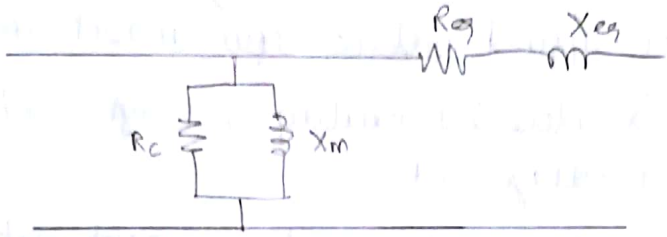
DETERMINATION OF TRANSFORMER EQUIVALENT CIRCUIT

AIM:

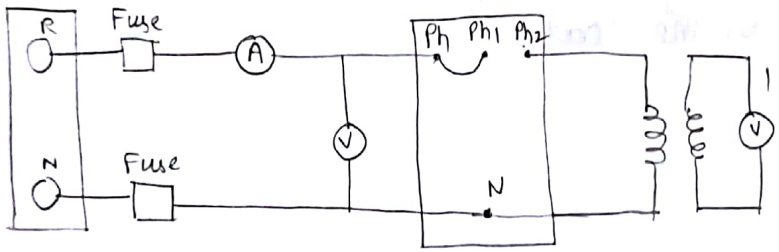
To perform open and short circuit tests on the transformer and find its regulation

CIRCUIT DIAGRAMS:

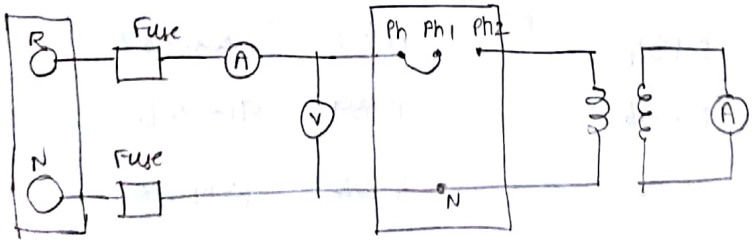


Approx. Equivalent circuit

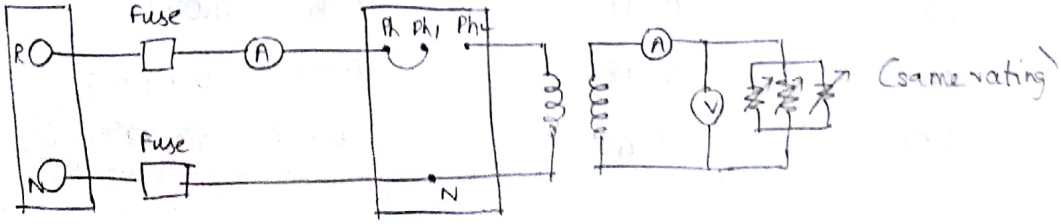
Open circuit Test:



Short circuit Test:



Load Test



PROCEDURE:

* Open circuit test is performed by applying voltage across the low voltage side and leaving the high voltage side open
* It is a good practise to wire the series connections first and then connect the voltage transducer
* After connections, the voltage is to be varied from 0 to 1.1 times the rated load. Note down applied voltage input current and power
* The short circuit test is done by exciting the high voltage side and shorting the low voltage side.
* Apply suitable voltage at the exciting end to ~~match~~ make rated current flow through
* For the load test, after making the connections keep the primary side at constant voltage and vary the resistive loads. Note down the voltages across the load.

OBSERVATIONS:

OC Test:

V	I	Power	Ym
205	0.054	0.07	463.587
50	0.056	0.59	913.364
75	0.06	1.44	1319.38
100	0.065	2.51	1667.83
125	0.074	3.9	1862.86
150	0.086	5.49	1927.45
175	0.117	7.55	1609.12
200	0.198	10.07	1044.43
230	0.45	14.07	515.899

SC Test : (Apply I_{rated} on 1°)

V	I	Power
12.7 V	4.4 A	33.2 W

Load Test :

R	I_{out}	P_{in}	I_{in}	V_{out}
0	0.41	112	0.72	239
1	0.79	201.8	0.99	236
2	1.18	293.8	1.34	233.4
3	1.57	378.4	1.68	232.2
4	1.92	458.5	2.01	229

CALCULATIONS :

Oc Test :

$$P = \frac{V^2}{R_c}$$

$$R_c = \frac{V^2}{P} = \frac{(230)^2}{14.07} = 3759.77\ \Omega$$

$$I_c = \frac{V_{in}}{R_c} = \frac{230}{3759.77} = 0.06117\ A$$

$$I_m = \sqrt{I_{in}^2 - I_c^2} = \sqrt{(0.45)^2 - (0.0611)^2} = 0.446\ A$$

$$X_m = \frac{230}{0.446} = 515.899\ \Omega$$

SC Test:

