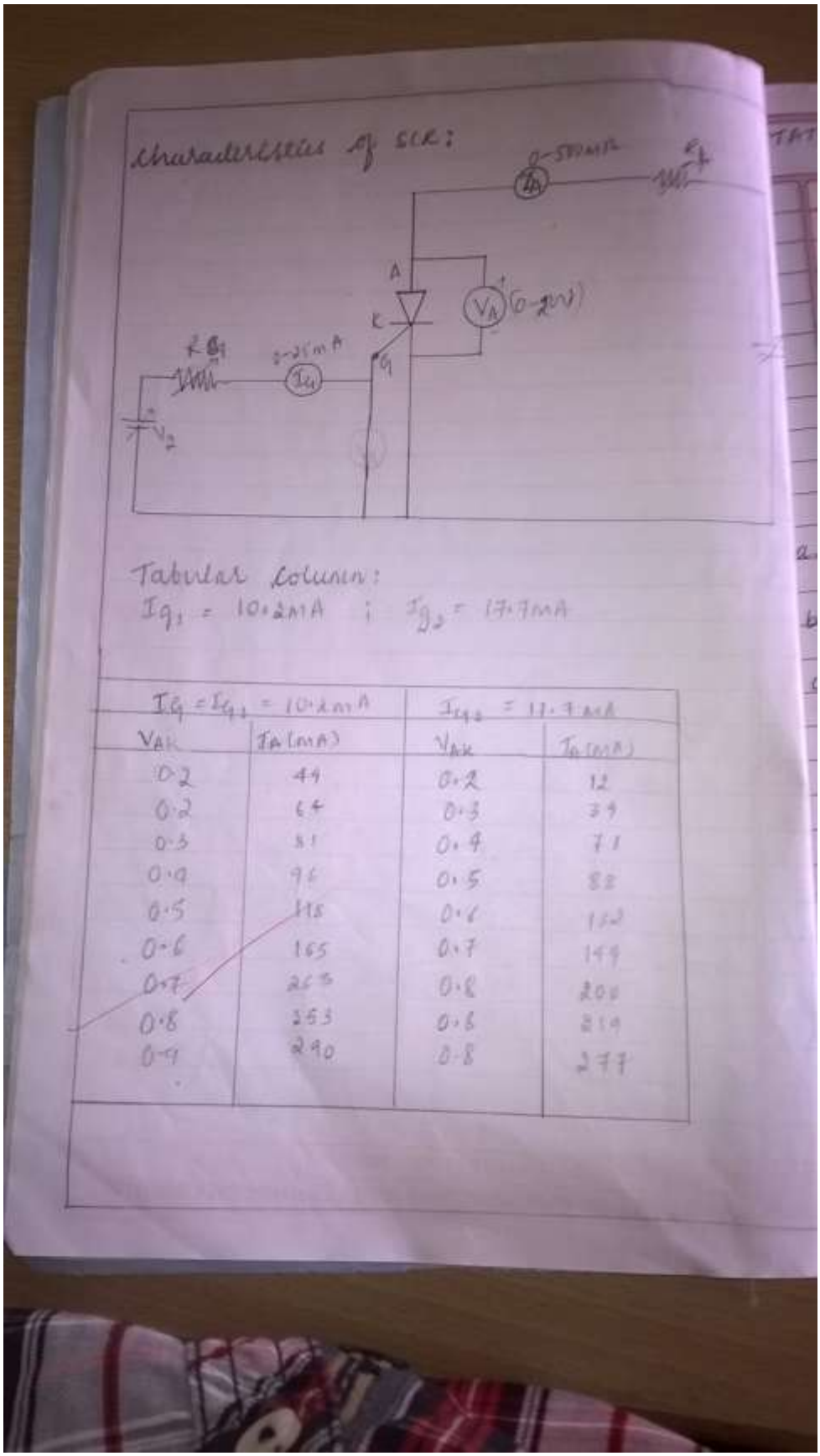

Characteristics of SCR:

Tabular Column:

I_{g_1} = 10.2mA ; I_{g_2} = 17.7mA

$I_G = I_{g_1}$ = 10.2mA		I_{g_2} = 17.7mA	
V_{AK}	I_A (mA)	V_{AK}	I_A (mA)
0.2	44	0.2	12
0.2	64	0.3	39
0.3	81	0.4	71
0.4	96	0.5	82
0.5	115	0.6	132
0.6	165	0.7	149
0.7	265	0.8	208
0.8	253	0.8	219
0.9	290	0.8	277

STATIC CHARACTERISTICS OF SCR

Date :
Page No. : 1

Aim : To plot the characteristics of an SCR & to find the forward resistance, holding current & latching current

Apparatus :

1. SCR TYN616	– 1
2. DC voltmeter & ammeter	– 1 each
3. Rheostat	

Procedure :

V.I characteristics

a. Make the connections as given in the ckt. dig including meters for I_H, TYN 616
b. Keep V_{AK} & V_{GK} potentiometer at minimum voltage position & at off position.
c. Keep load potentiometer R_A at maximum position & gate potentiometer R_g at maximum resistance position.
d. Switch ON the main supply to the unit.
e. Switch ON anode supply – V_{AK} & Set at 10 V.
f. Switch ON the gate supply.
g. Slowly vary voltage V_{GK} till the SCR turn ON. This can be noticed by sudden increase in $I_C = I_A$ & sudden drop of V_{AK} to 0.6 V. This gate current is the I_G to turn ON. Increase the I_g by reducing R_g. If the I_g is below I_{gmin} the SCR does not even turn ON even if the anode voltage increased.

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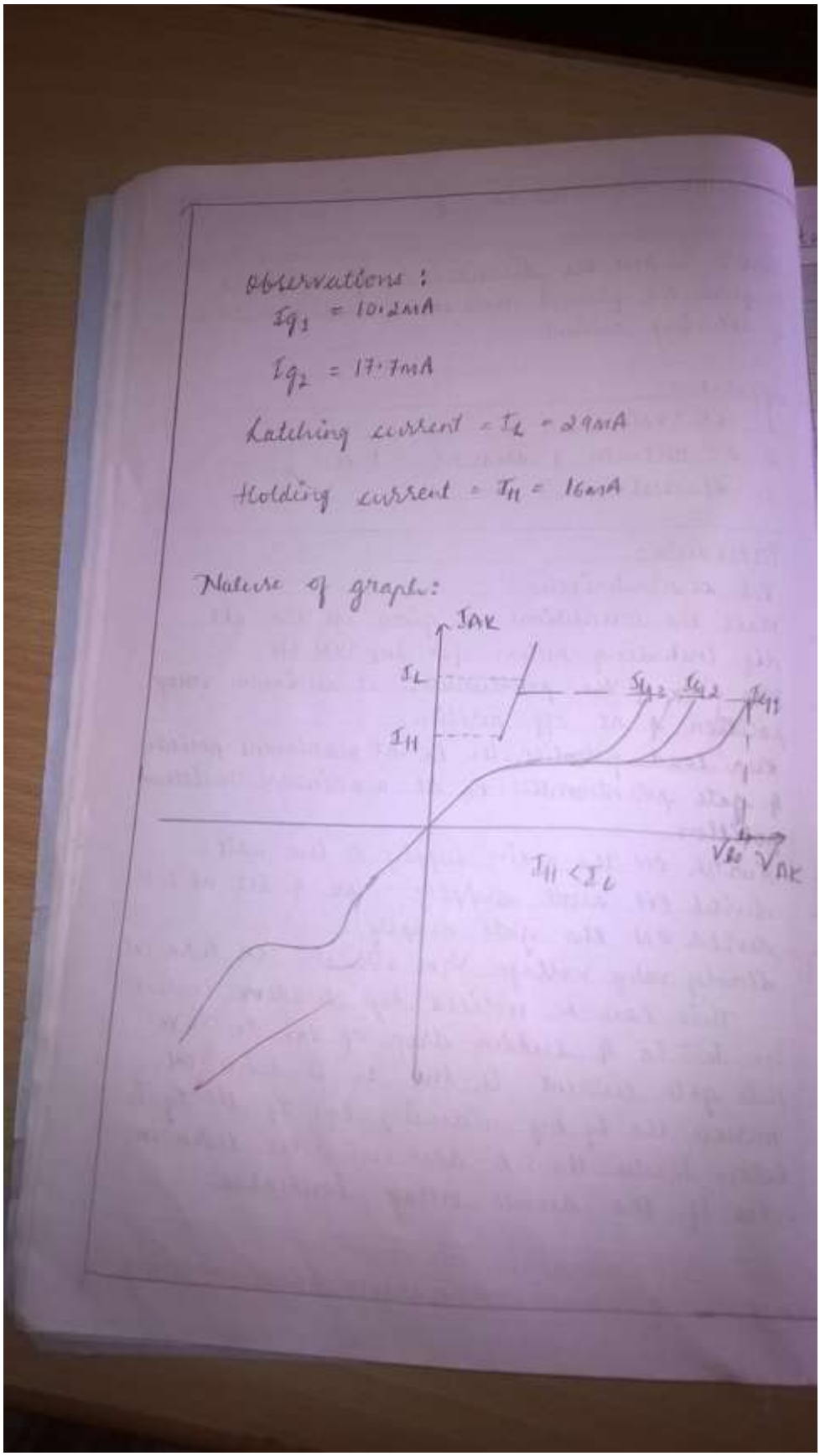

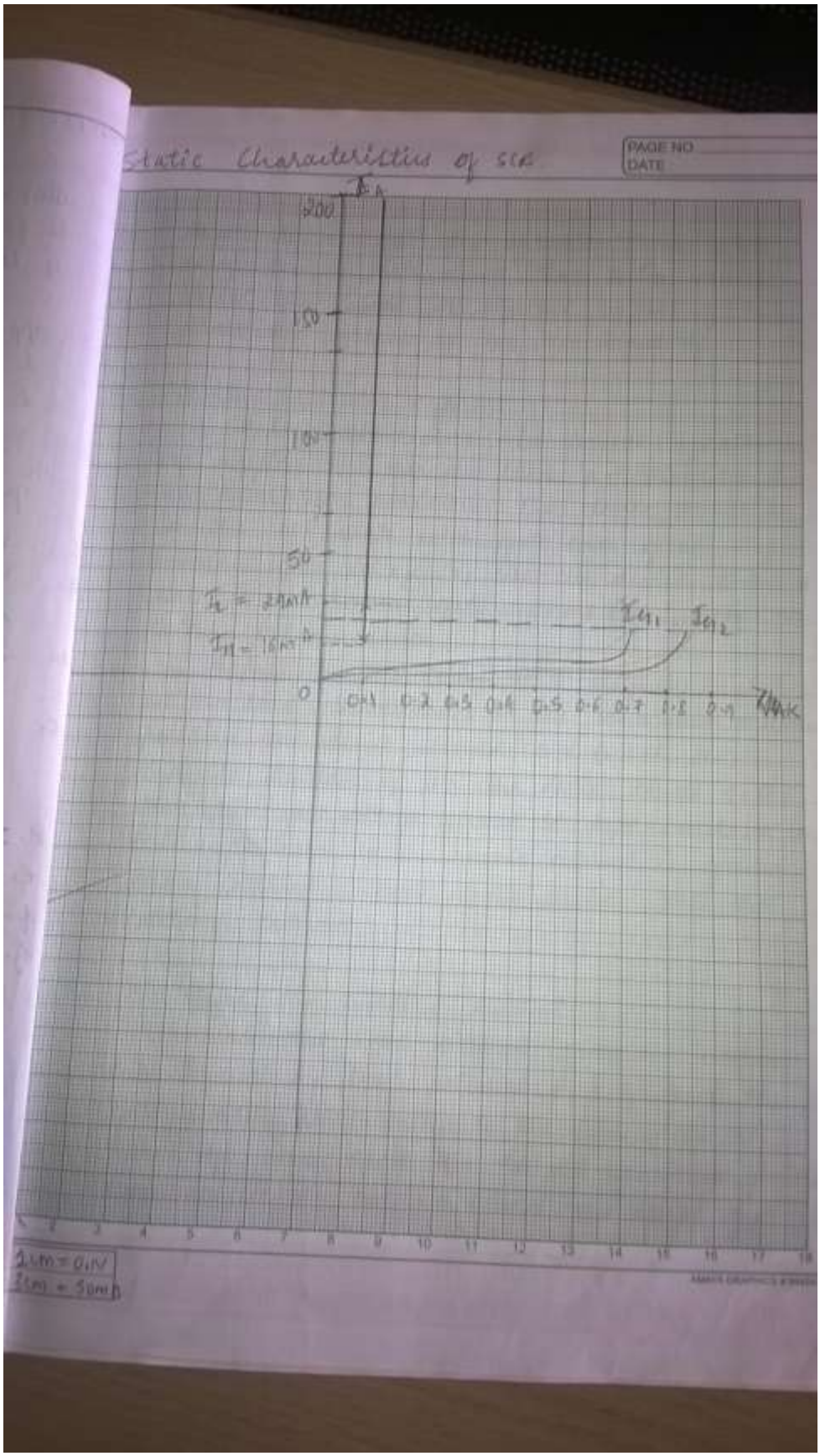

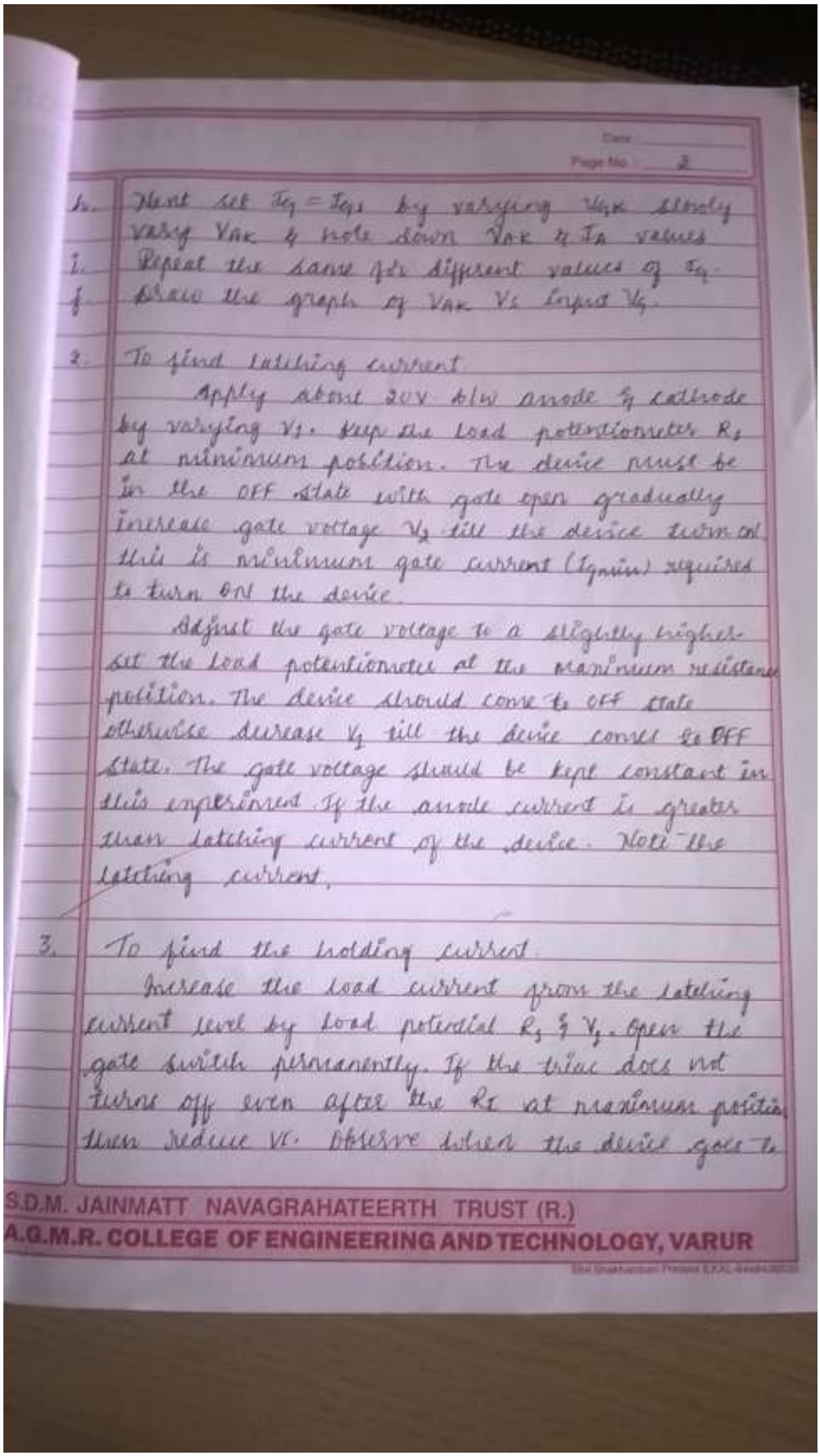

Date
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h. Next set $I_{G1} = I_{G1}$ by varying V_{GK} slowly vary V_{AK} & note down V_{AK} & I_A values
i. Repeat the same for different values of I_G.
j. Draw the graph of V_{AK} Vs Input V_G.

