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BATCH: A3

IGBT CHARACTERISTICS

AIM: To study the characteristics of IGBT.

APPARATUS: 1) Circuit board with IGBT SGH80N60.
2) 3½ & 4½ digit DMMs, ammeters & voltmeters.
3) Dual-trace CRO with probes.
4) 30V power supplies

THEORY:

characteristics of an IGBT are shown in Fig. 3.

CIRCUIT DESCRIPTION:

The section on the board, shown in Fig. 5, is used for obtaining the transfer & output characteristics of the IGBT.

PROCEDURE:

1. Transfer characteristics of IGBT

1.1 Connect a DC ammeter, A3, in 10mA, between X23(+ve) & X24(-ve), in the drain circuit.

1.2 Connect a 4½ digit DMM, V1, in 20V range, between X26(+ve) & X27(-ve), in the gate circuit.

1.3 Connect a 3½ digit DMM, V2, in 2V range, between X24(+ve) & X22(-ve), in the drain circuit.

1.4 Use a table fan to ensure proper cooling of the IGBT mounted on heatsink.

1.5 Set potentiometer R11 in the gate circuit to minimum position (maximum anticlockwise).

1.6 Connect a DC supply in the gate circuit, V_{GG} , between X25(+ve) & X22 (-ve). Set supply to 2V.

1.7 Connect a DC supply in the drain circuit, V_{DD} , between X21(+ve) & X22 (-ve). Set supply to 15V.

1.8 Slowly increase the gate voltage, v_{GS} , using V_{GG} & R11 till the IGBT **just** starts conducting i.e. i_D is around 50μA. Note value of v_{GS} which is now the threshold gate-source voltage $V_{GS(Th)}$.

1.9 Increase the gate voltage further and take five readings of i_D & v_{GS} upto i_D = 700mA. For every reading, ensure that v_{DS} = 15V by adjusting V_{DD} .

1.10 Reduce V_{GG} & V_{DD} .

2. Output characteristics of IGBT

2.1 Set V_{GS} to a value above $V_{GS(Th)}$.

2.2 Slowly increase the drain-source voltage, v_{DS} , by increasing the drain supply voltage, V_{DD} , and note the corresponding values of drain current i_D . Initially the IGBT will be in the ohmic region and then, for higher values of v_{DS} , it will enter the active region. Take three readings in the ohmic region and three readings in the active region, up to i_D =700 mA.

2.3 Increase V_{GS} and repeat step 5.2. Readings should be taken for a total three different values of V_{GS}

2.4 Switch off all supplies and remove all connections on the chassis

OBSERVATIONS:

1. Transfer characteristics of IGBT

1.1: $V_{GS(Th)}$= V

1.2: i_D vs v_{GS}

Sr. No.	i_D mA	v_{GS} V
1.		
2.		
3.		
4.		
5.		

2. Output characteristics of IGBT

2.1: v_{GS} = V

Sr. No.	Region	i_D mA	v_{DS} V
1.	Ohmic		
2.	Ohmic		
3.	Ohmic		
4.	Active		
5.	Active		
6.	Active		

2.2: v_{GS} = V

Sr. No.	Region	i_D mA	v_{DS} V
1.	Ohmic		
2.	Ohmic		
3.	Ohmic		
4.	Active		
5.	Active		
6.	Active		

2.3: v_{GS} = V

Sr. No.	Region	i_D mA	v_{DS} V
1.	Ohmic		
2.	Ohmic		
3.	Ohmic		
4.	Active		
5.	Active		
6.	Active		

CHARACTERISTICS & GRAPHS:

1. Transfer characteristics of IGBT.

2. Output characteristics of IGBT.

CALCULATIONS: Calculate on-state resistance (reciprocal of slope in ohmic region), and output resistance (reciprocal of slope in active region) for each value of v_{GS} .

