Exp 01

EEA-2970

GROUP NO.	03
CLASS S.NO.	14
SECTION	A2 MB
NAME	Pranay Singh

EXPERIMENT NO.: 07

OBJECT: Speed control of wound rotor (slip ring) induction motor by Rotor resistance variation

DATE OF PERFORMING THE EXPERIMENT: 10/04/23

DATE OF SUBMISSION OF REPORT: 17/04/23

OTHER GROUP PARTNERS:

CLASS S.NO.	NAME
12	Aagam Pathak
13	Laksh Gupta
15	Md. Ahsan
16	Prakhar Sahu

REMARK (If any by the teacher concerned):

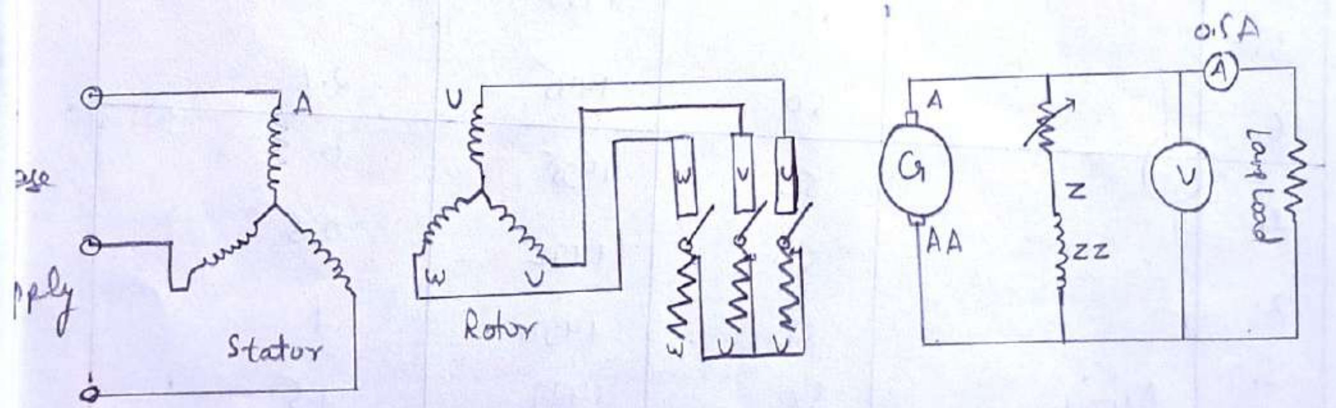
Pranay Singh
A2 MB-14

OBJECT: Speed control of a wound rotor (slip rings) using induction motor using rotor resistance variation.

Apparatus Used:

S.No.	Instrument Name	Specification	Make
1.	Voltmeter	0-150 V	EMIV 38 Broad Heath England
2.	Ammeter	0-5 A	EMIA 88 (Bajaj) Model Colow
3.	A.C. Motor	420 V	Siemens
4.	D.C. Generator	220V, 3.8A	MG - Electric works

Circuit Diagram:



Observation table:

S.No.	Rotor Resistance (Step)	Frequency (Hz)	Speed of Motor (rpm)	Load Current of DC Generator (A)
1.	Maximum	50	1457	0
2.		50	1435	0.5
3.		50	1409	1
4.		50	1381	1.5
5.		50	1346	2.1
1.	Medium	50	1481	0
2.		50	1473	0.5
3.		50	1470	1
4.		50	1464	1.5
5.		50	1455	2.1
6.		50	1445	2.6
1.	Minimum	50	1495	0
2.		50	1492	0.5
3.		50	1490	1
4.		50	1487	1.5
5.		50	1485	2.1
6.		50	1483	2.65
7.		50	1480	3.2

10/4

Sample Calculation

Low resistance: Reading (4)

No. of loads = 3, Speed of Motor = 1487 rpm

frequency = 50 Hz, No. of poles = 4

Synchronous speed $(N_s) = \frac{120 \times f}{P} = \frac{120 \times 50}{4}$

$= 1500$ rpm

Slip speed of Motor (s) $= \frac{N_s - N}{N_s}$

$\Rightarrow \frac{1500 - 1487}{1500} = 0.0086$

Output voltage of generator $(V_0) = 110$ V

Output current of generator $(I_0) = 1.5$ A

Output power of generator $= V_0 \times I_0$

$P_0 = 110 \times 1.5$

$P_0 = 165 W$

Efficiency of generator $(\eta_g) = 0.85$

$\therefore$ Input power of generator = Output power of Motor (Induction)

$P_{ig} = P_{om}$

$\eta_g = \frac{\text{Output Power of generator}}{\text{Input power of generator}} = \frac{P_{og}}{P_{ig}}$

$P_{ig} = \frac{P_{og}}{\eta_g} = \frac{165}{0.85} = 194.12$ W

Angular speed of Motor $(\omega) = \frac{2\pi N}{60}$ rad/sec

$\omega = \frac{2\pi \times 1487}{60} = 155.72$ rad/s

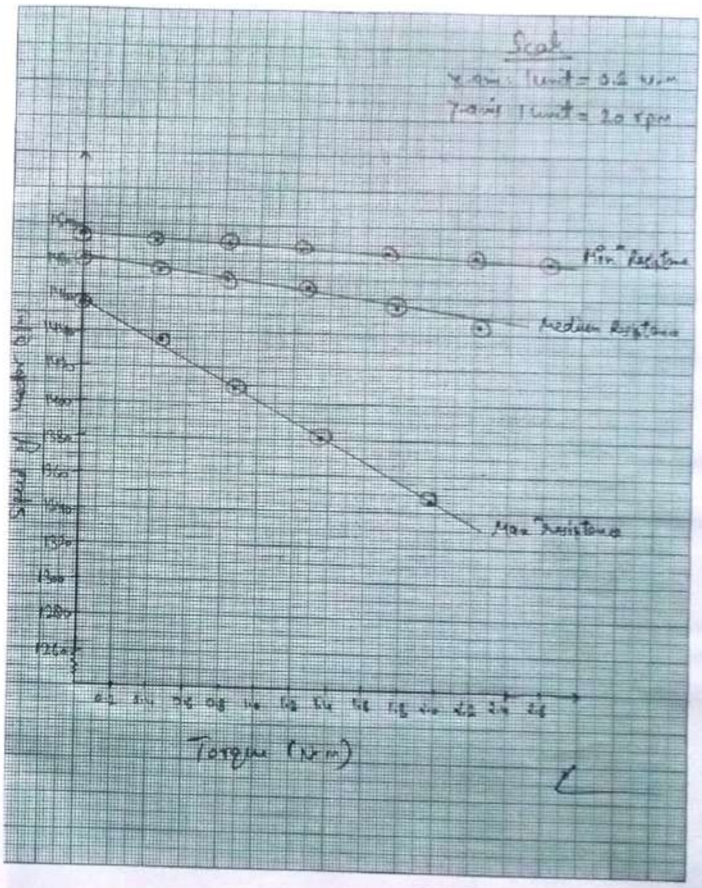
Output Torque of Induction Motor (τ) = $\frac{P_{om}}{\omega}$

$$= \frac{194.12}{155.72} = 1.24 \text{ N-m} \quad [P_{ig} = P_{om}]$$

Result Table:

Freq. of 3 phase supply = 50 Hz
Synchronous speed N_s = 1500 rpm

	Minimum Resistance		Medium Resistance		Max. Resistance	
S.No.	Angular speed (ω)	Torque T(N-m)	Angular speed (ω)	Torque (N-m)	Angular Speed (ω)	Torque (N-m)
1.	156.55	0	155.08	0	152.57	0
2.	156.24	0.414	15425	0.42	150.27	0.43
3.	155.95	0.829	153.93	0.84	147.55	0.87
4.	155.72	1.24	153.31	1.26	144.62	1.34
5.	155.51	1.75	152.36	1.78	140.95	1.93
6.	155.30	2.21	151.32	223		
7.	154.98	2.67				



Discussion:

Q1 Discuss methods of speed control of sphere induction motor.

> (Ans) Speed of a 3 phase induction motor can be considered by these methods =>

1) Stator voltage control: By adding resistance or inductances in the stator circuit, we can change the speed of an induction motor. We can also use an auto-management b/w supply line and stator of the motor.

I) Polar resistance Control: By adding resistance in rotor circuit, we can control the speed of the induction motor. This method is popular in control due to its lower cost and energy method.

IV) By changing pole: As we know, synchronous speed of a motor is inversely proportional to the no. of pole of the stator windings, so by changing poles we can control the speed of a motor.

V) Supply frequency control: As we know, synchronous speed of a motor is directly proportional to the supply frequency. Hence we can change the speed of a motor by changing its supply frequency.

EXP-02

6

11/4/23

ELECTRICAL TECHNOLOGY LAB

Late

NAME - PRANAY SINGH

F.No. - 21MEB448 . A2MB.14

E.No. - GL2254

Course No. - EEA 2970

Date of Experiment - 17/04/23

Date of Submission - 01/05/23

Object - To determine the efficiency Vs load, speed Vs load, & torque Vs load characteristics of a d.c. series motor.

Exp - 08

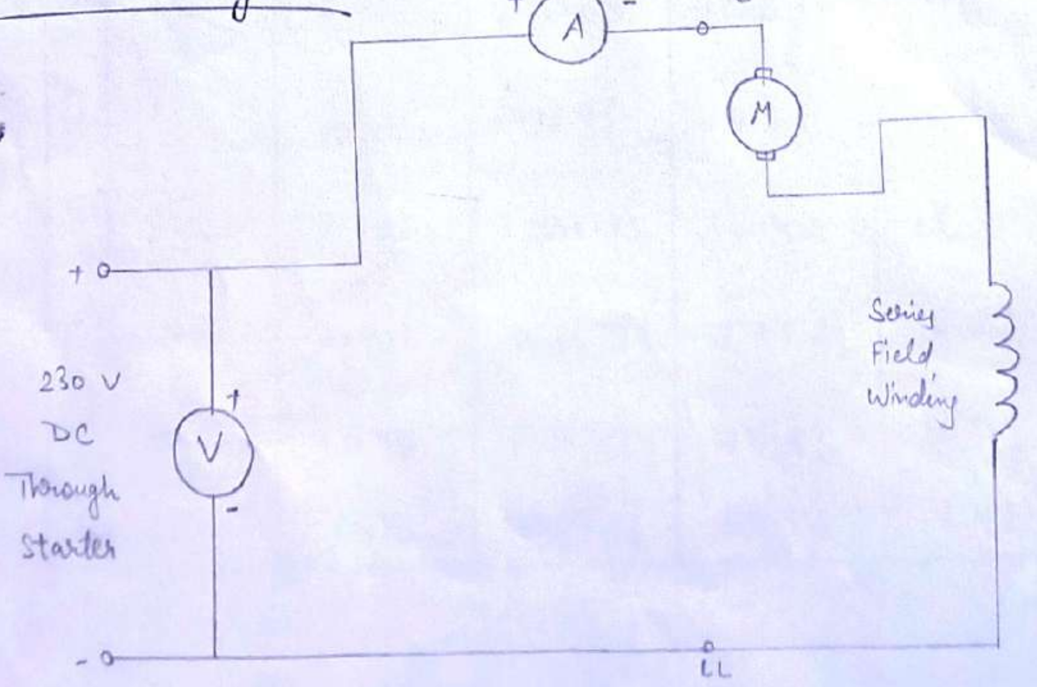
Pranay Singh
A2 MB-14

Object: To determine the efficiency Vs load, speed Vs load & torque Vs load characteristics of a d.c. series motor and predict the speed, torque characteristics.

Apparatus Used:

S.No.	Equipment Used	Range	Make
1.	Voltmeter	0-300 V	F.G. England
2.	D.C. Motor	960 rpm, 12.5 A	Made in Great Britain
3.	Pitch Balance	$T_1 = 100$ kgf, $T_2 = 50$ kgf	—
4.	Ammeter	0-15 A	Automatic Ltd.
5.	Techometer	—	—

Circuit Diagram



Observation table:

S.No.	V (Volt)	I (Amp)	T_1 (kgf) (100 kgf)	T_2 (kgf) 50 kgf	N (rpm)
1.	↑	12.5	37	8	954
2.		12	34	7	1024
3.		11	30	6	1064
4.	230	10	26	5.5	1126
5.		9	22	5	1208
6.		8	18	4	1322
7.	↓	7	13	3	1486

✓ 17/4/23

Sample Calculation

For reading No. ③ → $I = 11\ A$, $V = 230V$, $T_1 = 30\ kgf$, $T_2 = 6\ kgf$, $N = 1064\ rpm$

i) Input Power, $P_{in} = VI = 230 \times 11 = 2530\ W$

ii) Output Power, $P_{out} = \frac{2\pi N (T_1 - T_2) R g}{60} = \frac{2\pi \times 1064 (30-6) \times 0.0762 \times 9.8}{60}$

$= 1996.93\ W$

iii) Efficiency $= \frac{Output}{Input} \times 100\ \% = \frac{1996.93}{2530} \times 100 = 78.93\ \%$

iv) Torque developed $= (T_1 - T_2) R g = 24 \times 0.0762 \times 9.8$

$= 17.92\ Nm$

Result table:

S.No.	Current (A)	Input Power (W)	Output Power (W)	Efficiency (%)	Torque (Nm)	Voltage (V)
1.	12.5	2875	2163.49	75.25	21.65	230
2.	12	2760	2162.08	78.34	20.16	230
3.	11	2530	1996.93	78.93	17.92	230
4.	10	2300	1805.11	78.48	15.31	230
5.	9	2070	1605.92	77.58	12.69	230
6.	8	1840	1447.34	78.66	10.45	230
7.	7	1610	1162.06	72.17	7.46	230

Discussion

Q1 Why do the dc series motor gives high starting torque?

Soln: DC series motors are widely used for the purpose requiring high starting torque like in crane, electric traction, etc.

