Experiment no.: 2

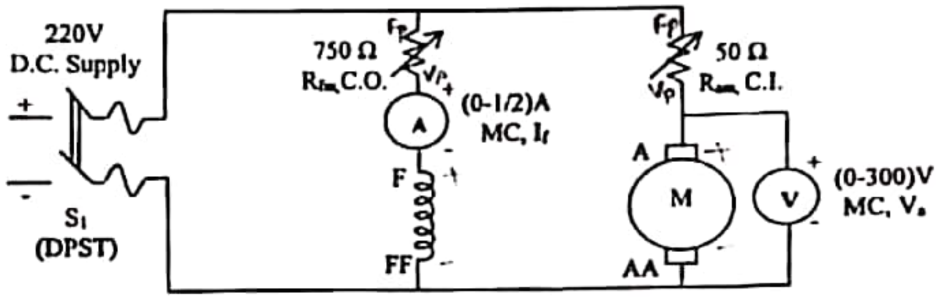
Speed control of D.C. shunt motor

Aim: To control the speed of the given D.C shunt motor by a) Armature control and b) Field control and to plot the speed variations.

Apparatus Required:

D.C. Shunt Motor	- 01
Ammeter (0 – 1/2)A, MC	- 01
Voltmeter (0 - 300)V, MC	- 01
Rheostat (50 Ω)	- 01
Rheostat (750 Ω)	- 01
Tachometer	- 01
Patch cords	- 02
Connecting wires	- 01

Circuit Diagram:



Name plate details D.C. Shunt Motor	
P =	I_f =
V =	N =
I_L =	

Procedure:

1. Connections are made as shown in the circuit diagram.
2. Keeping the rheostats R_{am} in cut-in and R_{fm} in cut-out, the supply switch S_1 is closed.

a). Armature Control:

3. By operating R_{fm}, the field current I_f is adjusted to a particular value (I_{f1}). The readings of ammeter, voltmeter and speed of the motor are noted down.
4. The armature voltage V_a is varied in steps by operating R_{am}. At each step the reading of the voltmeter and speed are noted down. (At each step the field current I_f must be constant).
5. Brought R_{am} to cut-in position, the steps 3 and 4 are repeated for another particular value of field current I_{f2}.
6. Finally R_{fm} and R_{am} rheostats are brought to their original positions and the supply switch S_1 is opened.

b). Field Control:

3. By operating R_{am}, the armature voltage V_a is adjusted to a particular value (V_{a1}). The readings of voltmeter, ammeter and the speed of the motor are noted down.
4. The field current I_f is varied in steps by operating R_{fm}. At each step the reading of the ammeter and the speed are noted down. (At each step the armature voltage V_a must be constant).
5. Brought R_{fm} to cut-out position, the steps 3 and 4 are repeated for another particular value of armature voltage V_{a2}.
6. Finally, R_{fm} and R_{am} rheostats are brought to their original positions and the supply switch S_1 is opened.

Tabular Column:

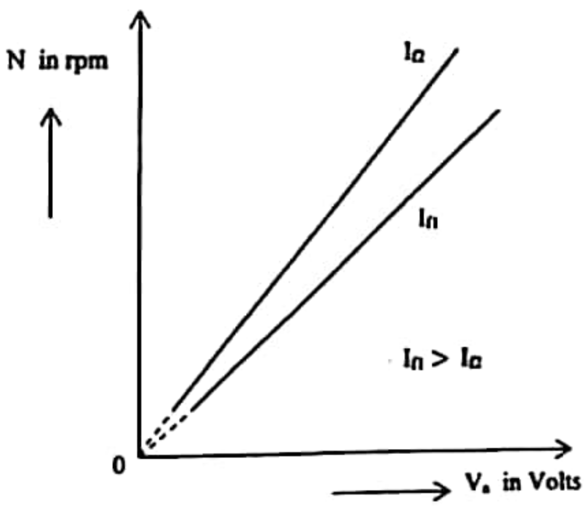
a). Armature Control:

Sl.No.	I_{f1} = Amps		I_{f2} = Amps	
	V_a Volts	N rpm	V_a Volts	N rpm

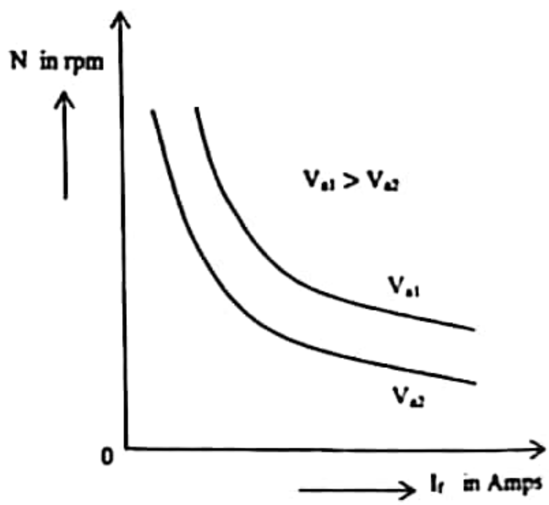
b). Field Control:

Sl.No.	V_{a1} = Volts		V_{a2} = Volts	
	I_f Amps	N rpm	I_f Amps	N rpm

Graphs:



a). Armature Control



b). Field Control

Experiment no.: 1

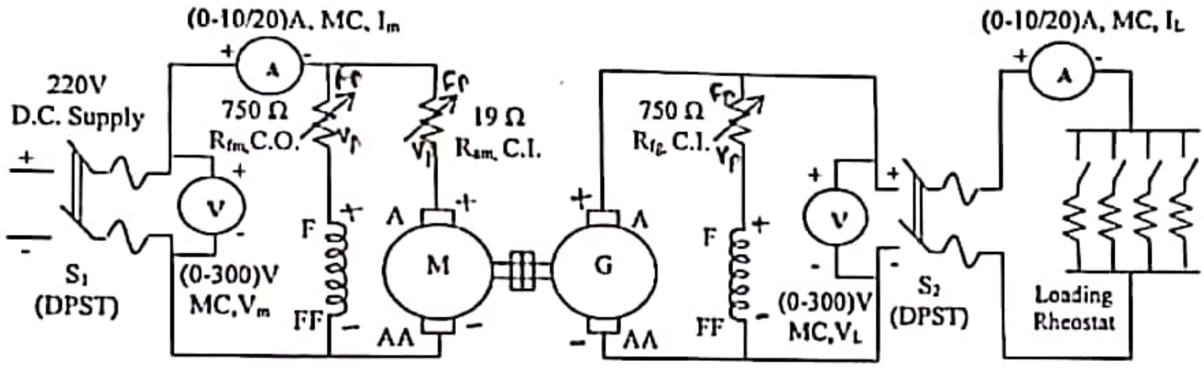
Load test on D.C. shunt motor

Aim: To conduct load test on a D.C shunt motor and to plot its performance characteristics

Apparatus Required:

D.C. Motor- D.C. Generator set		- 01
Ammeter	(0 – 10/20)A, MC	- 02
Voltmeter	(0 - 300)V, MC	- 02
Rheostat	(19Ω)	- 01
Rheostats	(750 Ω)	- 02
Loading rheostat		- 01
Tachometer		- 01
Patch cords		- 04
Connecting wires		-12

Circuit Diagram:



Name plate details	
D.C. Motor	D.C. Generator
P =	P =
V =	V =
I_L =	I_L =
I_f =	I_f =
N =	N =

Procedure:

1. Connections are made as shown in the circuit diagram.
2. Keeping the rheostats R_{am} in cut-in, R_{fm} in cut-out, R_{fg} in cut-in and load switch S_2 open, the supply switch S_1 is closed.
3. The motor is brought to its rated speed (1500 rpm) by first cutting-out R_{am} completely and then slowly cutting-in the R_{fm} , if necessary.
4. The generator voltage V_L is build up to the rated value of 220V by cutting-out R_{fg} gradually. Then the no-load readings of all the meters are noted down.
5. The load switch S_2 is closed. Using loading rheostat the load is increased in steps. At each step, the generator voltage (V_L) is kept constant at rated value by gradually cutting-out the R_{fg} and the readings of all the meters and speed (using Tachometer) are noted down.
6. The loading of the motor is continued till the current drawn by the motor equals to its rated value.
7. The load is decreased and at the same time maintain V_L constant by cutting-in the R_{fg} and the load switch S_2 is opened.
8. Now, brought R_{fg} to cut-in position, and then R_{fm} and R_{am} to cut-out and cut-in positions respectively. Finally, open the supply switch S_1.

Tabular Column:

Sl.No.	N rpm	I_m Amps	V_m Volts	I_L Amps	V_L Volts	% η	B.H.P (HP)	T N-m

Calculations:

P_{in} = Power input to the motor = $V_m \times I_m$=________ Watts

P_{out} = Power output of the motor = Power input to the generator

$$\therefore P_{out} = \frac{\text{Power output of the generator}}{\text{Efficiency of the generator}} = \frac{V_L \times I_L}{\eta_g} = \_\_\_\_\_\_\text{Watts}$$

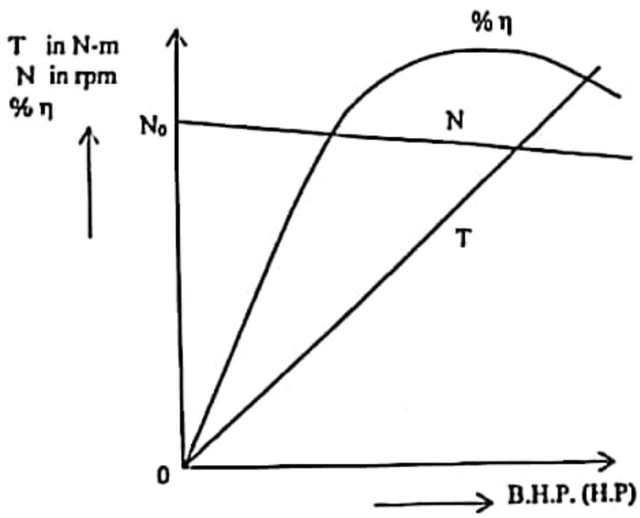
Assume, efficiency of the generator η_g= 0.75 (i.e, 75%)

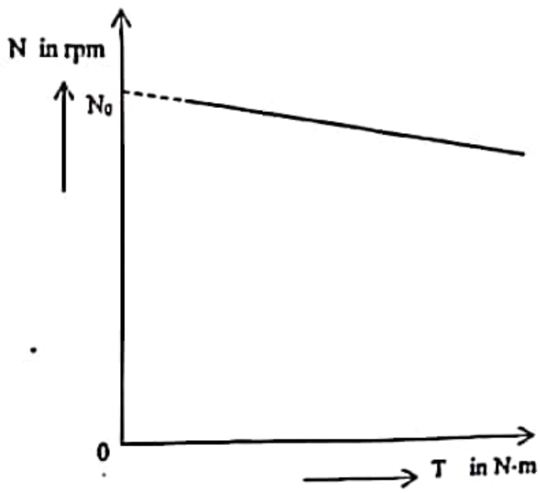
$$\text{Percentage efficiency (\% η) of the motor} = \frac{P_{out}}{P_{in}} \times 100 = \_\_\_\_\_\_\%$$

$$B.H.P = \frac{P_{out}}{735.5} = \_\_\_\_\_\_ H.P$$

$$\text{Torque (T)} = \frac{P_{out} \times 60}{2\pi \times N} = \_\_\_\_\_\_ N-m$$

Graphs:





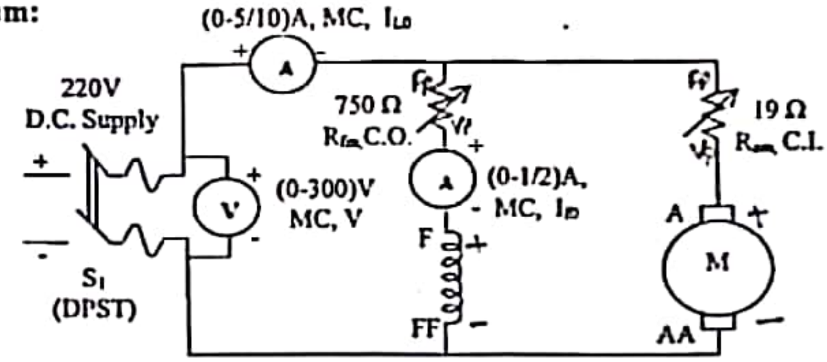
Experiment no.: 9 3
Swinburne's Test

Aim: To conduct Swinburne's test or no-load test on a given D.C shunt machine to obtain its efficiency.

Apparatus Required:

D.C. Shunt machine	- 01
Ammeter (0 – 5/10)A, MC	- 01
Ammeter (0 – 1/2)A, MC	- 01
Voltmeter (0 - 300)V, MC	- 01
Rheostat (19Ω)	- 01
Rheostats (750 Ω)	- 01
Tachometer	- 01
Patch cords	- 02
Connecting wires	- 08

Circuit Diagram:



Name plate details D.C. Shunt Motor	
P =	I_f =
V =	N =
I_L =	

Procedure:

1. Connections are made as shown in the circuit diagram.
2. Keeping the rheostats R_{am} in cut-in and R_{fm} in cut-out, the supply switch S_1 is closed.
3. The motor is brought to its rated speed (1500 rpm) by first cutting-out R_{am} completely and then slowly cutting-in the R_{fm}, if necessary.
4. The readings of ammeters and voltmeter are noted down.
5. Finally, R_{fm} and R_{am} rheostats are brought to their original positions and the supply switch S_1 is opened.
6. Armature resistance of the machine (R_a) is measured across the terminals A-AA using multimeter.

Tabular Column:

Sl.No.	V Volts	I_{LO} Amps	I_{fo} Amps	R_a Ohms
1				

Calculations: At no-load:

Power input to the motor = $V \times I_{LO}$ = ________ Watts

Armature copper loss = $(I_{LO} - I_{fo})^2 \times R_a$ = ________ Watts

Constant losses, W_c = (Power input) - (Armature copper loss) = ________ Watts

a) Efficiency of the machine when running as motor: At full load:

Note down full load current or rated current I_L, rated field current I_f of the motor from the name plate details.

Armature current of the motor, $I_a = (I_L - I_f)$ = __________ Amps

Armature copper loss = $I_a^2 \times R_a$ = __________ Watts

Power input to the motor = $P_{in} = V \times I_L$ = __________ Watts

Total losses = W_c + Armature copper loss = __________ Watts

Power output of the motor = P_{out} = (Power input) - (Total losses) = __________ Watts

Percentage efficiency ($\% \eta_m$)of the motor at full load $= \frac{P_{out}}{P_{in}} \times 100$ = ________%

Similarly efficiencies at 75%, 50% & 25% of full load are determined and results are tabulated.

b) Efficiency of the machine when running as generator: At full load:

Note down full load current or rated current I_L, rated field current I_f of the generator from the name plate details.

