Exp. 8

Name - Nakul
EntryNo. - 2022EEB1192
Group No. - 1.

Aim:- a). To perform open ~~s~~ short ckt test on a synchronous generator and determine its synchoronous impedance i) neglecting saturation & ii) considering saturation..

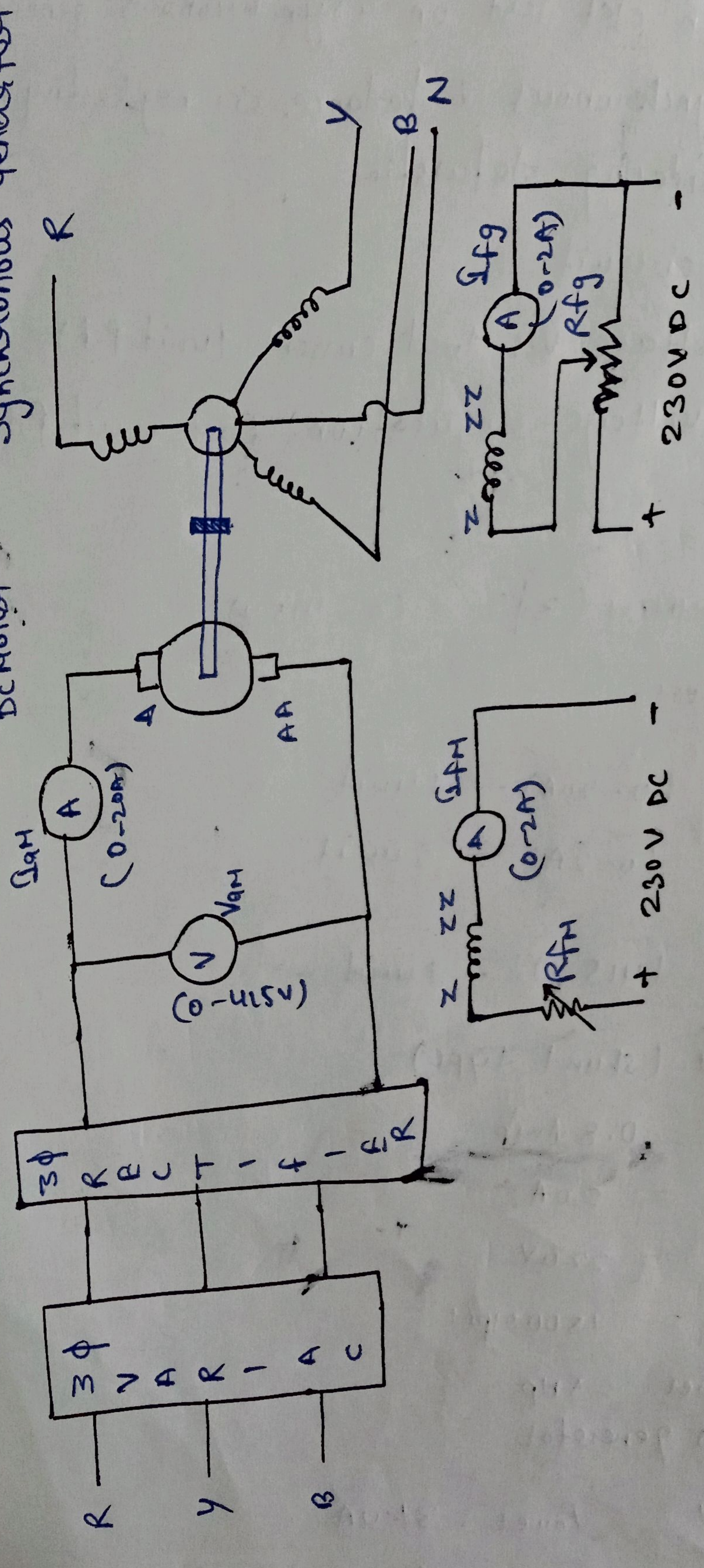
b). make equivalent circuit

c). draw terminal voltage v/s load current (unit P.F)
also determine voltage regulation. for unit P.f.

Equipment Required:-

1. Auto-Transformer (3ϕ) (0 - 415V)
2. 3ϕ Rectifier.
3. Ammeter (0-20A) - 1 unit
(0-2A) - 2 unit
4. voltmeter (415V) - 1 unit
5. DC Motor (shunt type)
I_p = 0.8 Amp.
I_A = 20A
V = 220V
N = 1500 rpm
Power = 5Hp
6. synchrous generator
N = 1500 rpm
V = 415V
I_f = 1.2A
I_a = 4.1 A
Power = 3KVA
7. variable Rheostat - 2 unit

Circuit diagram:



... ckt test

Rated speed = 1500 rpm

S.No.	I_{fg} (Amp)	V_t (volts)
1.	0.1	100
2.	0.2	140
3.	0.3	190
4.	0.4	230
5.	0.5	270
6.	0.6	300
7.	0.7	330
8.	0.8	352
9.	0.9	370
10.	1.0	390
11.	1.1	405
12	1.2	420

$R_a = 9.7\ \Omega$

$\Rightarrow \frac{R_a}{2} = R_{dc} = \frac{9.7}{2}$

$R_{ac} = 1.6 \times \frac{9.7}{2}$

Chandan Kumar

short ckt

Rated speed = 1500 rpm

I_{sc} (Amp)	I_f (Amp)
1	0.04
2	0.12
3	0.26
4	0.4

Load test

V_t (volts)	I_a (Amp)	Phase Voltage ($V_t/\sqrt{3}$)
415	0	239.6
405	1	233.826
380	2	219.393
390	3	225.166
380	3.8	219.393
370	4.6	213.619

Calculation:—

$R_a = 9.7$ {using multimeter)

$R_{dc} = \frac{R_a}{2} = 9.7$

$\Rightarrow R_{dc} = 9.7 \times 2 = 19.4\,\Omega$

& $R_{ac} = \frac{9.7\times2}{1.6} = 12.125\,\Omega$

for open ckt test:—

Phase voltage $(V_P) = \frac{V_t}{\sqrt{3}}$

i) $\frac{100}{\sqrt{3}} = 57.735$

ii) $\frac{140}{\sqrt{3}} = 80.829$

iii) $\frac{190}{\sqrt{3}} = 109.696$

iv). $\frac{230}{\sqrt{3}} = 132.790$

v). $\frac{270}{\sqrt{3}} = 155.884$

vi). $\frac{300}{\sqrt{3}} = 173.205$

vii) $\frac{330}{\sqrt{3}} = 190.525$

viii) $\frac{352}{\sqrt{3}} = 203.227$

ix). $\frac{370}{\sqrt{3}} = 213.619$

x). $\frac{390}{\sqrt{3}} = 225.166$

xi). $\frac{405}{\sqrt{3}} = 203.826$

xii) $\frac{420}{\sqrt{3}} = 242.487$

for load test:—

phase voltage $(V_P) = \frac{V_t}{\sqrt{3}}$

i) $\frac{415}{\sqrt{3}} = 239.6$

ii) $\frac{405}{\sqrt{3}} = 233.826$

iii) $\frac{380}{\sqrt{3}} = 219.39$

iv) $390/\sqrt{3} = 225.166$

v) $\frac{380}{\sqrt{3}} = 219.39$

vi) $\frac{370}{\sqrt{3}} = 213.619$

Z_s (saturated) $= \dfrac{\text{Rated voltage on occ line}}{\text{s.c current on scc line}}$