2. To find latching current

Apply about 20V b/w anode & cathode by varying V_2. Keep the load potentiometer R_2 at minimum position. The device must be in the OFF state with gate open gradually increase gate voltage V_2 till the device turn on this is minimum gate current (I_{GMin}) required to turn ON the device.

Adjust the gate voltage to a slightly higher set the load potentiometer at the maximum resistance position. The device should come to OFF state otherwise decrease V_2 till the device comes to OFF state. The gate voltage should be kept constant in this experiment. If the anode current is greater than latching current of the device. Note the latching current.

3. To find the holding current

Increase the load current from the latching current level by load potential R_2 & V_2. Open the gate switch permanently. If the triac does not turns off even after the R_2 at maximum position then reduce V_2. Observe when the device goes to

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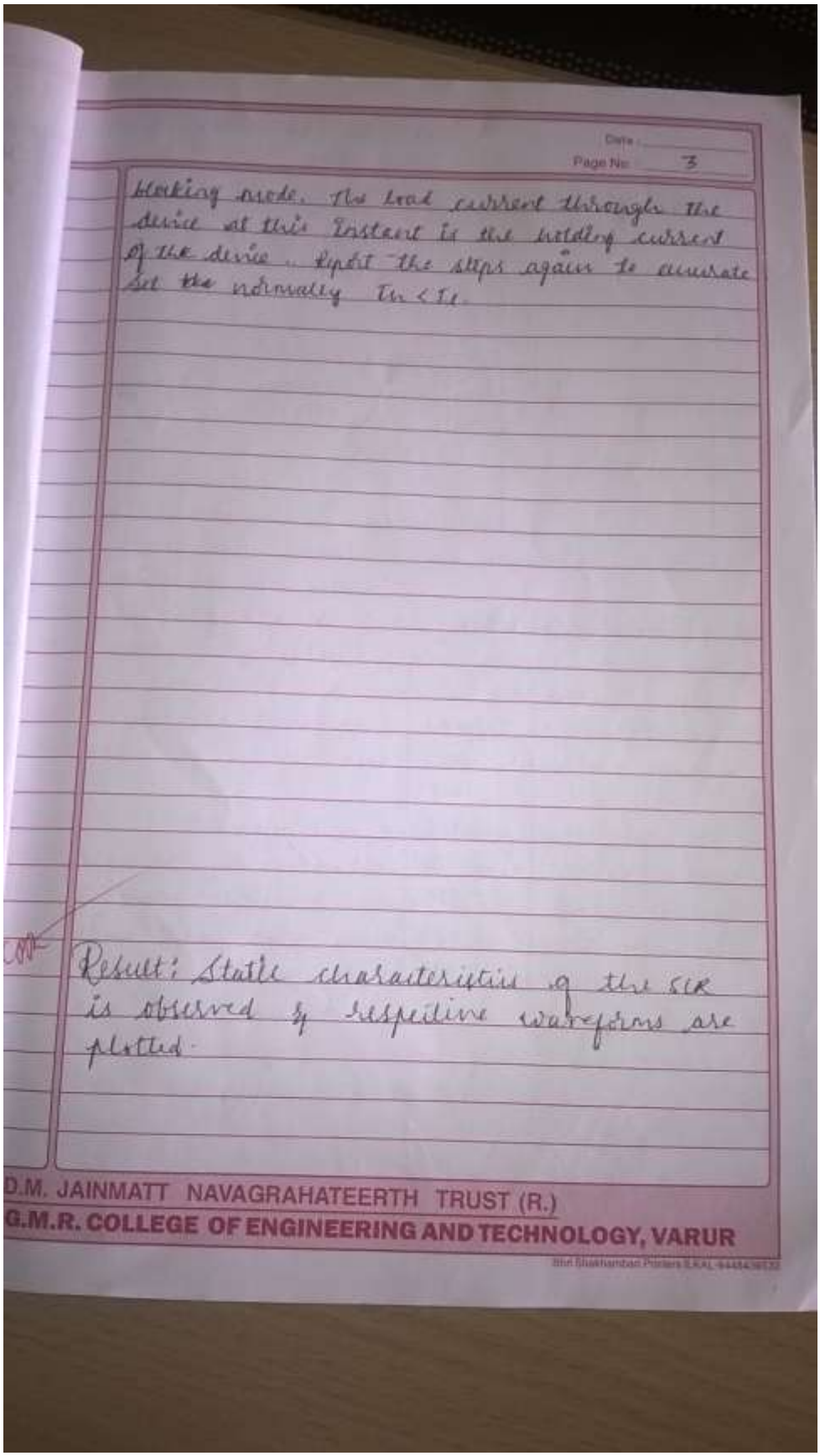

Date :
Page No. 3

blocking mode. The load current through the device at this instant is the holding current of the device. Repeat the steps again to calculate for the normally $I_H < I_L$.

Result: Static characteristics of the SCR is observed & respective waveforms are plotted.

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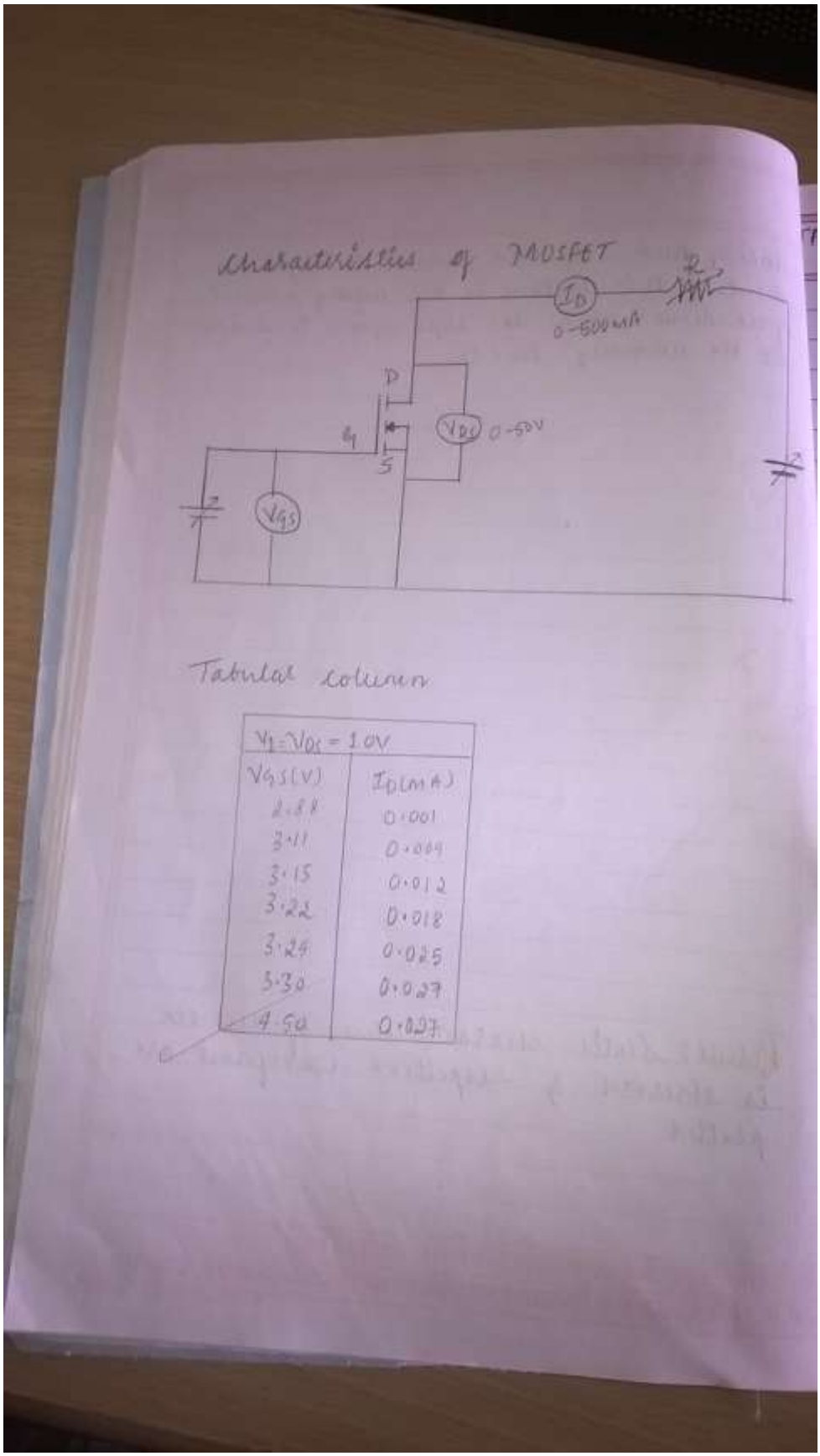
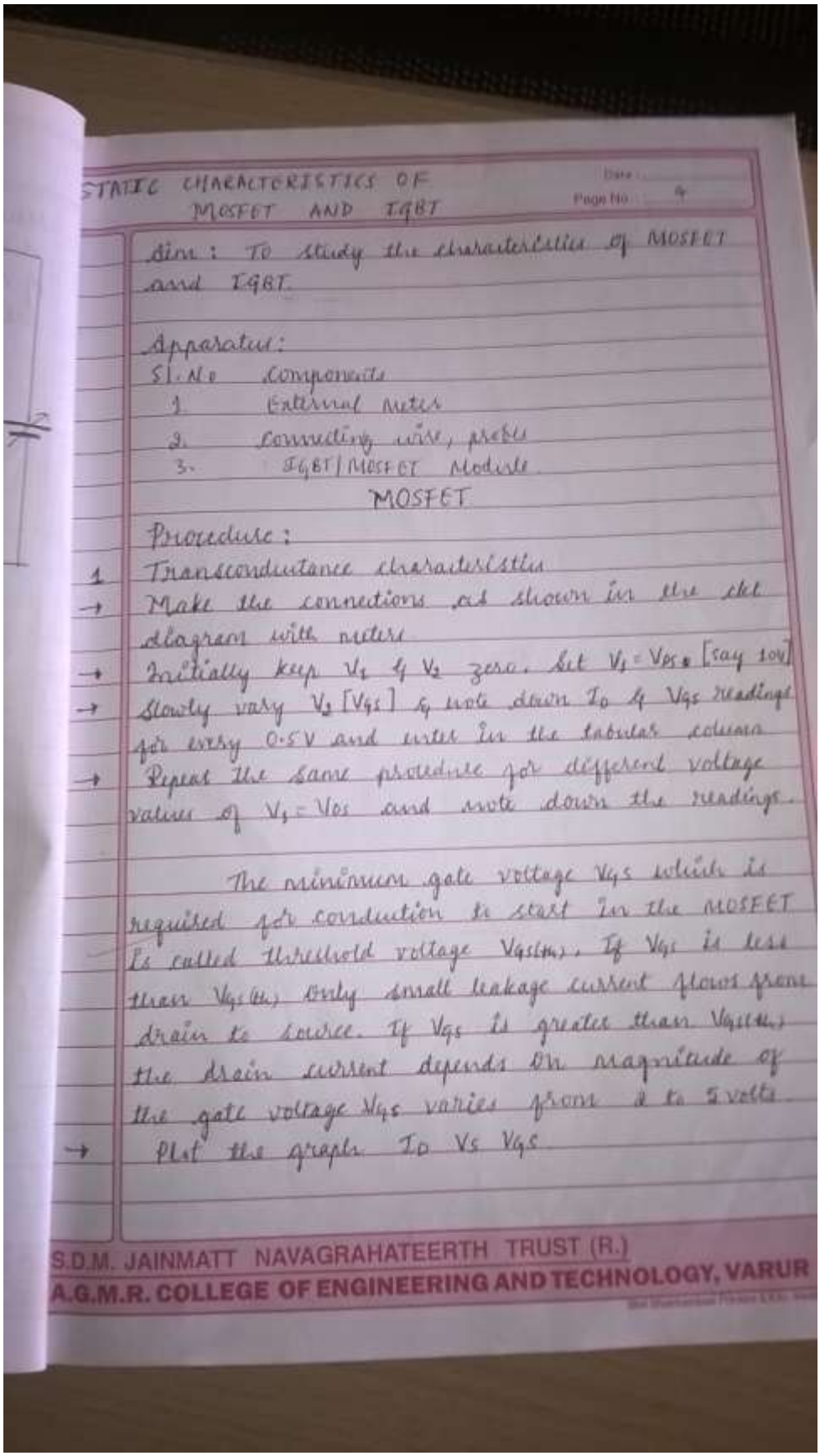


Tabular column

$V_1 = V_{DS} = 1.0V$	
V_{GS}(V)	I_D(mA)
2.88	0.001
3.11	0.004
3.15	0.012
3.22	0.018
3.24	0.025
3.30	0.027
4.50	0.027



STATIC CHARACTERISTICS OF MOSFET AND IGBT

Date :
Page No : 4

Aim : To study the characteristics of MOSFET and IGBT.