CONCLUSIONS:

LIST OF FIGURES:

Fig. 3 IGBT I-V Characteristics

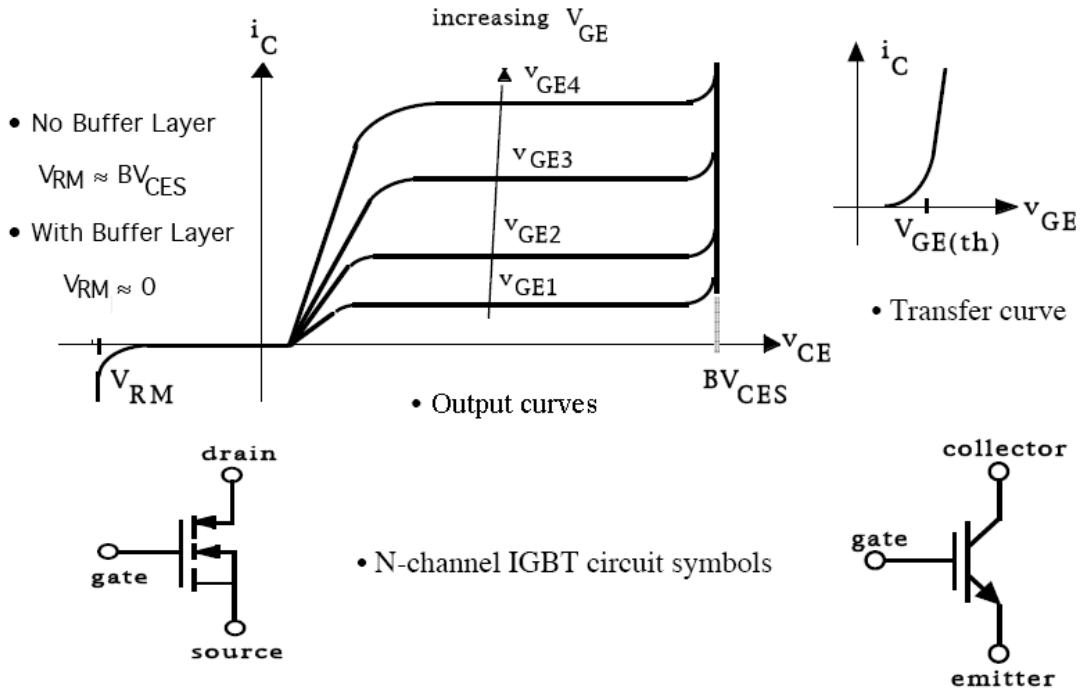
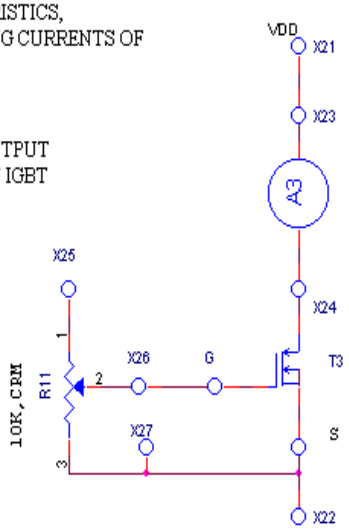


FIG1: V-I CHARACTERISTICS, LATCHING & HOLDING CURRENTS OF SCR & TRIAC

FIG2: TRANSFER * OUTPUT CHARACTERISTIC OF IGBT



Exp-2 IGBT

Name - Shreerang Mhatre
Roll no - 52
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* observation -

① Transfer characteristics of IGBT

Sr No	I_D mA	V_{GS} V
1	0.086 mA	3.56
2	0.28 mA	3.84
3	0.70 mA	4.00
4	0.140 mA	4.09
5	0.32 mA	4.51
6	0.67 mA	4.60
7	3.8 mA	4.60
8	6.0 mA	4.66
9	25 mA	4.74
10	67 mA	4.88
11	260 mA	5.10
12	620 mA	5.25

(2) Output characteristics of IGBT

i) $V_{GS} = 4.0\ V$

Sr No	Region	i_D mA	V_{DS} V
1	ohmic	30 μA	0.3 V
2	ohmic	65 μA	0.5 V
3	ohmic	65 μA	1 V
4	Active	5 μA	0.1 V
5	Active	12 μA	0.2 V

ii) $V_{GS} = 4.5\ V$

Sr No	Region	i_D mA	V_{DS} V
1	Ohmic	2 μA	0.1 V
2	ohmic	8 μA	0.2 V
3	ohmic	31 μA	0.3 V
4	Active	55 μA	0.4 V
5	Active	110 μA	0.5 V

iii) $V_{GS} = 5\ V$

Sr No	Region	i_D mA	V_{DS} V
1	ohmic	1 mA	0.5
2	ohmic	4.4 mA	0.7
3	ohmic	2.2 mA	0.6
4	Active	30 mA	0.8
5	Active	48 mA	0.9