$= \dfrac{\text{oc voltage correspoing AC}}{\text{s.c current correspondig to AB}}$

$= \dfrac{239.6}{11} = 21.78$

$\Rightarrow$

$X_s = \sqrt{Z_s^2 - Ra^2}$

$X_s = \sqrt{(21.78)^2 - (7.76)^2} = 20.45$

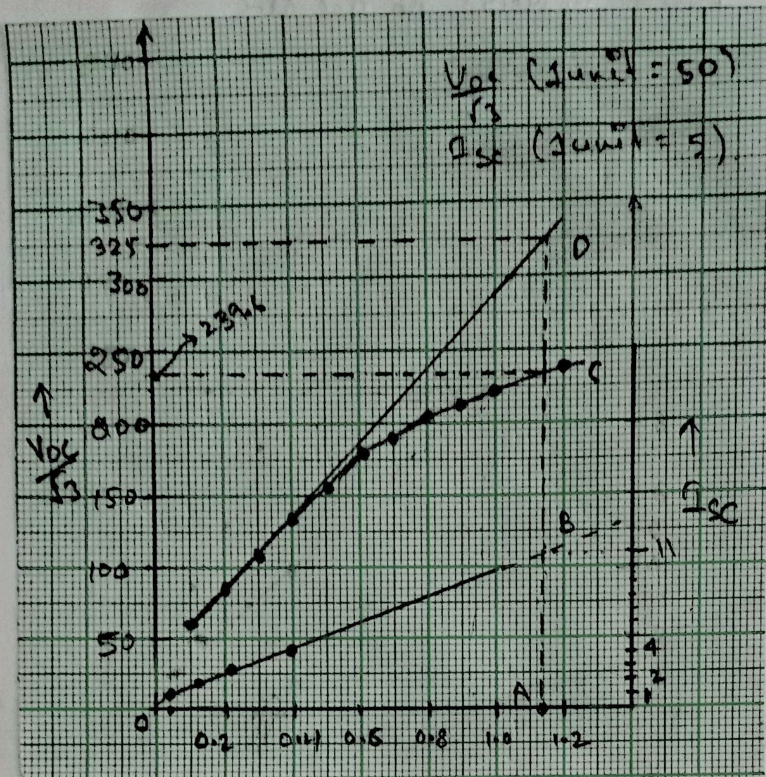
Z_s (unsaturated) $= \dfrac{\text{Rated voltage on Air gap line}}{\text{s.c current on scc line}}$

$= \dfrac{\text{o.c Voltage corresponding to AD}}{\text{s.c current corresponding to AB}}$

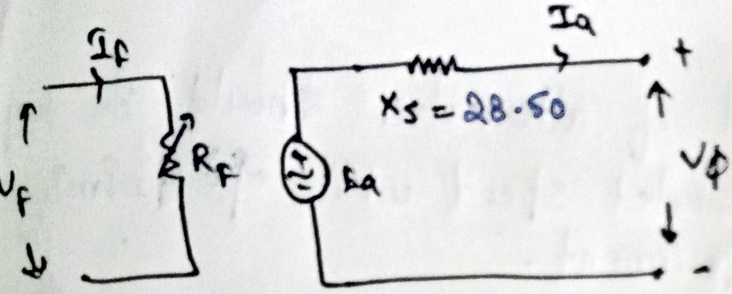
$= \dfrac{325}{11} = 29.54$

$X_s = \sqrt{Z_s^2 - Ra^2}$

$= \sqrt{(29.54)^2 - (7.76)^2} = 28.50$

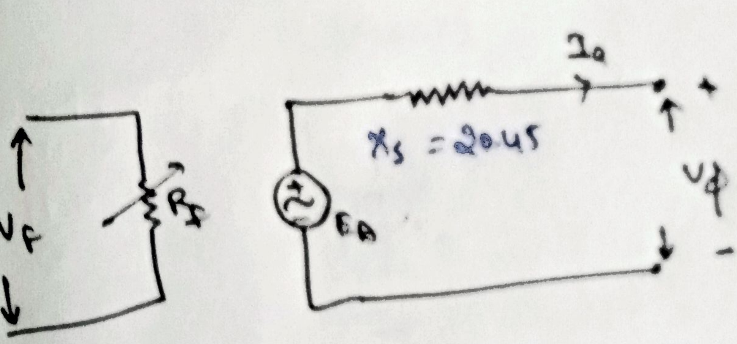


Voc/√3 (1 unit = 50)
Isc (1 unit = 5)
350
325
300
250
239.6
200
150
100
50
0
Voc/√3
Isc
0.2
0.4
0.6
0.8
1.0
1.2
A
B
C
D
11
4
2
1



Per phase Equivalent ckt diagram (unsaturated)

