor is self starting?
5. What are the basic parts of an induction motor?

TITLE: **LOAD TEST ON 1-ϕ SQUIRREL CAGE INDUCTION MOTOR**	GPRECD/EEE/ EMCP-II-EXPT-12
	DATE: 01-07-2022
SCHEME-20	

CIRCUIT DIAGRAM:

LOAD TEST:





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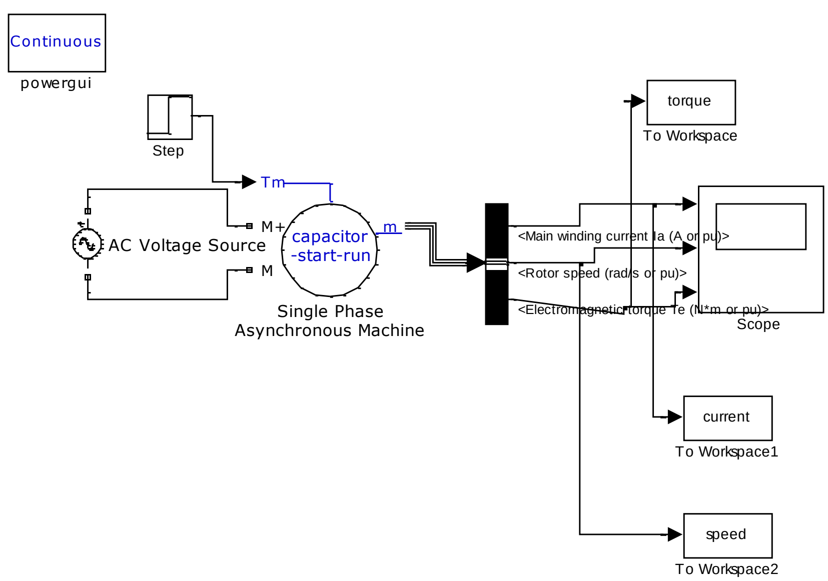
TITLE: **SIMULATION OF SINGLE PHASE INDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT - 13
SCHEME-20	DATE: 01-07-2022

OBJECTIVE: To develop a model of single phase induction motor using MATLAB SIMULINK.

APPARATUS:

CIRCUIT DIAGRAM:



SIMULINK model of a 1-φ Induction motor

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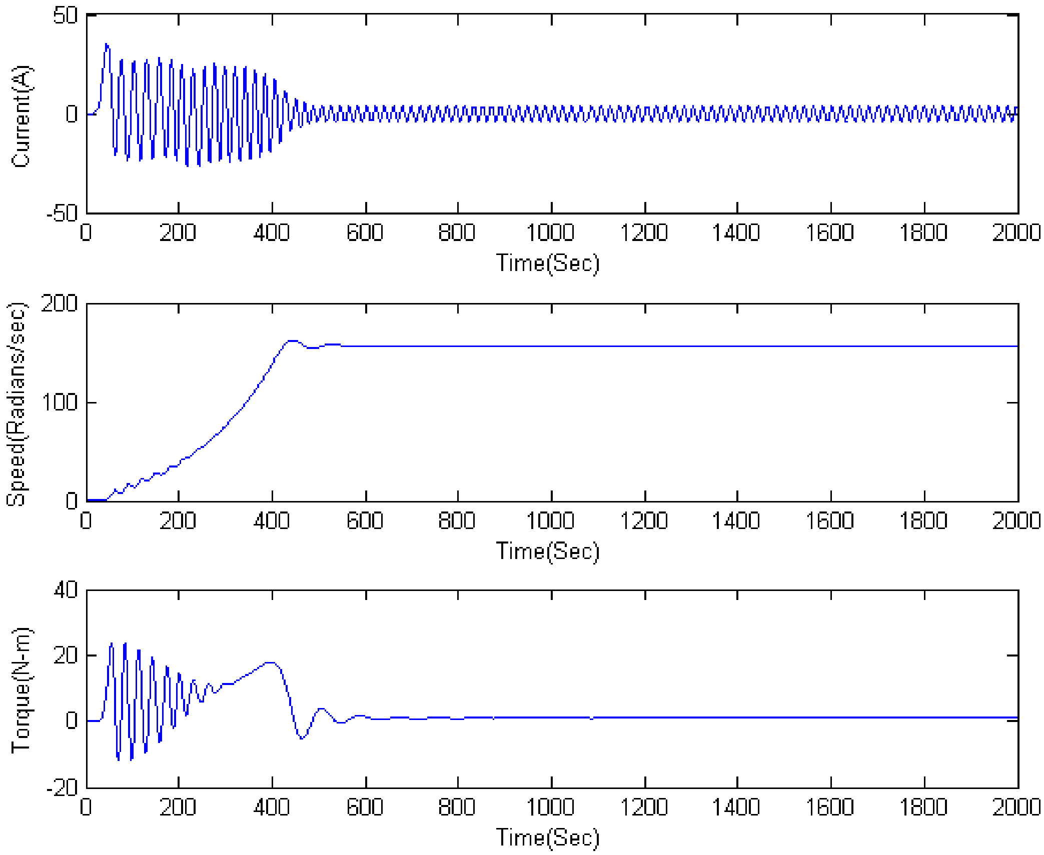
TITLE: **SIMULATION OF SINGLE PHASE INDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT - 13
SCHEME-20	DATE: 01-07-2022