$$P_{sc} = R_e I_L^2$$

$$33.2 = R_e \times (4.4)^2$$

$$R_{eq} = 1.715\ \Omega$$

$$Z_{eq} = \frac{V_L}{I_L} = \frac{12.7}{4.4} = 2.886\ \Omega$$

$$X_{eq} = \sqrt{(2.886)^2 - (1.715)^2} = 2.321\ \Omega$$

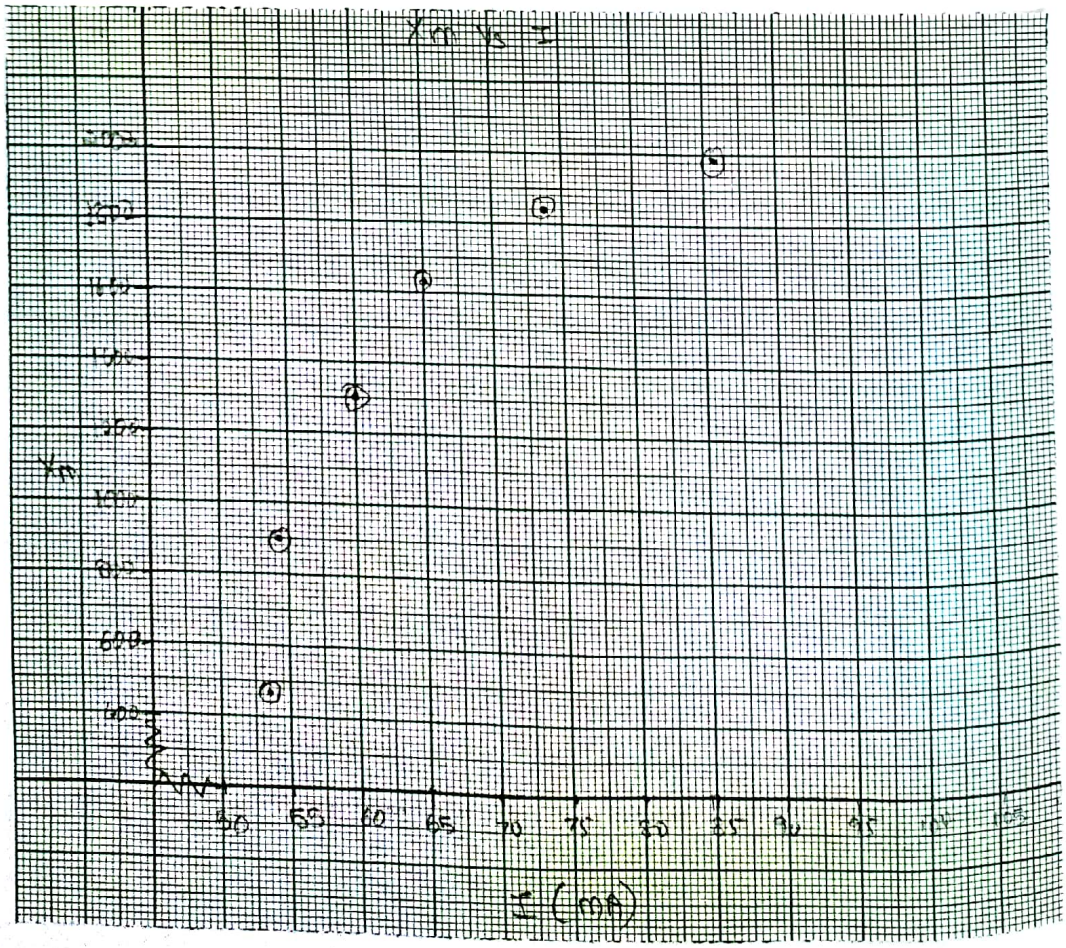
Voltage Regulation:

$$= \frac{E_{no\,load} - V_{full\,load}}{V_{full\,load}}$$

$$= \frac{239 - 229}{229}$$

$$= 0.0436 = 4.36\ \%$$

Plot of Xm Vs I:

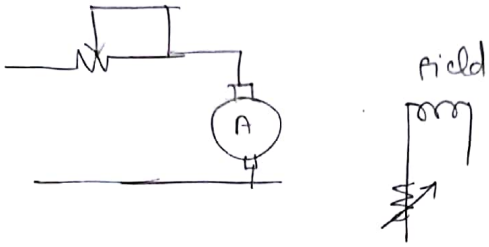


DC Motor - Speed control and Speed Torque techniques

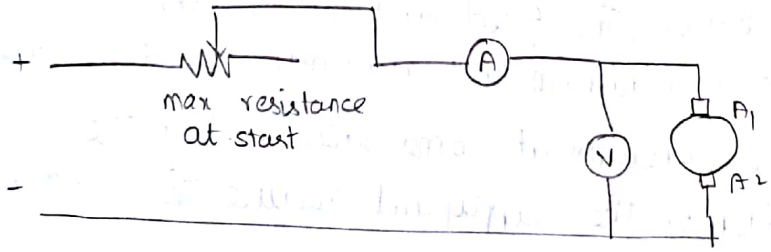
AIM:

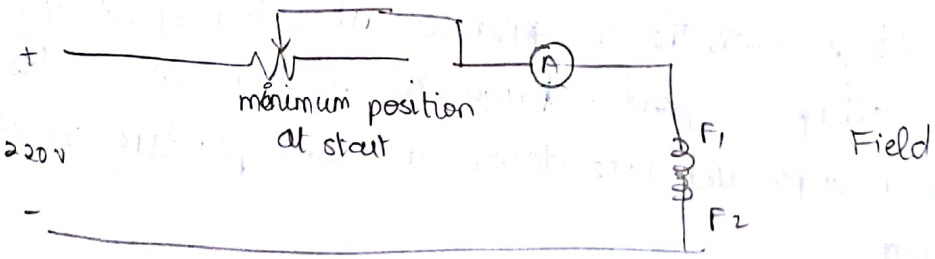
To demonstrate speed control in a DC motor by using armature control and field control methods and to determine speed torque characteristics

CIRCUIT DIAGRAMS:

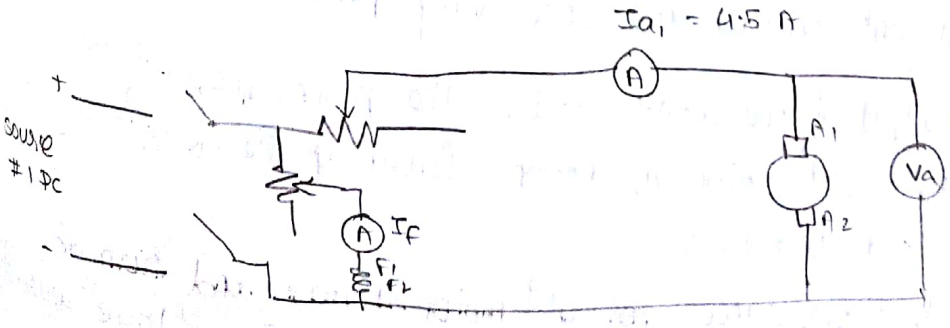


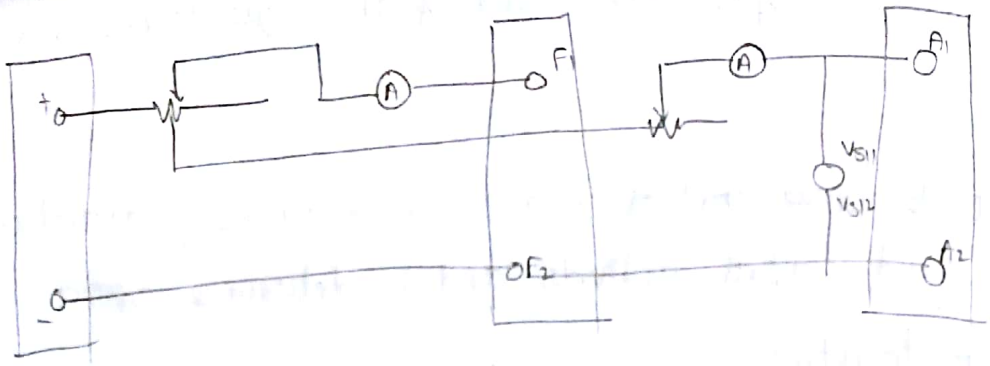
Armature Control (speed < rated speed)
Field control (speed > rated speed)



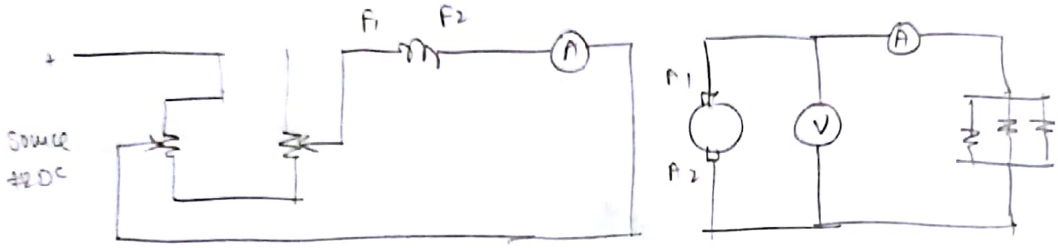


Speed control:





Load Test:



PROCEDURE:

* Connect the circuit as drawn, the field and the armature resistance should be kept in minimum and maximum positions resp.
* Keep the field of the DC generator at some value below the rated value and switch on the supply and reduce the armature resistance to run the motor at rated speed
* Measure the voltage across the DC generator at rated speed and calibrate this voltage to speed. change the speed by varying the field rheostat in steps and note down the corresponding value of field current.
* In armature control method, the armature resistance is varied to vary the current flowing and hence vary speed.
* For load test, output of one motor will be the prime mover of the second. set up the 2nd motor as shown. Power up the first one to about 1500 RPM. set load to 0.
* Keep field winding resistance for 2nd motor at max and turn on its supply. Now increase the field current to make the voltage across
* Increase load by one step and repeat the process

DC Motor Ratings:

KW → 1.1

Volts → 230

RPM → 1500/2000

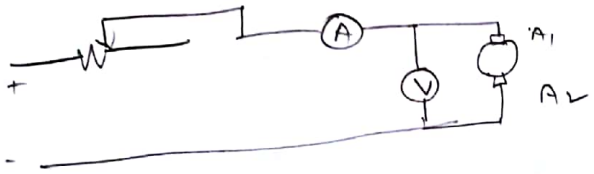
Amps → 6.5

Excitation V : 2V

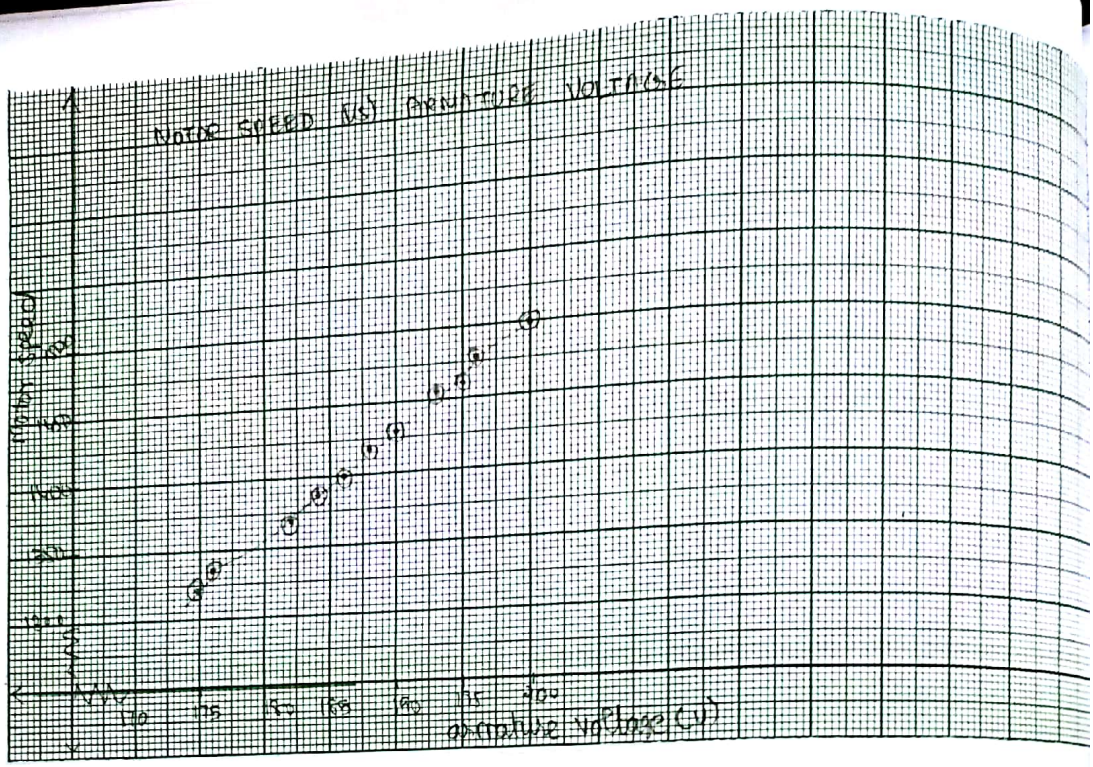
I : 0.6A

OBSERVATIONS:

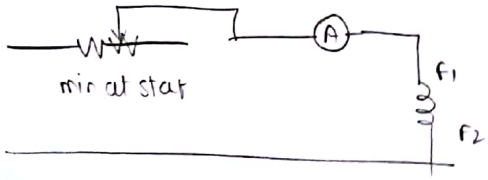
Armature Voltage control:



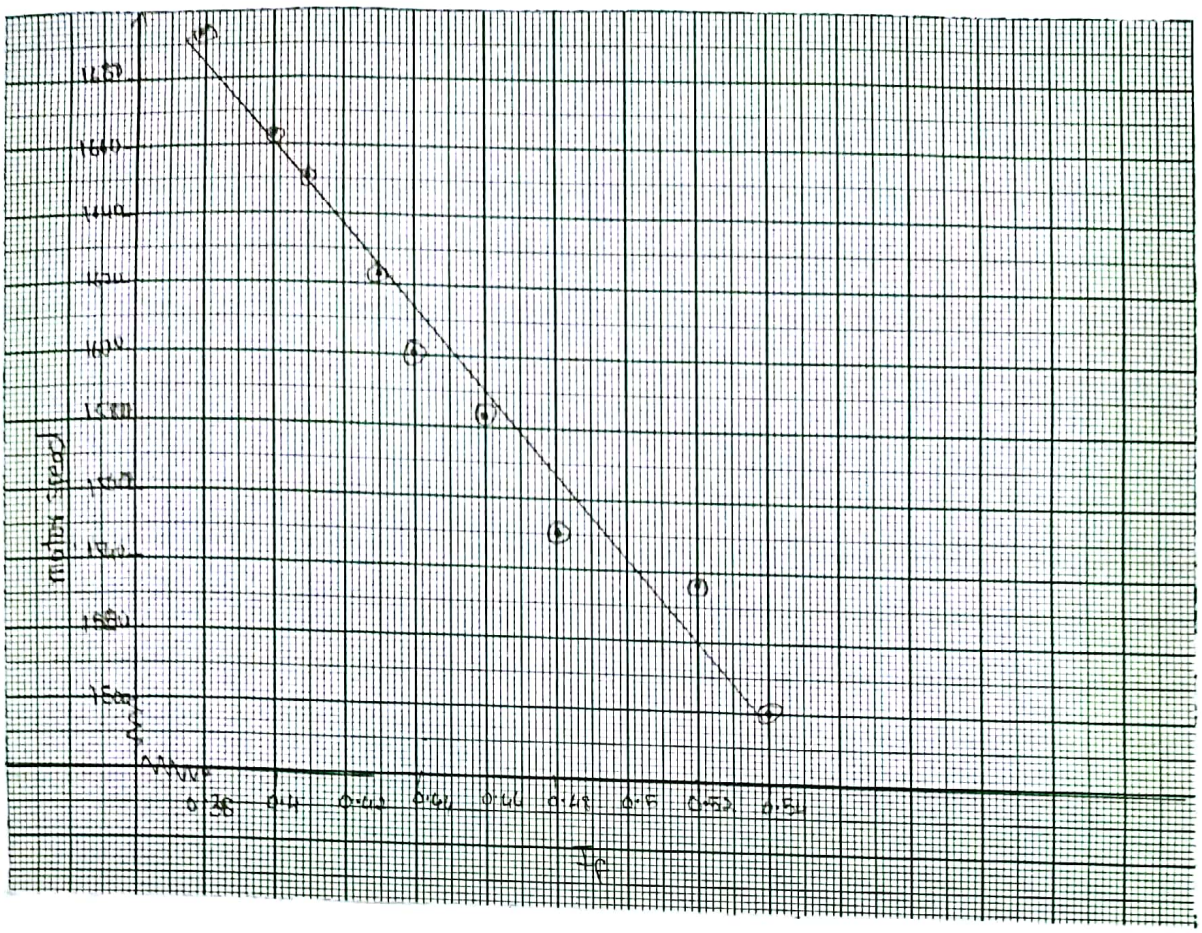
V_a	N
199.5	1500
196.4	1480
194.1	1464
193.2	1457
189.8	1430
188	1420
185.9	1404
184.1	1392
182.1	1376
180.2	1362
176.5	1335
174.9	1324



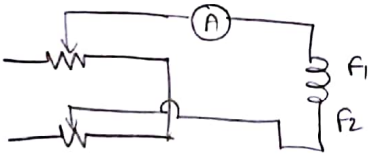
FIELD CONTROL

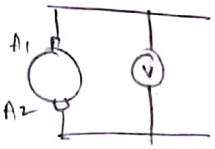


I_f	N
0.54	1500
0.52	1537
0.48	1550
0.46	1586
0.44	1605
0.43	1626
0.41	1655
0.40	1668
0.38	1696



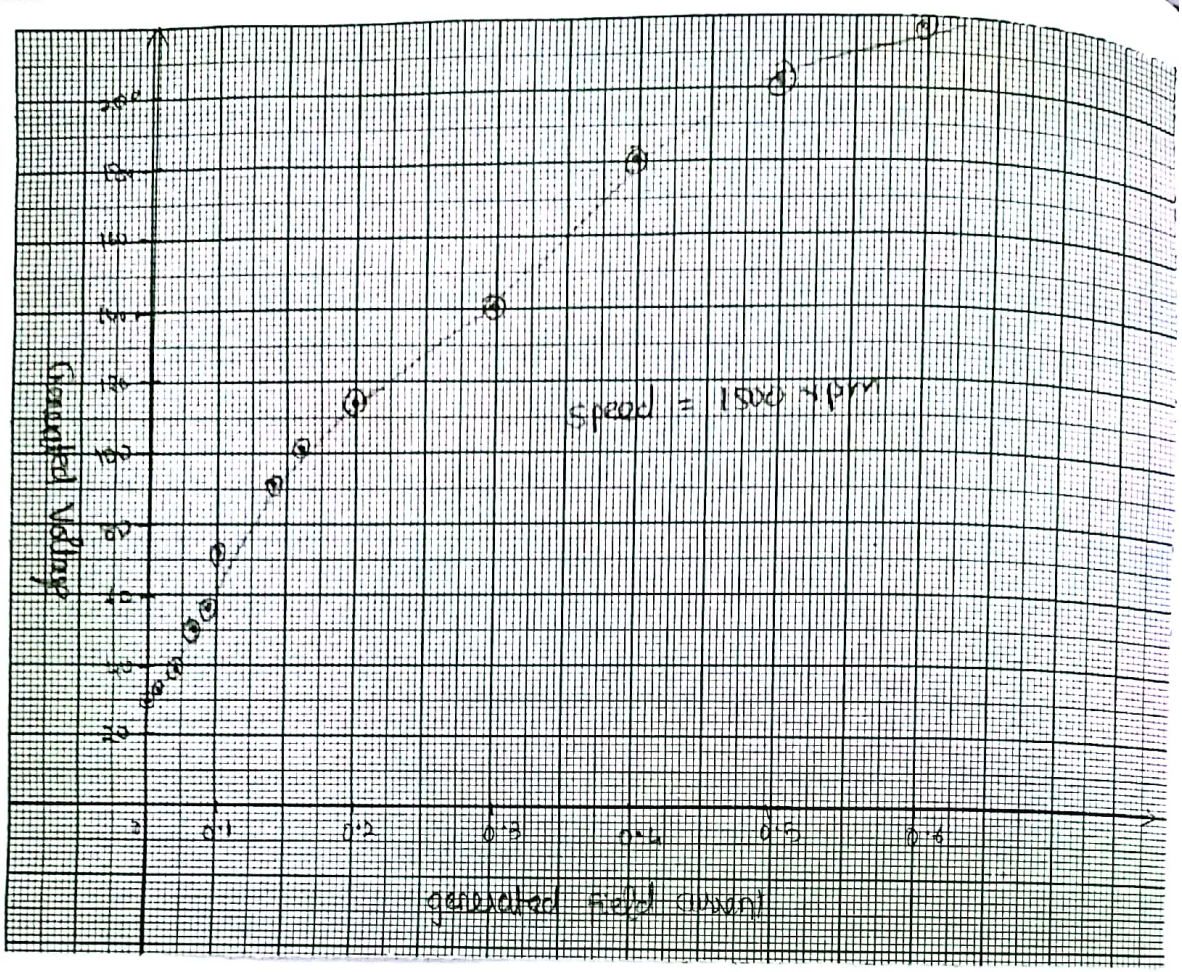
Open circuit characteristics of seperately excited DC generator