$$V_R = \frac{V_{NL} - V_{f1}}{V_{f1}} \times 100 = 415 -$$



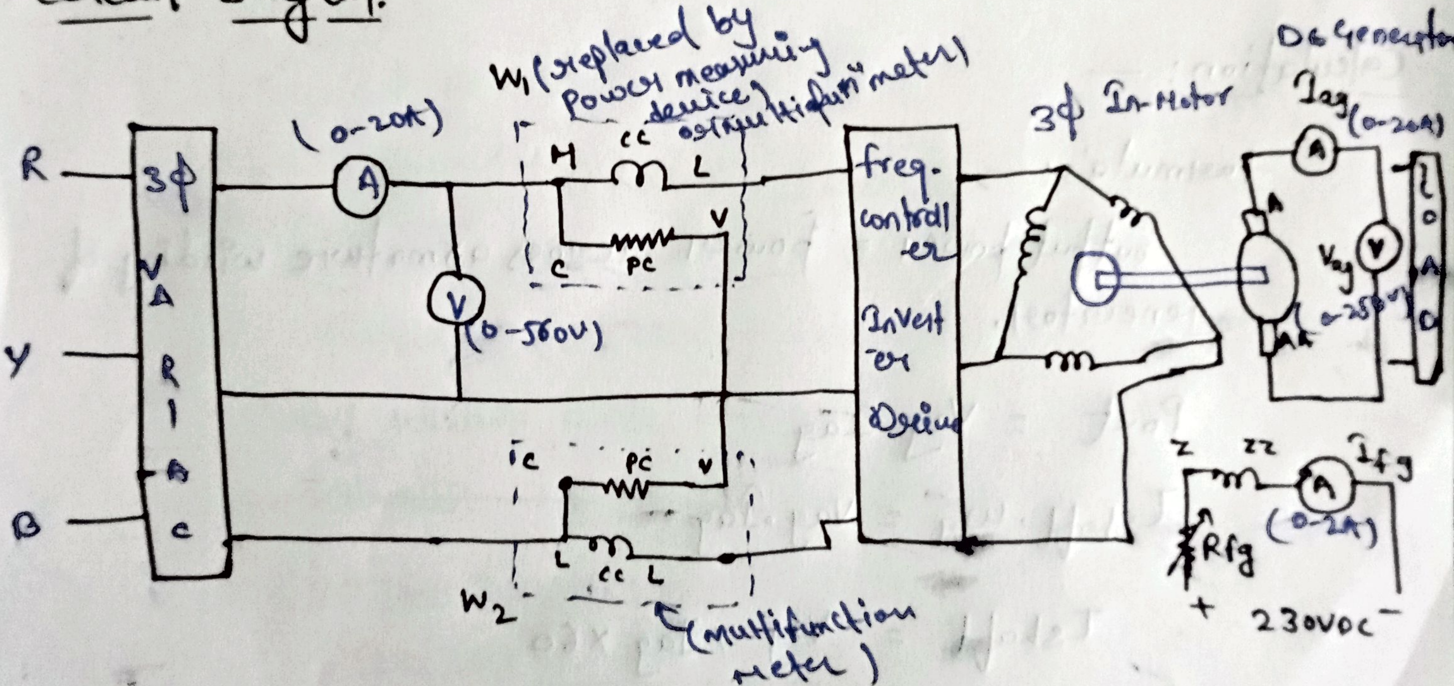
per phase Equivalent ckt diagram (saturated)

— Experiment = 7

Objective:—

- Calculation of friction and windage losses using variable frequency drive at no load.
- Torque speed characteristics (with const. value of v/f ratio & v, f variable) under const. torque load.
- Torque speed characteristics (with constant value of v/f ratio & v, f also fixed) under variable Torque load.

Circuit Diagram:—



Equipment Required:—

1. 3ϕ Variac
2. Ammeter (0-20 A) 1 unit
   (0-2A) 1 unit
3. Voltmeter (0-250V) 2 unit
4. 3ϕ Inductio Motor

speed (N) = 1480 rpm

A = 7.34 A

V = 415 ± 10% Volt

Power rating = 3.70 HP

5. DC generator (shunt type)

→ Armature current - 13.6 Amp

→ Armature Voltage - 220V

- field current - 2A

6. power measuring Device (instead of wattmeters)

Calculation: —

formula's: —

output power = power across armature winding of generator.

$$P_{out} = V_{ag} \cdot I_{ag}$$

$$T_{shaft} \cdot \omega_r = V_{ag} \cdot I_{ag}$$

$$T_{shaft} = \frac{V_{ag} \times I_{ag} \times 60}{2\pi N_p}$$

i) for constant torque load case: —

$$T_{shaft} = \frac{V_{ag} \times I_{ag} \times 60}{2\pi N_p}$$

$$T_1 = \frac{210 \times 3.5 \times 60}{2 \times 3.14 \times 1495} = 4.69 \text{ NM}$$

Exp-6

obj

Const Torque load (I_{ag} = 3A fixed) V/f = 7.5 (fixed)

S.No.	V_{in}	f (Hz)	W_1 (SUM) (KW)	I_{in} (Irms) line	V_{ag}	N (rpm)
1.	373.66	50	1.4	3.25	210	1495
2.	365.66	49	1.35	3.25	205	1465
3.	357.28	48	1.31	3.18	200	1435
4.	350.80	47	1.30	3.15	195	1405
5.	343.15	46	1.25	3.25	205	1374
6.	336.35	45	1.27	3.3	205	1343
7.	328.	44	1.24	3.3	200	1312
8.	321	43	1.22	3.25	200	1282
9.	313	42	1.18	3.23	195	1252
10	306	41	1.15	3.25	192	1222
11	2976	40	1.1	3.2	192	1192

Variable Torque load, V_{in} = 425V (fixed), f = 50 Hz (fixed)

S.No.	$(W_1 + W_2)$ KW	I_{in} Amp	I_{fg} Amp	I_{ag}(load)	V_{ag}	N
1.	1.2	2.89	1.8	1	232	1502
2.	1.3	3.00	1.8	1.8	230	1499
3.	1.38	3.2	1.8	2.8	230	1496
4.	1.46	3.4	1.8	3.8	225	1493
5.	1.56	3.7	1.8	4.8	225	1490
6.	1.65	3.9	1.8	5.6	222	1487
7	1.75	4.2	1.8	6.6	220	1484
8.	1.85	4.5	1.8	7.4	219	1481
9.	2.05	5.1	1.8	9.1	215	1475
10.	2.26	5.8	1.8	10.8	210	1468
11.	2.57	6.8	1.8	12.6	210	1460
12.	2.78	7.3	1.8	14	210	1453