For any d.c. motor, torque is directly proportional to the flux and armature current i.e. $\tau = K_a \phi I_a$ —(i) where $K_a \rightarrow$ constant
$\phi \rightarrow$ flux
$I_a \rightarrow$ Armature current

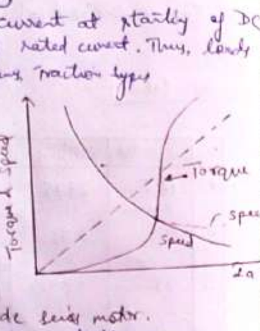
In case of dc series motor, the flux produced is directly proportional to the armature current. Hence torque is directly proportional to the square of armature current.

Therefore, $\phi = C I_a$ where $C \rightarrow$ constant

Then, $\tau = K (I_a)^2$ —(ii) $\boxed{K = K_a C}$

As we know that the max^n permissible current at starting of DC motor is limited about 1.5 times that of rated current. Thus, loads requiring high starting torque such as crane, traction type

This is clear that higher the armature or load current, higher is the torque till the magnetic flux causes saturation. Once saturation occurs, the flux will no longer increases in proportion to the increment in current and thus limits the increase in torque

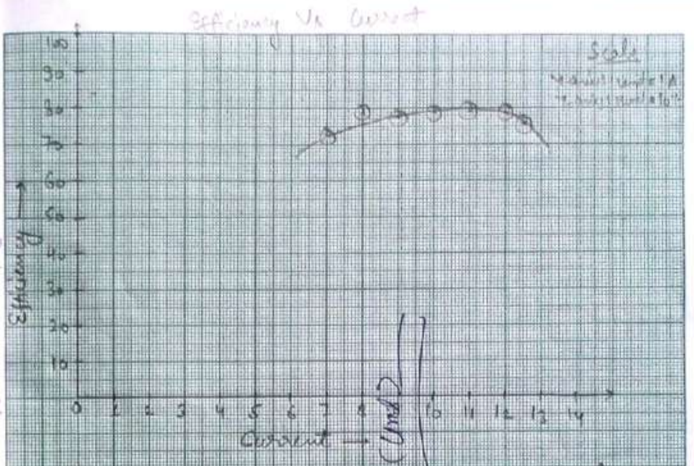


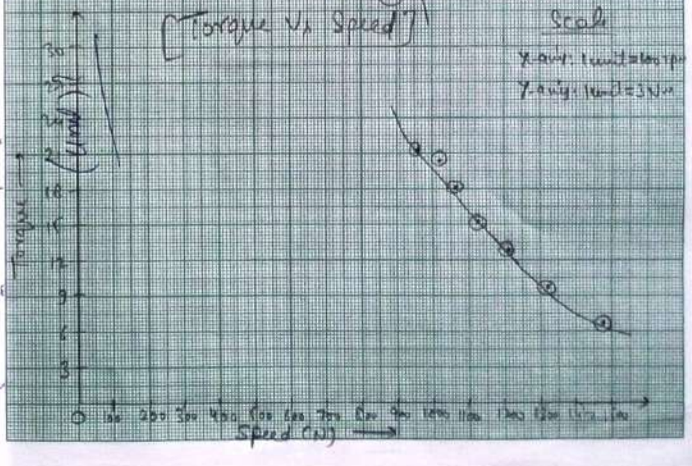
Q2 Mention industrial application of dc series motor.

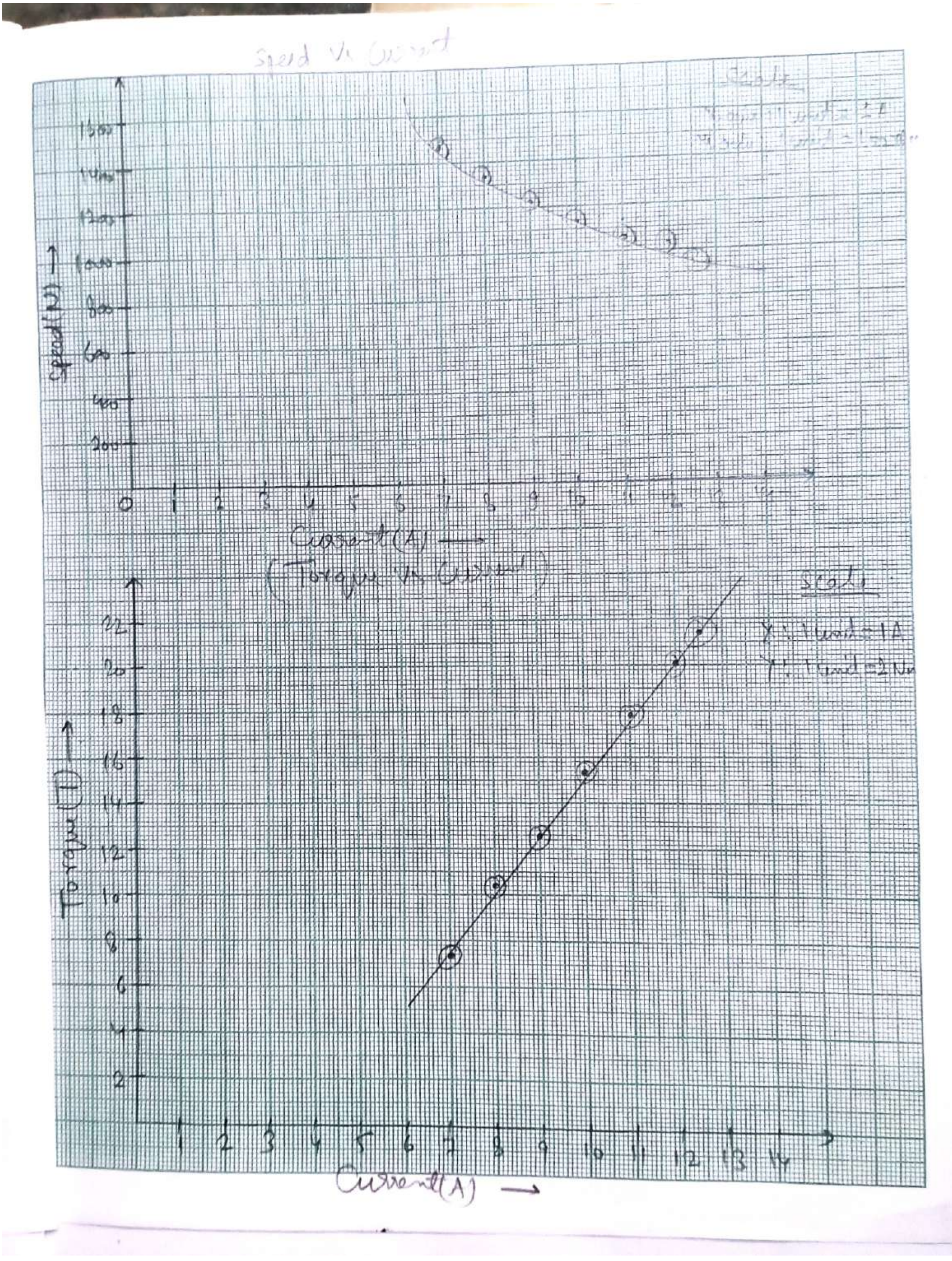
Soln Some applications where d.c. motor in industry are

(i) DC series motor are widely used for electrical traction application i.e. these motors are widely used in electric locomotive, rapid transit system and trolley car.

(ii) DC series motors are employed in crane, hoist and in conv because of high starting torque capability.






Speed (N)
Current (A)
(Torque Vs Current)
Scale
X: 1 unit = 1A
Torque (T)
Current (A)

Eb-3

Department of Mechanical Engg.

Zakir Hussain College of Engineering And Technology

AMU, Aligarh

late

LAB REPORT

Name : PRANAY SINGH

Class : A2MB

Faculty No. : 21MEB448

Serial no. : 14

Enroll No. : GL2254

Course Title : Electrical Technology Lab

Course No : EEA 2970

Brief Objective : Determination of speed load and efficiency load characteristics of a d.c. shunt and compound motor

Date of Experiment Performed : 06/02/2023

Date of Submission : 13/02/2023

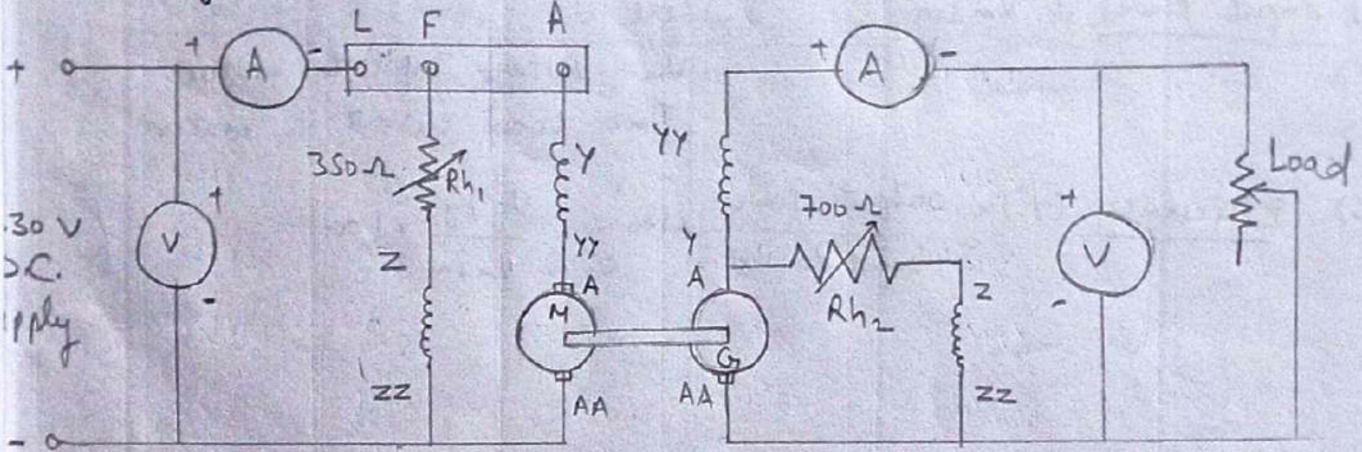
Teacher's Remark :

Experiment -1

Name- Pranay Singh
F.No.- 21MEB448
S.No.- 14(A2MB)

OBJECT: Determination of speed load and efficiency load characteristics of a d.c. shunt and compound motor.

Circuit Diagram:



Differentially / Cumulatively Compounded D.C. Motor

Apparatus Used:

S.No.	Equipment Name	Range	Make
1.	Voltmeter	0-300 V	Automatic Lt. India
2.	Ammeter	0-15 A	Automatic Lt. India
3.	Rheostat	490 Ω, 2 A	British Electric Lt.
4.	Wires	—	India
5.	D.C. Motor	1450 rpm / 230 V	Bombay
6.	D.C. Generator	1450 rpm / 253 V	Bombay
7.	Bulb	150 watt	Mysore

Formula Used:

(1) Output Power = $V_g I_g$

where,
V_g = Voltage input to generator
I_g = Load current to generator

(2) Input Power = $V_m I_m$

where,
V_m = Voltage input to motor
I_m = Load current to motor

(3) Efficiency (%) = $\frac{\text{Output Power}}{\text{Input Power}} \times 100 = \frac{V_g I_g}{V_m I_m} \times 100$

OBSERVATION TABLE:

1. Cumulatively Compounded D.C. Motor

S.No.	Input to Motor		Output from generator		Speed (RPM)
	V (Volts)	I (Amp)	V	I	
1.	246	3.2	230	0	1600
2.	246	4.4	230	1.3	1587
3.	246	5.6	230	2.6	1572
4.	246	6.9	230	3.8	1560
5.	246	10.2	230	6.8	1541
6.	246	11.8	230	8	1532

2. Differentially Compounded D.C. Motor

S.No.	Input to Motor		Output from generator		Speed (RPM)
	V	I	V	I	
1.	240	3.2	230	0	1600
2.	240	4.4	230	1.3	1578
3.	240	5.8	230	2.6	1556
4.	240	7	230	3.8	1536
5.	240	8.2	230	5.1	1516
6.	240	10.2	230	6.4	1494

6/3/20

3. Shunt Compounded D.C. Motor.

SNo.	Input to motor		Output from generator		Speed (RPM)
	V	I	V	I	
1.	240	3.2	230	0	1600
2.	240	5	230	1.3	1581
3.	240	5.8	230	2.6	1565
4.	240	7	230	3.8	1550
5.	240	8.2	230	5.1	1535
6.	240	10.2	230	6.8	1520
	~~240~~	~~12~~	~~230~~	8	~~1505~~

Sample Calculation for reading 3:
(Shunt Compounded)

We know output power generator = $V_g I_g = (P_o)_g$

Input power to motor $(P_i)_m = V_m I_m$

Input power to generator $(P_i)_g$ = output power from motor $(P_o)_m$

$\because [(P_i)_g = (P_o)_m]$

Efficiency of generator $(\eta)_g = \frac{\text{Output Power } (P_o)_g}{\text{Input Power } (P_i)_g}$

(We assume $\eta = 85\%$)

$$0.85 = \frac{230 \times 2.6}{\text{Input } ((P_i)_g)}$$

$(P_i)_g = 703.53$ watt $\quad [(P_i)_g = (P_o)_m]$

Efficiency of motor $(\eta)_m = \frac{\text{Output Power } (P_o)_m}{\text{Input Power } (P_i)_m}$

$$(\eta)_m = \frac{703.53}{240 \times 5.8} = 0.5054$$

$(\eta)_m = 50.54\%$

umulatively Compounded ⇒

We know output power generator = $V_g I_g = (P_o)_g$

Input power to motor $(P_i)_m = V_m I_m$

Input power to generator $(P_i)_g$ = output power from motor $(P_o)_m$

$\because [(P_i)_g = (P_o)_m]$

Efficiency of generator $(\eta)_g = \frac{\text{output Power } (P_o)_g}{\text{Input Power } (P_i)_g}$