Apparatus :

Sl. No	Components
1.	External meters
2.	Connecting wire, probes
3.	IGBT/MOSFET Module

MOSFET

Procedure :

1. Transconductance characteristics
→ Make the connections as shown in the ckt diagram with meters
→ Initially keep V_1 & V_2 zero. Set $V_1 = V_{DS}$ [say 10V]
→ Slowly vary V_2 [V_{GS}] & note down I_D & V_{GS} readings for every 0.5V and enter in the tabular column
→ Repeat the same procedure for different voltage values of $V_1 = V_{DS}$ and note down the readings.

The minimum gate voltage V_{GS} which is required for conduction to start in the MOSFET is called threshold voltage $V_{GS(th)}$. If V_{GS} is less than $V_{GS(th)}$ only small leakage current flows from drain to source. If V_{GS} is greater than $V_{GS(th)}$ the drain current depends on magnitude of the gate voltage V_{GS} varies from 0 to 5 volts.

→ Plot the graph I_D Vs V_{GS}

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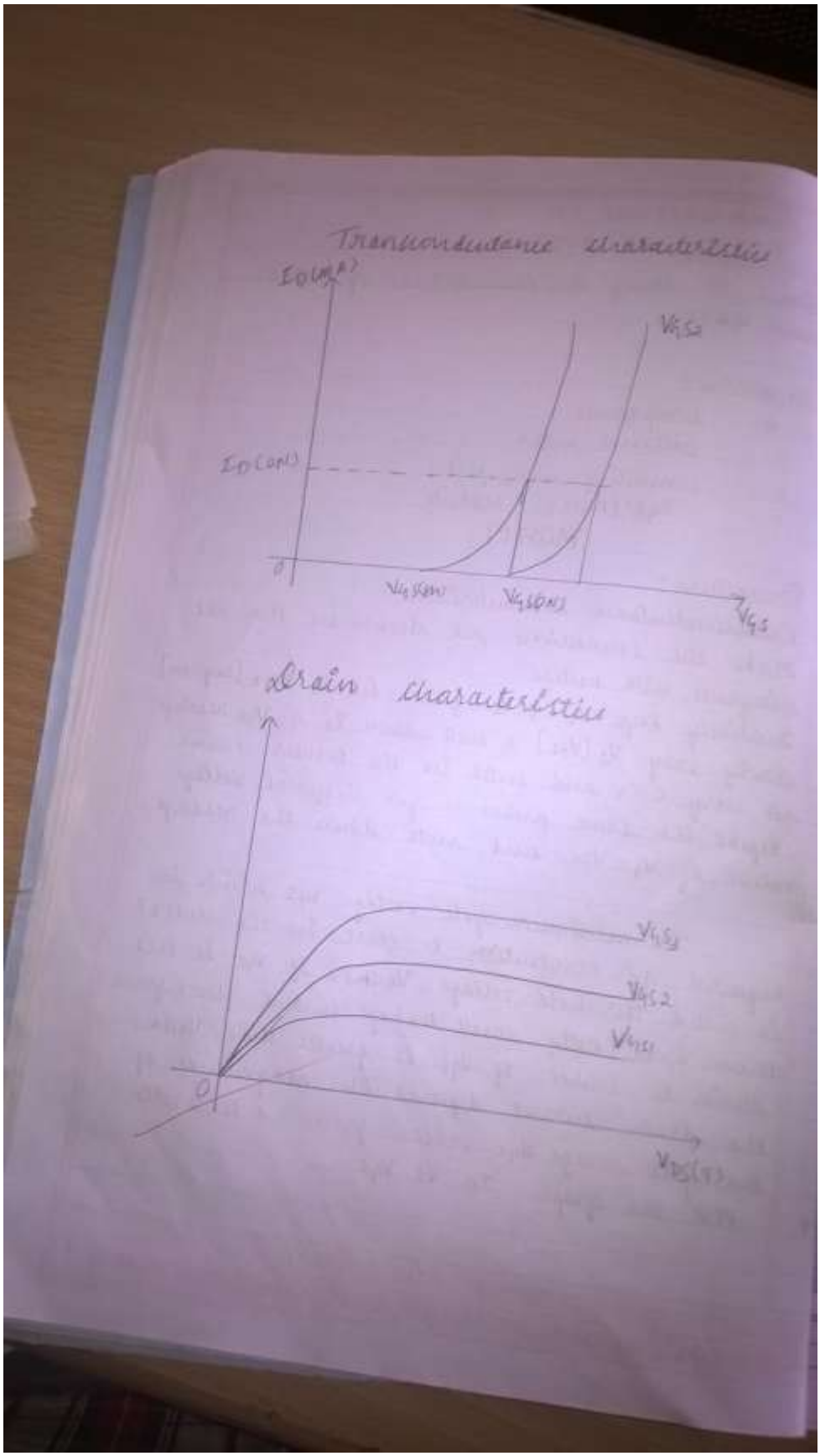

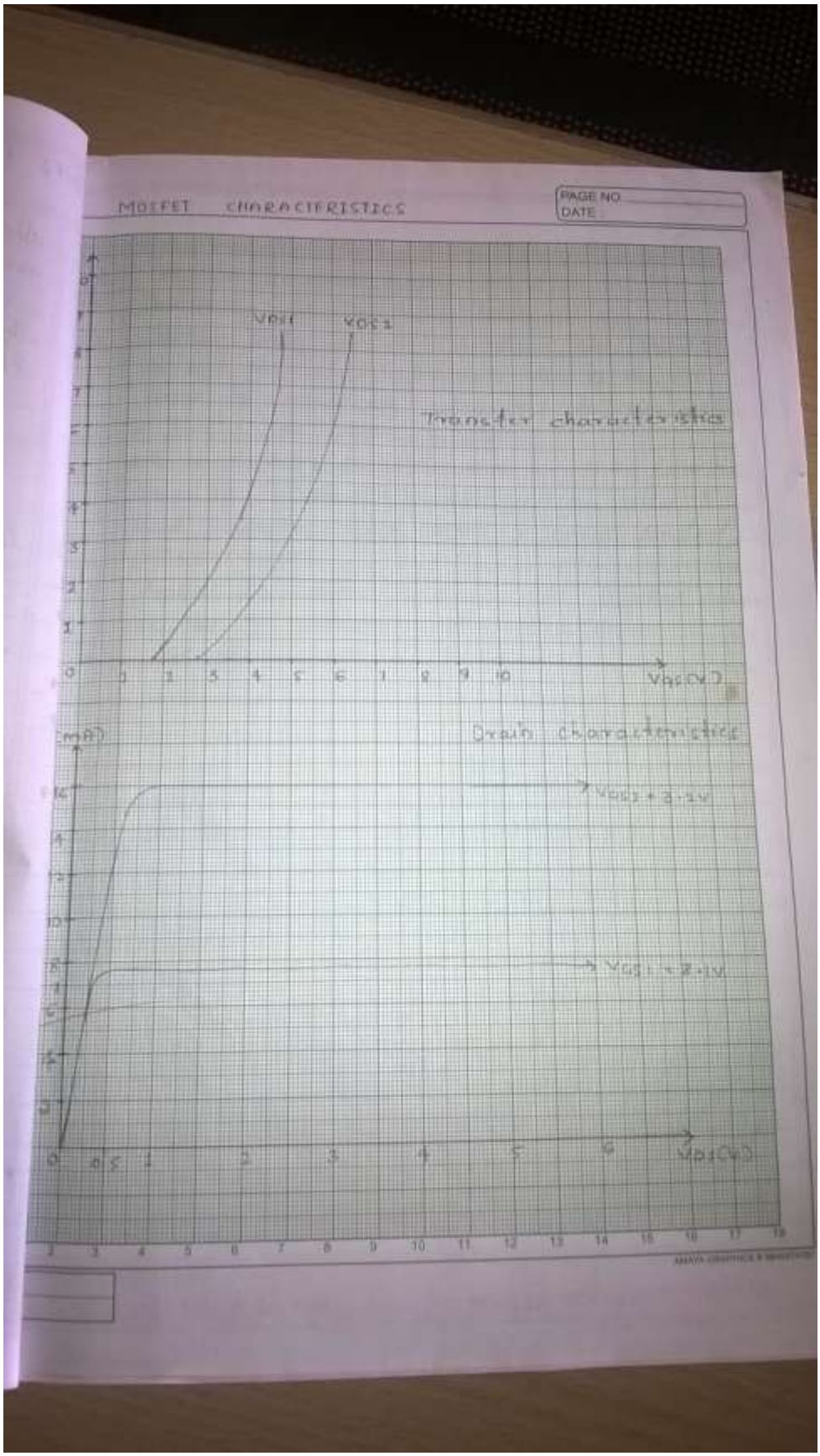

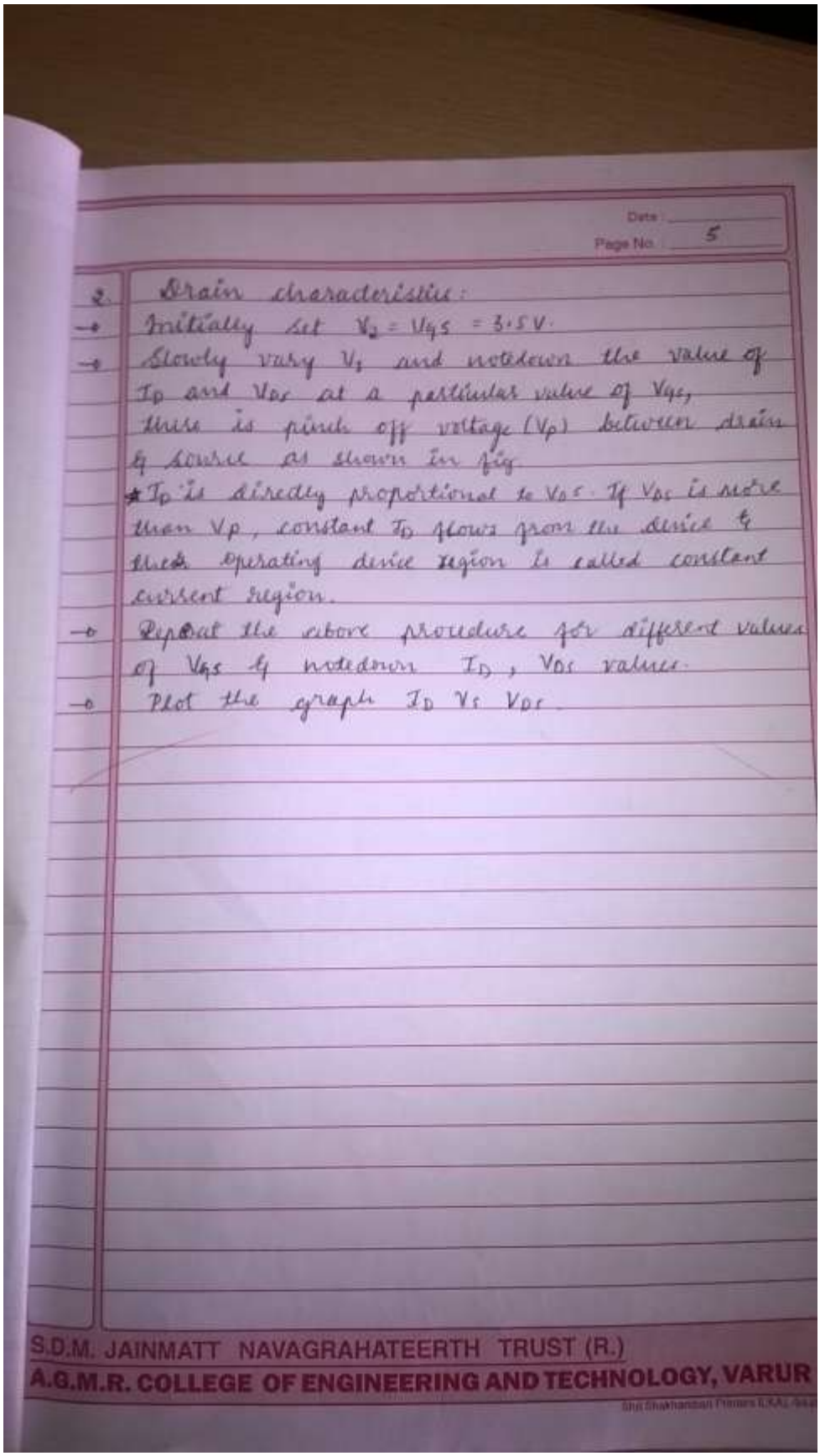

Date
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2. Drain characteristics:

- Initially set $V_2 = V_{GS} = 3.5\,V$.
- Slowly vary V_1 and notedown the value of I_D and V_{DS} at a particular value of V_{GS}, there is pinch off voltage (V_p) between drain & source as shown in fig.

* I_D is directly proportional to V_{DS}. If V_{DS} is more than V_p, constant I_D flows from the device & that operating device region is called constant current region.

- Repeat the above procedure for different values of V_{GS} & notedown I_D, V_{DS} values.
- Plot the graph I_D Vs V_{DS}.