AbdulAziz
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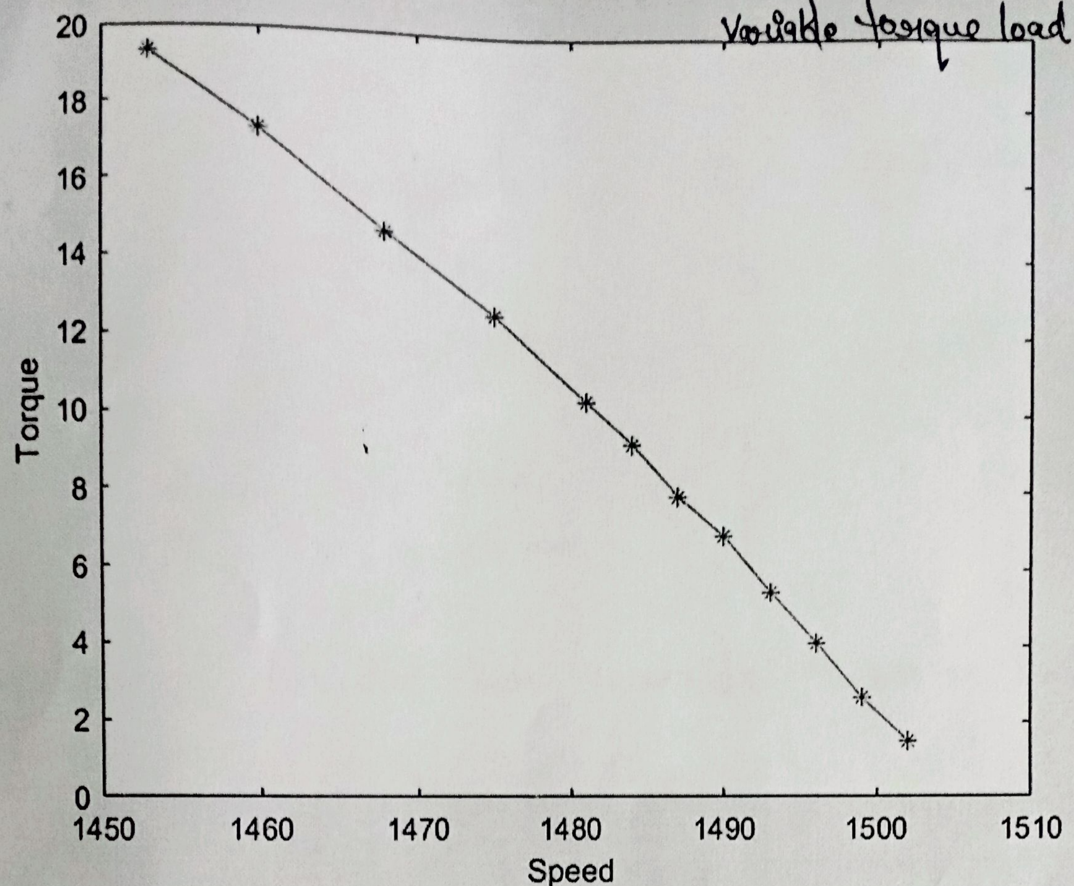
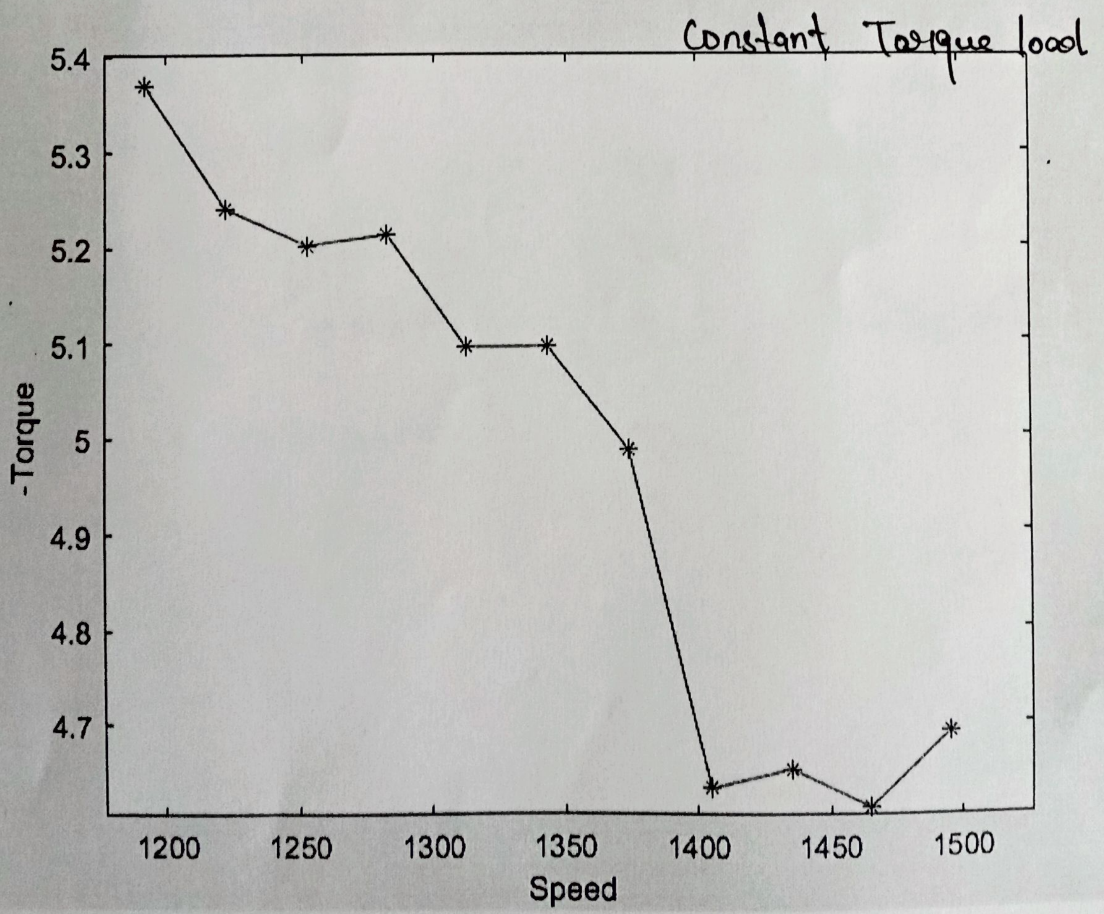

Variable torque load
Torque
Speed
20
18
16
14
12
10
8
6
4
2
0
1450
1460
1470
1480
1490
1500
1510


Constant Torque load
-Torque
Speed
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
1200
1250
1300
1350
1400
1450
1500

$$\tau_2 = \frac{205 \times 3.5 \times 60}{2 \times 3.14 \times 1465} = 4.61 \text{ NM}$$

Similarlly :-

$\tau_3 = 4.65$ NM

$\tau_4 = 4.63$

$\tau_5 = 4.98$

$\tau_6 = 5.09$ NM

$\tau_7 = 5.09$

$\tau_8 = 5.21$

$\tau_9 = 5.20$

$\tau_{10} = 5.24$ Nm

$\tau_{11} = 5.37$ Nm

ii, Similarly we did for variable Torque load:-

$$\tau_{shaft} = \frac{V_{ag} \times I_{ag} \times 60}{2\pi \times N_s}$$

$\tau_1 = 1.47$ Nm

$\tau_2 = 2.63$ Nm

$\tau_3 = 4.11$ Nm

$\tau_4 = 5.46$ Nm

$\tau_5 = 6.92$ Nm

$\tau_6 = 7.98$ Nm

$\tau_7 = 9.34$ Nm

$\tau_8 = 10.44$ Nm

$\tau_9 = 12.66$ Nm

$\tau_{10} = 14.75$ Nm

$\tau_{11} = 17.30$ Nm

$\tau_{12} = 19.32$ Nm

Conclusion:-

i) from constant Torque load characterisics (in v/f control method), we conclude that, we can use this method, where we do not want much change in Torque.