Armature current of the generator, $I_a = (I_L + I_f)$ = __________ Amps

Armature copper loss = $I_a^2 \times R_a$ = __________ Watts

Power output to the generator = $P_{out} = V \times I_L$ = __________ Watts

Total losses = W_c + Armature copper loss = __________ Watts

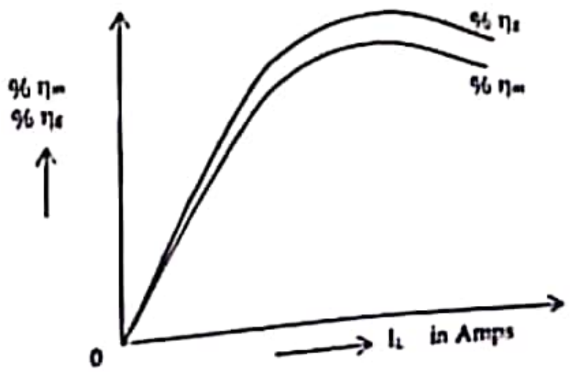
Power input of the generator = P_{in} = (Power output) + (Total losses) = __________ Watts

Percentage efficiency ($\% \eta_g$)of the generator at full load $= \frac{P_{out}}{P_{in}} \times 100$ = ________%

Similarly efficiencies at 75%, 50% & 25% of full load are determined and results are tabulated.

Sl.No.	Load current I_L Amps	$\% \eta_m$	$\% \eta_g$
1	Full load		
2	75% full load		
3	50% full load		
4	25% full load		

Graph:



Experiment no.: 4

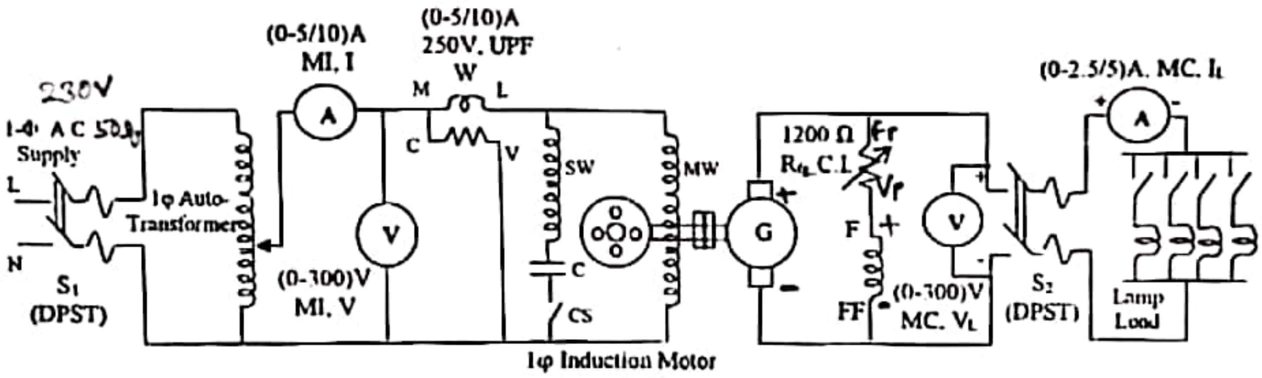
Load Test on Single Phase Induction Motor

Aim: To conduct load test on the given single phase induction motor and to determine its percentage efficiency, BHP, torque, slip and draw the performance characteristics.

Apparatus Required:

1φ Induction Motor - D.C. Generator set	- 01
1φ Auto Transformer	- 01
Ammeter (0 – 5/10)A, MI	- 01
Voltmeter (0 - 300)V, MI	- 01
Wattmeter (0 – 5/10)A, 250V, UPF	- 01
Ammeter (0 – 2.5/5)A, MC	- 01
Voltmeter (0 – 300)V, MC	- 01
Rheostat (1200 Ω)	- 01
Lamp load	- 01
Tachometer	- 01
Patch cords	- 06
Connecting wires	- 12

Circuit Diagram:



SW- Start Winding. MW – Main Winding. C – Capacitor. CS – Centrifugal Switch

L - Line/phase

N - Neutral

Name plate details		
1 φ Induction Motor		D.C. Generator
Power =	f =	Power =
V =		V =
I =		I_L =
N =		I_f =
P = Poles =		N =

Procedure:

1. Connections are made as shown in the circuit diagram.
2. Keeping the load switch S_2 open and R_{fg} in cut-in position, the supply switch S_1 is closed.
3. Using 1φ auto-transformer the supply voltage is gradually increased to rated value (230V).
4. Now, the d.c. generator voltage is build up to its rated value of 220V by cutting out of R_{fg}.
5. Corresponding to this no load, the readings of all the meters & the speed are noted.
6. The induction motor is indirectly loaded by loading the d.c. generator, i.e., close the load switch S_2 & with the help of lamp load, the d.c. generator is loaded in steps until the ammeters I reads the rated current of the induction motor. At each step, the d.c. generator terminal voltage is maintained constant at its rated value (220V) using R_{fg} and the readings of all the meters and speed are noted.