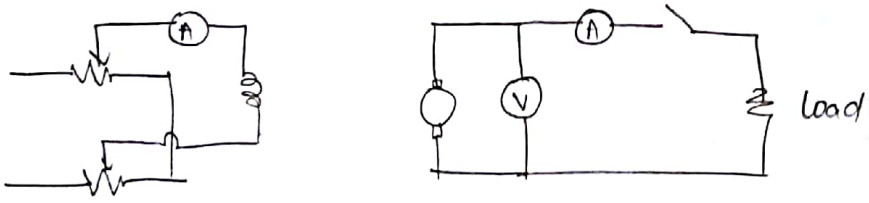


E_{oen}	I_f
27	0.001
30.5	0.014
38.8	0.037
50.5	0.066
62.9	0.072
75.5	0.118
87.2	0.14
99.2	0.167
115.6	0.2
126.9	0.23
143.4	0.27
168.8	0.35

E_{oen}	I_f
177.3	0.388
189.9	0.45
197.3	0.49
202.1	0.53
205.5	0.56
209.6	0.59



Load Characteristics:



R	N	V	I	Armature current (motor)
0	1500	209.2	0.046	1.14
1	1500	207	0.386	1.52
2	1500	205.6	0.71	1.89
3	1500	202.87	1.03	2.25
4	1500	202.8	1.36	2.69
5	1500	201.3	1.67	3.05

LOAD TEST :

$$\text{Regulation} = \frac{\text{No load voltage} - \text{Full load voltage}}{\text{No load voltage}}$$

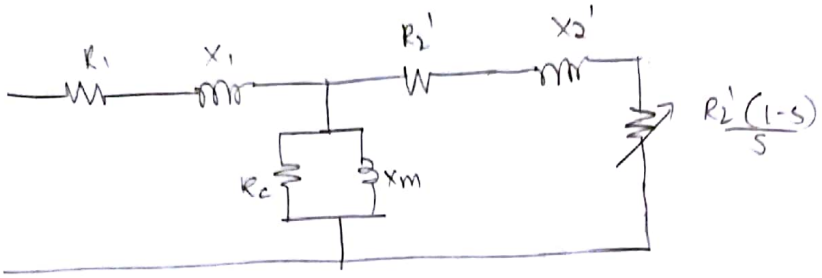
R	Regulation
1	1.05 %
2	1.7 %
3	3.1 %
4	3.05 %
5	3.77 %

Induction Machines

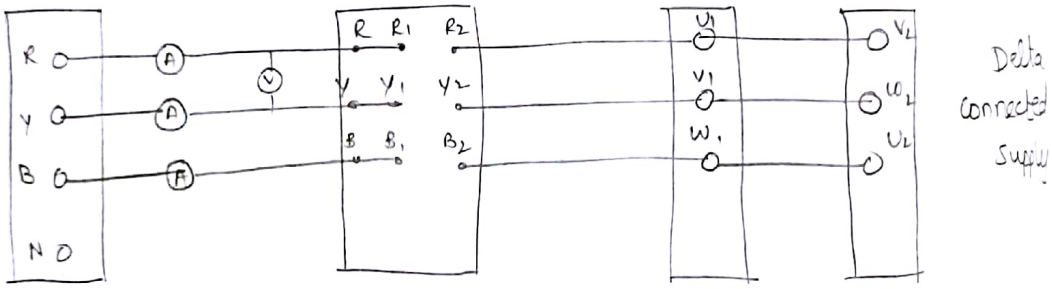
AIM:

To determine circuit parameters of an induction machine.