In this method we observed as speed of motor increase Torque produced is decreased but decreament in Torque was less as compare to speed.

ii) In variable load torque characterstic, we can observe that change in torque is inversely proportional to speed ($T \propto \frac{1}{N}$) as speed increases Torque decreases. Hance torque produced increases as much as load is increased with much changes (drop) in speed.

iii) Power v/s voltage graph ploted in no-load test and graph was related to power axis to obtain friction and windage losses.

P_{fw} = 110 watts.

NAME: NAKUL

Exp. 6

ENTRY NO.: 2022EEB1192

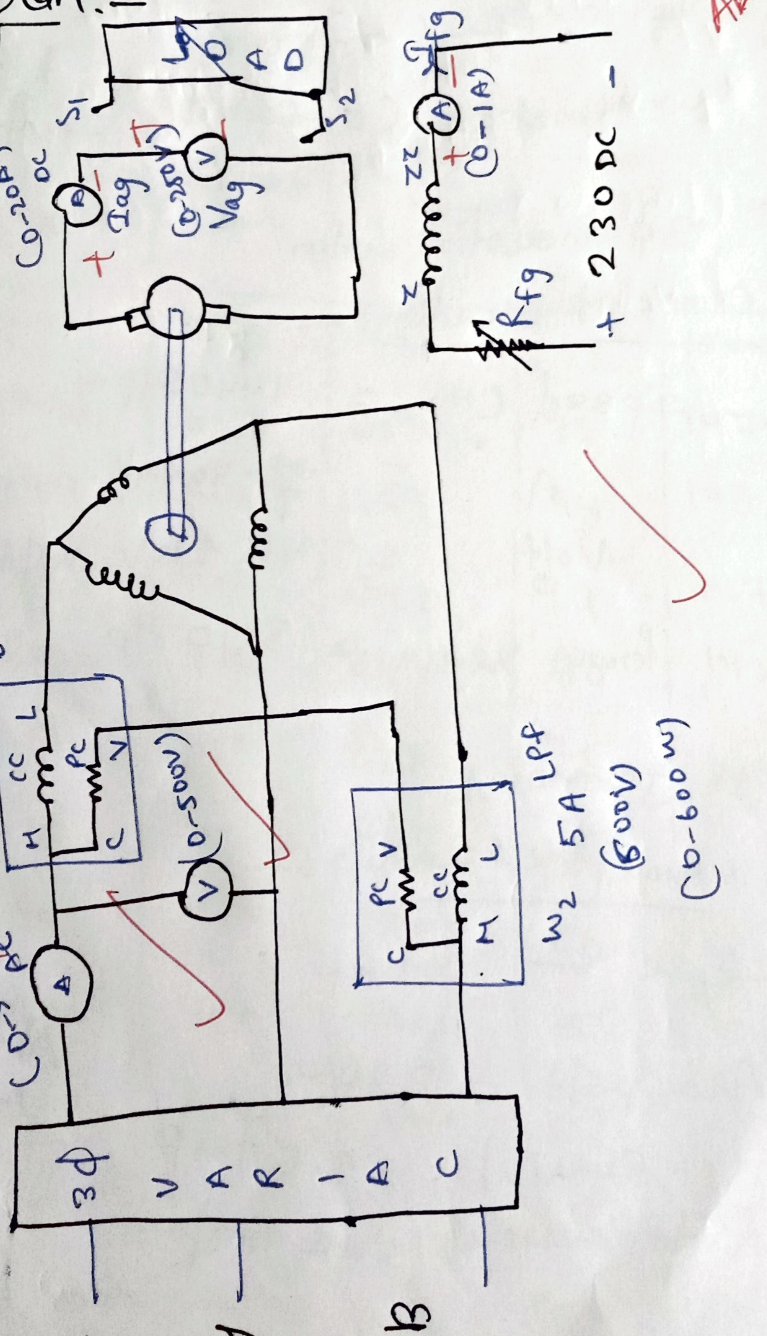
Objective:- To perform no load, block rotor test and load test on a 3ϕ squirrel cage Induction motor.

- To conclude equivalent circuit of a 3ϕ Induction motor.

7.5/10

Abdul Aziz 1/13/24

Circuit diagram:-



Exp. 5   44046022   2022EBB1172
2022EEB1201
2022EEB1207

objective:– No load, blocked rotor test on 3ϕ squirrel case induction motor

list of Equipments: —

1. 3ϕ Varic
2. Ammeter (0–2A 3unit
0–20A). 2unit
3. Voltmeter (0–560V).
4. wattmeter (0–600W). (2unit)
5A/10A, 150/300/600V
5. 3ϕ Induction motor
nameplate reading: —
speed (N) = 1440 RPM
A = ~~7~~.40 Amps.
volt = 415 ± 10% volt
power rating = 3.70 Hp.

6. DC generator
nameplate reading: —
type — shunt
Arm. volt = 220V
Arm current = 13.6 Amp
field current = 1 Amp.

Abdul Azeez 19/12

... load test :-

Blocked rotor test :-

S.No.	Motor voltage (volts)	Motor current (Amp)	W_1 Mf = 2	W_2 Mf = 2	N (rpm)
1.	$\frac{160}{2} = 80$	7.4	170	0	0

Load test :-

S.No.	Motor Voltage (volts)	Motor current Amp	$W_1 \times 8$ Mf = 1	$W_2 \times 8$ Mf = 1	N speed	Vag	Iag Mf = 2
1.	415	3.5	10	0	1500	240	0
2.	400	5.7	250	95	1472	170	6.8
3.	399	5.4	249	94	1474	175	6.3
4.	399	5.2	230	90	1476	180	5.6
5.	399	5.0	220	80	1477	182	5.4
6.	400	4.9	210	75	1480	185	5.0
7	400	4.7	200	65	1482	189	4.6
8.	400	4.6	190	60	1483	191	4.3
9.	400	4.4	172	55	1484	194	3.9
10.	400	4.2	160	50	1485	196	3.5