(We assume $\eta = 85\%$)

$$0.85 = \frac{230 \times 2.6}{\text{Input } [(P_i)_g]}$$

$(P_i)_g = 703.53$ Watt $\quad [(P_i)_g = (P_o)_m]$

Efficiency of Motor $(\eta)_m = \frac{\text{Output Power } (P_o)_m}{\text{Input Power } (P_i)_m}$

$$(\eta)_m = \frac{703.53}{246 \times 5.6} = 0.5106$$

$(\eta)_m = 51.06\%$

Differentially Compounded D.C. Motor

We know output power generator = $V_g I_g = (P_o)_g$

Input power to motor $(P_i)_m = V_m I_m$

∴ Input power to generator $(P_i)_g$ = output power from motor $(P_o)_m$

∴ $[(P_i)_g = (P_o)_m]$

Efficiency of generator $(\eta)_g = \frac{\text{output Power } (P_o)_g}{\text{Input Power } (P_i)_g}$

(We assume $\eta = 85\%$)

$$0.85 = \frac{230 \times 2.6}{\text{Input } (P_i)_g}$$

$(P_i)_g = 703.53$ watt $[(P_i)_g = (P_o)_m]$

Efficiency of motor $(\eta)_m = \frac{\text{output Power } (P_o)_m}{\text{Input Power } (P_i)_m}$

$$(\eta)_m = \frac{703.53}{240 \times 5.8} = 0.5054$$

$(\eta)_m = 50.54\%$

Result table :

Shunt Compound

Power input to motor (watt)	Power output from motor (watt)	Efficiency of motor $(\eta)_m$	Speed (rpm)
768	0	0	1600
1200	351.76	29.31%	1581
1392	703.53	50.54%	1565
1680	1028.24	61.2%	1550
1968	1380	70.12%	1535
2448	1840	75.16%	1520

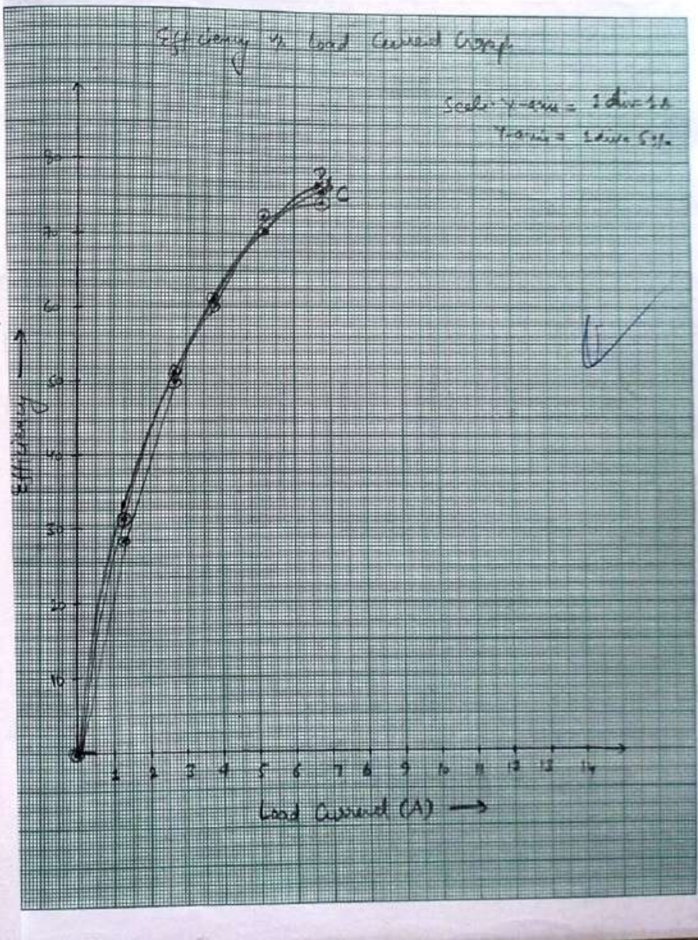
Differentially ~~Cumulatively~~ Compound

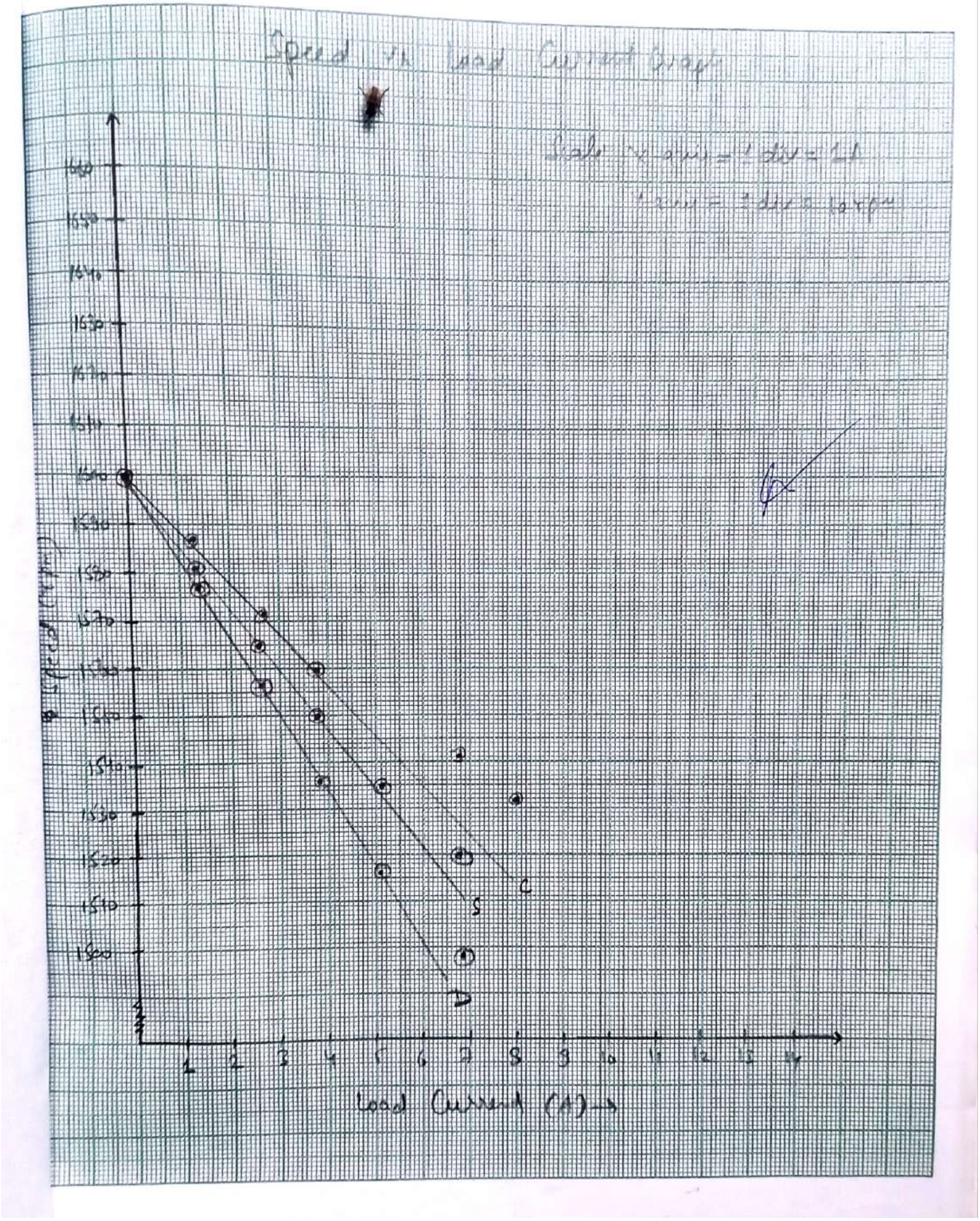
Power input to motor (watt)	Power output from motor (watt)	Efficiency of motor $(\eta)_m$	Speed (rpm)
768	0	0	1600
1056	351.76	33.34%	1578
1392	703.53	50.54%	1556
1680	1028.24	61.21%	1536
1968	1380	70.12%	1516
2448	1840	75.16%	1494

Cumulatively ~~Differentially~~ compounded

Power input to motor (watt)	Power output from motor (watt)	Efficiency of motor (η) %	Speed (rpm)
787.2	0	0	1600
1082.4	351.76	32.49 %	1587
1377.6	703.53	51.06 %	1572
1697.4	1028.24	60.57 %	1560
2509.2	1840	73.33 %	1541
2902.8	2164.71	74.57 %	1532

Discussion :





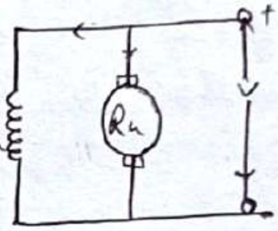
Speed vs Load Current Graph
1660
1650
1640
1630
1620
1610
1600
1590
1580
1570
1560
1550
1540
1530
1520
1510
1500
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Load Current (A) →
C
S
D

Discussion :

1) Explain why dc shunt motors are regarded as constant speed motors. Mention industrial applications of shunt motors.

Ans: In a DC shunt motor, speed is directly proportional to the voltage across the armature terminals and inversely proportional to the flux (ϕ) due to the field windings $(N \propto \frac{1}{\phi})$

i.e. $N \propto 1/I_{sh}$.



In a shunt motor, the shunt field current, I_{sh} is always constant since the field winding is connected in parallel to the armature winding and the supply voltage.

Under a constant supply voltage and normal load, the field flux in a shunt motor remains approximately the same.

The flux decreases due to the armature reaction is negligible under normal condition.

If load change is not considered since a DC shunt motor has a constant flux ϕ and a constant supply voltage, the speed of the motor remains constant.

This is the reason why, DC shunt motors are regarded as constant speed motors.

Shunt DC motors are utilized in Centrifugal Pumps, Lifts, Weaving Machines, Lathe Machines, Blowers, fans, Conveyors, Spinning Machines, and other applications where a consistent speed is required.

Exp-4

8A

20/2/24

EEA-2970

GROUP NO.	03
CLASS S.NO.	14
SECTION	A2MB
NAME	PRANAY SINGH

EXPERIMENT NO.: 02 ~~01~~

OBJECT: Determination of characteristics of 3 phase induction motor by load test.

DATE OF PERFORMING THE EXPERIMENT: 13/02/23

DATE OF SUBMISSION OF REPORT: 20/02/23

OTHER GROUP PARTNERS:

CLASS S.NO.	NAME
12	Gagan Pathak
13	Laksh Gupta
15	Moh. Arham
16	Prakhar Sahu

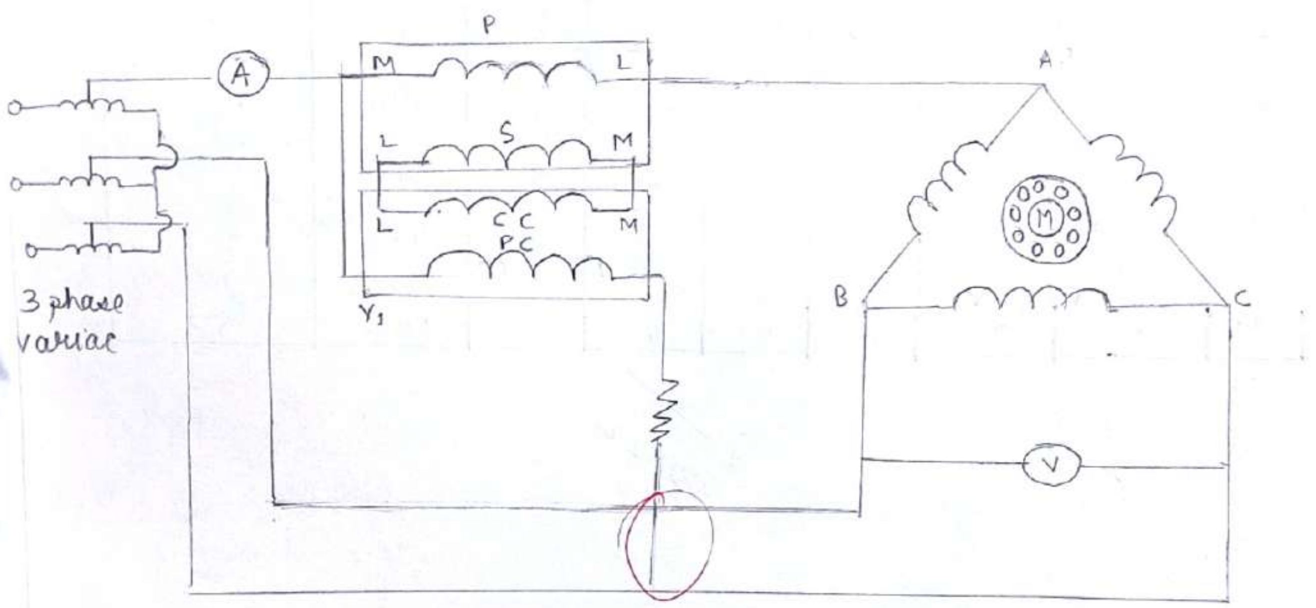
REMARK (If any by the teacher concerned):

Experiment - 2

Name - Pranay Singh
S.No - 14 (A2MB)
R.No - 21MEB448

Object: Determination of characteristics of 3 phase induction motor by load test.

Circuit Diagram:



circuit diagram for load test on 3 phase induction motor.

