EXPT NO. 01

AIM : Familiarization of the electrical machine laboratory apparatus.

Theory :

1. RESISTOR - To control the flow of current to other components in a circuit.

2. CAPACITOR - To store the electrical energy and give this energy again to the circuit when necessary.

3. INDUCTOR - To block AC while allowing DC to pass.

4. VOLTMETER - An instrument used for measuring electrical potential difference b/w ~~a~~ two points in an electric circuit.

5. AMMETER - An instrument used for measuring electric current in units of amperes.

6. RELAY - Relays are switches that open and close circuits electromechanically or electronically.

7. RHEOSTAT - An adjustable resistor used in applications that require the adjustment of current or varying of resistance in circuit.
   Its resistance element can be a metal wire or ribbon of carbon or a conducting liquid.

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8. CIRCUIT BREAKER – A switching device that interrupts the abnormal or fault currents. It disturbs the flow of high magnitude current and in addition, performs the function of a switch.

9. AUTO TRANSFORMER – A transformer with only one winding wound on a laminated core. It is similar to a two winding transformer.

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EXPT # 02

Aim : To perform the speed control test on slip control test on slip ring induction motor by rotor resistance control method

Theory :

INTRODUCTION — A wound rotor induction motor or slip ring induction motor has a stator like the squirrel cage induction motor, but a rotor with insulated windings brought out via slip rings and brushes.
However, no power is applied to the slip ring.

SLIP RING CHARACTERISTICS —

- A slip ring motor or a phase wound motor is an induction motor which can be started with full line voltage, applied across its stator terminals.
- Diff. methods of speed control :
  i) Rotor Rheostat Control
  ii) Cascade Control.

SPEED CONTROL BY ROTOR RHEOSTAT CONTROL —

- Ext. rheostat which is used for the starting purpose of these slip ring motors can be used for its speed control too.
- But the pt. to look into is the starting rheostat must be rated for 'continuous' operation.

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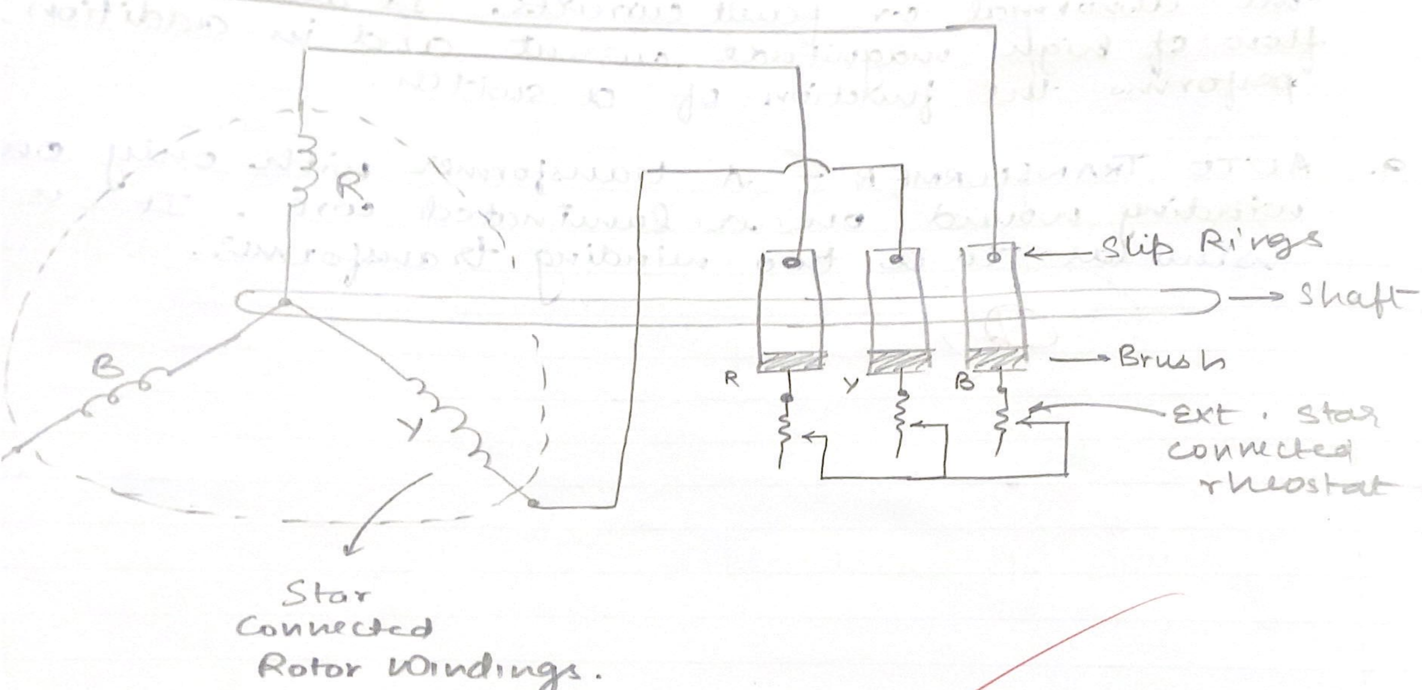

~ Equivalent Circuit of Slip Ring Induction ~

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- The resistance is engaged maximum during starting and slowly cut off to increase the speed, if the need arises to reduce the speed, the resistance is slowly added up and thus speed reduces.

$$T = S/R$$

$R \rightarrow$ Rotor resistance.