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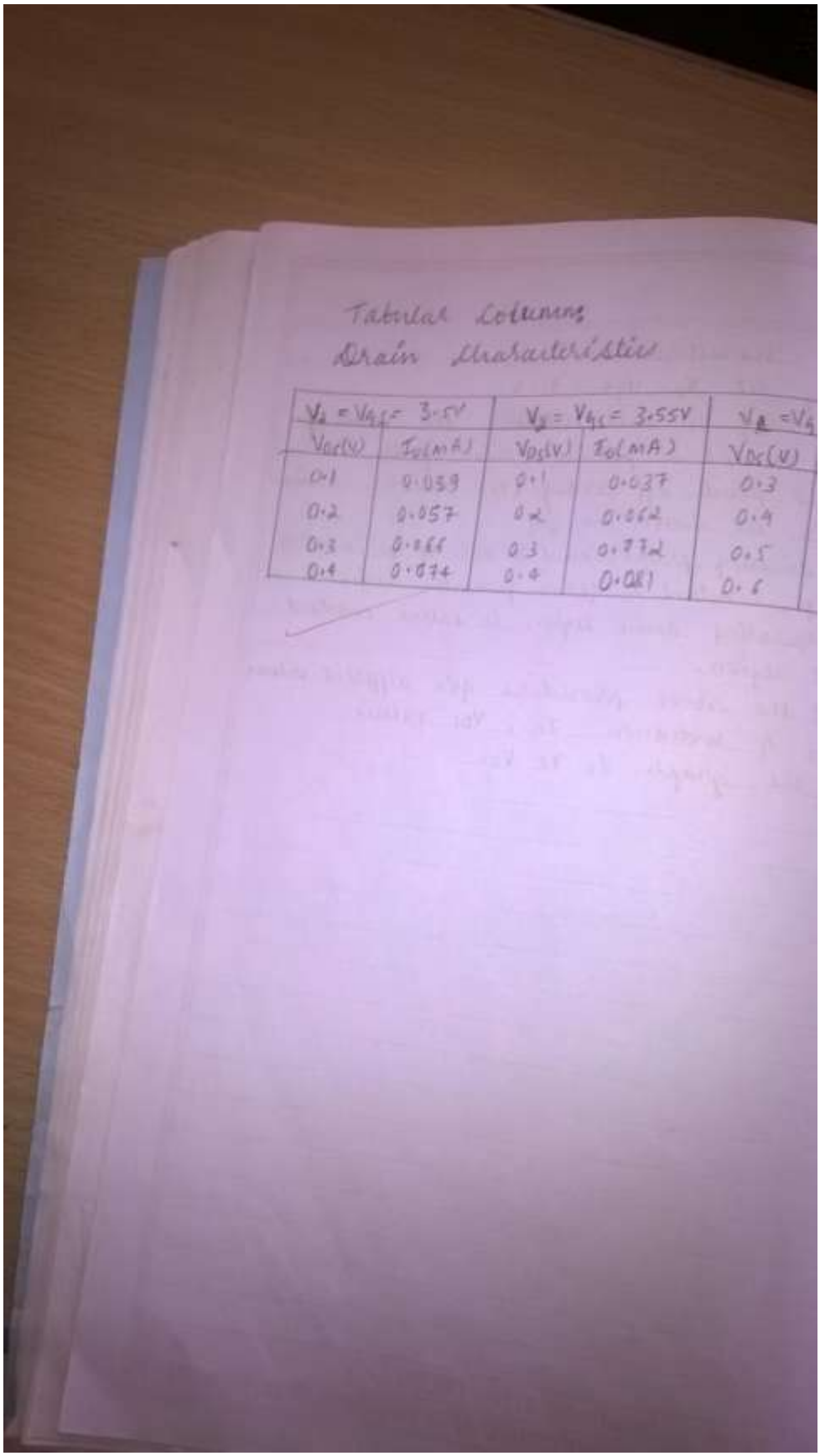
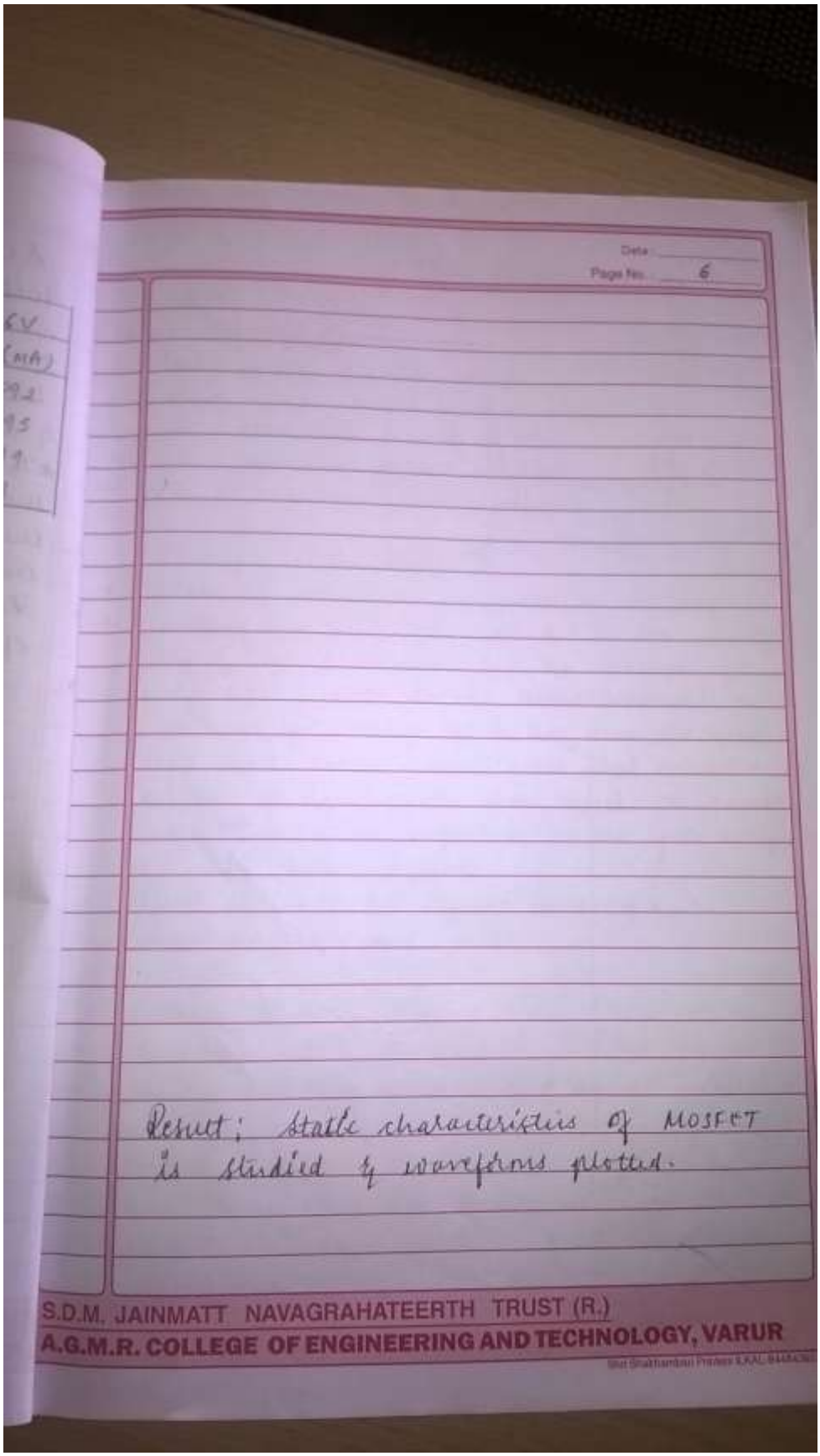
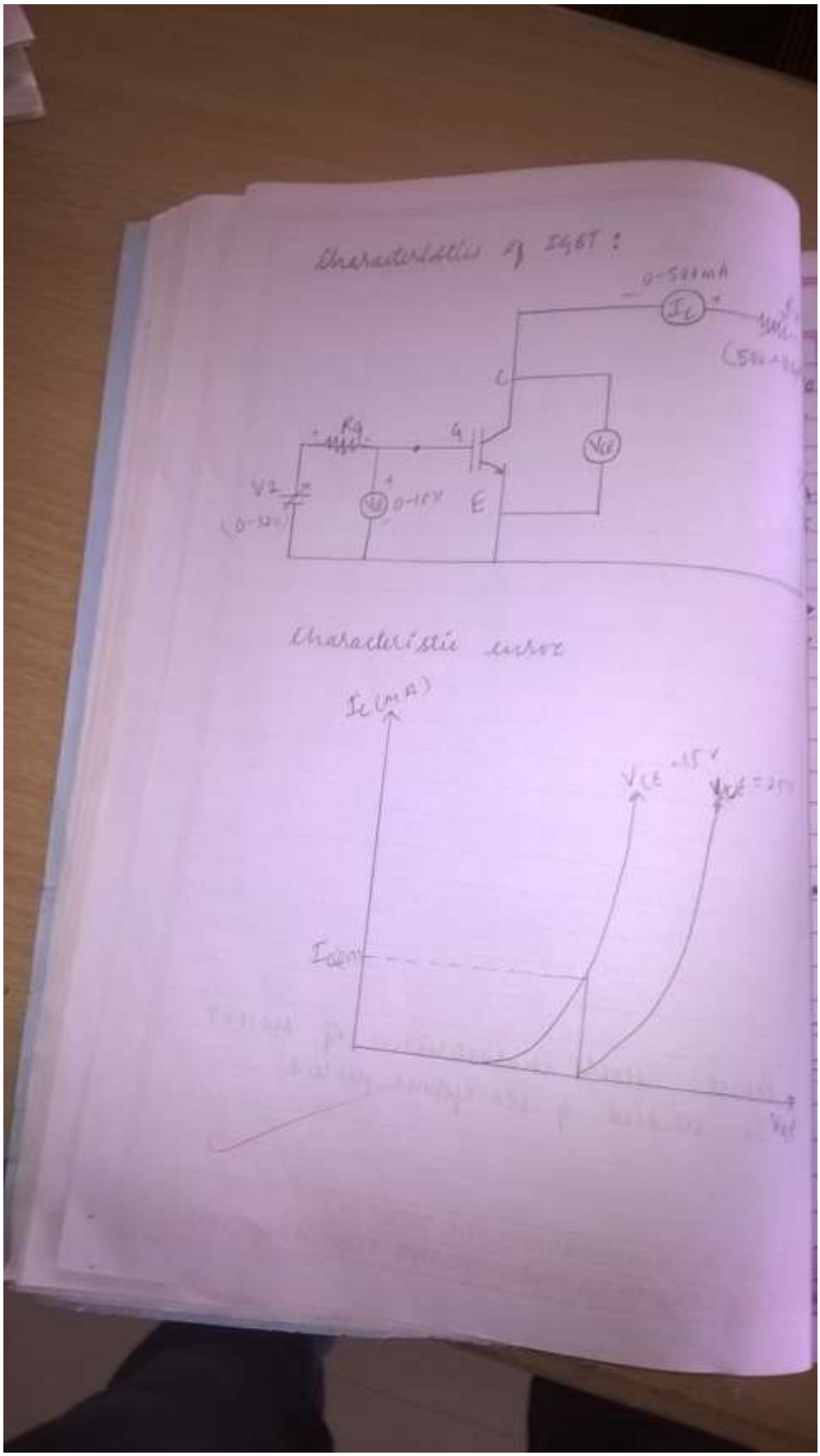


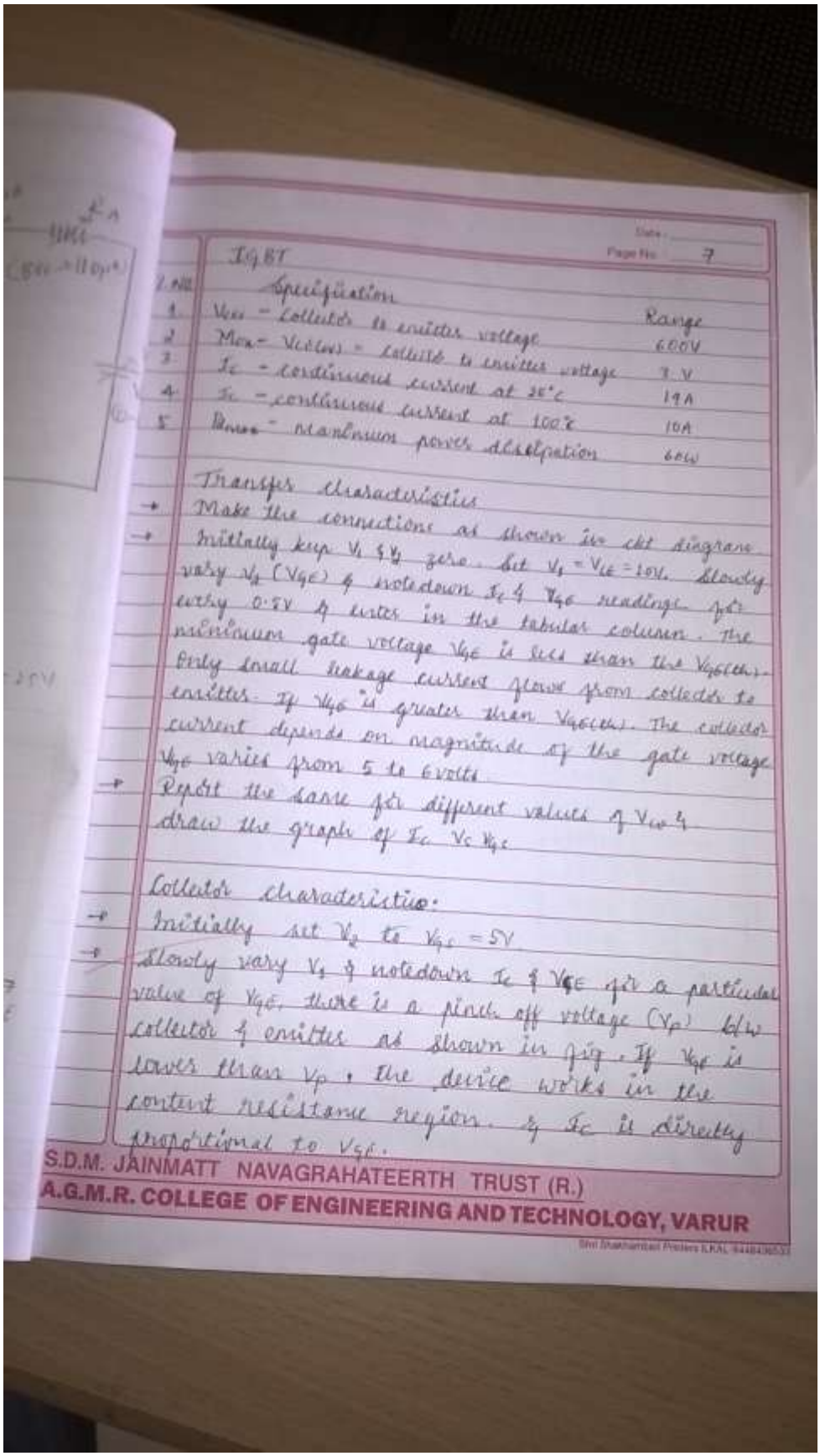
Tabular Columns

Drain Characteristics

$V_g = V_{gs} = 3.5V$		$V_g = V_{gs} = 3.55V$		$V_g = V_{gs}$
$V_{DS}(V)$	$I_D(mA)$	$V_{DS}(V)$	$I_D(mA)$	$V_{DS}(V)$
0.1	0.059	0.1	0.037	0.3
0.2	0.057	0.2	0.062	0.4
0.3	0.066	0.3	0.772	0.5
0.4	0.074	0.4	0.081	0.6







IGBT

Specification

		Range
1	V_{ces} - Collector to emitter voltage	600V
2	$V_{GE(th)}$ - Collector to emitter voltage	7 V
3	I_c - continuous current at 25°C	19A
4	I_c - continuous current at 100°C	10A
5	P_{max} - maximum power dissipation	60W

Transfer characteristics

→ Make the connections as shown in ckt diagram

→ Initially keep V_1 & V_2 zero. Set $V_1 = V_{CE} = 10V$. Slowly vary V_2 (V_{GE}) & notedown I_c & V_{GE} readings for every 0.5V & enter in the tabular column. The minimum gate voltage V_{GE} is less than the $V_{GE(th)}$. Only small leakage current flows from collector to emitter. If V_{GE} is greater than $V_{GE(th)}$. The collector current depends on magnitude of the gate voltage V_{GE} varies from 5 to 6 volts

→ Repeat the same for different values of V_{CE} & draw the graph of I_c V_c V_{GE}

Collector characteristics:

→ Initially set V_2 to $V_{GE} = 5V$

→ Slowly vary V_1 & notedown I_c & V_{CE} for a particular value of V_{GE}. There is a pinch off voltage (V_p) b/w collector & emitter as shown in fig. If V_{GE} is lower than V_p, the device works in the content resistance region. & I_c is directly proportional to V_{CE}.