Apparatus Used:

S.No.	Equipment Name	Range	Make
1.	Ammeter	0-15 A	Holand
2.	Voltmeter	0-300 V	-
3.	Induction motor with balance	950 rpm, 230V, 14A 100 kgf, 50 kgf	Bombay
4.	Current transformer		Bombay
5.	Wattmeter	0-300 W	Automatic Electric Ltd.
6.	Pressure Coil	—	—

Observation table:

S.No.	Voltage (V)	Current (A)	Wattmeter Reading (watt)		Tension (T) (kgf)		Speed (N) rpm	Frequency (f) (Hz)
			W_1	W_2	T_1	T_2		
1.	230	14	195	70	60	12	948	50
2.	230	13	180	50	52	11	951	50
3.	230	12	160	45	45	10	962	50
4.	230	11	150	30	40	9	970	50
5.	230	10	140	20	35	8	975	50
6	230	9	120	10	26	6	982	50
7.	230	8	90	-10	12	3	992	50
8.	230	7	70	-40	0	0	1000	50

R 13/2/22

Formula used:

$$\text{Torque} = (T_1 - T_2)\left(\frac{D}{2}\right) g \quad \text{N-m}$$

$$\text{Input Power} = W_1 + W_2$$

$$\text{Output Power} = \frac{2\pi N \times \text{Torque}}{60 \times MF \times WF}$$

where, $T_1, T_2 \rightarrow$ Tension in belt

$D \rightarrow$ Diameter of Pulley (6 inch = 0.1524 m)

$W_1, W_2 \rightarrow$ Reading of wattmeter

$N \rightarrow$ Speed rpm

$MF \rightarrow$ Multiplying factor

$WF \rightarrow$ Wattmeter factor

$\text{Factor} = MF \times WF = 4 \times 4 = 16$

Sample Calculation:

For reading '3':

$T_1 = 45$ kgf, $T_2 = 10$ kgf, $W_1 = 160$ W, $W_2 = 45$ W, $N = 962$ rpm

$$\text{Torque} = (T_1 - T_2)\left(\frac{D}{2}\right) \times g = (45-10)\left(\frac{0.1524}{2}\right) \times 9.8 = 26.14 \text{ Nm}$$

$$\text{Output Power} = \frac{2\pi N T}{60 \times \text{Factor}} = \frac{2 \times \pi \times 962 \times 26.14}{60 \times 16} = 164.58 \text{ W}$$

$$\text{Input Power} = W_1 + W_2 = 160 + 45 = 205 \text{ W}$$

$$\text{Efficiency } (\eta) = \frac{\text{output P}}{\text{input P}} = \frac{164.58}{205} \times 100 = 80.3\%$$

Result Table:

S.No.	Voltage (V)	Current (A)	Speed (N) rpm	Input Power (W_1+W_2)	Torque N-m	Output Power (Watt)	% Efficiency
1	230	14	948	265	35.84	222.37	83.91 %
2	230	13	951	230	30.62	190.58	82.86 %
3	230	12	962	205	26.14	164.58	80.28 %
4	230	11	970	186	23.15	146.97	81.65 %
5	230	10	975	160	20.16	128.65	80.41 %
6	230	09	982	130	14.94	96.02	73.86 %
7	230	08	992	80	6.72	43.63	54.54 %
8	230	07	1000	30	0	0	0 %

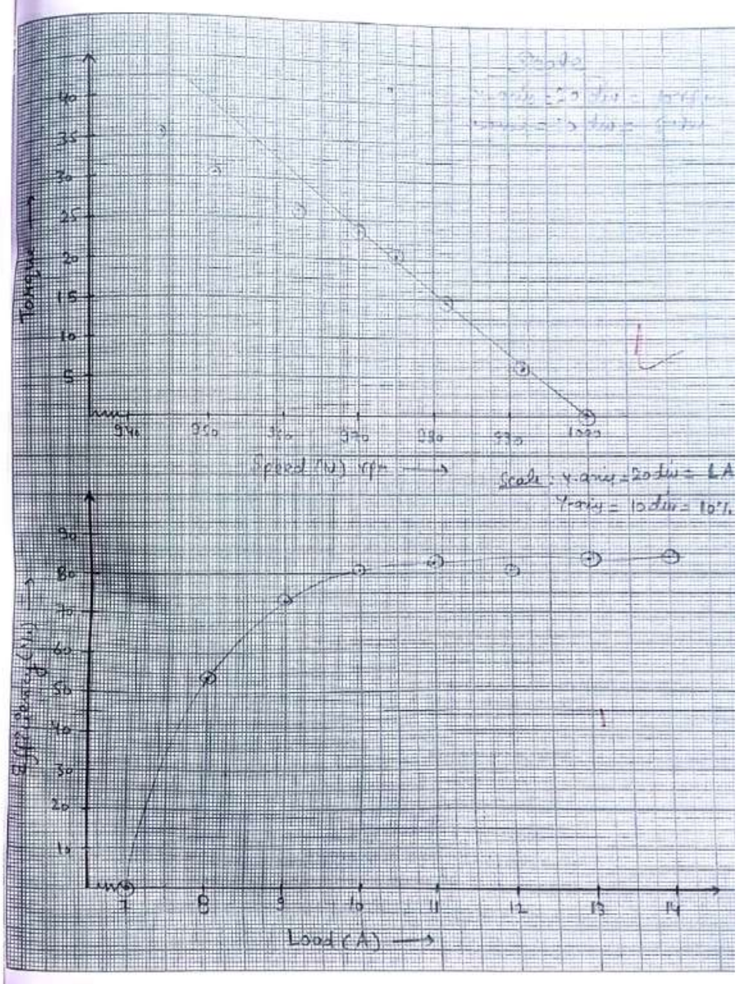
Discussion: The load test of induction motor is performed to compare its complete performance i.e. Torque, η, etc.
During this test motor is operated at a rated voltage (230V) of appear constant frequency (50 Hz) loaded normally on brake belt.

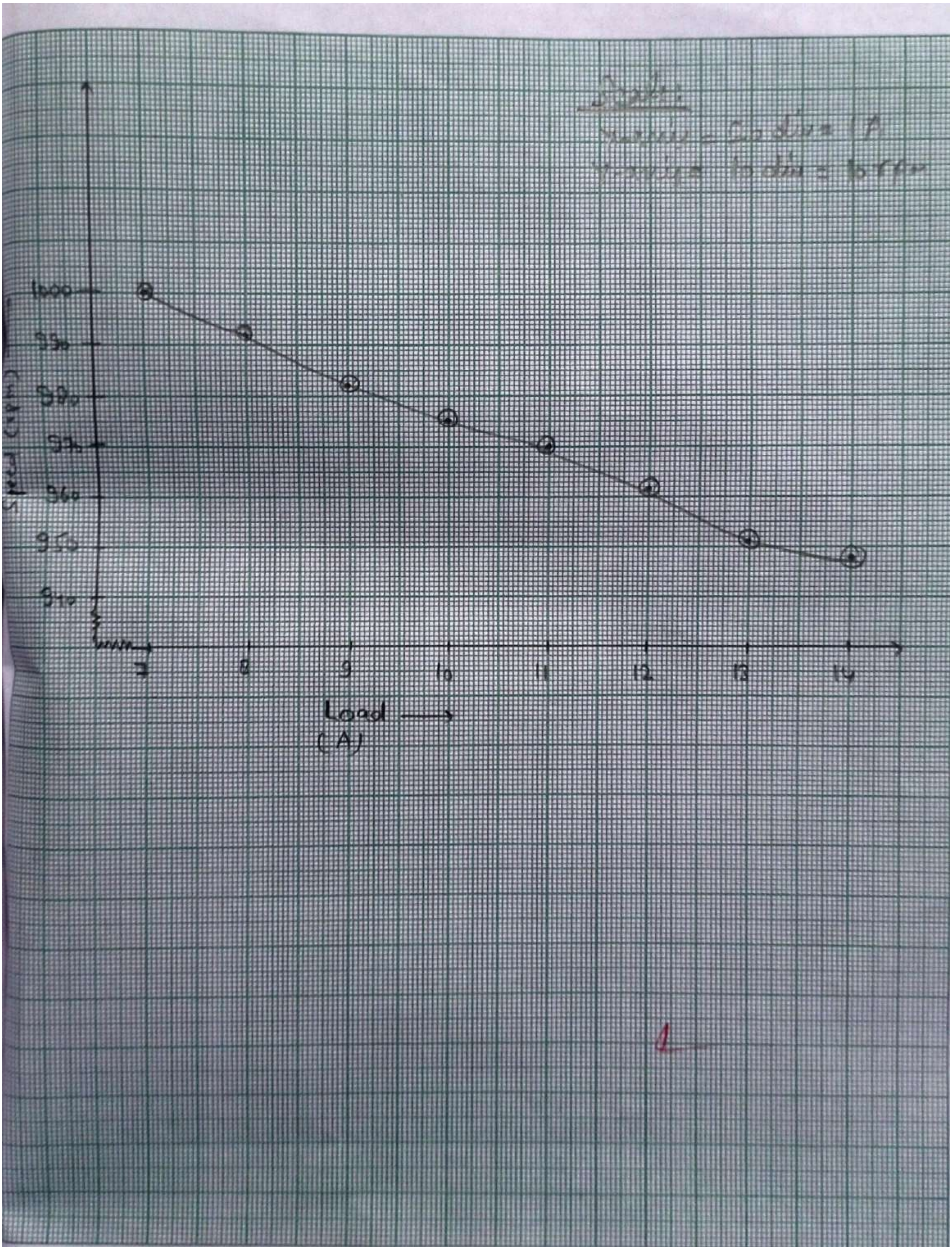
Discussion from graph:

① Torque v/s Speed → We can see from the graph that as the speed of the motor increases, the torque decreases.

② Efficiency v/s Load → We can see from the graph that as the load current increases, the efficiency also increases.

③ Speed v/s Load → We can see from the graph that as the load increases, the speed decreases.




1000
990
980
970
960
950
940
7
8
9
10
11
12
13
14
Load
(A)

Exp-5

7

R
1/5/23

EEA-2970

GROUP NO.	03
CLASS S.NO.	14
SECTION	A2MB
NAME	PRANAY SINGH

EXPERIMENT NO.: 05

OBJECT: Static characteristics of an SCR

DATE OF PERFORMING THE EXPERIMENT: 20/02/23

DATE OF SUBMISSION OF REPORT:

OTHER GROUP PARTNERS:

CLASS S.NO.	NAME
12	Gagan Pathak
13	Laksh Gupta
15	Mo. Arham
16	Pratchas Sahu

REMARK (If any by the teacher concerned):

Observation table:

Latching Current = 26 mA

Holding Current = 11 mA

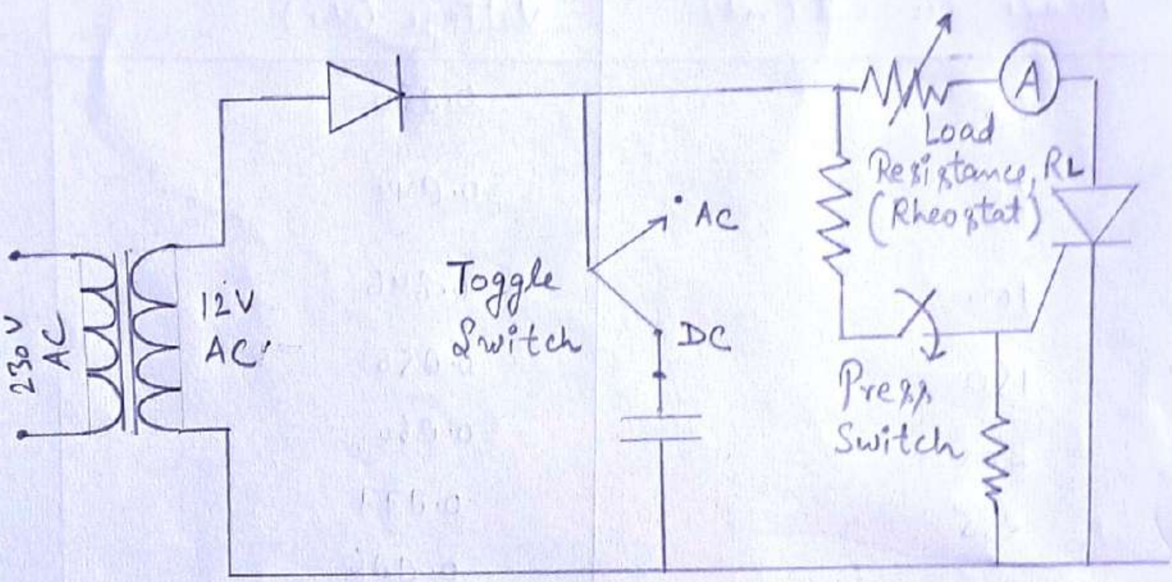
S.No.	Anode Current (mA)	Voltage (Vak)
1	25	0.850
2	65	0.844
3	100	0.846
4	150	0.850
5	200	0.860
6	255	0.877
7	305	0.885
8	365	0.896
9	415	0.910
10	455	0.920
11	500	0.930

20/2/23

EXP-03

OBJECT: Static characteristics of an SCR

CIRCUIT DIAGRAM:



Apparatus Used:

S.No.	Equipment Name	Range	Make
1.	Multimeter (Digital)	0-999 V (DC)	Scientech
2.	Ammeter (DC)	(i) 0-0.5 A (ii) 0-100 mA	AE - Limited
3.	Rheostat	1590 Ω, 0.5 A	Stead
4.	Stepdown transformer	230 V to 12 V	Delta
5.	SCR		

my Si,
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2254

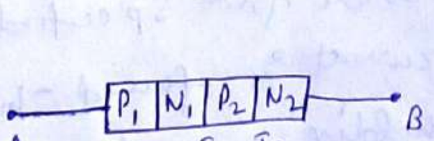
Discussion

Q1. Why SCR conducts so long as gate signal is present in a.c. test?

Sol: This is because with no gate signal applied, a silicon controlled rectifier blocks current in both direction of an AC waveform, and once it is triggered into conduction, the regenerative latching action means that it cannot be turned "OFF" again just by using its Gate.
In case of an SCR we obtain a rectifier AC output due to presence of diode but the voltage becomes zero at the end of each of half wave cycle. Hence it conducts as long as gate signal is present in a.c. test.

Q2. Why SCR fails to maintain conduction below holding current?

Sol: For turning off the SCR anode current must fall below the holding current. If the anode current is greater than the holding current. SCR fails to turn off even when it is in conducting mode and a reverse voltage is applied between anode and cathode.
SCR fails to conduct below holding current due to reduced current carries flowing through J^4 J_2 is also reduced current in N_1 of P_2 region, regain their semiconductor properties depletion layer forms across J_2 which is reversed biased and bring back the device to blocking state.



Q3. What are the specifications of SCR used in experiment?

Sol: Experimentally, holding current is found to be 15 mA, but according to specification, the holding current is 40 mA. Thus deviation is of 25 mA.