$S \rightarrow$ Slip of motor

DISADVATAGES –

As the rotor resistance is increased – the I^2R losses also increases which in turn decrease the operating efficiency of motor.

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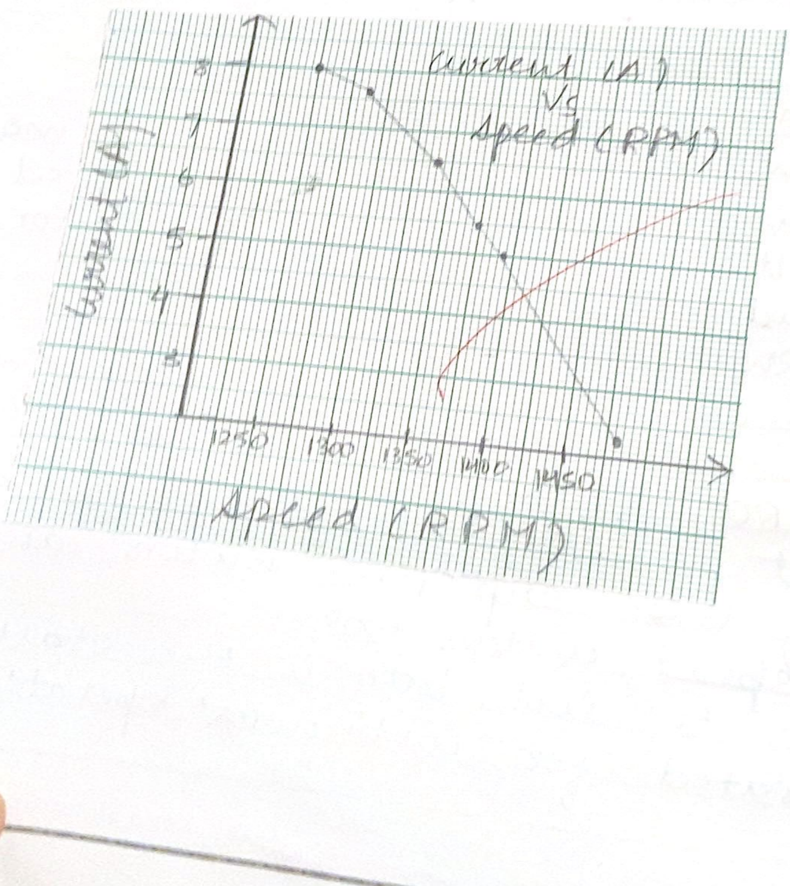
S.No.	Current (A)	Power (W)	Speed (RPM)
1	2.6	40	1474
2	4.8	680	1388
3	5.5	820	1363
4	6.4	1040	1334
5	7.5	1160	1278
6	8	1200	1250



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EXPT # 04

Aim : To study blocked rotor test on induction motor.

Theory :

- A large % of electrical power generated in world is consumed by induction motors, as these are main drive motors used in industries.
- While motor designer calculates parameters using design details, measured values are prefrable for prediction

Steady-state performance of a polyphase induction motor can be obtained using per phase equivalent circuit.

V_1 → i/p voltage per phase

R_1, X_1 → resistance and leakage reactance of stator per phase

R_2, X_2 → resistance and leakage reactance of rotor per phase

X_m → magnetizing reactance

R_c → Core loss resistance

I_1, I_2 → Stator and rotor currents per phase

Developed torque, $T = \frac{3(I_2)R_2}{(S\omega_s)}$ N-m.

ω_s → synchronous speed in rad/sec

ω_r → rotor speed in rad/sec

s → slip

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The parameters could be determined by 'no-load' and 'blocked-rotor' tests, the former determines R_c and X_m.
while the latter yields R_1, R_2, X_1, X_2. Following eqns could be used:

$X_1 = R_1 + jX_1$

$X_2 = R_2 / S + jX_2$

$S = \omega_s - \omega_r / \omega$

Torque : $T = 3(I_2)_2 R_2/S$

Input power : $= 3V_1 / I p f$

Op power : $= (1-S)\omega_s$

In blocked rotor test, rotor is not allowed to rotate so the speed of rotor is zero rpm slip corresponding to zero speed is unity.
Now, ↑ stator voltage till motor current reaches to its rated value.

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EXPT # 05

Aim: To study load test on separately excited DC motor.