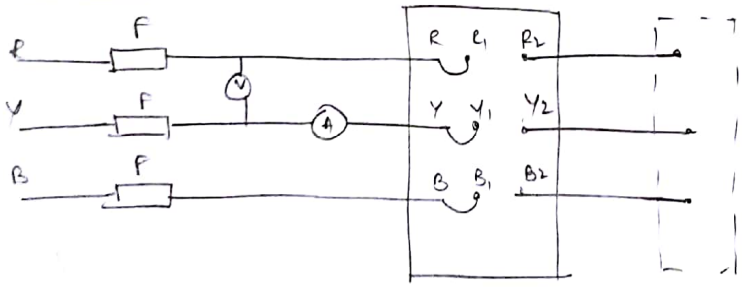
CIRCUIT DIAGRAM:

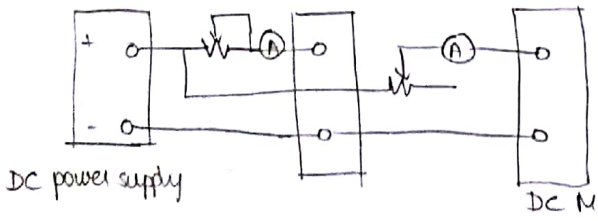


Blocked Rotor Test

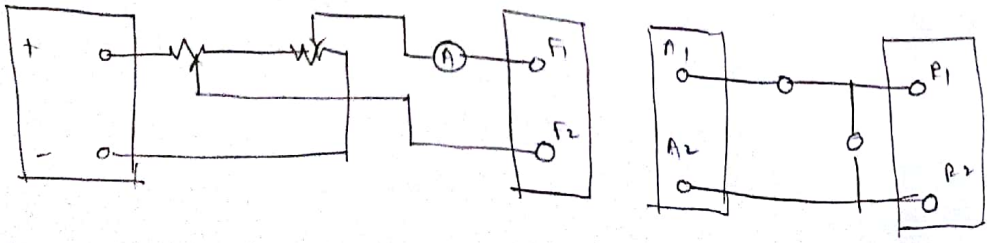


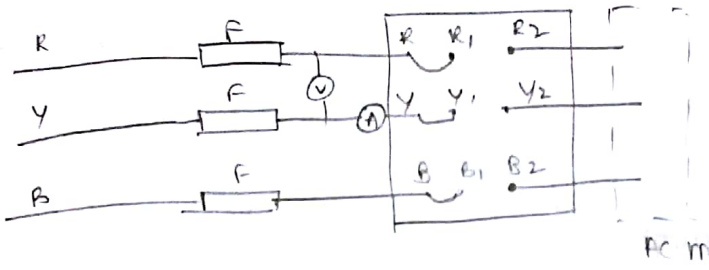
No Load





Load Test:





PROCEDURE:

i) Observe the supply frequency and calculate the synchronous speed. DC machine is used to get 0 slip.

+ Make sure both machines run in same direction independently
+ Once the two are connected, run the DC machine at sync. speed without exciting AC motor.
+ Vary AC excitation from 0 to a little over rated voltage

ii) Use the blocking mechanism to hold the motor
* Slowly vary AC voltages to make rated current flow

iii) With the DC machine connected and running at sync speed. Obtain approximate flux density variation.

INDUCTION MOTOR RATINGS:

$V_{rated} = 415V$ Freq = 50 Hz

$I_{rated} = 2.2\ A$

$P_{rated} = 1\ kW$

Delta connected

Sync speed = 1500

OBSERVATIONS :

No load Test

Voltage	Current	Power
52.7	0.12	0.08
108	0.2	5.5
229	0.55	27.3
303	0.8	45.2
365	1.02	63.5
415	1.25	78.6

Block Rotor Test

Ac current	AC Voltage	Power
2.2	54.6	122.6

Load Test

V_{in}	V_o	I_L	P	Load	Speed
417	218	1.26	202	0	1500
414	211	1.31	424	1	1491
411	206	1.45	633	2	1484
407.3	201	1.63	836	3	1477
404	196	1.8	1032	4	1467
400	191	2.05	1212	5	1460

CALCULATIONS :

1. Blocked Rotor Test

V_{i-e} = 76 V

I_{in} = 2.2 A (rated)

P = 0.134 KW

$V_{ph} = 76\ V$

$I_{ph} = 2.2/\sqrt{3}\ A$

$P/3 = \frac{134}{3} W$

Assuming $R_1 = R_2'$ $\quad X_1 = X_2'$

$$\frac{134}{3} = \left(\frac{2.2}{\sqrt{3}}\right)^2 (R_1 \times 2)$$

$$\Rightarrow R_1 = R_2' = 13.84\ \Omega$$

$$Z_{bc} = \frac{76\sqrt{3}}{2.2}$$

$$X_1 = \frac{1}{2}\sqrt{Z_{bc}^2 - 4R_1^2}$$

$$X_1 = X_2' = 26.52\ \Omega$$

2. No load Test :

$V_{ph} = 389\ V$ $\quad \frac{P}{3} = \frac{65}{3} W$

$I_{ph} = \frac{1}{\sqrt{3}} A$

$$\frac{65}{3} = \frac{1}{3} \times 13.84 + \frac{P_{iron}}{3}$$

↓ neglecting mech loss

$P_{iron} = 51.16\ W$

$17.053 = \frac{(389)^2}{R_c}$ (neglect volt drop)