Specification of SCR

Type No.	$I_{t\,rms}$ (A)	V_{DRM} (V)	V_{RRM} (V)	V_{RSM} (V)	V_F (V)	V_{GT} (V)	I_{GT} (mA)	T_{SM}
DE2508	25	800	800	900	1.5	3	40	100

(1) Conducting State

- → Maximum forward voltage drop at $t_j = 25°C$ — $V_{tmax} = 2.5\,V$
- → Average ON state current — $I_{T(av)} = 16\,A$
- → Holding current DC value — $I_H = 40\,mA$
- → Average ON-state Power dissipation — $P_0 = 30\,W$
- → RMS surge (non-repetitive) ON-State Current — $P_t = 220\,A^2\,sec$

(2) Gate Parameter

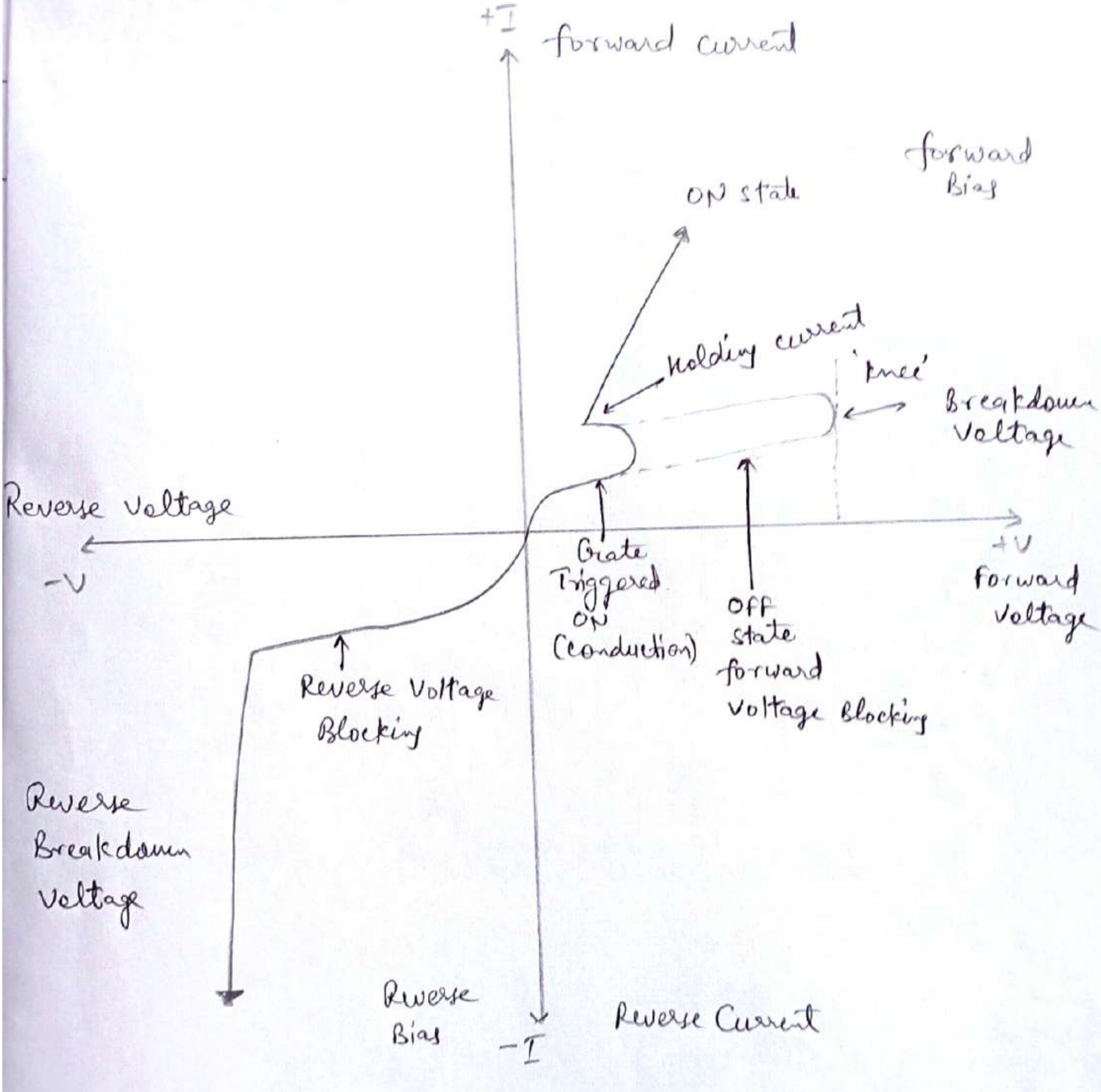
- → Max^m Gate Triggering Current — $I_{GTM} = 60\,mA$
- → Max^m Gate Triggering voltage — $V_{GTM} = 3.5\,V$

(3) Switching Parameter

- → Rate of applied voltage = 20 V/μs
- → Rate of change of ON-state voltage = 25 A/μs

Ques How much exp. data deviate from specified data?

Sol: Experimentally holding current is found to be 11 mA but acc. to specification, the holding current is 40 mA. Thus deviation is of 29 mA.

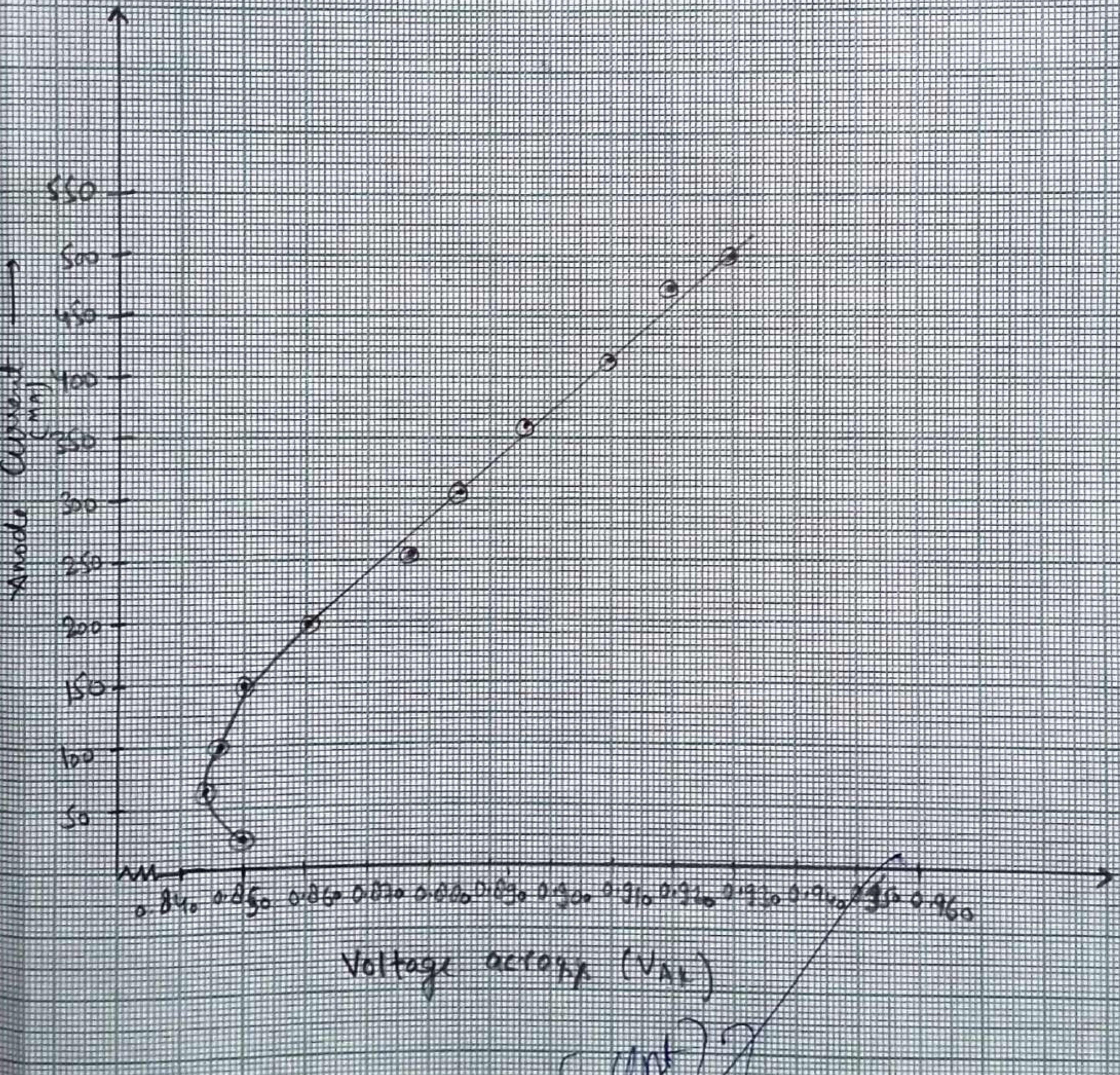


V-I characteristics of an SCR

Scale:

X-axis: 1 unit = 0.010 V

Y-axis: 1 unit = 50 mA



Exp 06

(8)
P
27/3/23

EEA-2970

GROUP NO.	03
CLASS S.NO.	14
SECTION	A2MB
NAME	Pranay Singh

EXPERIMENT NO.: 04

OBJECT: TRIAC & AC phase control

DATE OF PERFORMING THE EXPERIMENT: 27/02/2023

DATE OF SUBMISSION OF REPORT:

OTHER GROUP PARTNERS:

CLASS S.NO.	NAME
12	Oragon Pathak
13	Lakxh Gupta
15	Mo. Arham
16	Prakhar Sahu

REMARK (If any by the teacher concerned):

Exp. 04

Pranav Singh
A2 IAB-141

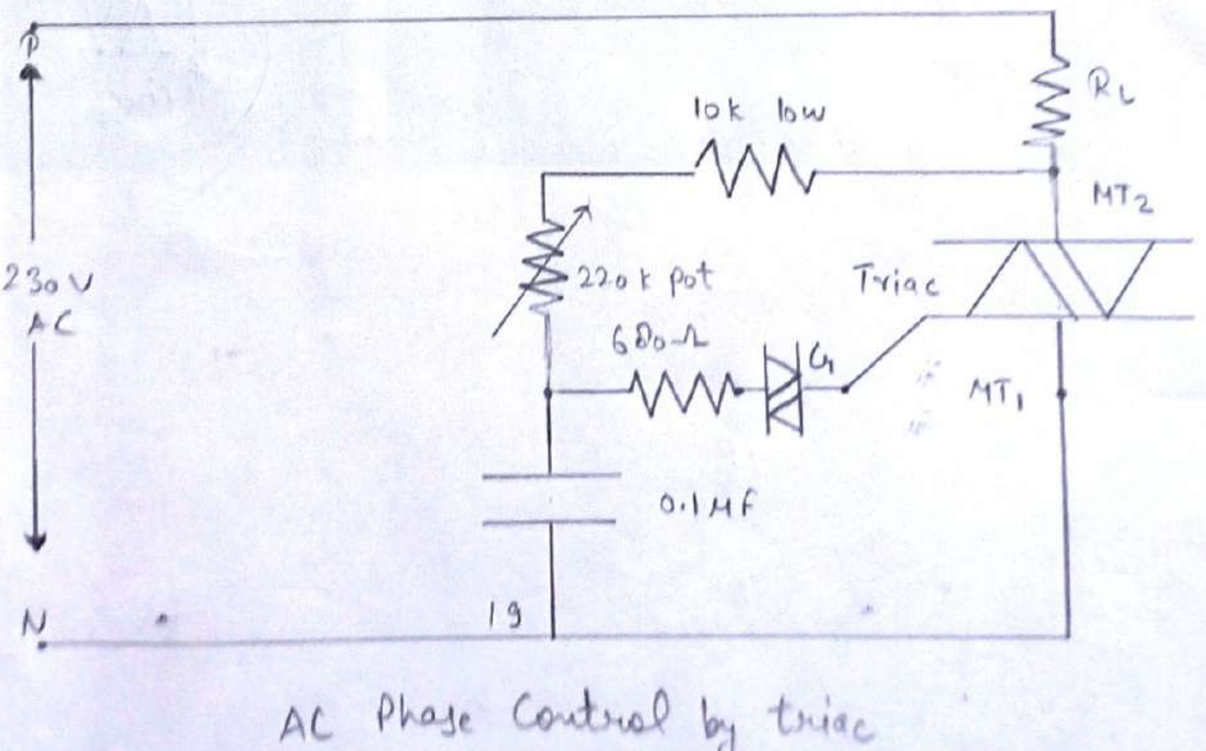
OBJECT: Triac and a.c. phase control.