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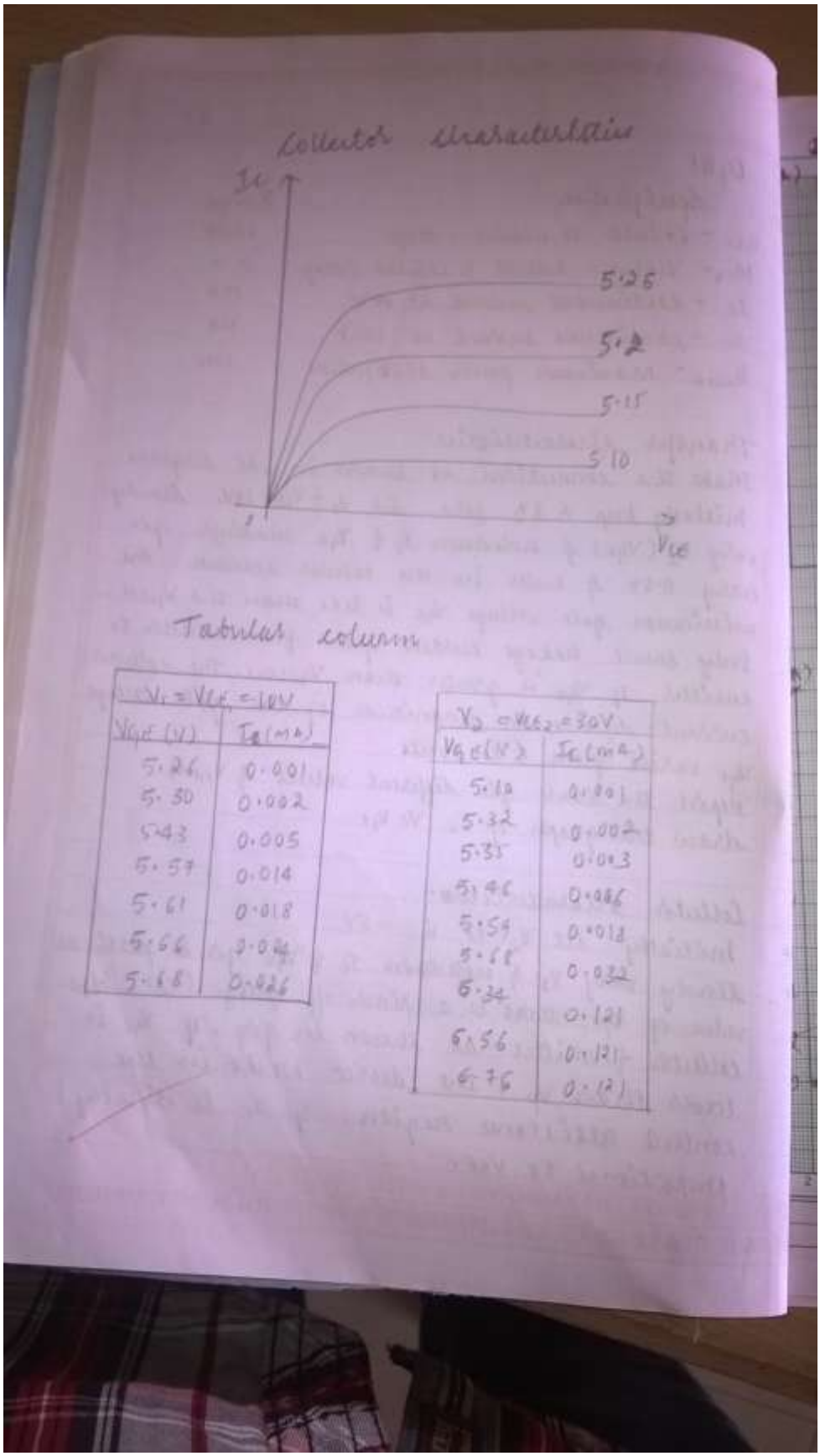
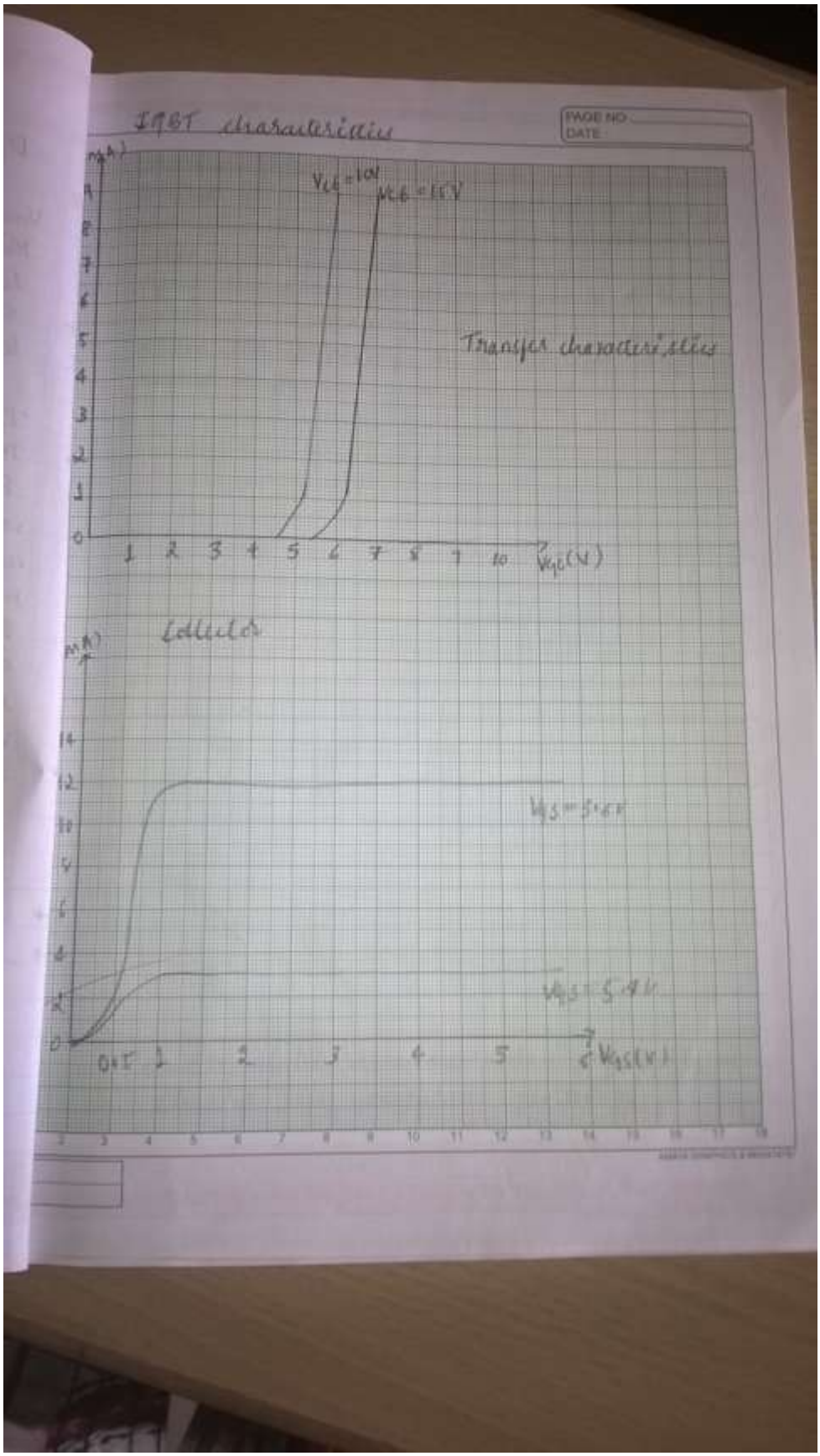
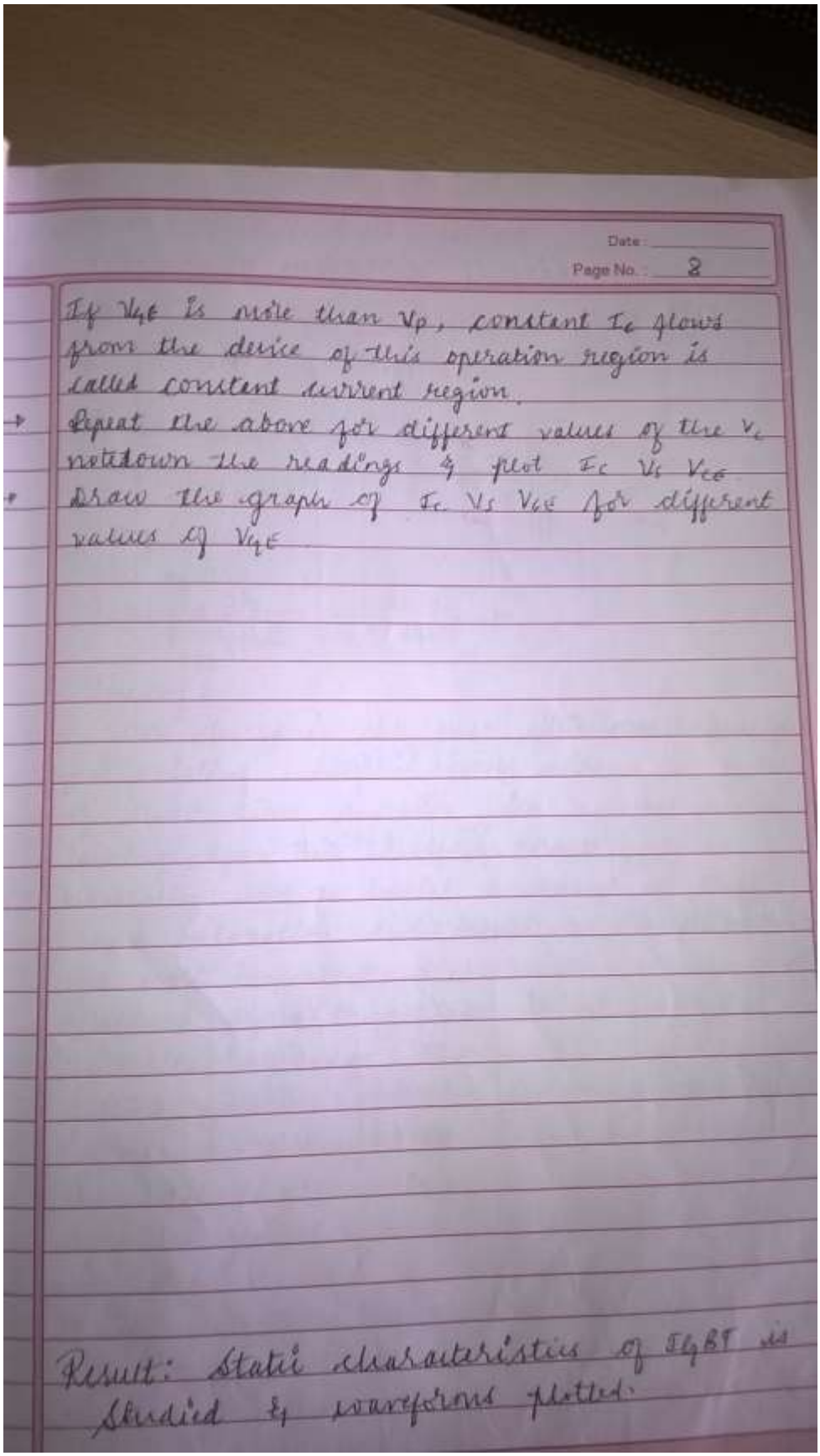


Tabular column

$V_c = V_{CC} = 10V$	
V_{BE} (V)	I_B (mA)
5·26	0·001
5·30	0·002
5·43	0·005
5·57	0·014
5·61	0·018
5·66	0·024
5·68	0·026

$V_b = V_{BB} = 30V$	
V_{BE} (V)	I_C (mA)
5·10	0·001
5·32	0·002
5·35	0·003
5·46	0·006
5·54	0·018
5·68	0·032
6·34	0·121
6·56	0·121
6·76	0·121





Date :
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If V_{GE} is more than V_p, constant I_c flows from the device of this operation region is called constant current region.

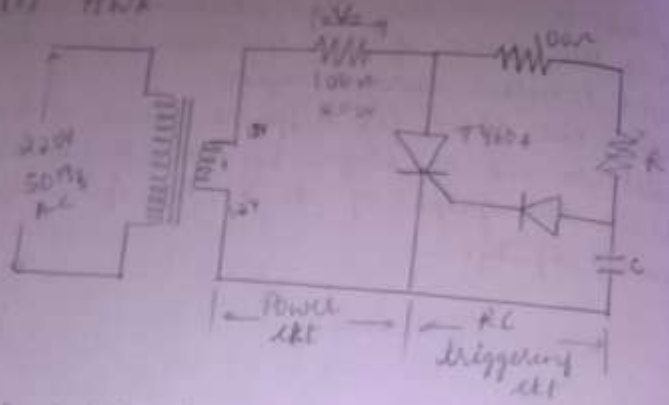
Repeat the above for different values of the V_s notedown the readings & plot I_c Vs V_{ce}

Draw the graph of I_c Vs V_{CE} for different values of V_{GE}

Result: Static characteristics of IGBT is studied & waveforms plotted.

Circuit diagram

[1] HWR



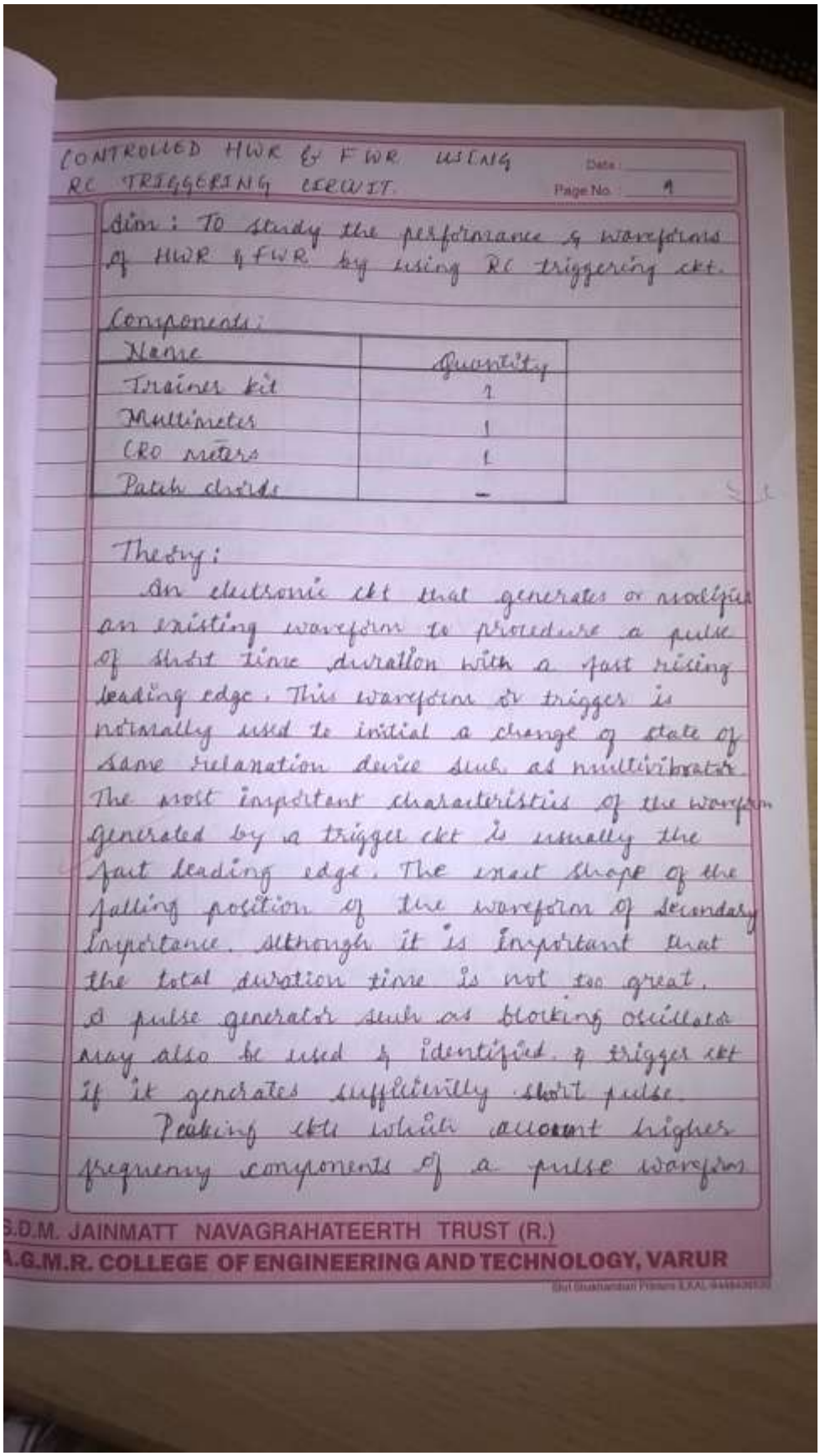
Calculations :

$$\alpha = \sin^{-1}(V_n/V_m)$$

$$V_{o(rms)} = \frac{V_m}{2\pi}\left[1+\cos\alpha\right]$$

Tabular Column:

V_n(V)	V_m(V)	α	$V_{o(rms)}$(V)	$V_{practical}$(V)
10	20	30°	5.94	6.25
14	20	44.62°	5.46	6.0
26	28	116.7°	5.02	4.6V



CONTROLLED HWR & FWR USING RC TRIGGERING CIRCUIT.