* Calculations -

For $V_{GS} = 4.0\,V$

On state resistance

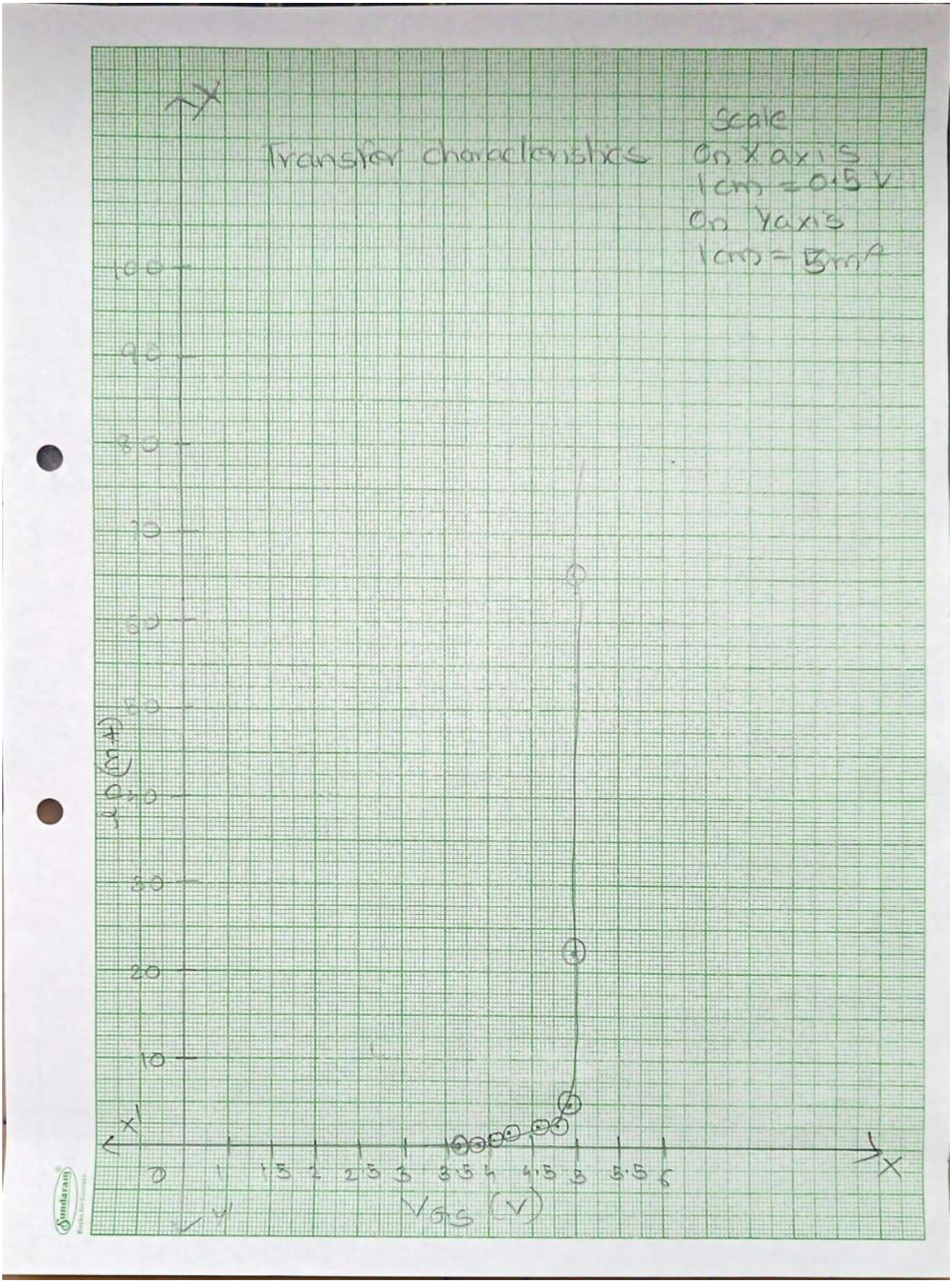
$$R_{ON} = \frac{(0.2 - 1)}{(12 - 65)10^{-3}} = 1.509\ k\Omega$$