Expected Wave Forms:



RESULT:

REMARKS IF ANY

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TITLE: **SIMULATION OF SINGLE PHASE INDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT - 13
SCHEME-20	DATE: 01-07-2022

Viva Questions:

1. What are the two types of induction motors?

2. What are the methods of starting of an induction motor?

3. How can the directions of rotation of the motor be reversed?

4. Whether a single phase induction motor is self starting?

5. What are the basic parts of an induction motor?

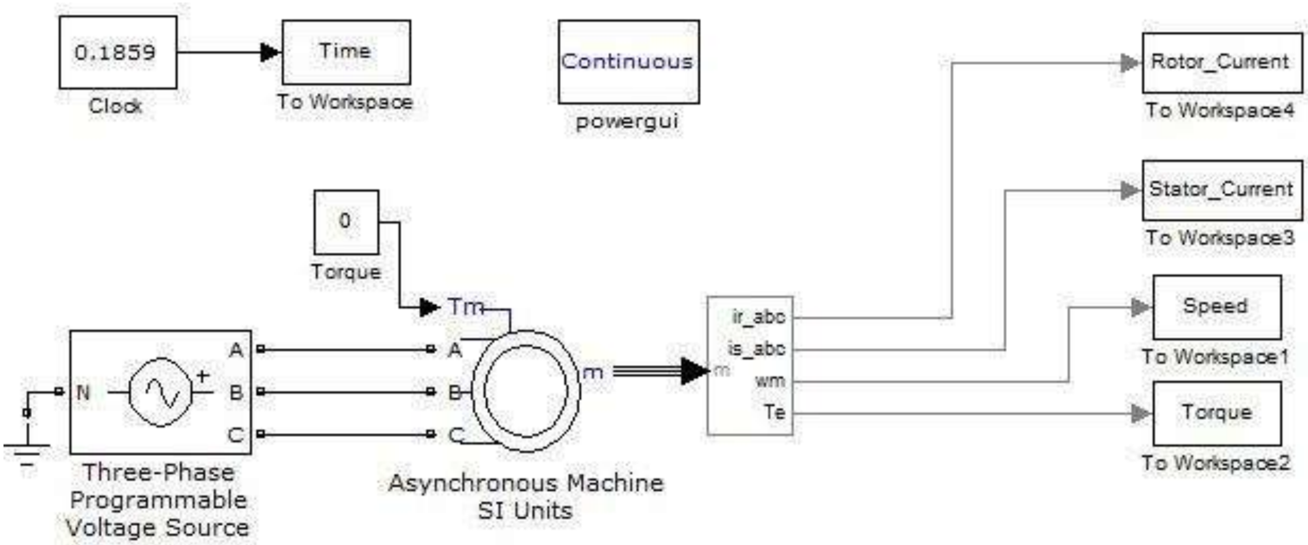
TITLE: **SIMULATION OF THREE PHASE INDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT - 14
SCHEME-20	DATE: 01-07-2022