Date :
Page No. 1

Aim : To study the performance & waveforms of HWR & FWR by using RC triggering ckt.

Components :

Name	Quantity
Trainer kit	1
Multimeter	1
CRO meters	1
Patch chords	-

Theory :

An electronic ckt that generates or modifies an existing waveform to procedure a pulse of short time duration with a fast rising leading edge. This waveform or trigger is normally used to initial a change of state of some relaxation device such as multivibrator. The most important characteristics of the waveform generated by a trigger ckt is usually the fast leading edge. The exact shape of the falling position of the waveform of secondary importance. Although it is important that the total duration time is not too great. A pulse generator such as blocking oscillator may also be used & identified a trigger ckt if it generates sufficiently short pulse.

Peaking ckts which accent higher frequency components of a pulse waveform

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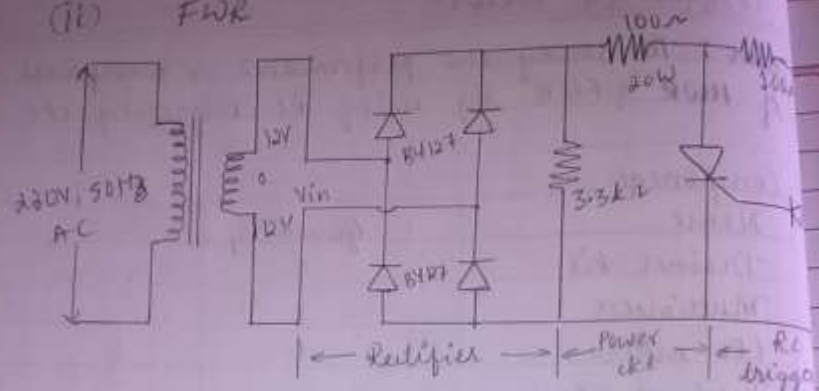
(ii) FWR



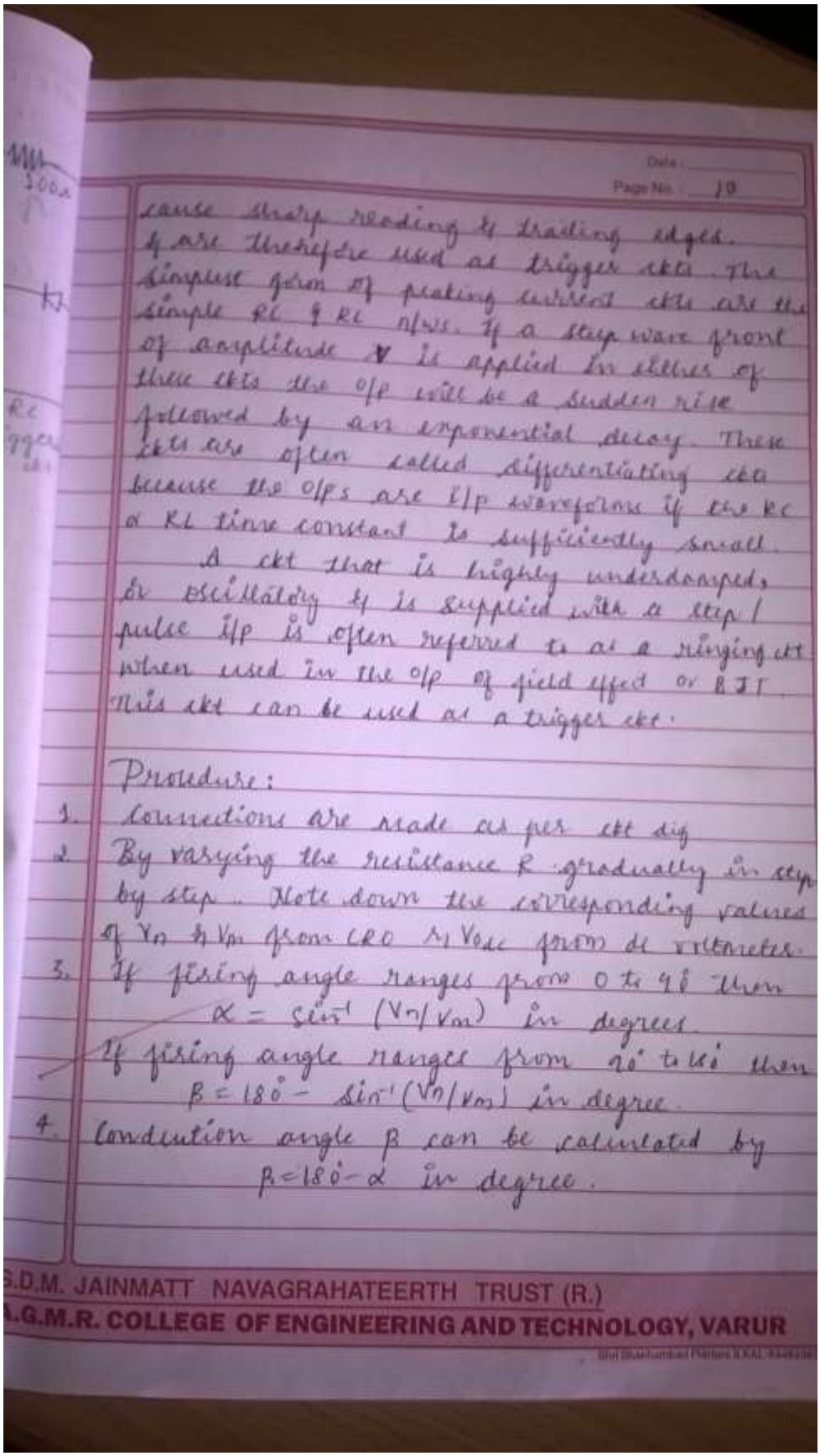
Calculation :

$$\alpha = \sin^{-1}(V_n/V_m)$$

$$V_{o(dc)} = \frac{V_m}{\pi}[1+\cos\alpha]$$

Tabular Column :

V_m(V)	V_n(V)	α	$V_{practical}$	$V_{o(dc)}$ (V)
23	16	44.08°	12.25	12.58
23.8	16	47.74	11.75	12.53
22V	16	180-51.5=128.5°	6.2	6



cause sharp reading & trading edges. & are therefore used as trigger ckts. The simplest form of pulse current ckts are the simple RC & RL nlws. If a step wave front of amplitude V is applied in either of these ckts the o/p will be a sudden rise followed by an exponential decay. These ckts are often called differentiating ckts because the o/ps are I/p waveforms if the RC & RL time constant is sufficiently small.

A ckt that is highly underdamped, & oscillatory if is supplied with a step / pulse I/p is often referred to as a ringing ckt when used in the o/p of field effect or BJT. This ckt can be used as a trigger ckt.

Procedure:

1. Connections are made as per ckt dig
2. By varying the resistance R gradually in step by step. Note down the corresponding values of V_n & V_m from CRO & V_{dc} from dc voltmeter.
3. If firing angle ranges from 0 to 90° then
   $\alpha = \sin^{-1}(V_n/V_m)$ in degrees.
   If firing angle ranges from 90° to 180° then
   $\beta = 180° - \sin^{-1}(V_n/V_m)$ in degree.
4. Condution angle β can be calculated by
   $\beta = 180° - \alpha$ in degree.

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5. Current & power is calculated by
$I_{dc} = V_{dc}/R$ A & $P_{dc} = V_{dc}^2/R$ Watts
Compare V_{dc} with Vo practical
where $V_{dc(HWR)} = (V_m/2\pi)(1+\cos\alpha)$.

$$V_{dc(FWR)} = (V_m/\pi)(1+\cos\alpha)$$

6. A graph of V_{dc} Vs α, V_{dc} Vs β, I_{dc} Vs α, I_{dc} Vs β, P_{dc} Vs α & P_{dc} Vs β are to be plotted.

Result: Performance of HWR & FWR is observed & waveform plotted.

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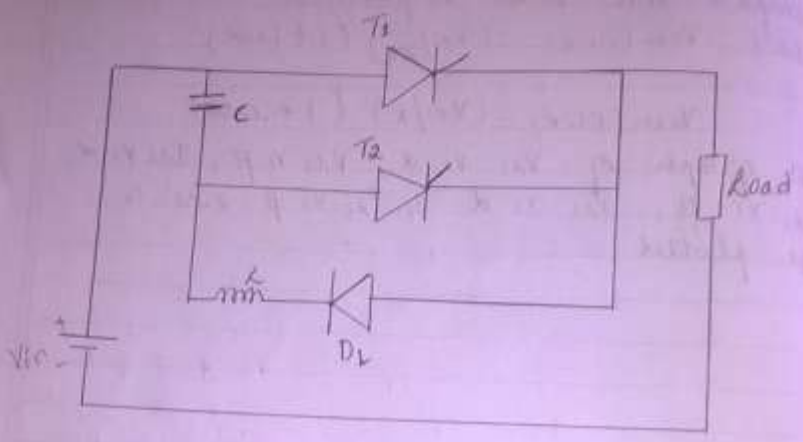
Circuit Diagram



Tabular Column:

T_{ON} (CRO) in MS	$T_{CRO}=T$ MS	$k=\frac{T_{ON}}{T}$	V_o(V)
3	21	0.142	3.1
5	21	0.238	4.6
6	21	0.285	6.3
8	21	0.380	8.0
10	21	0.476	10.1
12	21	0.571	12.9

SCR TURN OFF USING AUXILIARY COMMUTATION

Date

Page No. 12

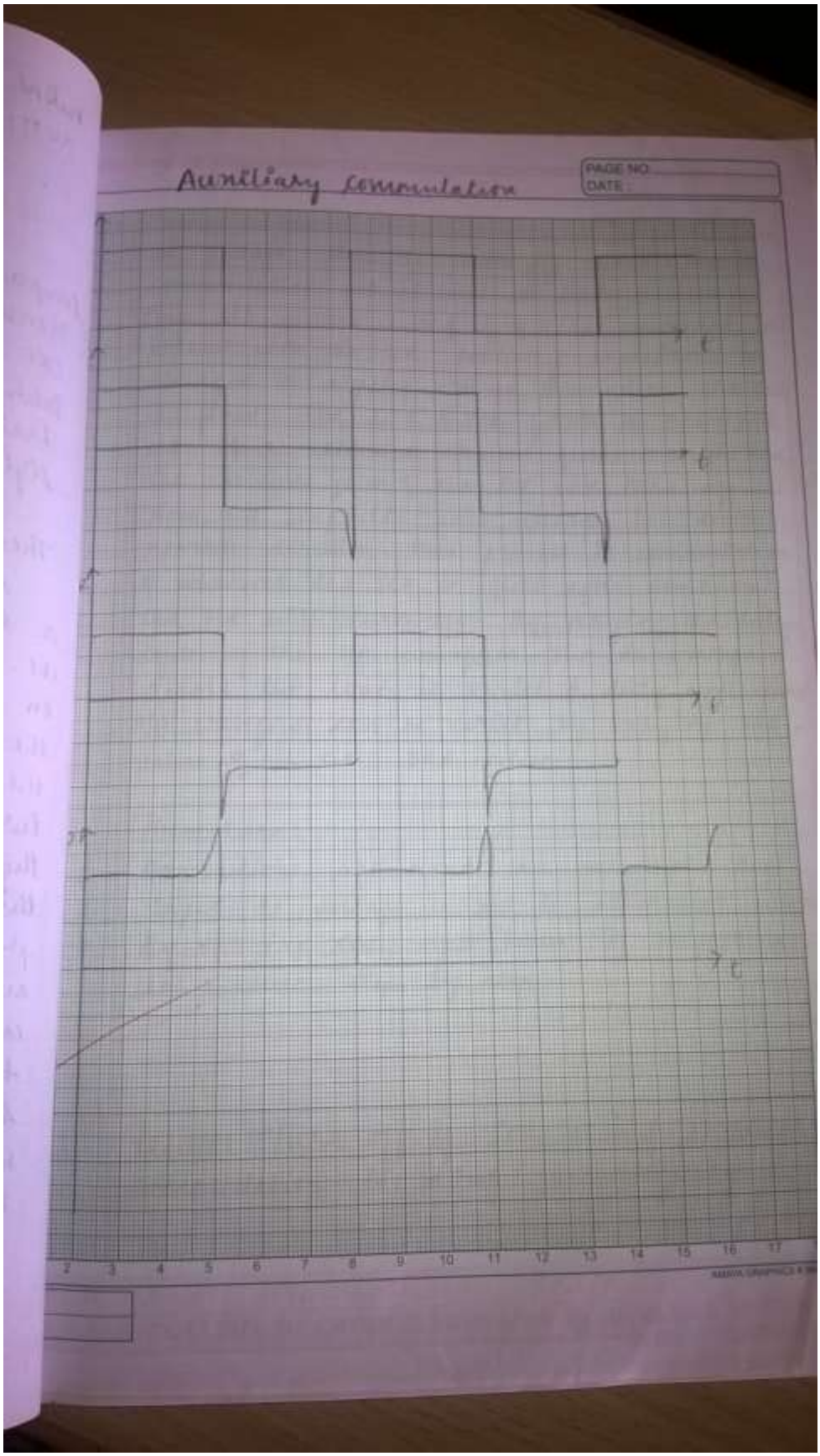
Aim: To study SCR turn off using auxiliary commutation