K-11

7. The load is decreased in steps, maintaining the terminal voltage of the d.c. generator constant using R_{fg} and the load switch S_2 is opened.
8. Now, R_{fr} is brought to cut in position then, 1φ auto-transformer to zero output position & the supply switch S_1 is opened.

Tabular Column:

Sl. No.	V Volts	I Amps	$W = W_R \times K$ Watts	V_L Volts	I_L Amps	N rpm	% η	B.H.P (HP)	T N-m	% slip	p.f.
1											
2											
3											
4											
5											

W_R =Wattmeter Reading,

$$K = \text{Wattmeter constant} = \left[\frac{(\text{Voltage range}) \times (\text{Current range}) \times (\text{p.f. of wattmeter})}{\text{Full scale divisions of wattmeter}}\right]$$

Calculations: From Load Readings:

P_{og} = Power output of the d.c. generator = $V_L \times I_L$ = ________ Watts

Assume efficiency of d.c. generator = 0.8

P_{out} = Power output of induction motor = Power input to d.c generator = $\frac{P_{og}}{0.8}$ = ____ Watts

P_{in} = Power input to the induction motor = W = ________ Watts

Percentage efficiency of the Induction motor = $\% \eta = \frac{P_{out}}{P_{in}} \times 100$ = ______%

$$B.H.P = \frac{P_{out}}{735.5} = \_\_\_\_\_\_ H.P.$$

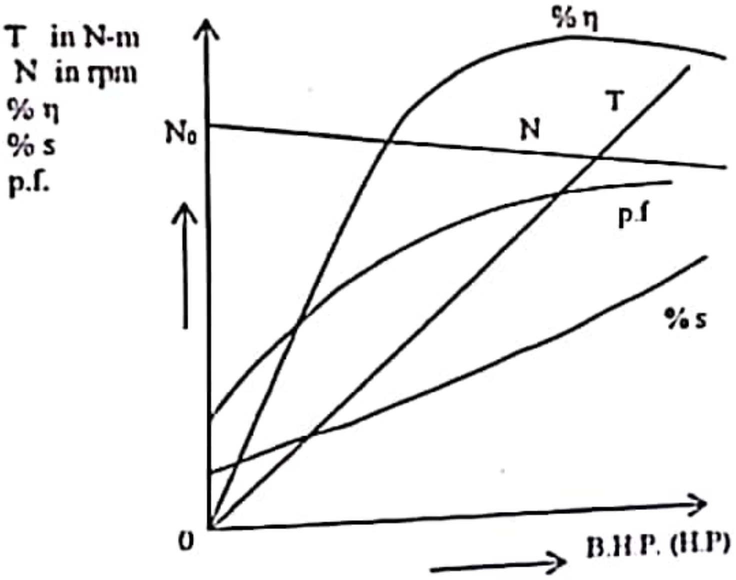
$$\text{Torque}\ (T) = \frac{P_{out} \times 60}{2\pi \times N} = \_\_\_\_\_\_ N-m$$