OBJECTIVE:

To develop a model of three phase induction motor using MATLAB SIMULINK

APPARATUS:

CIRCUIT DIAGRAM:



SIMULINK model of a 3-φ Induction motor

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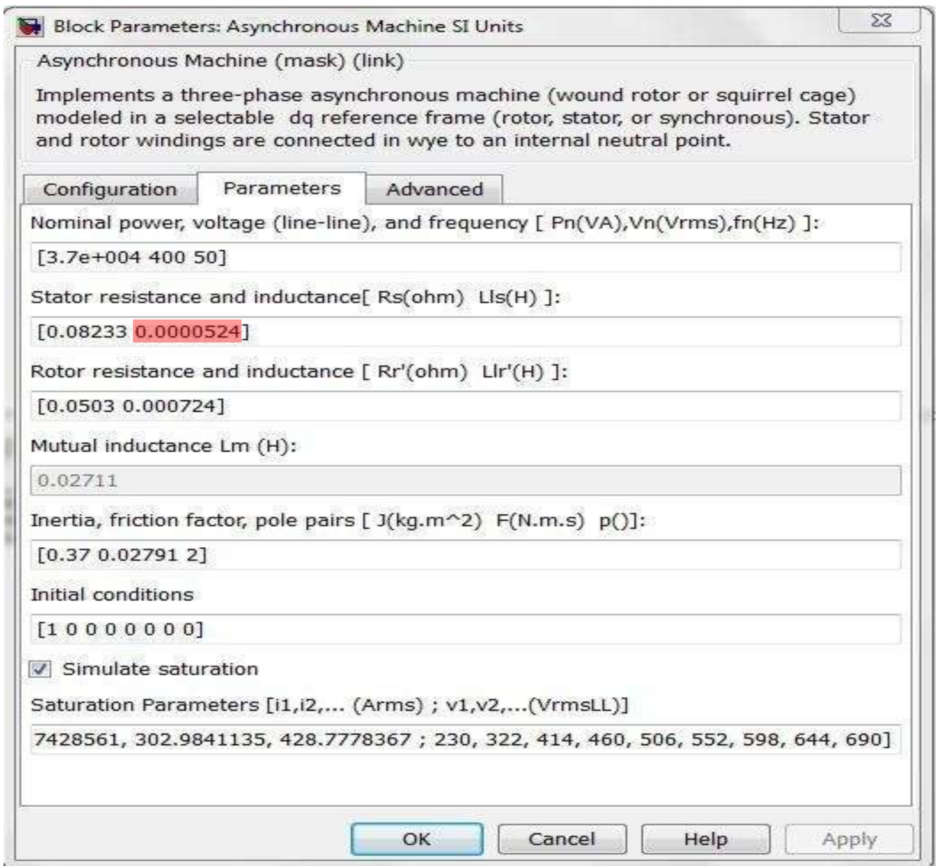
Parameters of 3-φ induction motors (Low stator impedance):

Low stator inductance (~0.05 mH)