(i) To study a diac based trigger circuit
(ii) To study ac phase controlled switching using a diac and triac

Apparatus used :

S.No.	Equipment Name	Range	Make
1.	Auto Transformer	0-230V, 10A 2.7 kVA	AE
2.	DSO	50 MHz (EDUX1002G)	Keysight
3.	Digital Multimeter	0-1000V (D.C.)	Scientech
4.	Bulb	15 W	Crompton
5.	Experimental kit		

Circuit Diagram :



AC Phase Control by triac

OBSERVATION TABLE:

S.No.	Input Voltage (V)	Output Voltage (V)	Firing Angle
1.	230	45.9	5.5×22.5 = 123.75
2.	230	94.1	4.2×22.5 = 94.5
3.	230	149.6	3×22.5 = 67.5
4.	230	192.4	2×22.5 = 45
5.	230	210.2	0.9×22.5 = 20.25

27/2/2023

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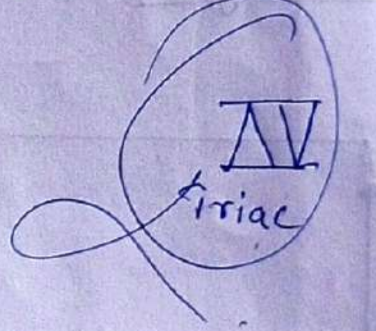
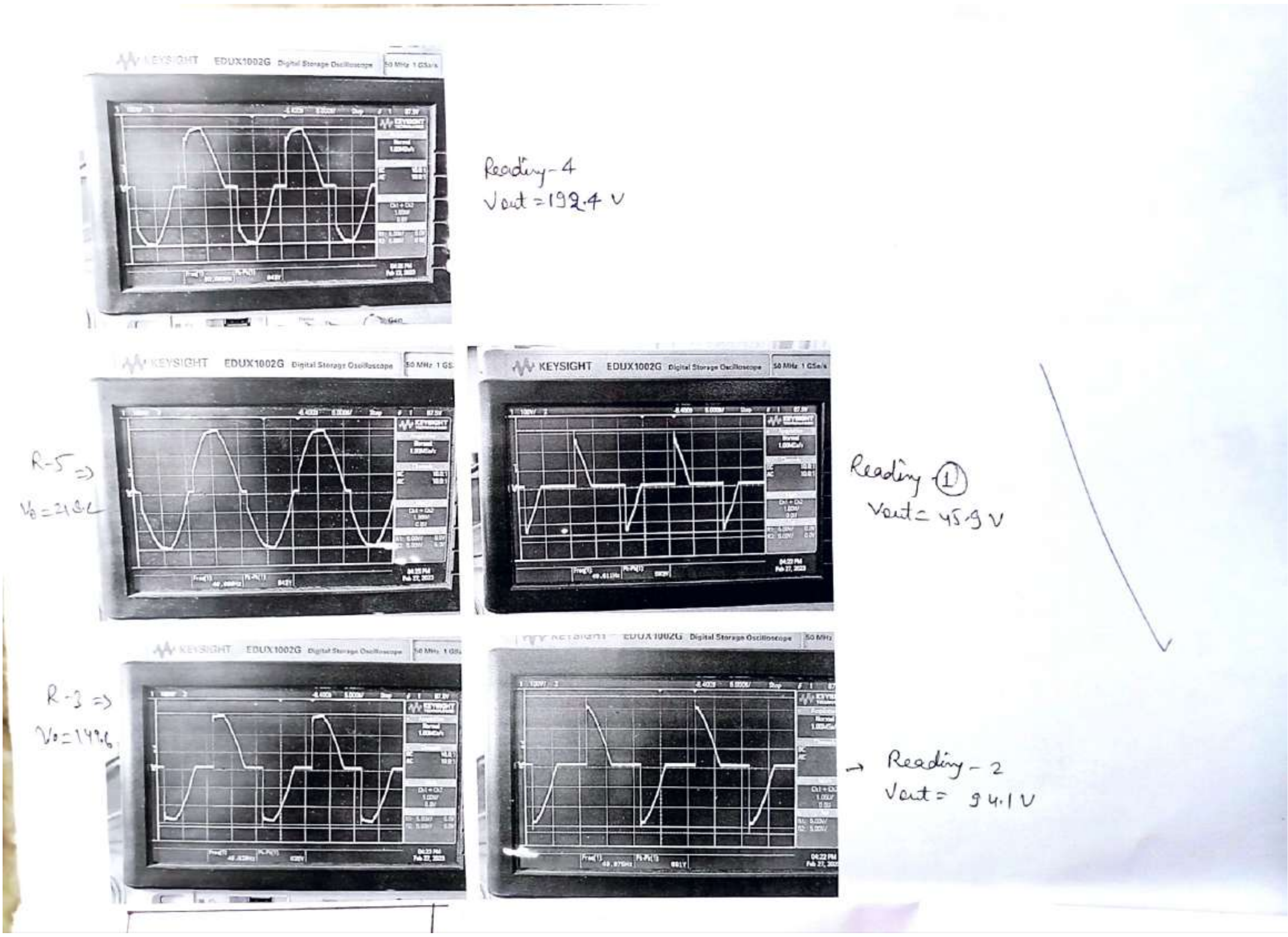



KEYSIGHT EDUX1002G Digital Storage Oscilloscope
50 MHz 1 GSa/s
Reading-4
Vout = 192.4 V
R-5 =>
Reading ①
Vout = 45.9 V
R-3 =>
Reading - 2
Vout = 94.1 V

Sample Calculation

Reading No. (3)

16 divisions = 360 = 2π

$\alpha = \frac{360}{16} \times 3 = 67.5^\circ = 67.5 \times \frac{\pi}{180} = 1.178$ radians

$V_{in} = 230V$, $V_m = 230\sqrt{2} = 325.27\,V$

$$V_{out} = \frac{V_m}{\sqrt{2\pi}}\left((\pi - \alpha) + \frac{\sin 2\alpha}{2}\right)^{1/2}$$

$$= \frac{325.27}{\sqrt{2\pi}}\left[(\pi - 1.178) + \frac{1}{2}\sin(2 \times 1.178)\right]^{1/2}$$

$$= 198.11$$

$V_{out} = 198.11\,V$

Reading No (5)

$\alpha = \frac{360}{16} \times 0.9 \times \frac{\pi}{180} = 0.353$ radians

$V_{in} = 230V$, $V_m = 230\sqrt{2} = 325.27\,V$

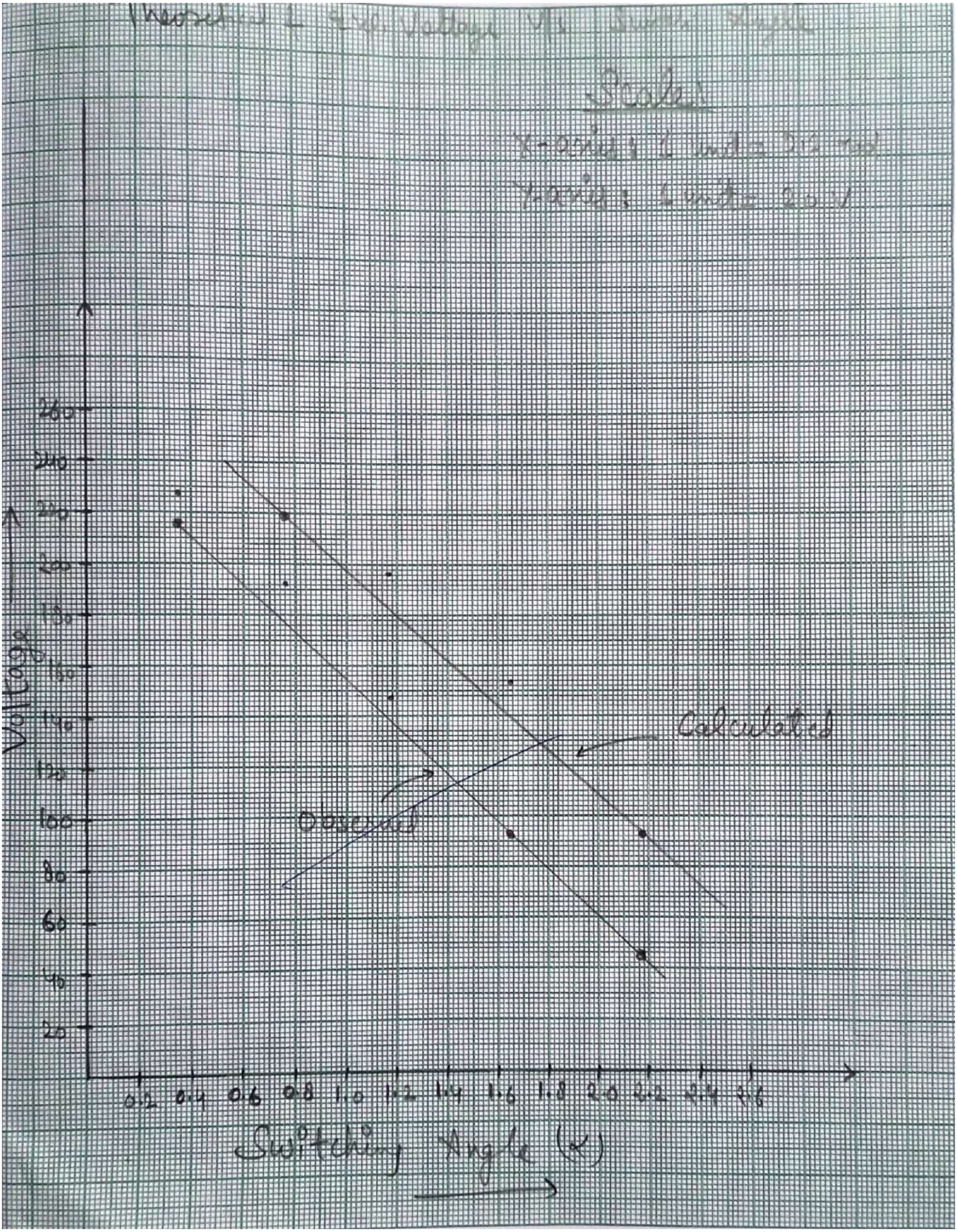
$$V_{out} = \frac{325.27}{\sqrt{2\pi}}\left[(\pi - 0.353) + \frac{1}{2}\sin(2 \times 0.353)\right]^{1/2}$$

$$= 228.95$$

$V_{out} = 228.95$

Result Table

S.No.	Observed output Voltage (V)	Calculated Output Voltage (V)	Switching Angle (α) radians
1.	45.9	93.54	2.16
2.	94.1	154.24	1.65
3.	149.6	198.11	1.178
4.	192.4	219.51	0.785
5.	210.2	220.95	0.353


Voltage
Scale:
X-axis : 1 unit = 0.2 rad
Y-axis : 1 unit = 20 V
260
240
220
200
180
160
140
120
100
80
60
40
20
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
Calculated
Observed
Switching Angle (α)

Discussion

1) What are the advantages and disadvantages of a triac over SCR?

:: Advantage of TRIAC over SCR:

i) The TRIAC can be triggered by both +ve & -ve gate terminal.

ii) The TRIAC can control DC as well as AC Power.

iii) In TRIAC four different modes of operation are possible.

Disadvantage of TRIAC over SCR:

i) TRIAC is not reliable as compared to SCR.

ii) TRIAC is not suitable for D.C. application.

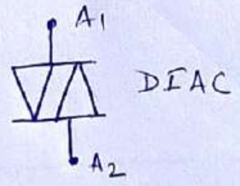
iii) It has very high switching delay.

iv) TRIAC has low rating as compared to SCR.

2) Discuss the characteristics of a Diac.

:: A DIAC is a diode that conducts electric current only after its breakdown voltage (V_{BO}) has been reached. DIAC stands for "Diode for Alternating Current".

A DIAC is a device which has two electrodes and is a member of thyristor family. DIAC are used in triggering of the resistors.



3) What are maximum V, I, $\frac{di}{dt}$ and $\frac{dv}{dt}$ ratings of triac used?

Soln $V_{max} = 230\sqrt{2} = 325.27\ V$

Exp-7

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EEA-2970

GROUP NO.	03
CLASS S.NO.	14
SECTION	A2MB
NAME	PRANAY SINGH

EXPERIMENT NO.: 07

OBJECT: Speed Control of Universal Motor by SCR

DATE OF PERFORMING THE EXPERIMENT: 27/03/2023

DATE OF SUBMISSION OF REPORT: 03/04/2023

OTHER GROUP PARTNERS:

CLASS S.NO.	NAME
12	Gagan Pathak
13	Lakesh Gupta
15	Mo. Arham
16	Prakhar Sahu

REMARK (If any by the teacher concerned):

EXP-05

PRANAY SINGH
21MEB448
GL2254

OBJECT: Speed Control of Universal Motor (UM) by SCR.

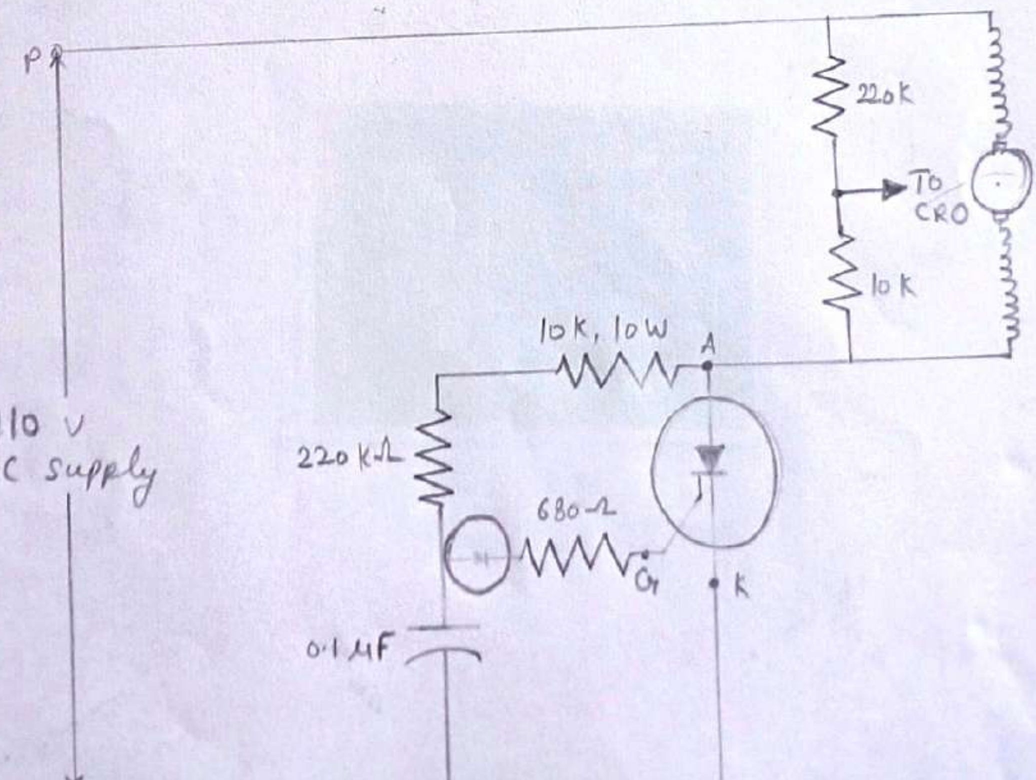
(i) To study an RC triggering circuit for SCR.

ii) To study the speed variation of UM using above triggering circuit for half wave control of ac supply voltage.