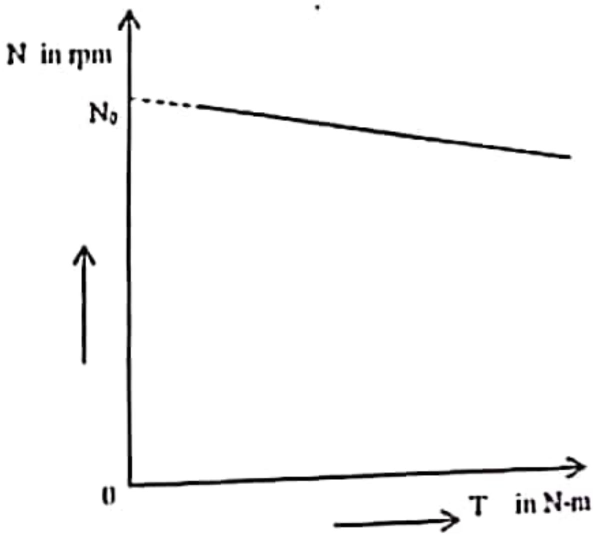
N_s = Synchronous speed of induction motor = $\frac{120 \times f}{P}$ = ______rpm

$\% s$ = Percentage slip of induction motor $= \frac{N_s - N}{N_s} \times 100 =$ ______%

$p.f$ = Power factor $= \cos\varphi = \frac{W}{V \times I}$

Graphs:





Experiment no.: 5

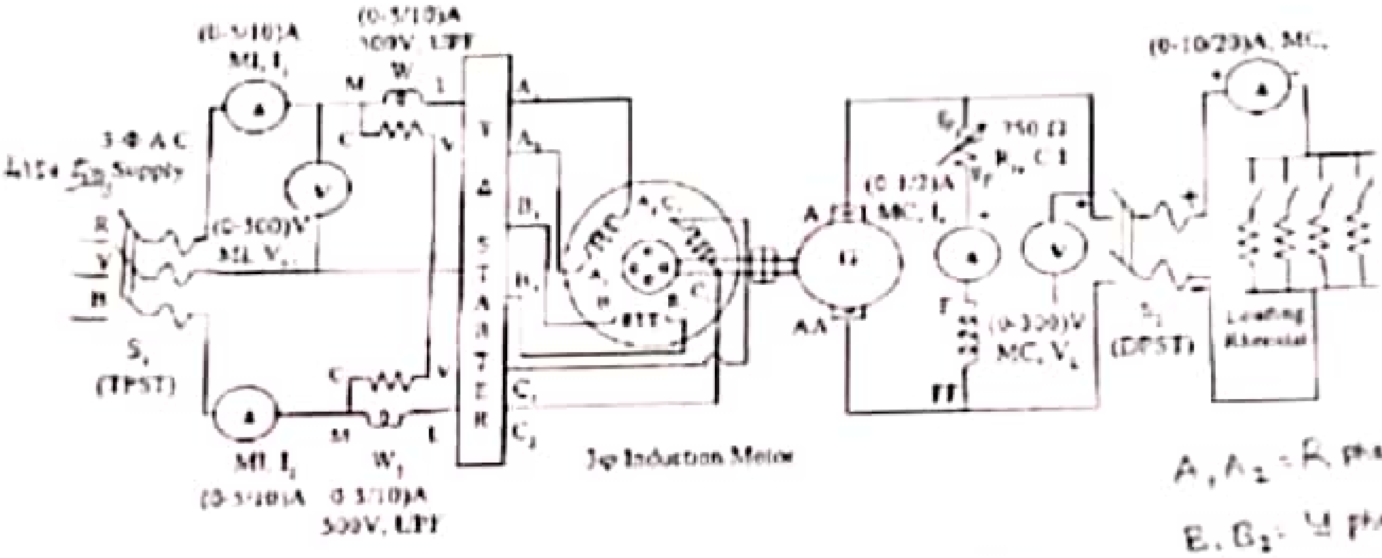
Load Test on Three Phase Induction Motor

Aim: To conduct load test on the given three phase induction motor and to determine its percentage efficiency, BHP, torque, slip and draw the performance characteristics.