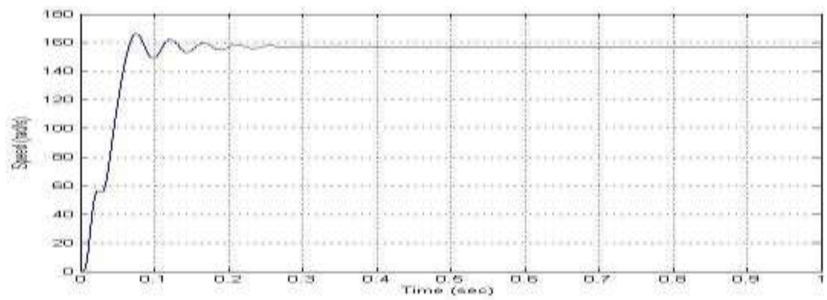


Figure 1: Rotor Speed Vs Time

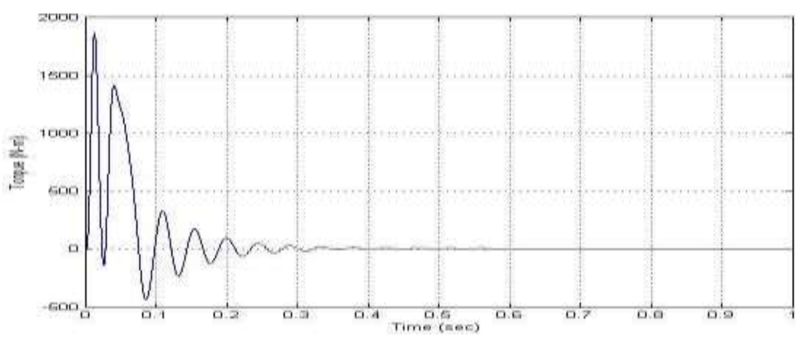


Figure 2: Torque Vs Time

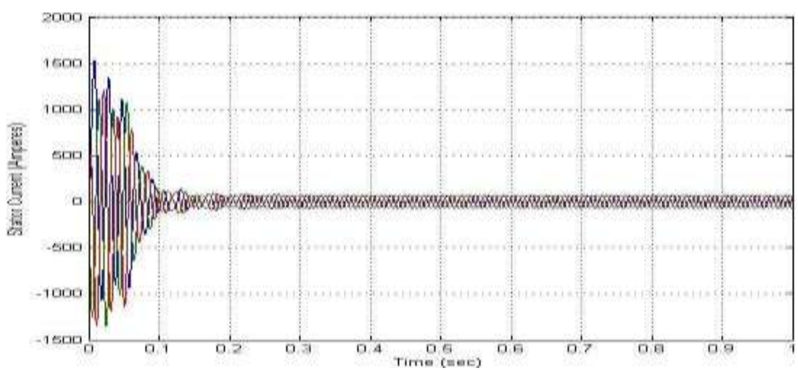


Figure 3: Stator Current Vs Time

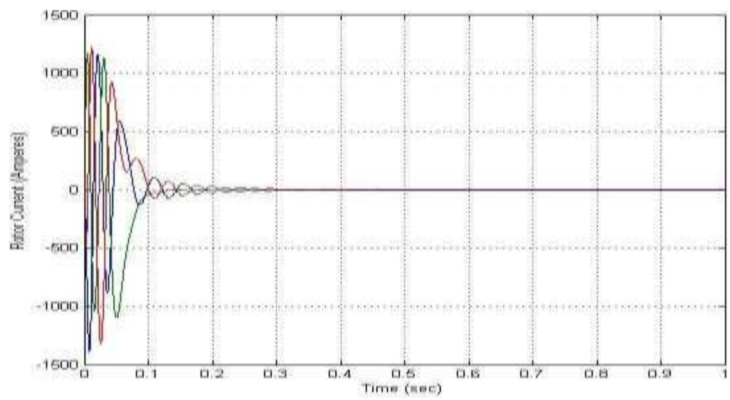


Figure 4: Rotor Current Vs Time

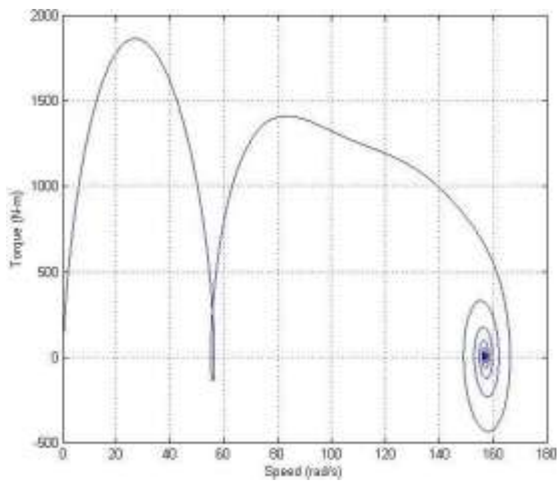


Figure 5: Torque-Speed Characteristics

RESULT:

REMARKS IF ANY:

VIVA QUESTIONS:

1. Define slip of an induction motor?
2. What will be the slip at maximum torque?
3. Write the torque equation for three phase induction motor?
4. What is the starting torque of an induction motor?
5. Draw the torque slip characteristics of an induction motor?