Apparatus Used:

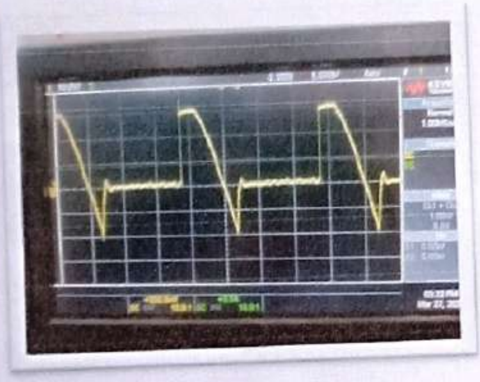
S.No	Equipment	Range	Make
1.	Hand Analog Techometer	0-10000 rpm	Fuji Koggo
2.	Universal Motor	230V	Tullu
3.	DSO (EDUX1002A)	50MHz	Keysight
4.	Auto Transformer	0-230V	AE
5.	SCR	-	

Circuit Diagram:

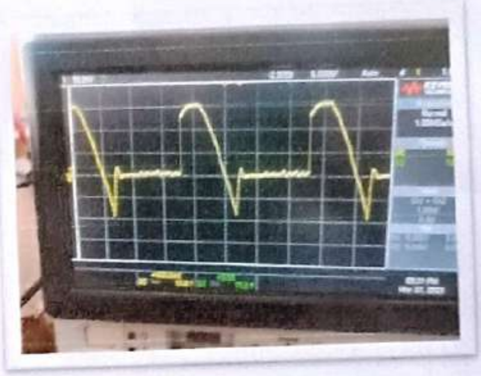


(I)

(II)



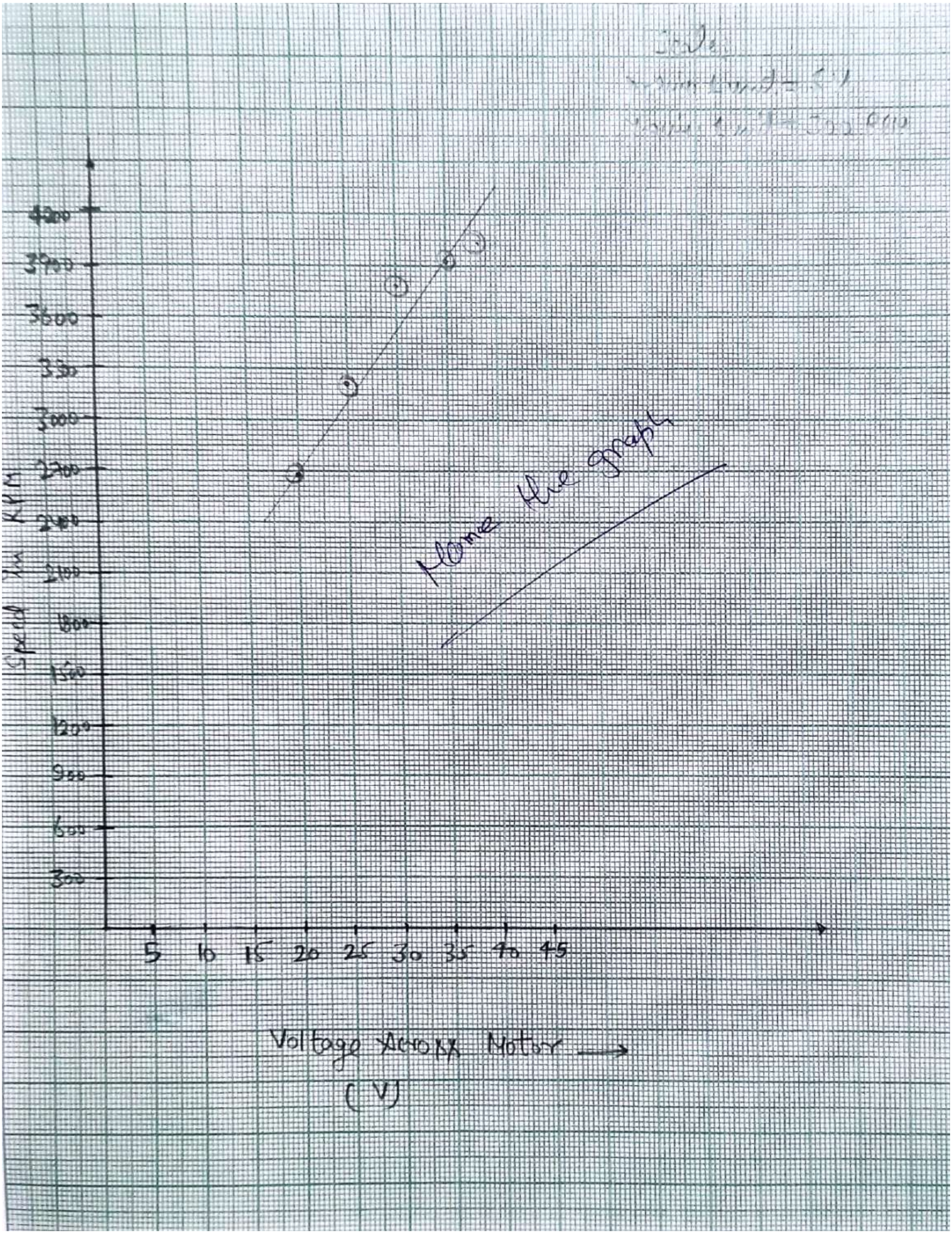
(III)



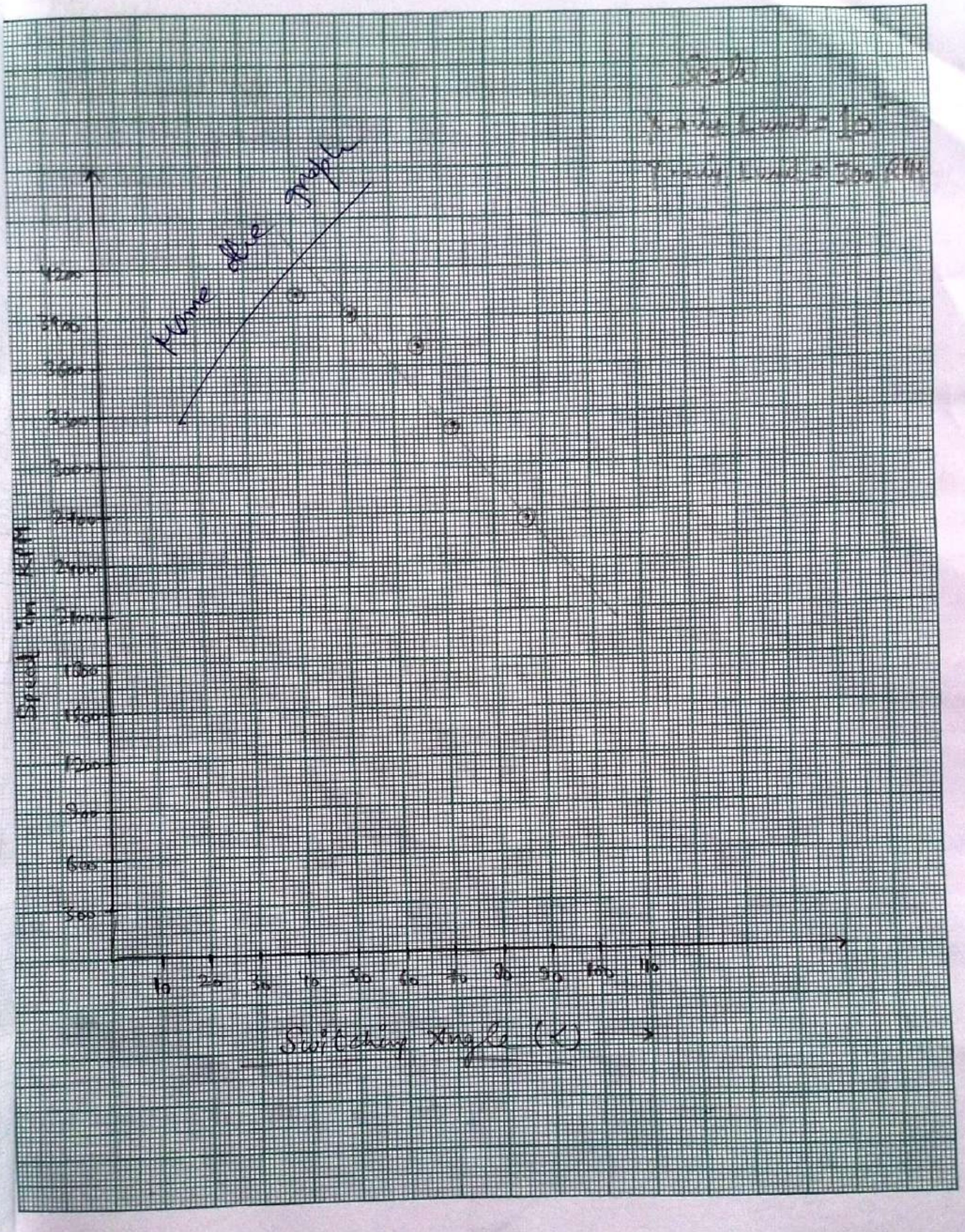
IV

(V)

Firing angle ?



Speed in RPM
4200
3900
3600
3300
3000
2700
2400
2100
1800
1500
1200
900
600
300
5
10
15
20
25
30
35
40
45
Voltage Across Motor →
(V)
Name the graph


Scale
X-axis 1 unit = 10°
Y-axis 1 unit = 300 RPM
Move the graph
Speed in RPM
Switching Angle (α)

Discussion

1) Plot speed v/s switching angle and comment on it.

Ans:- From the graph plotted b/w speed of the universal motor and switching angle, we can see that the speed, and switching angle are inversely proportional to each other i.e when the switching angle is increased the speed of motor decreases.

2) Plot speed v/s voltage and comment on it.

Ans:- From the graph plotted b/w speed of the universal motor and the supplied voltage, we can see the linearity b/w speed and voltage i.e, when the voltage across the motor is increased, the speed of the universal motor increases.

Speed of Motor $\propto$ Voltage Across

3) For an inductive circuit, explain how the load voltage changes even if switching angle did not change.

Ans:- Average output voltage is given by

$$V_{dc} = \frac{V_m}{2\pi}\int_0^{\pi} \sin\omega t \, d(\omega t)$$

$$V_{o(dc)} = \frac{V_m}{2\pi}[1+\cos\alpha], \quad V_m = \sqrt{2}V_s$$

We can change the V_m supplied to the load by varying voltage across the variable diode. Thus we can change the load voltage, even if the switching angle did not change by changing the value of gate current. Hence for an inductive circuit, by changing gate current, the load voltage changes even if the switching angle does not change.

Exp 08

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EEA-2970

GROUP NO.	03
CLASS S.NO.	14
SECTION	A2MB
NAME	PRANAY SINGH

EXPERIMENT NO.: 08

OBJECT: Speed Control of dc motor by a phase controlled converter

DATE OF PERFORMING THE EXPERIMENT: 03/04/2023

DATE OF SUBMISSION OF REPORT: 10/04/2023

OTHER GROUP PARTNERS:

CLASS S.NO.	NAME
12	Cragan Pathak
13	Laksh Gupta
15	Md. Arham
16	Prakhar Sahu

REMARK (If any by the teacher concerned):

Pranay Singh
A2 NB -14

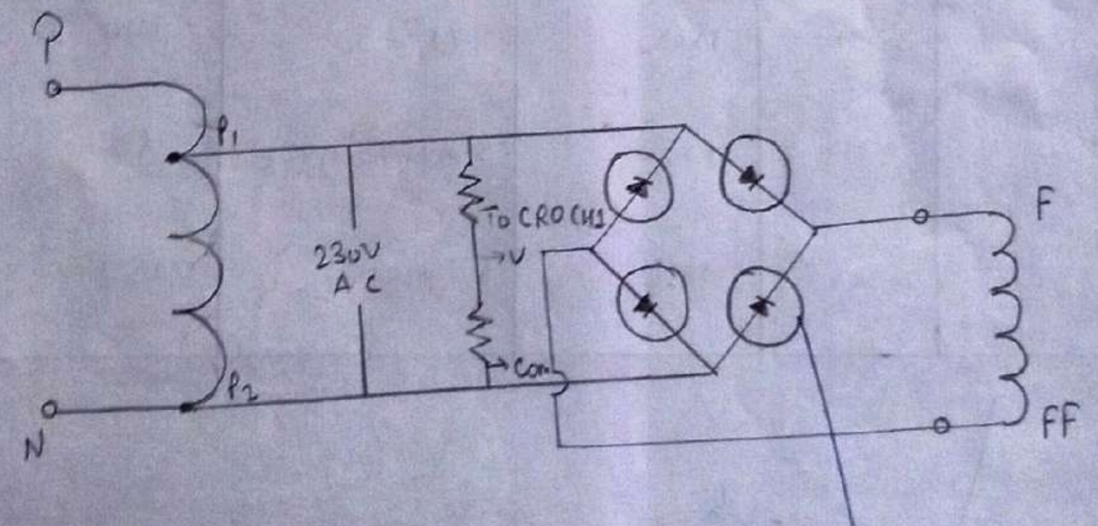
Exp-06

OBJECT: Speed control of dc motor by a phase-controlled converter.