Theory:

Load Test on Seperately excited DC motor:

Separetly excited DC motors are very often used as actuators in industrial applications. These actuators have low friction, small size, high speed, low construction cost, operate safely without the use of limit switches and generate moderate torque at a high torque to weight ratio.

DC motors are preferred over AC motors b/c of their lower manufacturing costs and case of controller implementations.

Construction of DC Machines:

The main parts of a DC machine are field winding Armature winding, yoke, commutator segments and brushes. When acting as motor - both the armature and field windings are given DC supply or the field may be created by permanently magnets.

Current flows through both field and armature windings.

Main flux in the machine is produced by the field windings. Current flowing through the armature winding interacts with the main flux to produce the torque.

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Commutator and brushed arrangement is used to change the direction of armature current ~~as~~ the armature ~~current~~ conductors pass under diff polarities of magnetic field.
It leads to production of continuous and unidirection torque.
As the armature rotates, it cuts the flux lines produced by the field.
Direction of induced EMF is found by Fleming's right hand rule and is opp in direction to applied voltage.

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EXPT # 06

Aim: To study the speed control of seperately excited DC motor.

Theory:

DC motors are in general much more adaptable to adjustable speed drives than AC motors which are associated with a constant speed rotating fields. It is thus necessary to gather an idea about speed control methods along with their associated characteristic

Torque, T developed and speed, n of a dC motor are given as:

$$T = K\phi I_a$$

$$N = V_f - I_a R_a / K\phi$$

where K is constt. decided by the design of the machine (total no. of conductors, no. of parallel paths and no. of poles).
The alone eqn explain diff. methods of speed control.

Varying Field Excitation (ϕ).
In shunt and compound motors speed control can be achieved by varying the shunt field circuit resistance. The highest speed is limited by armature reactions under weak field conditions causing rotor motability.

Torque varies directly ~~pr~~ with the flow and ∴
has its highest allowance value at lowest speed.

Varying Armature Terminal Voltage (V_t)

A change of armature terminal voltage results in speed with constant excitation. Usually the power available is constt. voltage AC, so auxiliary equipment in form of rectifier is required to provide controlled armature voltage for motor.

In this region, motor operates in constant torque mode.

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EXPT #07

Aim: To study the speed control of DC motor by field resistance control. Draw the graph b/w the armature current and motor speed by varying the field resistance.

Introduction:

We know that the speed of shunt motor is:

$$N = (V_a - I_a R_a)/K\phi$$

where;

$V_a \rightarrow$ voltage applied across the armature.

$\phi \rightarrow$ flux per pole

$I_f \rightarrow$ field current $(\phi \propto I_f)$

$I_a \rightarrow$ armature current $\rightarrow$ decided by mechanical load present on shaft.

$\therefore$ By varying V_a we can vary 'N'.

For fixed supply voltage and the motor connected as shunt we can vary V_a by controlling an external resistance connected in series with the armature. I_f, can be varied by controlling ext. field resistance R_f, connected with field current.

Thus for shunt motor we have essentially two methods for controlling speed, named by:

1. Varying armature resistance
2. Varying field resistance.

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Speed Control by varying field current:

In this method field current resistance is varied to control the speed of a DC shunt motor.

$N = (V_a - I_aR_a)/K\phi$

If we vary, 'I_f' — flux ϕ will change, hence speed will vary. To change 'I_f' an external resistance is connected in series with the field windings.
The resistance = shunt field regulator the field coil produces rated flux when no ext. resistance is connected and rated voltage is applied across field coil.
It should be understood that we can only decrease flux from its rated value by adding ext. resistance.

Thus speed of the motor will rise as we decrease the current and speed control above the base speed will be achieved. Speed v/s armature current is shown.

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EXPT #08

Aim: To study the load characteristics of DC shunt generator. Draw the internal characteristics and external characteristics under different loading condition.

Introduction →

- In a shunt generator, the field winding is connected in parallel with the armature winding so that terminal voltage of the generator is applied across it.
- The shunt field windings has many turns of fine wire having high resistance.

∴ only a part of armature current flows through the load.

The armature current 'Ia' splits up into two parts. — a (I_{sh}) small fraction flowing through shunt field winding while the major part (I_L) goes to the external load.

~~External~~ Internal Characteristics :

The internal characteristic curve represents the relation b/w the generated V (E_g) and load current (I_L). When the generator is loaded then the generated voltage is decreased due to armature damage.

External / Load characteristics :

Ac curve is showing the ext. characteristics of the shunt wound DC generators. It is showing the variation of terminal voltage with the load current

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Ohmic drop due to armature resistance gives lesser terminal voltage.

$$V = (E_g - I_a R_a) = E_g - (I_L - I_{sh}) R_a$$

Terminal voltage can always be maintained constt. by adjusting the load terminal.

External characteristics of shunt DC generator when the load resistance of a shunt wound DC generator is decreased, then load current of generator increased.

The drastic reduction of terminal voltage across the load results the drop in the load current although at that time load is high or resistance (load) is low.

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