$R_c = 8873.57\ \Omega$

$i_c = \frac{389}{R_c}$

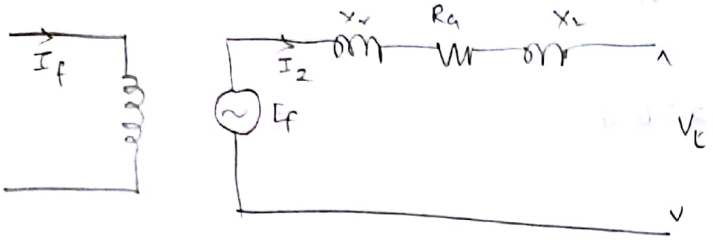
$i_m = \sqrt{\frac{1}{3} - i_c^2} = 0.5757\ A$

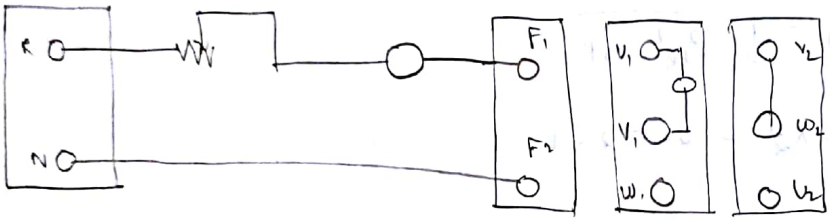
$X_m = 675.69\ \Omega$

Synchronous Machines

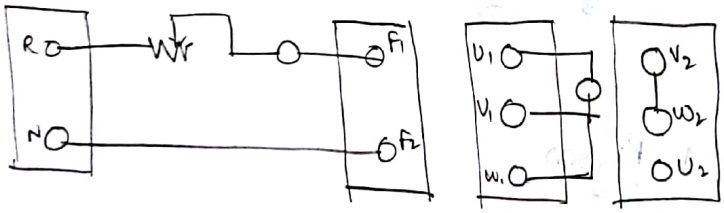
AIM: To perform open and short circuit tests on a synchronous machine and estimate its regulation

CIRCUIT DIAGRAMS:

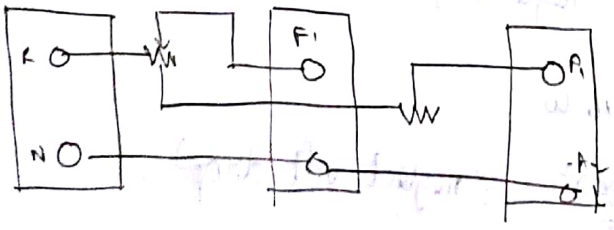


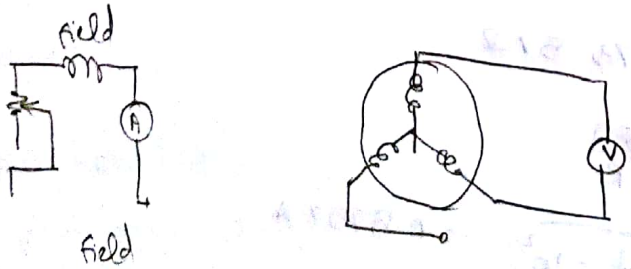


Open circuit Test Sync Machine

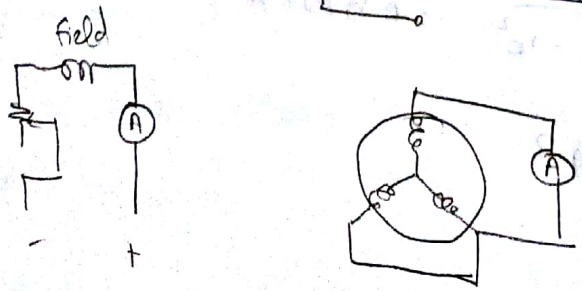


Sync Machine





open ckt



Short ckt

PROCEDURE:

* In this experiment, a DC machine runs the generator sync. machine and hence it acts as a generator
* Make the connection as shown for open circuit Test.
* Run the DC Motor at rated speed of the sync. machine
* Now slowly vary the field current of sync machine from 0. As it is increased, speed falls, so adjust the DC motor's speed to make it constant.
* For the short circuit test, vary the field current till rated current flows through the armature.

OBSERVATION:

Gen voltage	Field current
10	0.02
112	0.19
176	0.29
240	0.4
289	0.4A
363	0.65
437	0.88

open circuit characteristics

short circuit current	Gen voltage	Gen field current
2.07 A	3.87	0.35

short circuit characteristics