$R_{motor} = 4.0\,\Omega$ $R_{ZZ} = 235.5\,\Omega$

Calculation:—

(i) No-Load test:—

$$P_{nL} = w_1 + w_2 = 380 - 280 = 100W$$

$$|Z_{eq}| = \frac{V_{nL}(P)}{I_{nL}} = \frac{415\sqrt{3}}{3.55} = 202.48\,\Omega$$

$$X_1 + X_M = 202.48\,\Omega \quad (1)$$

Block rotor test:—

$$|Z_{BR}| = \frac{V\sqrt{3}}{I} = \frac{80\sqrt{3}}{7.4} = 18.72\,\Omega$$

$$\cos\theta = \frac{P(w_1 + w_2)}{\sqrt{3}\,V_L I_L} = \frac{340}{\sqrt{3} \times 80 \times 7.4} = 0.33$$

$$\theta = \cos^{-1}(0.33) = 70.73$$

$$R_{eq} = R_1 + R_2 = Z_{BR}\cos\theta$$

$$R_1 + R_2 = 18.72 \times 0.33 = 6.1776\,\Omega \quad (ii)$$

$$X_{eq} = X_1 + X_2 = 18.72 \sin\theta$$

$$= 18.72 \times 0.943 = 17.65\,\Omega$$

$$X_1 = X_2 = 0.5 X_{BR} = 0.5(17.65) = 8.825\,\Omega$$

from eq (1)

$$X_M = 202.48 - 8.825 = 193.65\,\Omega$$

S.No.	Motor voltage (Volt)	Motor current (Amp).	W_1 (+ve) (Mf = 4) (watts)	W_2 (−ve) (Mf = 4) (watts)	N (rpm)	Vag	Iag
1.	415 V	3.55	95	70	1503	NA	NA
2.	400	3.45	90	67	1503	NA	NA
3.	380	3	88	60	1503	NA	NA
4	360	2.7	74	50	1503	NA	NA
5.	340	2.4	64	41	1503	NA	NA
6.	320	2.2	56	35	1503	NA	NA
7	300	2.1	51	32	1503	NA	NA
8	280	2.0	44	28	1503	NA	NA
9	260	1.85	38	23	1503	NA	NA
10	240	1.70	33	21	1503	NA	NA

calculation:—

each resistance = R (Δ conneted)

$$\frac{2}{3} R_{DC} = 1.86$$

$$R_{DC} = 2.79\,\Omega$$

$$R_{AC} = 1.5 \times R_{DC} = 4.185\,\Omega = R_1$$

from Eq (ii)

$$R_2 = 6.1776 - 4.185 = 1.993\,\Omega$$

Hance:—

$R_1 = 4.185\,\Omega$

$R_2 = 1.993\,\Omega$

$X_1 = 8.825\,\Omega$

$X_2 = 8.825\,\Omega$

$X_M = 193.65\,\Omega$

Tshaft

Experimental:—

$P_{in} = W_1 + W_2 = 160 \times 8 + 50 \times 8 = 1680$ watt

$I = 4.2$ Amp

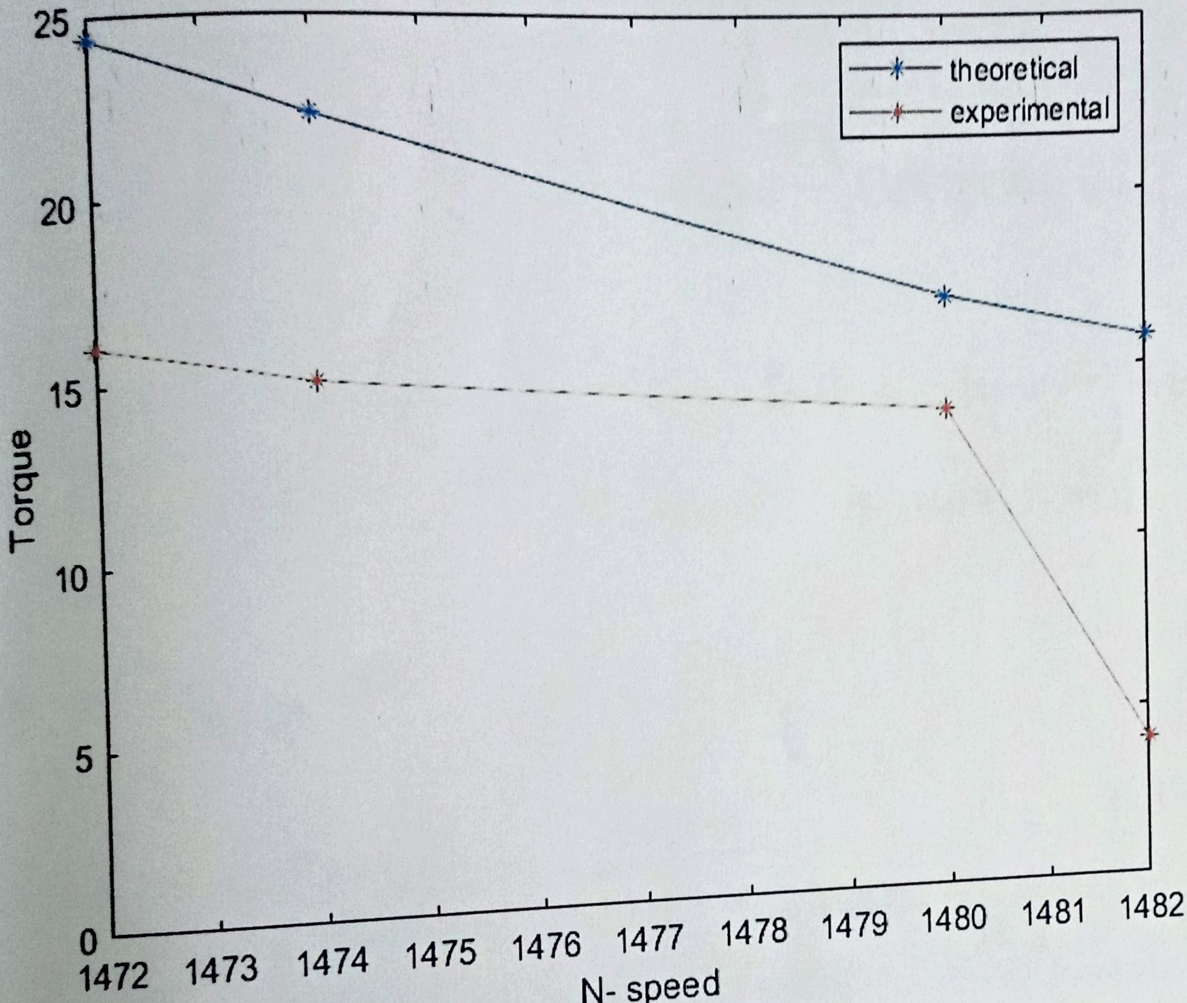
$N = 1485$ rpm

$P_{ag} = P_{in} - 3I^2 R_1$

$1680 - 3(4.2)^2 \times (4.185)$

$= 1680 - 221.47 = 1108.53$ watt

$P_{ag} = 1458.53$ watt.