TITLE: **SIMULATION OF TORQUE Vs SPEED CHARACTERISTICS OF THREE PHASE INDUCTION MOTOR**

GPRECD/EEE/EMCP-II- EXPT - 15

SCHEME-20 DATE: 01-07-2022

OBJECTIVE:

To develop a model of three phase induction motor using MATLAB SIMULINK to determine the torque vs speed characteristics.

APPARATUS:

Machine details used in MATLAB code execution for Variable rotor resistance

RMS value of supply voltage (line-to-line)	415 Volts*
Number of poles	4
Stator resistance	0.075 ohm
Rotor resistance	0.1 ohm**
Frequency	50 Hz***
Stator leakage reactance at 50 Hz frequency	0.45 ohm
Rotor leakage reactance at 50 Hz frequency	0.45 ohm

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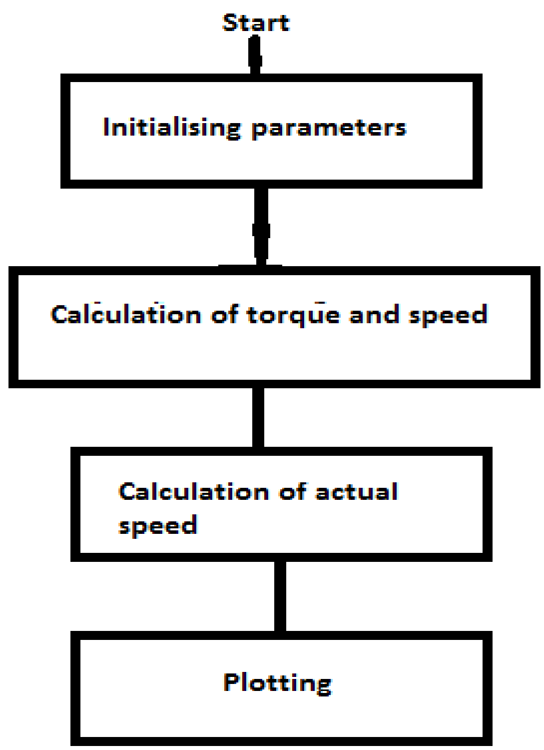
HOD, EEE Dept

TITLE: **SIMULATION OF TORQUE Vs SPEED CHARACTERISTICS OF THREE PHASE INDUCTION MOTOR** SCHEME-20	GPRECD/EEE/EMCP-II- EXPT -15 DATE: 01-07-2022

Flow Chart:



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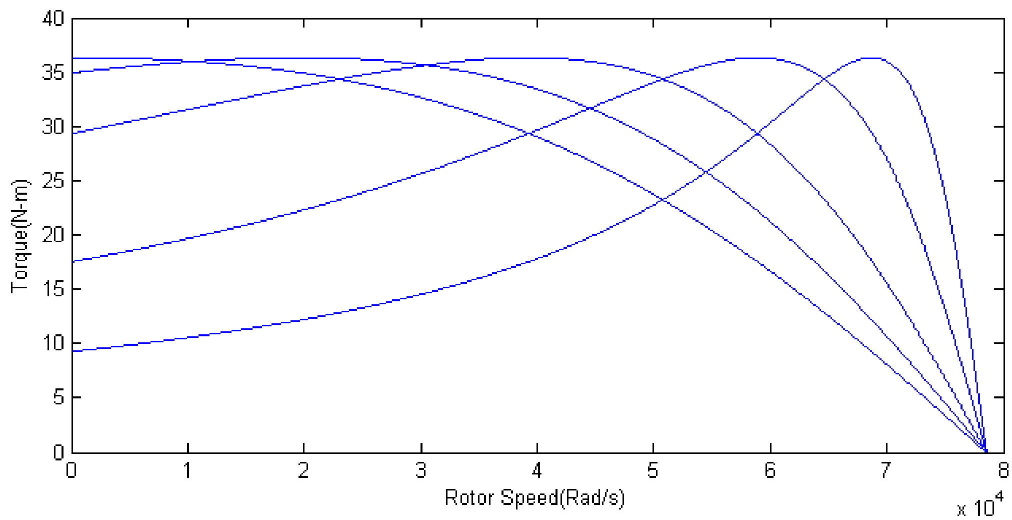
MATLAB Code for Speed Control of 3-φ Induction motor using Variable rotor resistance

```
function out = inductionvarRr()
Vl1=input('Enter the Suppy Voltage (line to line) RMS value: ');
P=input('Enter the number of poles: ');
Rs=input('Stator Resistance: ');
Rr1=input('Enter the first Rotor Resistance: ');
Rr2=input('Enter the second Rotor Resistance: ');
Rr3=input('Enter the third Rotor Resistance: ');
Rr4=input('Enter the fourth Rotor Resistance: ');
Rr5=input('Enter the fifth Rotor Resistance:');
Xs=input('Stator Leakage Reactance @ 50 Hzfrequecny: ');
Xr=input('Rotor Leakage Reactance @ 50 Hz frequecny: ');

Ls=Xs/(2*pi*50);
Lr=Xr/(2*pi*50);
Wsync1=4*pi*50/P;

Tmf2=zeros(Wsync1*500+1,1);
Tmf3=zeros(Wsync1*500+1,1);
 Tmf4=zeros(Wsync1*500+1,1);
Tmf5=zeros(Wsync1*500+1,1);
Tmf1=zeros(Wsync1*500+1,1);


m=1;

for Wrotor1=0:0.002:Wsync1

Tmf1(m)=(3*(((Vl1^2)*Rr1/((Wsync1-Wrotor1)/Wsync1))/((Rs+Rr1/((Wsync1-
Wrotor1)/Wsync1))^2+(2*pi*50*Ls+2*pi*50*Lr)^2))/Wsync1); %star connected m=m+1;
end

m=1;
for Wrotor1=0:0.002:Wsync1

Tmf2(m)=(3*(((Vl1^2)*Rr2/((Wsync1-Wrotor1)/Wsync1))/((Rs+Rr2/((Wsync1-
Wrotor1)/Wsync1))^2+(2*pi*50*Ls+2*pi*50*Lr)^2))/Wsync1);
m=m+1;
end
```

```
m=1;
for Wrotor1=0:0.002:Wsync1

Tmf3(m)=(3*(((Vl1^2)*Rr3/((Wsync1-Wrotor1)/Wsync1))/((Rs+Rr3/((Wsync1-
Wrotor1)/Wsync1))^2+(2*pi*50*Ls+2*pi*50*Lr)^2))/Wsync1);
m=m+1;
end

m=1;

for Wrotor1=0:0.002:Wsync1

Tmf4(m)=(3*(((Vl1^2)*Rr4/((Wsync1-Wrotor1)/Wsync1))/((Rs+Rr4/((Wsync1-
Wrotor1)/Wsync1))^2+(2*pi*50*Ls+2*pi*50*Lr)^2))/Wsync1);
m=m+1;
end m=1;
for Wrotor1=0:0.002:Wsync1

Tmf5(m)=(3*(((Vl1^2)*Rr5/((Wsync1-Wrotor1)/Wsync1))/((Rs+Rr5/((Wsync1-
Wrotor1)/Wsync1))^2+(2*pi*50*Ls+2*pi*50*Lr)^2))/Wsync1);
m=m+1;
end
plot(Tmf1);
 hold on;
plot(Tmf2);
plot(Tmf3);
plot(Tmf4);
 plot(Tmf5);
 hold off;

ylabel('Torque(N-m)');
 xlabel('Rotor Speed(Rad/s)');
 end
```

TITLE: **SIMULATION OF TORUE Vs SPEED CHARACTERISTICS OF THREE PHASE INDUCTION MOTOR**	GPRECD/EEE/EMCP-II- EXPT - 15
SCHEME-20	DATE: 01-07-2022

EXPECTED GRAPH:



RESULT:

REMARKS IF ANY:

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VIVA QUESTIONS:

1. What are the different methods of speed control of an induction motor?
2. Which method is the best method why?
3. Why pole changing and the variable supply frequency methods are very rarely used
4. Discuss about slip power recovery?
5. Why the ratio of V/f is maintained constant in case of speed control?