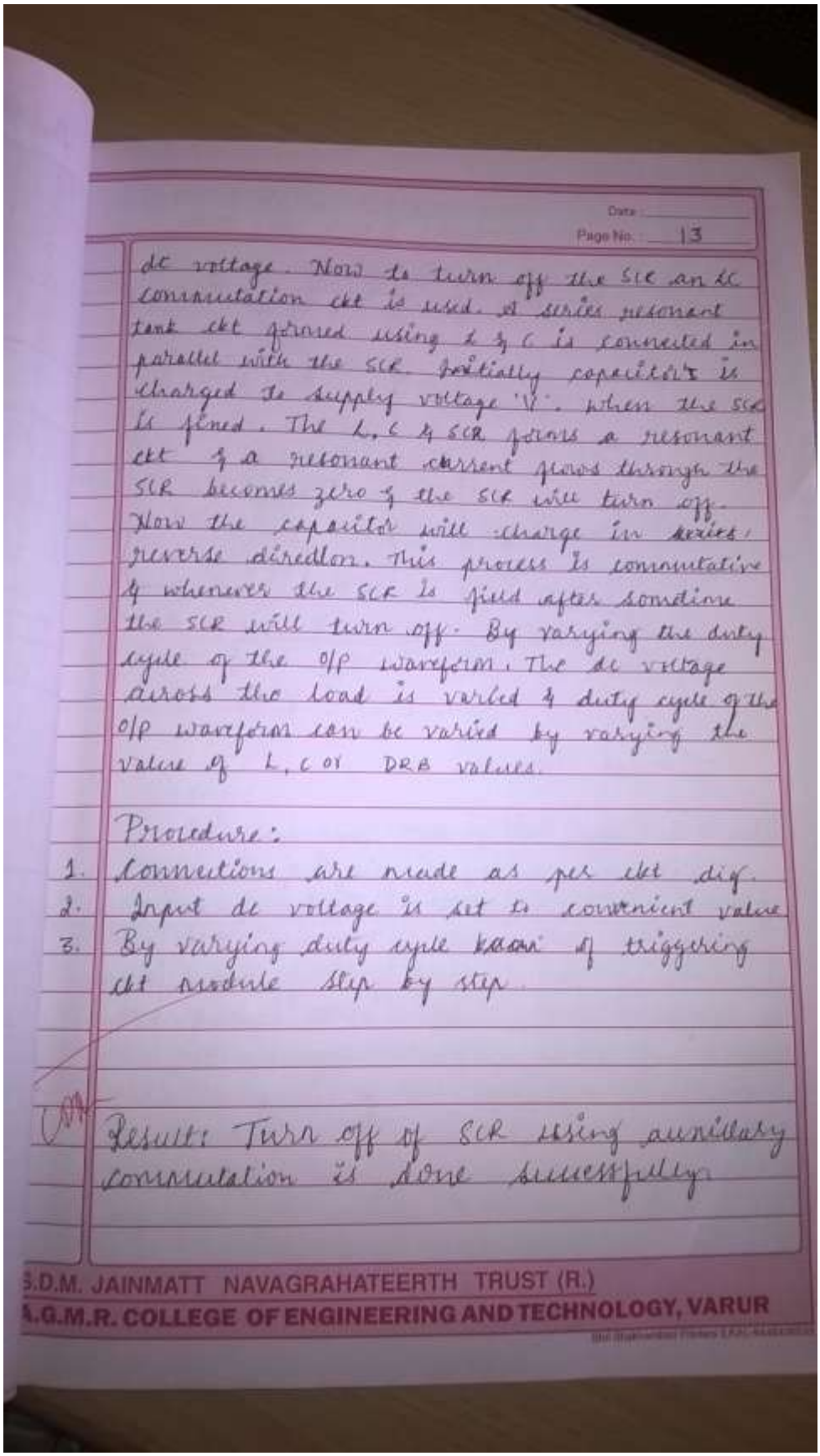
Components:

Name	Quantity
CRO probes	1
Patch chords	10
Trainer kit	1
Digital multimeter	1

Theory:

Commutation is the process of turning off a thyristor. In this auxiliary commutation ckt. The main thyristor is turned off by turning on the auxiliary thyristor. Whenever we apply the triggering pulse to the main thyristor the SCR will be conducting. When we need to turn off the main thyristor the auxiliary thyristor is turned on. When the auxiliary thyristor is turned on, the reverse voltage present in the capacitor is applied across the main thyristor which will turn off. Hence we call this commutation as voltage commutation. Here frequency of the firing signal. The ckt shown is an example of step down chopper whenever triggering pulse is applied to the thyristor the SCR will be fired & the o/p voltage across the load will be equal to the applied





Date:
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dc voltage. Now to turn off the SCR an dc commutation ckt is used. A series resonant tank ckt formed using L & C is connected in parallel with the SCR. Initially capacitor is charged to supply voltage 'V'. When the SCR is fired. The L, C & SCR forms a resonant ckt & a resonant current flows through the SCR becomes zero & the SCR will turn off. Now the capacitor will charge in series, reverse direction. This process is commutative & whenever the SCR is fired after sometime the SCR will turn off. By varying the duty cycle of the o/p waveform. The dc voltage across the load is varied & duty cycle of the o/p waveform can be varied by varying the value of L, C or DRB values.

Procedure:

1. Connections are made as per ckt dig.
2. Input dc voltage is set to convenient value
3. By varying duty cycle ~~kaan~~ of triggering ckt module Step by step

Result: Turn off of SCR using auxiliary commutation is done successfully.

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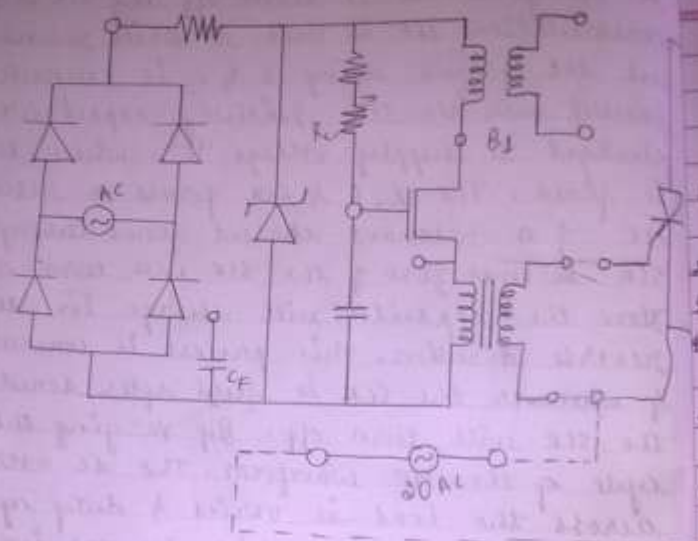
Circuit Diagram:



Tabular Column:

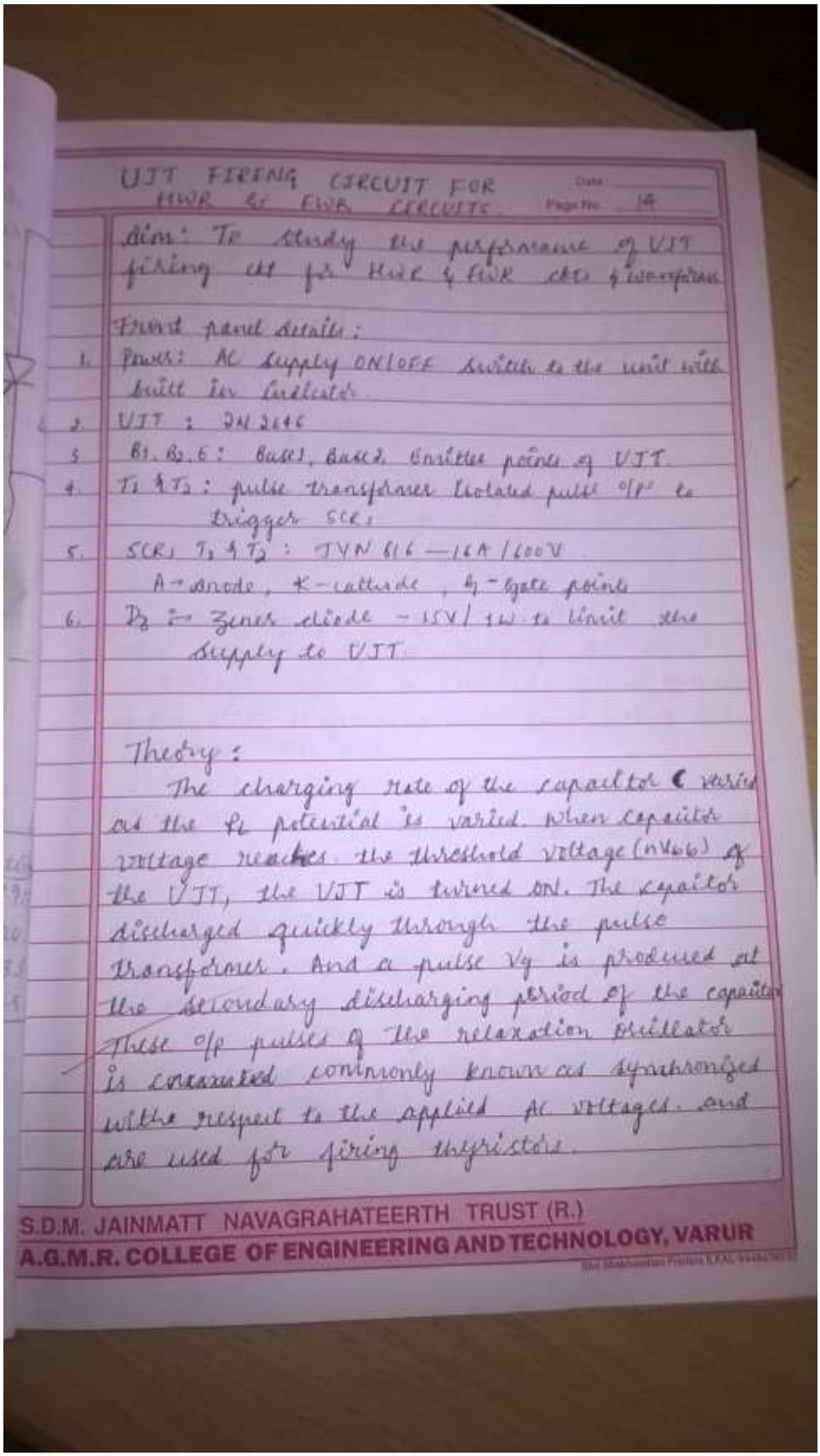
[i] 0 to 90°

V_m (V)	V_{rms} (V)	α°	β°	$V_{o(rms)}$	$V_{o(avg)}$
16.2	30.4	30	150	16.95	15.8
16.4	30.10	37.68	142.31	17.16	16.2
18.5	30.11	20.14	159.86	12.81	16.3
15	30.10	25.53	154.47	15.17	17.4

where $\alpha = \sin^{-1}[V_m/V_{rms}]$

$\beta = 180° - \alpha$

$V_{o(rms)} = \frac{V_m}{\pi}[1 + \cos\alpha]$



UJT FIRING CIRCUIT FOR HWR & FWR CIRCUITS

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Aim: To study the performance of UJT firing ckt for HWR & FWR ckts & waveforms

Front panel details:

1. Power: AC supply ON/OFF switch to the unit with built in indicator.
2. UJT : 2N2646
3. B1, B2, E: Base1, Base2, Emitter points of UJT.
4. T1 & T2 : pulse transformer isolated pulse o/p to trigger SCR.
5. SCR1 T1 & T2 : TYN 616 — 16A / 600V
   A → Anode, K - cathode, G - Gate points
6. D_Z :- Zener diode - 15V / 1W to limit the supply to UJT.

Theory:

The charging rate of the capacitor C varied as the P1 potential is varied. When capacitor voltage reaches the threshold voltage (ηV_{BB}) of the UJT, the UJT is turned ON. The capacitor discharged quickly through the pulse transformer. And a pulse V_g is produced at the secondary discharging period of the capacitor. These o/p pulses of the relaxation oscillator is connected commonly known as synchronized with the respect to the applied AC voltages. and are used for firing thyristors.

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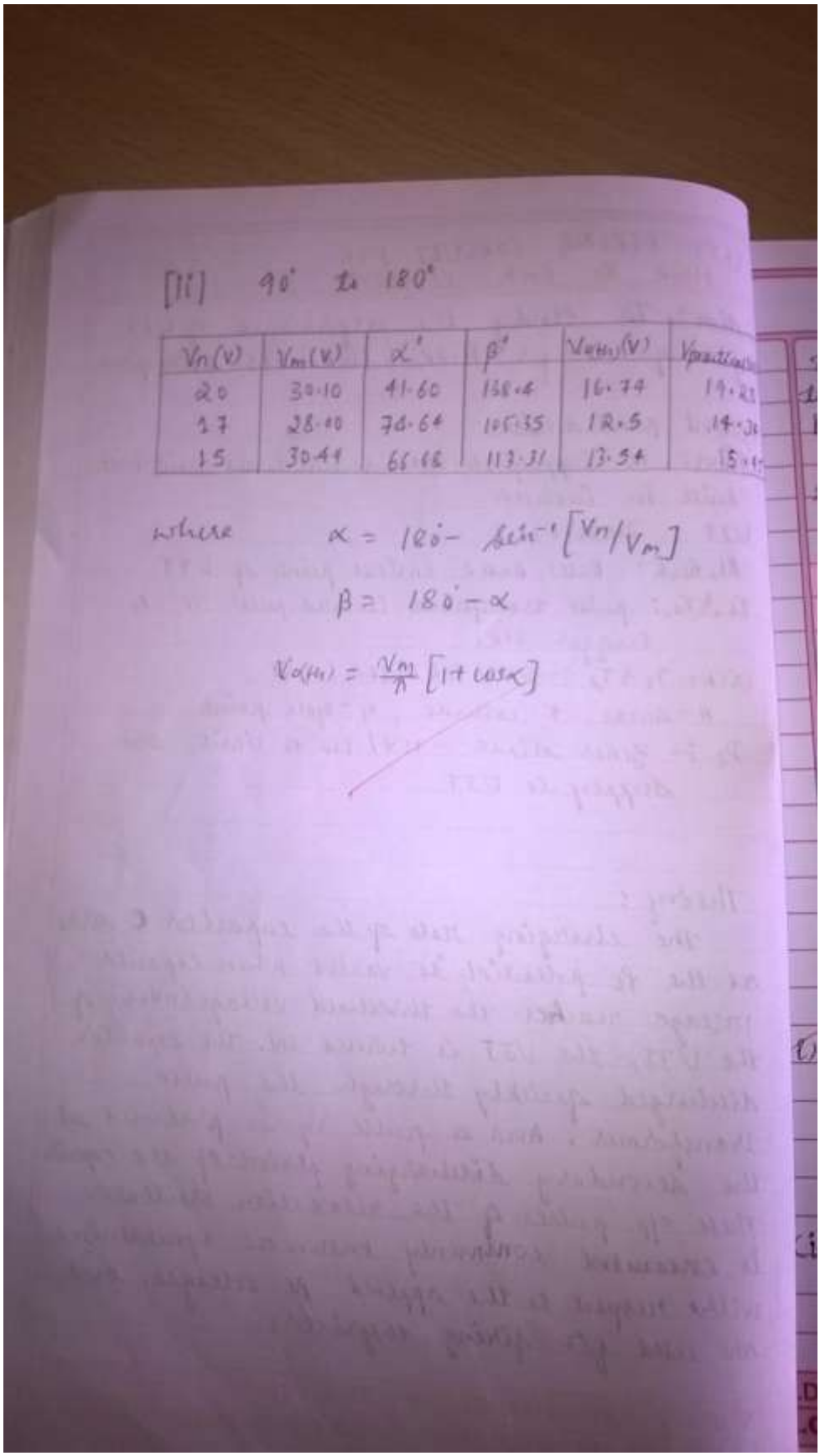