Graph for no load test is missing

$\frac{P_{ag}}{P_{conv}} = \frac{1}{1-s} \Rightarrow P_{conv} = P_{ag}(1-s)$

$P_{conv} = 1108.53(1-s)$

$P_{conv} = 1443.94$ watt

$s = \frac{N_s - N_r}{N_s}$

$= \frac{1500-1485}{1500} = \underline{\underline{0.01}}$

$P_{out} = P_{conv} - P_{f\&w}$

$= 1418.5$ Watt

$P_{out} = T_{shaft} \times \omega$

$T_{shaft} = \frac{P_{out}}{\omega} = \frac{1418.5}{\frac{2\times3.14}{60}\times 1485} = 9.126$ NM

Theoretical:-

$V_{th} = \frac{V_1 X_m}{X_1 + X_m} = \frac{400 \times 193.65}{193.65 + 8.825} = 382.57$ V

$R_{th} = \left(\frac{X_m}{X_1 + X_m}\right)^2 \cdot R_1 = \left(\frac{193.65}{193.65+8.825}\right)^2 \times 4.185 = 0.915\Omega$

$X_{th} = X_1 = 8.825\ \Omega$

$T_{ind} = \frac{3V_{th}^2 R_2/s}{\omega_s\left[\left(R_{th} + \frac{R_2}{s}\right)^2 + (X_{th} + X_2)^2\right]} = \frac{\frac{3(382.57)^2 \times 2}{0.01}}{\frac{2\times3.14 \times 1500}{60} \times \left(\cancel{3.8} + \frac{2}{0.01}\right)^2 + (8.825 +)}$

$=$

Precautions:—

- perform no load test at rated voltage
- also perform block rotor test at rated current
- Meter should be used accordingly to [illegible]
- use upf wattmeter in block rotor test
- use LPF wattmeter in no-load test.

Conclusion:—

- No load test was performed to get shunt branch parameter X_m (performed at rated voltage)
- Block rotor test performed to find out series parameter X_1, X_2, R_1, R_2
- torque - speed characteristics of the motor at different value of load obtained from load test
  (i) for experimental value and theoretical values

NAME - NAKUL

ENTRY NO. - 2022EEB1192

GROUP NO. - 1.

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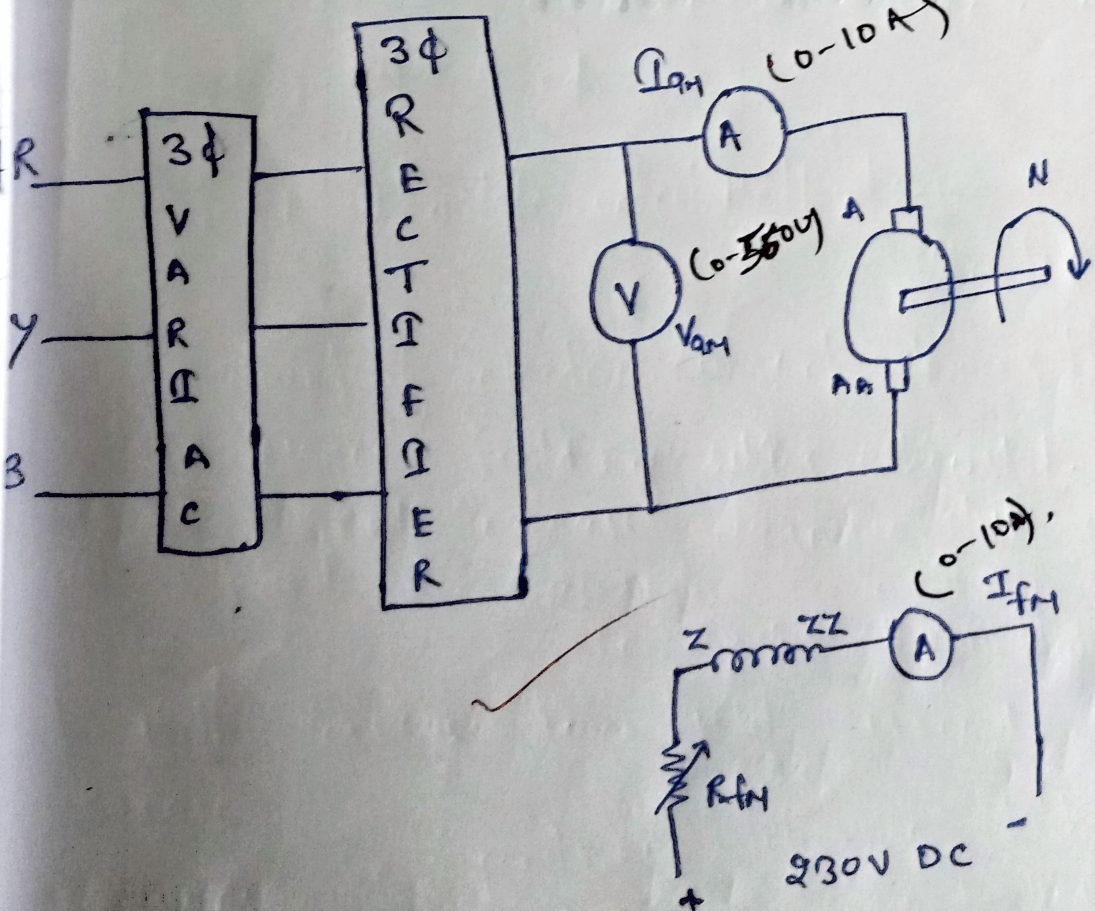
Exp.5

Objective:-

- To control the speed of a Dc seperately Excited Motor by varying the Armature terminal voltage
- To control the speed of DC seperately Excited Dc Motor by varying the resistance in the field.

Circuit Diagram:-



Speed control of DC Motor (seperately Excited)

List of Equipments:-

1. 3ϕ Variac
2. 3ϕ Rectifier
3. Voltmeter (0-~~500~~) 1 unit
4. Ammeter (0-10A) (0-2A) 2 unit
5. DC Motor : 1 unit

Name plate Readings:-

Speed (N) = 1500 rpm

I_{aM} = ~~18 Amp~~

I_{fM} = 1.5 Amp

Arm Volt = 220 Volt

field volt = 220 Volt

Armature voltage control

$I_{fM} = 1.5$ Amp.