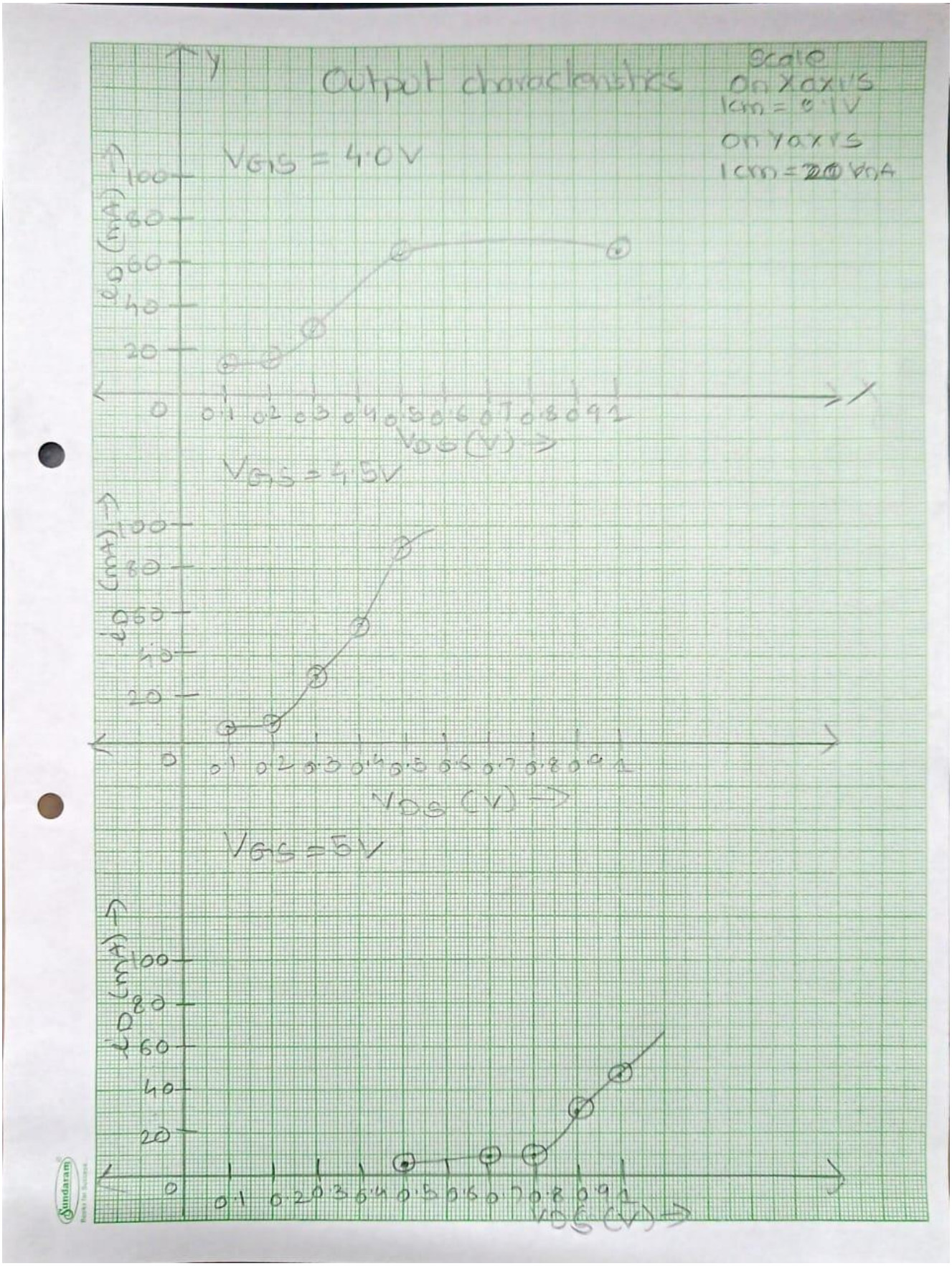
For $V_{GS} = 4.5\,V$

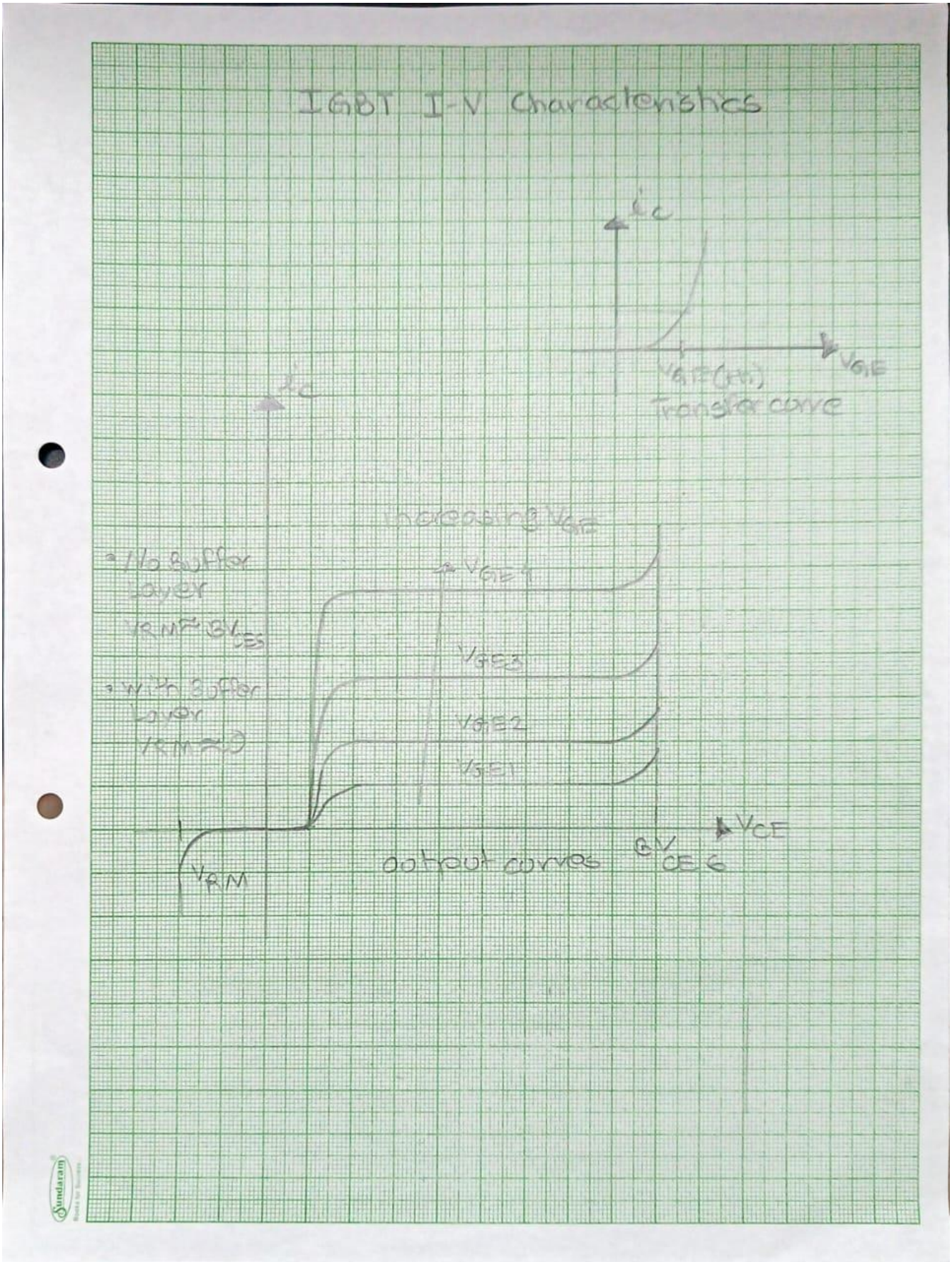
$$R_{ON} = \frac{(0.5 - 0.3)}{(110 - 31)10^{-3}} = 2.816\ \Omega$$

For $V_{GS} = 5\,V$

$$R_{ON} = \frac{(0.9 - 0.6)}{(48 - 2.2)10^{-3}} = 6.637\ \Omega$$


Transfer characteristics
Scale
On X axis
1 cm = 0.5 V
On Y axis
1 cm = 5 mA
Y
X
X'
Y'
100
90
80
70
60
50
40
30
20
10
0
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
VGS (V)


Output characteristics
scale
on X axis
1cm = 0.1V
on Y axis
1cm = 20 mA
$V_{GS} = 4.0V$
I_{DS} (mA)
V_{DS} (V)
$V_{GS} = 4.5V$
I_{DS} (mA)
V_{DS} (V)
$V_{GS} = 5V$
I_{DS} (mA)
V_{DS} (V)


IGBT I-V Characteristics
i_c
V_{GE}
$V_{GE(th)}$
Transfer curve
i_c
increasing V_{GE}
V_{GE4}
V_{GE3}
V_{GE2}
V_{GE1}
V_{CE}
BV_{CES}
V_{RM}
output curves
• No buffer layer
$V_{RM} = BV_{CES}$
• With buffer layer
$V_{RM} < BV_{CES}$