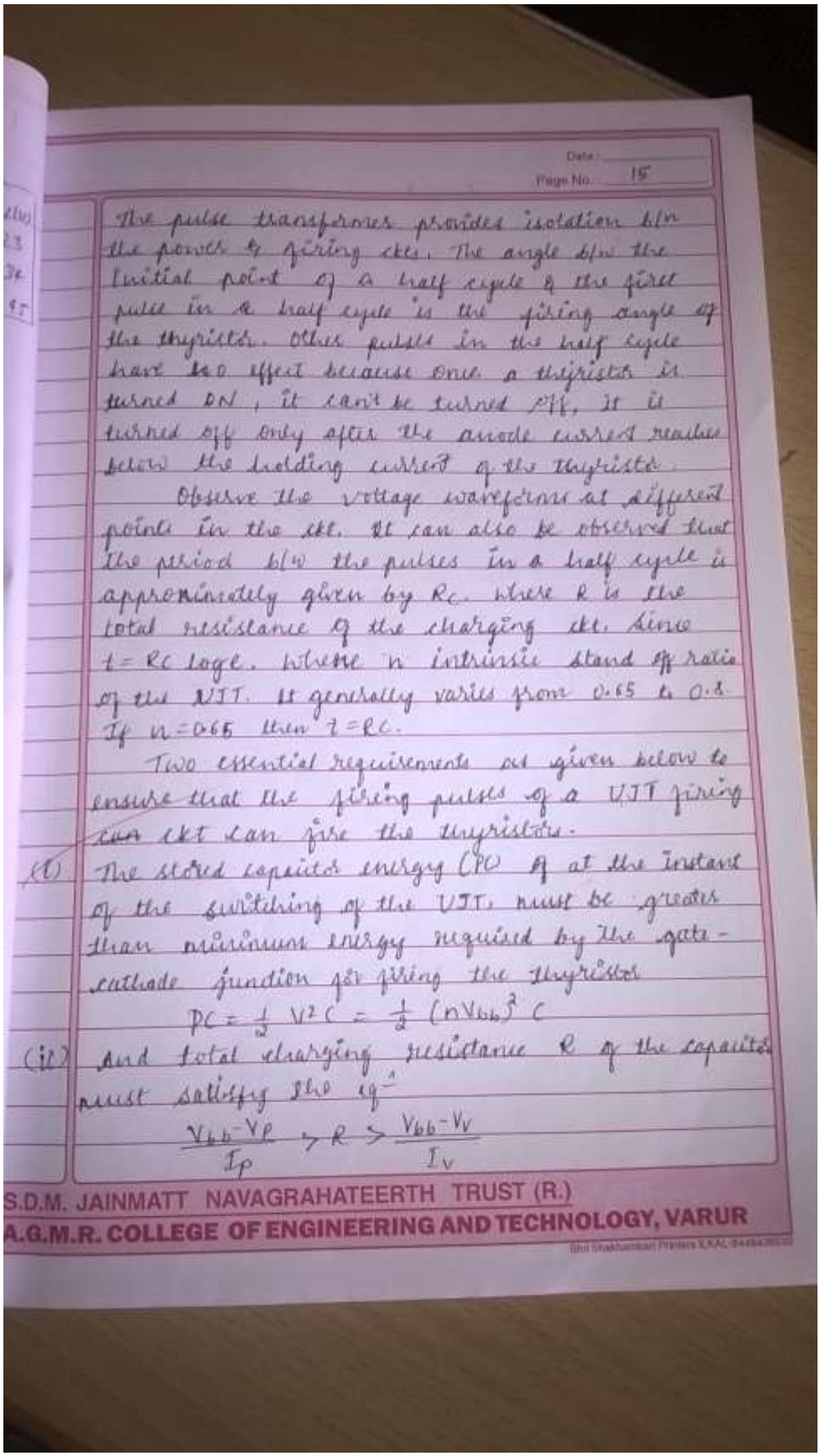
[ii] 90° to 180°

V_n(V)	V_m(V)	α°	β°	$V_{o(rms)}$(V)	$V_{practical}$
20	30.10	41.60	138.4	16.74	19.23
17	28.10	78.64	101.35	12.5	14.36
15	30.44	65.18	113.31	13.54	15.41

where $\alpha = 180° - \sin^{-1}[V_n/V_m]$

$\beta = 180° - \alpha$

$V_{o(rms)} = \frac{V_m}{\pi}[1 + \cos\alpha]$



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The pulse transformer provides isolation b/n the power & firing ckt. The angle b/w the initial point of a half cycle & the first pulse in a half cycle is the firing angle of the thyristor. Other pulses in the half cycle have no effect because once a thyristor is turned ON, it can't be turned off. It is turned off only after the anode current reaches below the holding current of the thyristor.

Observe the voltage waveforms at different points in the ckt. It can also be observed that the period b/w the pulses in a half cycle is approximately given by RC. where R is the total resistance of the charging ckt. Since $t = RC \log_e \frac{1}{1-\eta}$. Where η intrinsic stand off ratio of the UJT. It generally varies from 0.65 to 0.8. If $\eta = 0.65$ then $t = RC$.

Two essential requirements are given below to ensure that the firing pulses of a UJT firing ckt can fire the thyristors.

(i) The stored capacitor energy $\frac{1}{2}CV^2$ of at the instant of the switching of the UJT, must be greater than minimum energy required by the gate-cathode junction for firing the thyristor

$$PC = \frac{1}{2} V^2 C = \frac{1}{2} (\eta V_{bb})^2 C$$

(ii) And total charging resistance R of the capacitor must satisfy the eq^n

$$\frac{V_{bb} - V_p}{I_p} > R > \frac{V_{bb} - V_v}{I_v}$$

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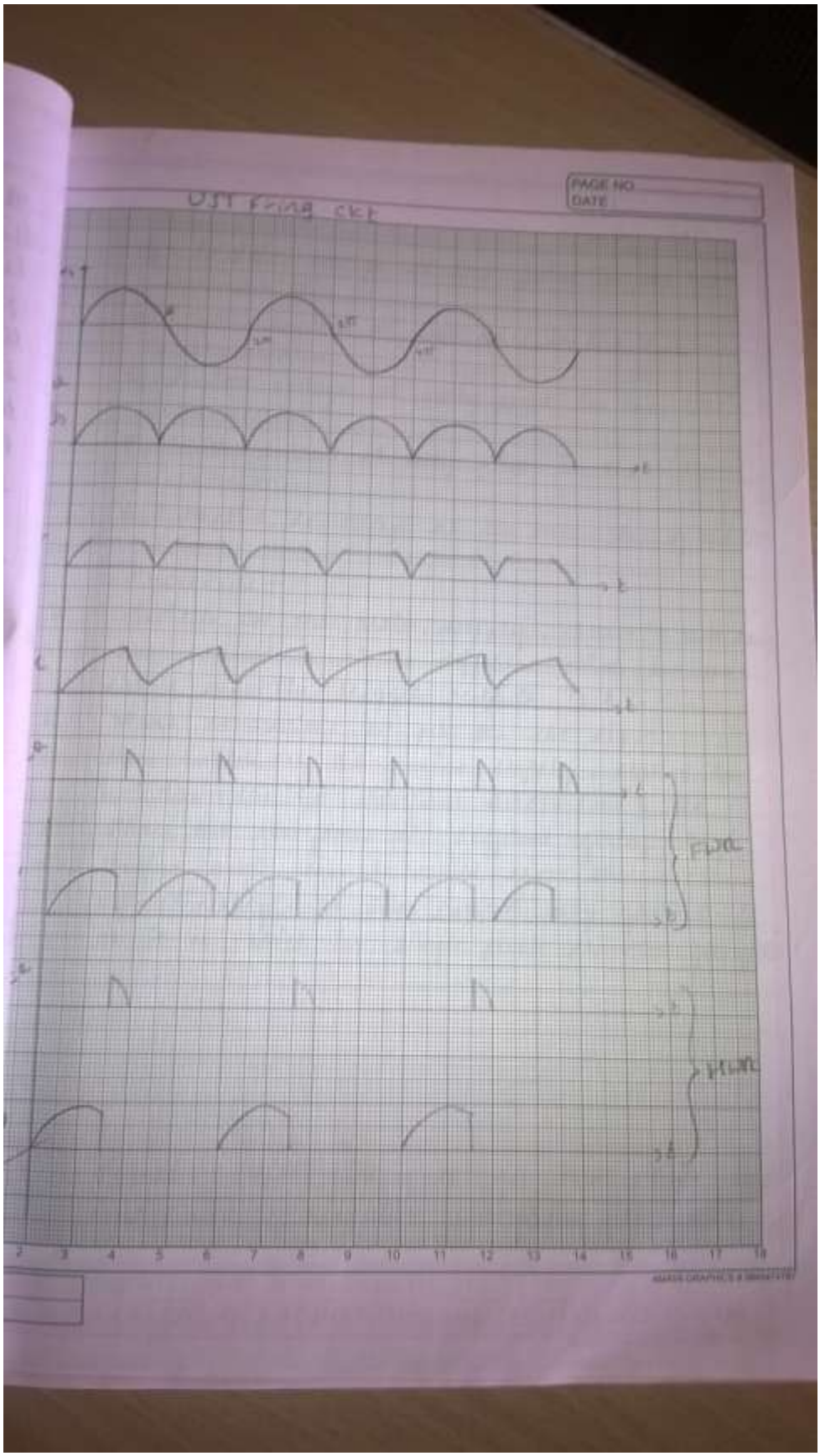

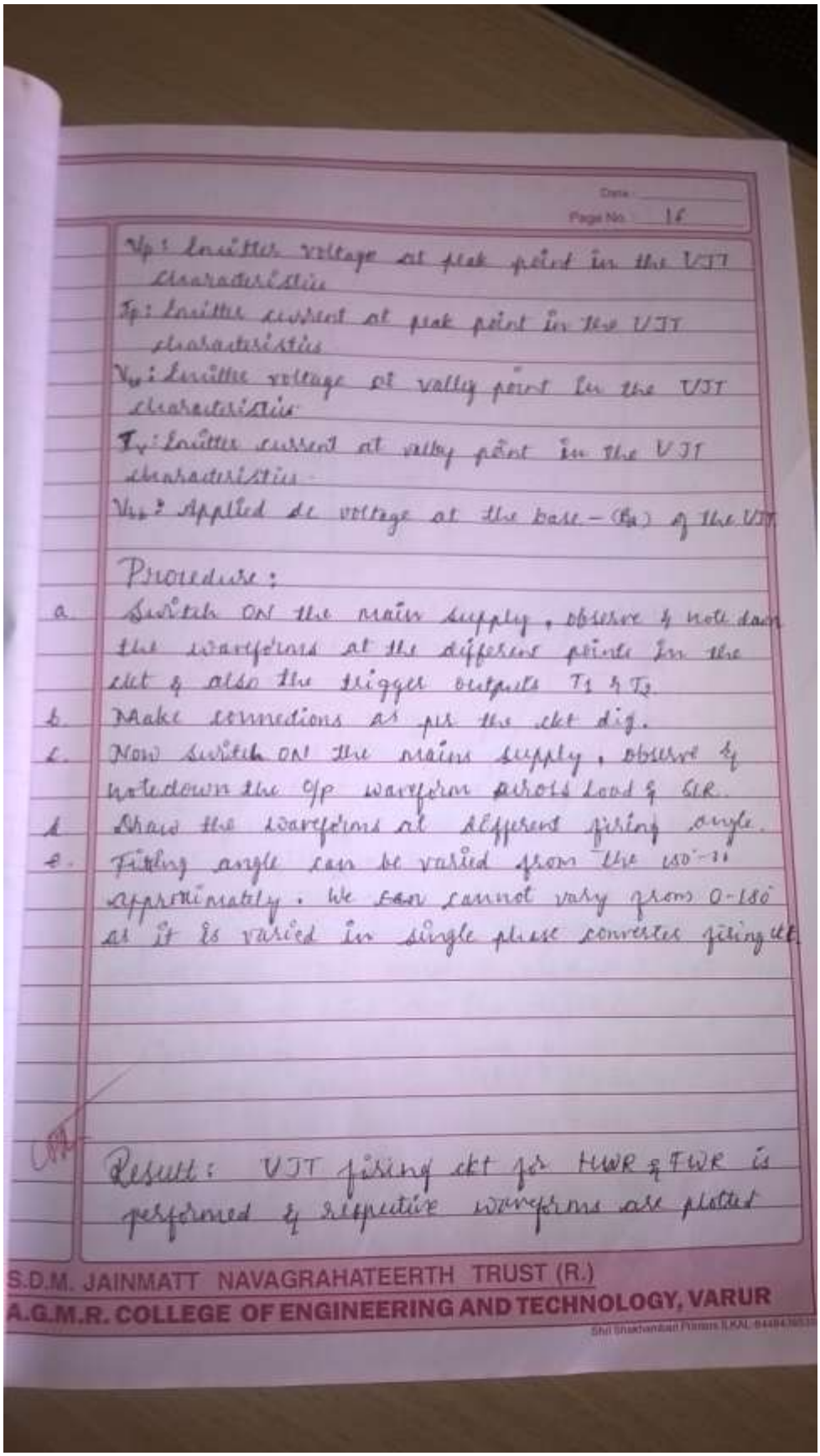

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V_p: Emitter voltage at peak point in the UJT characteristics

I_p: Emitter current at peak point in the UJT characteristics

V_v: Emitter voltage at valley point in the UJT characteristics

I_v: Emitter current at valley point in the UJT characteristics

V_{bb}: Applied dc voltage at the base – (B_2) of the UJT

Procedure:

a. Switch ON the main supply, observe & note down the waveforms at the different points in the ckt & also the trigger outputs T_1 & T_2.

b. Make connections as per the ckt dig.

c. Now switch ON the mains supply, observe & notedown the Op waveform across load & SCR.

d. Obtain the waveforms at different firing angle.

e. Firing angle can be varied from the 150°-11 approximately. We can cannot vary from 0-180° as it is varied in single phase converter firing ckt.

Result: UJT firing ckt for HWR & FWR is performed & respective waveforms are plotted

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