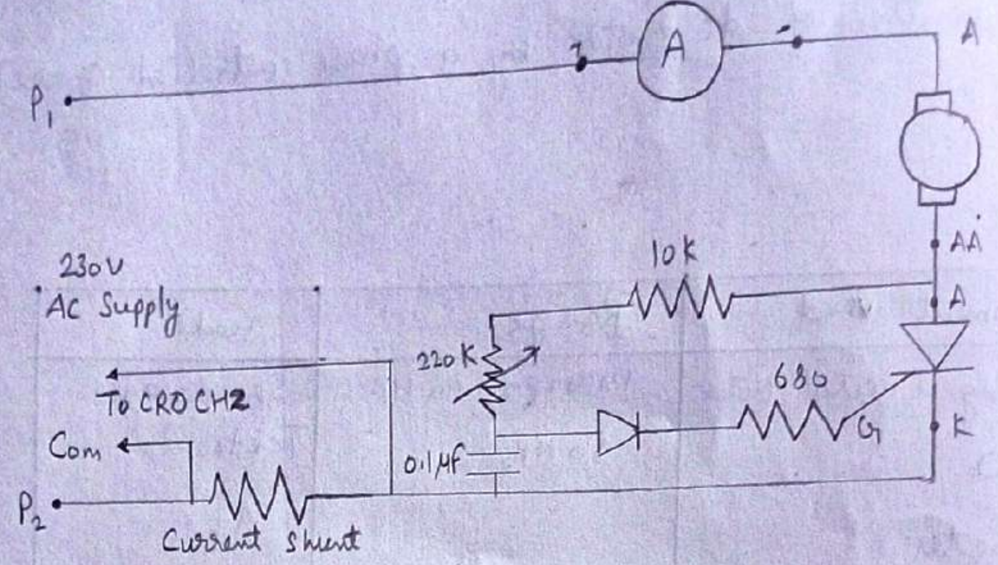
Apparatus Used:

S.No	Equipment Used	Range	Make
1.	Separately excited Motor	1440rpm, 0.5HP	Speedway
2.	DSO	50 MHz	Tektronix
3.	Ammeter		A.E.
4.	Equipment kit	—	—
5.	Tachometer	1000 RPM	Teclock
6.	Auto Transformer	10A, 270V	A.E.

Circuit Diagram:



Power Circuit for field winding of dc motor.

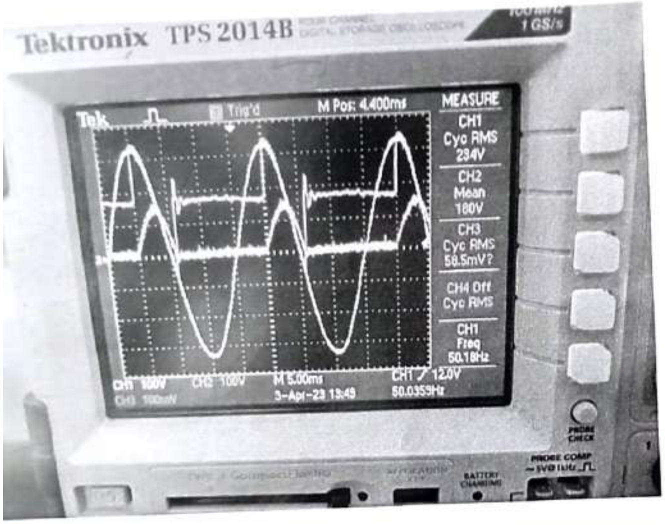


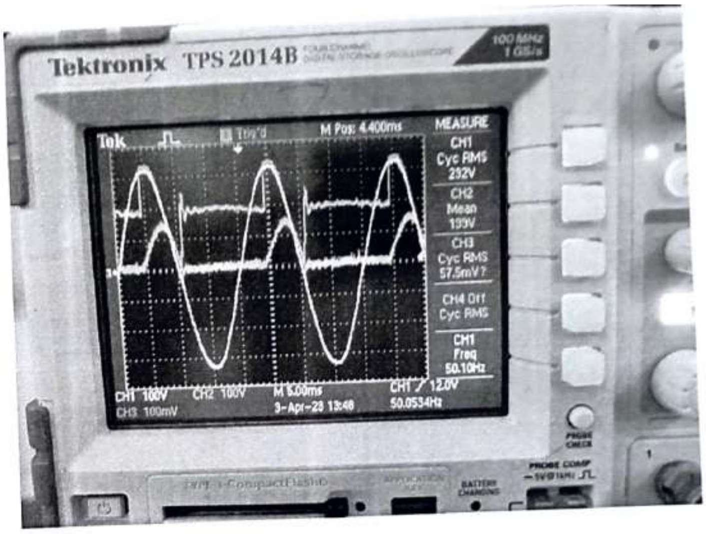
Power Circuit for armature of dc motor

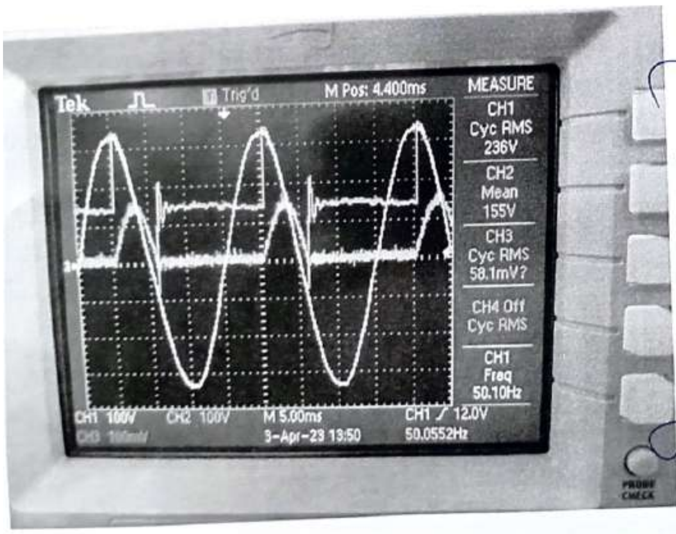
Observation table:

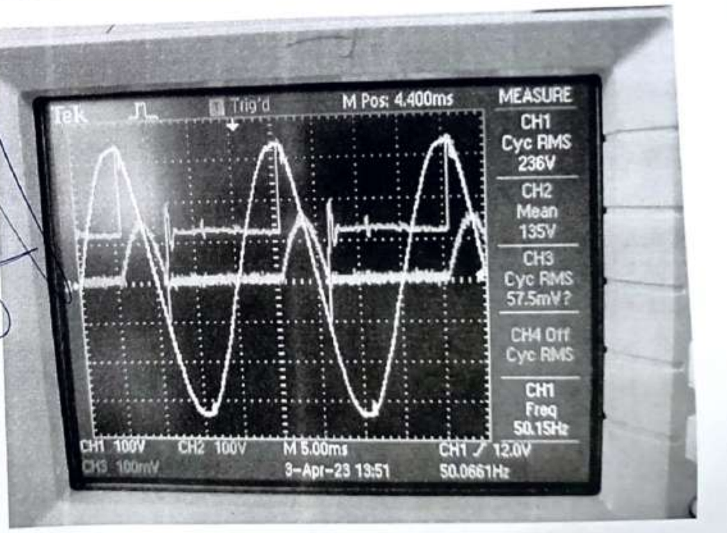
S.No.	Input Voltage (AC)	Armature Current (A)	Speed (r/min)	Triggering Angle (α)	Armature Voltage (V)
1.	230	0.235	1760	4.5×18 = 81°	197
2.	230	0.225	1565	5×18 = 90°	177
3.	230	0.215	1330	5.2×18 = 93.6°	157
4.	230	0.205	1160	5.8×18 = 104.4	137

3/4/2023

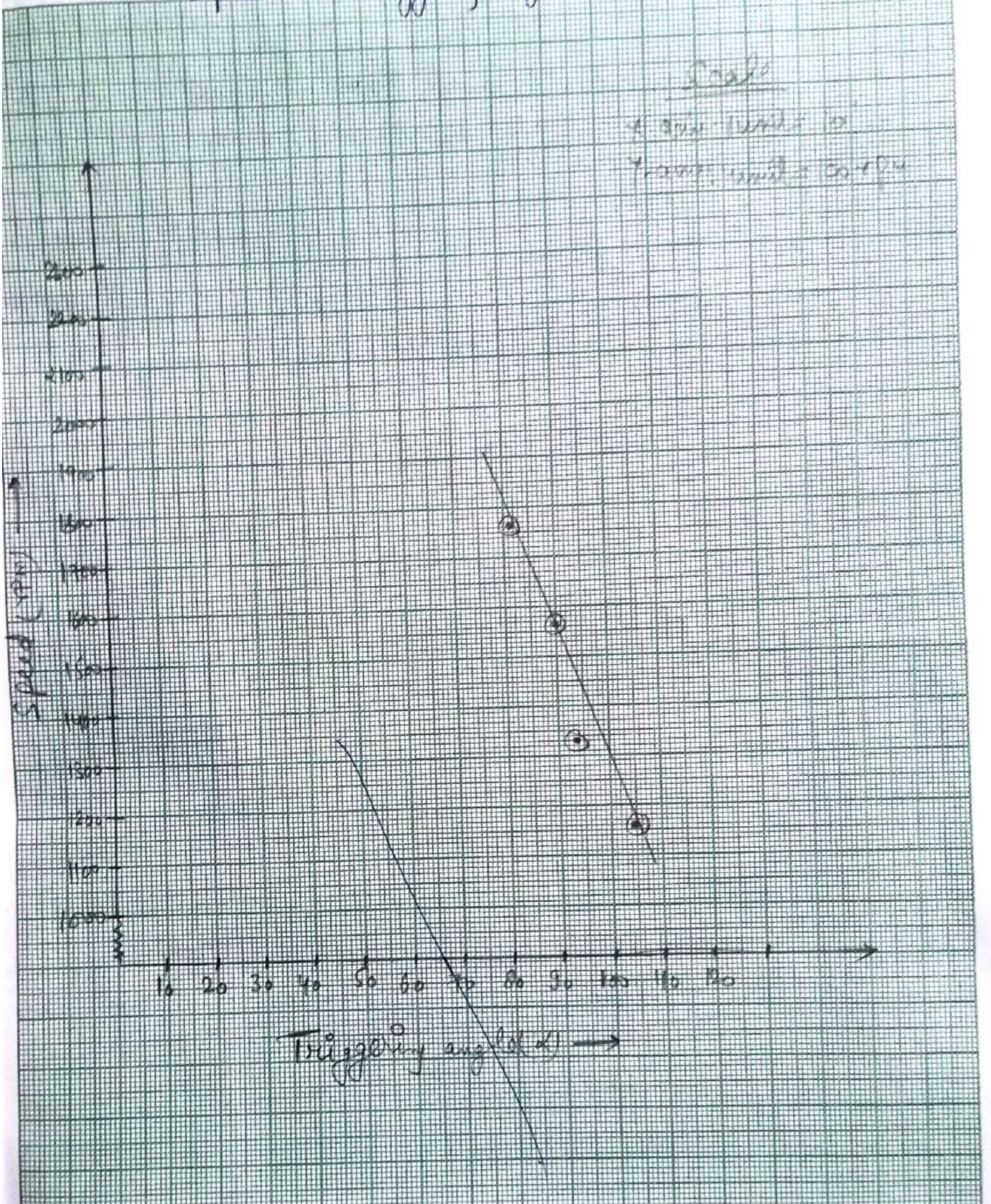

Tektronix TPS 2014B
Tek
Trig'd
M Pos: 4.400ms
MEASURE
CH1
Cyc RMS
234V
CH2
Mean
180V
CH3
Cyc RMS
58.5mV?
CH4 Off
Cyc RMS
CH1
Freq
50.18Hz
CH1 100V
CH2 100V
M 5.00ms
CH1 ⁄ 12.0V
CH3 100mV
3-Apr-23 13:49
50.0359Hz


Tektronix TPS 2014B
100 MHz
1 GS/s
Tek
Trig'd
M Pos: 4.400ms
MEASURE
CH1
Cyc RMS
232V
CH2
Mean
199V
CH3
Cyc RMS
57.5mV?
CH4 Off
Cyc RMS
CH1
Freq
50.10Hz
CH1 100V
CH2 100V
M 5.00ms
CH1 ⁄ 12.0V
CH3 100mV
3-Apr-23 13:48
50.0534Hz


Tek
Trig'd
M Pos: 4.400ms
MEASURE
CH1
Cyc RMS
236V
CH2
Mean
155V
CH3
Cyc RMS
58.1mV?
CH4 Off
Cyc RMS
CH1
Freq
50.10Hz
CH1 100V
CH2 100V
M 5.00ms
CH1 ⁄ 12.0V
3-Apr-23 13:50
50.0552Hz


Tek
Trig'd
M Pos: 4.400ms
MEASURE
CH1
Cyc RMS
236V
CH2
Mean
135V
CH3
Cyc RMS
57.5mV?
CH4 Off
Cyc RMS
CH1
Freq
50.15Hz
CH1 100V
CH2 100V
M 5.00ms
CH1 ⁄ 12.0V
CH3 100mV
3-Apr-23 13:51
50.0661Hz

Speed Vs triggering angle



Calculation

No. of divisions in half wave = 10 divisions

Angle per division = $\frac{180}{10} = 18°$

Triggering Angle:

1) No. of divisions = 4.5
Triggering angle (α) = 4.5 × 18 = 81°

2) No. of division = 5
Triggering angle (α) = 5 × 18 = 90°

3) No. of division = 5.2
Triggering angle (α) = 5.2 × 18 = 93.6°

4) No. of division = 5.8
Triggering angle (α) = 104.4°

Discussion:

Q Draw the graph of speed v/s switching angle & comment.

A: After drawing the graph we can clearly conclude that when we increase triggering angle, there is a significant decrease in the speed of the motor.

Hence, it is clear that the speed of the D.C. motor can be controlled by using these controlled converter by adjusting the triggering angle (α).

$$239 \times 3.6 = 860.4$$

$$230 \times 0 = 0$$

$$\frac{0}{860.4} \times 100 = 0$$

$$238 \times 4.4 = 1047.2$$

$$230 \times 1.6 = 368$$

$$\frac{368}{1047.2} \times 100 = 35.14\%$$

$$238 \times 5 = 1190$$

$$230 \times 2 = 460$$

$$\frac{460}{1190} \times 100 = 38.66\%$$

$$238 \times 6 = 1428$$

$$230 \times 3.4 = 782$$

$$\frac{782}{1428} \times 100 = 54.76\%$$

$$238 \times 7.2 = 1713.6$$

$$230 \times 4.6 = 1058$$

$$\frac{1058}{1713.6} \times 100 = 61.74\%$$

$238 \times 9.2 = 2189.6$

$230 \times 6.2 = 1426$

$$\frac{1426}{2189.6} \times 100 = 65.13\%$$

$238 \times 10.6 = 2522.8$

$230 \times 7.6 = 1748$

$$\frac{1748}{2522.8} \times 100 = 69.29\%$$