S.No.	V_{aM}	N	I_{aM}
1.	40	177	0.50
2.	80	341	0.50
3.	120	467	0.50
4.	160	667	0.50
5.	200	817	0.50
6.	240	977	0.50
7.	280	1145	0.50
8.	320	1305	0.50
9.	360	1481	0.50
10	400	1640	0.51

Anurag Patel
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Field Rheostat Control

$V_{aM} = 220$ Volts

S.No.	I_{fM}	N	I_{aM}
1.	0.36	1425	0.7
2.	0.40	1362	0.7
3.	0.50	1206	0.6
4.	0.60	1114	0.5
5.	0.70	1056	0.5
6.	0.80	1014	0.45
7.	0.90	979	0.45
8.	1.00	948	0.45
9.	1.10	924	0.45
10.	1.20	903	0.45
11.	1.30	882	0.45

Formula section :-

$\downarrow I_f = \dfrac{V_T}{R_f \uparrow}$ $\{$ if $R_f \uparrow \Rightarrow I_f \downarrow \}$

$\Rightarrow I_f \downarrow \Rightarrow \phi \downarrow$

$\Rightarrow \downarrow E_A = k\,\phi \downarrow \omega_m \xrightarrow[\text{in } I_a]{\text{cause of large } \uparrow}$

$\uparrow\uparrow I_a = \dfrac{V_T - E_A \downarrow}{R_A}$ $\quad \tau_{ind} = k\,\phi \downarrow I_A \uparrow\uparrow$

$\{ I_A$ dominants$\}$.

Field Rheostat control

$V_{aM} = 380$ volts

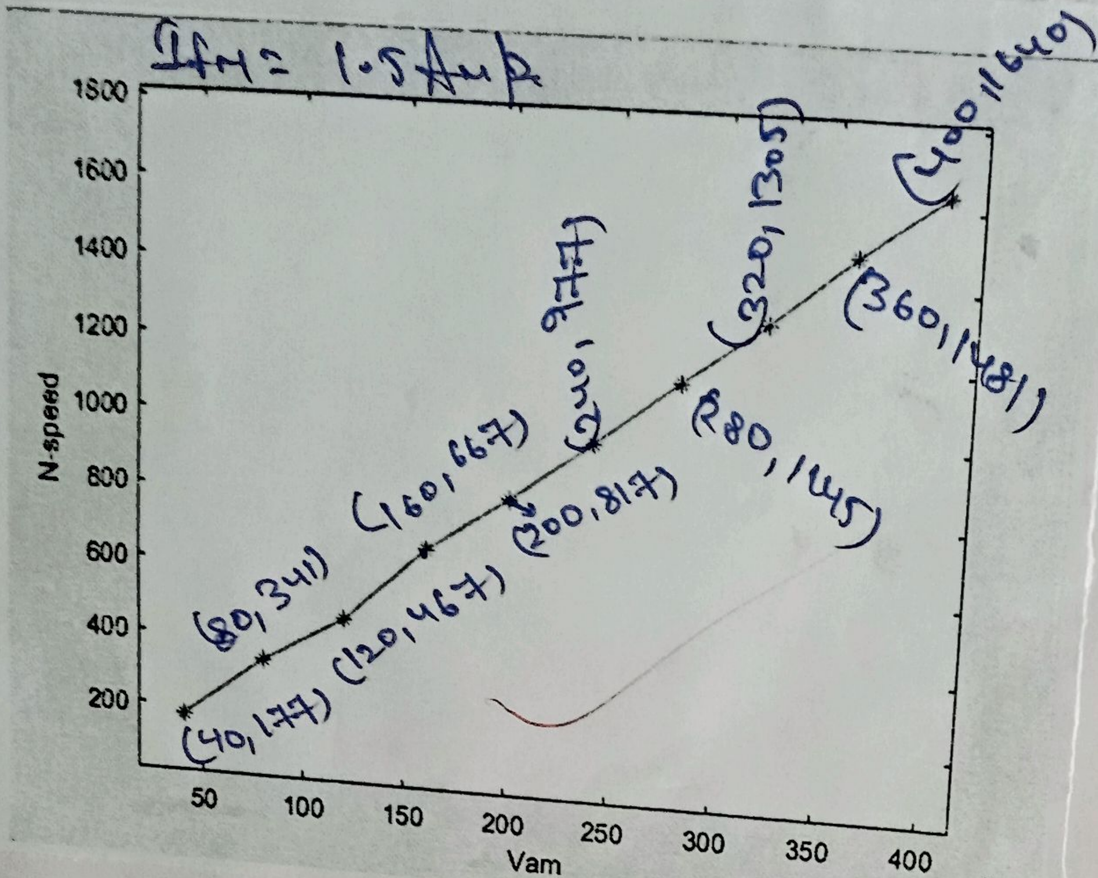
S.No.	I_{fM}	N	I_{aM}
1.	1.46	1530	0.5
2.	1.20	1600	0.5
3.	1.10	1627	0.5
4.	1.00	1665	0.5
5.	0.90	1712	0.5
6.	0.80	1768	0.5
7.	0.70	1840	0.5
8.	0.60	1947	0.5
9.	0.50	2103	0.50
10.	0.40	2300	0.5

Anurag

$T_{ind} > T_{load} \Rightarrow$ speed (N) $\uparrow$

$E_A \uparrow \Rightarrow I_a \downarrow$ so $T_{ind} \downarrow$ again $T_{ind} = T_{load}$

(at higher steady-state speed).



Ifn = 1.5 Amp
1800
1600
1400
1200
1000
800
600
400
200
N-speed
50
100
150
200
250
300
350
400
Vam
(40,177)
(80,341)
(120,467)
(160,667)
(200,817)
(240,977)
(280,1145)
(320,1305)
(360,1481)
(400,1640)

Armature

Conclusion :-

In this Experiment of speed control of seperately Excited Dc motor, we performed for two method.

1. Armature control Method:-

By varying the armature voltage, we observed a proportion change in the motor speed with increase in armature voltage speed of motor also increased. This alins with our theoretical expectations.

Since Armature voltage directly affects the electromagnetic torque generated with in the motor, consequently impacting its speed.

the field Rheostate control Method:-

In this method, we adjust amount of electric current flowing through motor's magnetic field by ~~adding~~ rheostat. when electric current increase magnetic flux also increase and speed decrease.

In our observation table we got with increase in field current speed decrease.

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Comparison:- In depends on situation which one is better if you need precise control over speed and there in not much change in load than armature control method is better

If you need big change in load and you need to maintain a steady state then rheostate con method is better.

Precautions:—

1. After all connection, circuit must be ver from instructor.

2. all connection should tight, loose connectio may produce arcing.

3. you should have knowledge about emergency button.

4. Handle all equipment carefully.