Apparatus Required:

3φ Induction Motor - D.C. Generator set	- 01
Ammeter (0 - 5/10)A, MI	- 02
Voltmeter (0 - 600)V, MI	- 01
Wattmeter (0 - 5/10)A, 500V, UPF	- 02
Ammeter (0 - 10/20)A, MC	01
Ammeter (0 - 1/2)A, MC	- 01
Voltmeter (0 - 300)V, MC	- 01
Rheostat (750 Ω)	- 01
Loading rheostat	- 01
Tachometer	- 01
Patch cords	- 08
Connecting wires	- 20

Circuit Diagram:



A, A2 - R phase Red colour
B, B2 - Y phase yellow colour
C, C2 - B phase Blue colour

Name plate details	
3 φ Induction Motor	**D.C. Generator**
Power = f =	Power =
V_L =	V =
I_L =	I_L =
N =	I_f =
P = Poles =	N =

Procedure:

1. Connections are made as shown in the circuit diagram.
2. Keeping the load switch S_2 open and R_{sh} in cut-in position, the supply switch S_1 is closed.
3. The induction motor is started using the star-delta (Y-Δ) starter.
4. Now, the d.c. generator voltage is build up to its rated value of 220V by cutting out of R_{sh}.
5. Corresponding to this no load, the readings of all the meters & the speed are noted. If any of the wattmeters 'kick back', then its potential coil terminals common (C) & voltage (V) are interchanged & its reading is noted as negative.

6. The induction motor is indirectly loaded by loading the d.c. generator, i.e., close the load switch S_2 & with the help of loading rheostat, the d.c. generator is loaded in steps until the ammeters I_1 and I_2 read the rated current of the induction motor. At each step, the d.c. generator terminal voltage is maintained constant at its rated value (220V) using R_g and the readings of all the meters and speed are noted.
7. The load is decreased in steps, maintaining the terminal voltage of the d.c. generator constant using R_{f_g} and the load switch S_2 is opened.
8. Now, R_{f_g} is brought to cut in position then, induction motor is stopped using the starter & the supply switch S_1 is opened.
9. The d.c. generator armature resistance (R_a) is measured across A-AA using multimeter.

Tabular Column:

Sl. No	V_{11} Volts	I_1 Amps	I_2 Amps	$W_1 = W_{R1} \times K_1$ Watts	$W_2 = W_{R2} \times K_2$ Watts	V_L Volts	I_f Amps	I_L Amps	N rpm	% η	B.H.P (HP)	T N-m	% slip	p.f.
1														
2														
3														
4														
5														

R_a = ________ Ω, W_{R1} & W_{R2} – Wattmeter Readings

K_1 & K_2 – Wattmeter constants = $\left[\frac{(\text{Voltage range}) \times (\text{Current range}) \times (\text{p.f. of wattmeter})}{\text{Full scale divisions of wattmeter}}\right]$

Calculations:

From No-Load Readings:

P_{SL} = No load losses of the d.c. generator = $\frac{W_1 + W_2}{2}$ = ________ Watts

From Load Readings:

P_{cu} – Armature copper loss of d.c. generator = $(I_L + I_{sh})^2 \times R_a$ = ________ Watts

P_{og} – Power output of the d.c. generator = $V_L \times I_L$ = ________ Watts

P_{out} – Power output of induction motor = Power input to d.c generator = $P_{og} + P_{cu} + P_{SL}$ = ________ Watts

P_{in} = Power input to the induction motor = $W_1 + W_2$ = ________ Watts

Percentage efficiency of the induction motor = % η = $\frac{P_{out}}{P_{in}} \times 100$ = ________ %

B.H.P = $\frac{P_{out}}{735.5}$ = ________ H.P.   Torque (T) = $\frac{P_{out} \times 60}{2\pi \times N}$ = ________ N – m

N_s = Synchronous speed of induction motor = $\frac{120 \times f}{P}$ = ______rpm

% s = Percentage slip of induction motor = $\frac{N_s - N}{N_s} \times 100$ = ______%

φ = Power factor (p.f.)angle = $\tan^{-1}\left[\frac{\sqrt{3}\,(W_1 - W_2)}{W_1 + W_2}\right]$ in deg

p.f. = Power factor = cos φ

Graphs: