North South University
Department of Electrical & Computer Engineering
LAB REPORT
Analog Electronics Lab
EEE111L

Experiment Number: 5

Experiment Name: The Input-Output characteristics of CE (common emitter) configuration of BJT

Experiment Date: 22/11/2021

Report Submission Date: 29/11/2021

Section: 7 **Group No:** 2

Students Name & ID:

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Remarks:	Score

Objectives:

• Our objective in this experiment is to study the input-output characteristics of CE (common emitter) configuration of BJT.

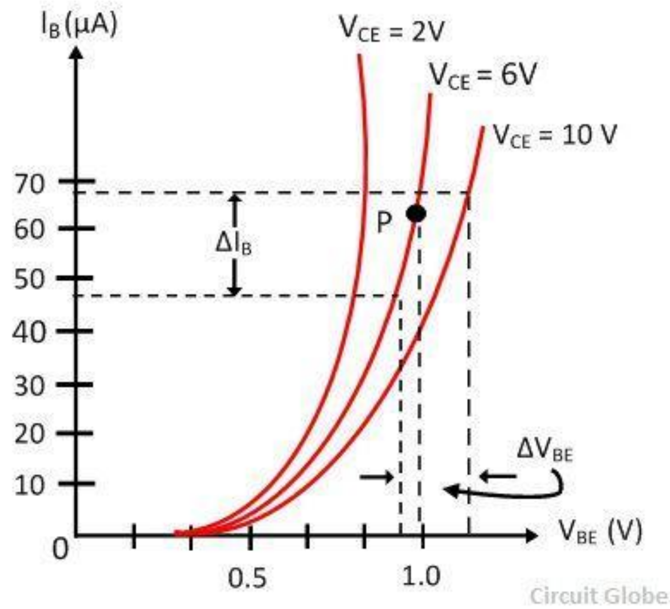
Theory:

Emitter:
In comparison to the two base and collector terminals, the emitter terminal is the most severely doped. Because the emitter's job is to send the charge carrier to the collector via the base, this is the case. The emitter is larger than the base, but smaller than the collector.

Base:
The base region is exceedingly tiny, being smaller than both the emitter and the collector. The base is always kept small to ensure that charge carriers entering the base from the emitter do not recombine in the base region and are guided to the collector region. The base has a lower doping intensity than the emitter and collector for the same reason as the emitter and collector.

Collector:
Because all of the charge carriers from the emitter recombine at the base, heat is emitted, the collector terminal is moderately doped, and the collector zone is slightly larger than the emitter region. As a result, the collector terminal must be large enough to disperse the heat and prevent the gadget from burning out.

Input Characteristic Curve:
The curve plotted between base current IB and the base-emitter voltage VEB is called the Input characteristics curve. For drawing the input characteristic, the reading of base currents is taken through the ammeter on emitter voltage VBE at constant collector-emitter current. The curve for different values of collector-base current is shown in the figure below.



Input Characteristic Graph

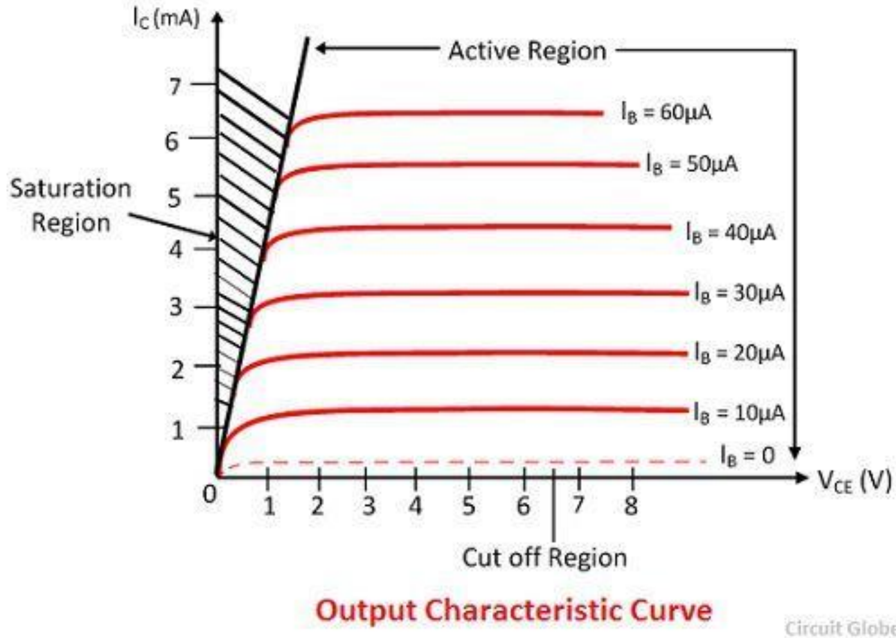
The curve for common base configuration is similar to a forward diode characteristic. The base current IB increases with the increases in the emitter-base voltage VBE. Thus, the input resistance of the CE configuration is comparatively higher than that of CB configuration.

The effect of CE does not cause a large deviation on the curves, and hence the effect of a change in VCE on the input character is ignored.

Input Resistance:
The ratio of change in base-emitter voltage VBE to the change in base current ΔIB at constant collector-emitter voltage VCE is known as input resistance R_I, i.e.

$$r_i = \frac{\Delta V_{BE}}{\Delta I_B} \text{ at constant } V_{CE}$$

Output Characteristic:
The output characteristic of a CE setup is the curve drawn between collector current IC and collector-emitter voltage VCE at a constant base current IB. The image below depicts the characteristic curve of a typical NPN transistor in CE form.



The collector current increases slightly when the collector-emitter VCE current grows in the active zone. The curve has a steeper slope than the output characteristic of the CB arrangement. The common base connection has a higher output resistance than the CE connection.

With an increase in VCE at constant voltage IB, the value of the collector current IC rises, and the value of likewise rises.

When the VCE declines, the IC drops rapidly as well. The transistor's collector-base junction is always forward biased and work saturate. The collector current becomes independent of the input current IB in the saturation region.

A little current IC is not zero in the active zone IC = IB, and it is equal to reverse leakage current ICEO.

Output Resistance:
The output resistance R_O is defined as the ratio of the fluctuation in collector-emitter voltage to the collector-emitter current at constant base current IB and the output resistance of the CE configuration is higher than that of the CB configuration.

$$r_o = \frac{\Delta V_{CE}}{\Delta I_C} \ at\ constant\ I_B$$

Equipment List:

- Transistor (C828) – 1 piece
- Resistor (100kΩ, 1kΩ) – 1 piece each
- Trainer Board
- DC Power Supply
- Digital Multimeter
- Cords and wires

Circuit Diagram:

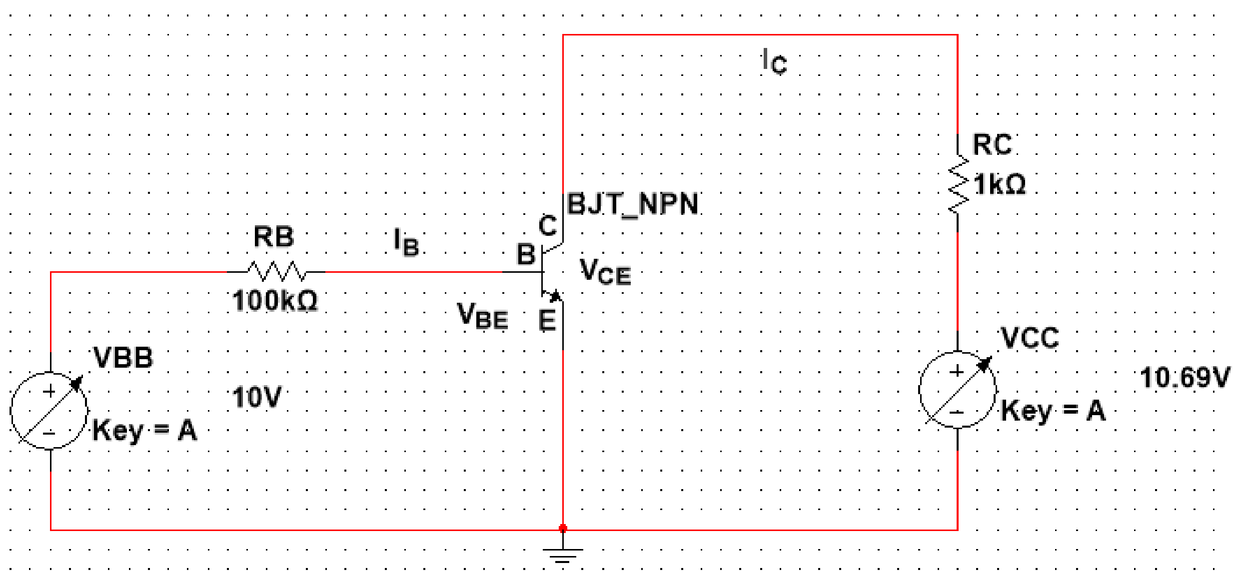


Figure – 1: BJT NPN Transistor Circuit

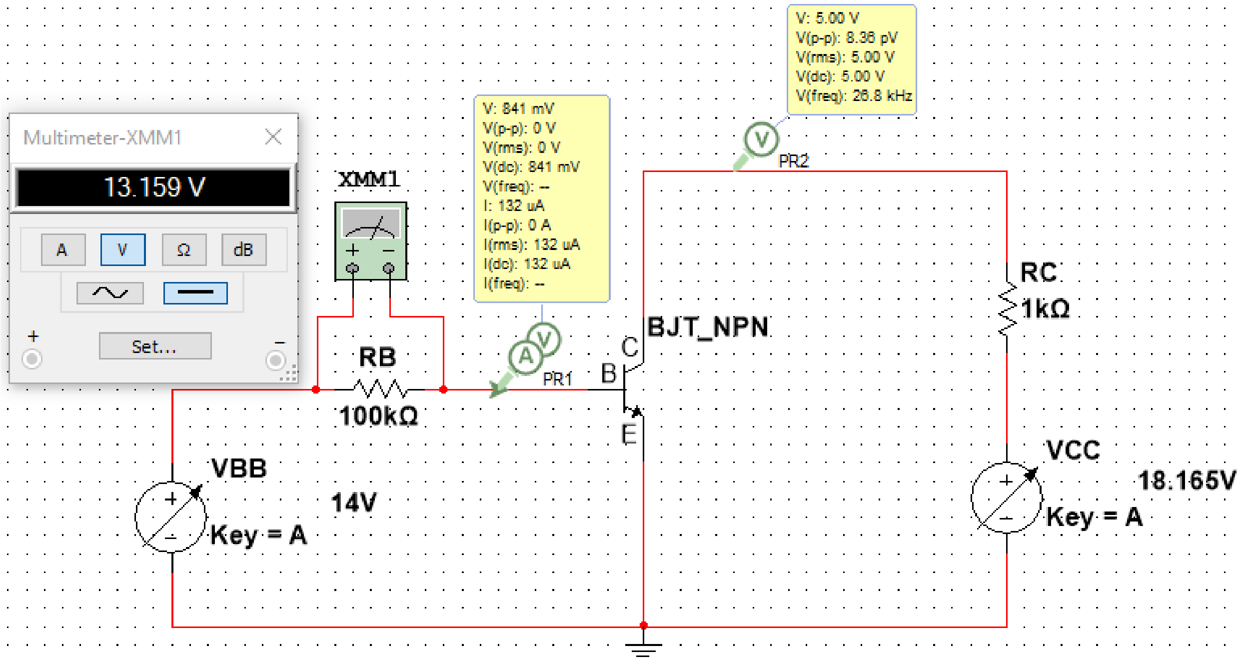


Figure 2 – Circuit to get the values for the Input characteristics of BJT

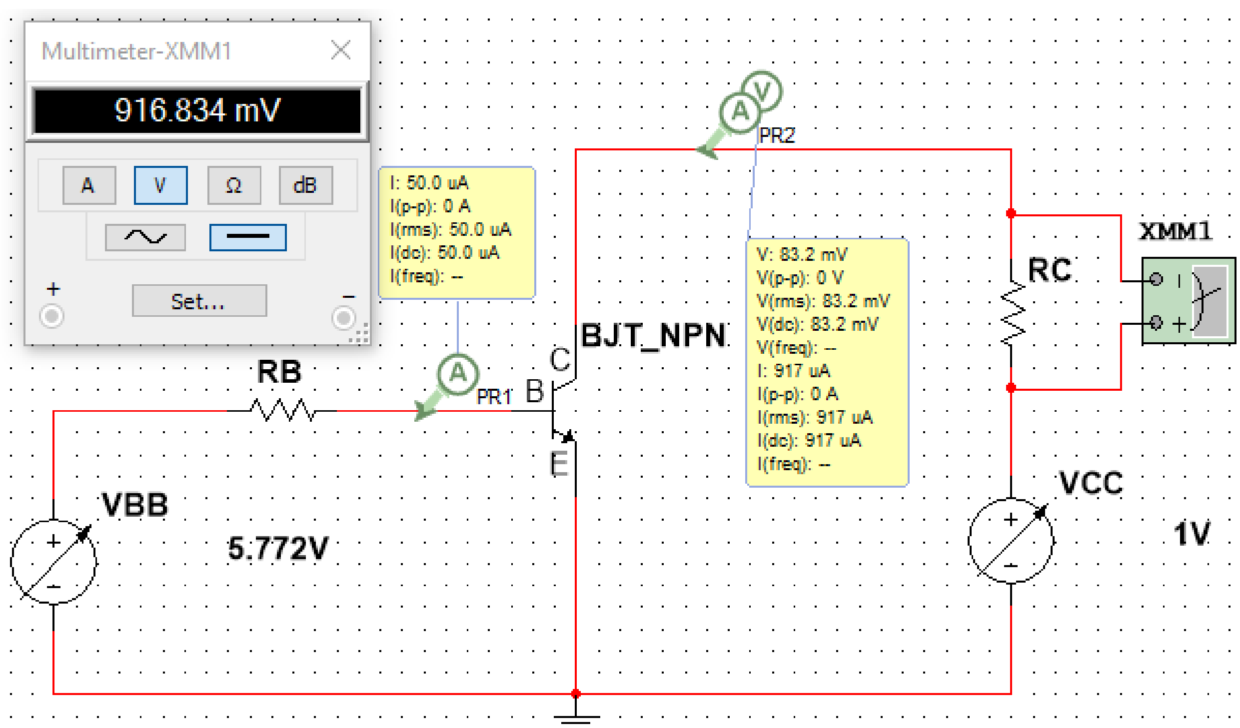


Figure 3 – Circuit to get the values for the Output characteristics of BJT

Data & Table:

Table 1: Input Characteristics of BJT

V_{CE} = 1 V				V_{CE} = 5V			
V_{BB} **(Volts)**	V_{BE} **(Volts)**	V_{RB} **(Volts)**	$I_B = V_{RB}/R_B$ **(μA)**	V_{BB} **(Volts)**	V_{BE} **(Volts)**	V_{RB} **(Volts)**	$I_B = V_{RB}/R_B$ **(μA)**
0.1	100mV	0V	0A	0.1	100mV	0V	0A
0.2	200mV	0V	0A	0.2	200mV	0V	0A
0.3	300mV	0V	0A	0.3	300mV	0V	0A
0.4	400mV	0V	0A	0.4	400mV	0V	0A
0.5	200mV	0.025mV	0A	0.5	500mV	0.024mV	0A
0.6	599mV	1.137mV	0A	0.6	599mV	1.136mV	0A
0.7	677mV	23.168mV	0A	0.7	677mV	23.168mV	0A
0.8	711mV	88.503mV	0.89μA	0.8	711mV	88.502mV	0.89μA
0.9	729mV	171.406mV	1.71μA	0.9	729mV	171.406mV	1.71μA
1.0	739mV	260.573mV	2.61μA	1.0	739mV	260.573mV	2.61μA
1.2	753mV	446.636mV	4.47μA	1.2	753mV	446.636mV	4.47μA
1.4	763mV	637.436mV	6.37μA	1.4	763mV	637.436mV	6.37μA
1.6	769mV	830.59mV	8.31μA	1.6	769mV	830.59mV	8.31μA
1.8	775mV	1.025V	10.3μA	1.8	775mV	1.025V	10.3μA
2.0	779mV	1.221V	12.2μA	2.0	779mV	1.221V	12.2μA
3.0	795mV	2.205V	22.1μA	3	795mV	2.205V	22.1μA
5.0	811mV	4.189V	41.9μA	5	811mV	4.189V	41.9μA
7.0	821mV	6.179V	61.8μA	7	821mV	6.179V	61.8μA
10	832mV	9.168V	91.7μA	10	832mV	9.168V	91.7μA
14	841mV	13.159V	132μA	14	841mV	13.159V	132μA

Here, we're considering 0V and 0A for values that are too small like nV, pA, nA.

Table 2: Output Characteristics of BJT

	I_B = 10 **µA**			I_B = 50 **µA**		
V_{CC} **(Volts)**	V_{CE} **(Volts)**	V_{RC} **(Volts)**	$I_C = V_{RC} / R_{BC}$ (**mA)**	V_{CE} **(Volts)**	V_{RC} **(Volts)**	$I_C = V_{RC} / R_{BC}$ (**mA)**
0.1	51.2mV	48.81mV	48.81µA	31.7mV	68.252mV	68.252µA
0.2	73.0mV	126.993mV	126.993µA	43.2mV	156.842mV	156.842µA
0.3	87.5mV	212.479mV	212.479µA	51.6mV	248.45mV	248.45µA
0.4	98.9mV	301.07mV	301.07µA	58.2mV	341.795mV	341.795µA
0.5	109mV	391.104mV	391.104µA	63.8mV	436.23mV	436.23µA
0.6	118mV	481.824mV	481.824µA	68.5mV	531.477mV	531.477µA
0.7	128mV	572.499mV	572.499µA	72.7mV	627.274mV	627.274µA
0.8	137mV	662.671mV	662.671µA	76.5mV	723.484mV	723.484µA
0.9	148mV	751.580mV	751.580µA	80.0mV	820.026mV	820.026µA
1.0	162mV	837.847mV	837.847µA	83.2mV	916.834mV	916.834µA
1.2	219mV	981.124mV	981.124µA	89.0mV	1.111V	1.111mA
1.5	498mV	1.002V	1.002mA	96.6mV	1.403V	1.403mA
2.0	998mV	1.002V	1.002mA	108mV	1.892V	1.892mA
2.5	1.5V	1.002V	1.002mA	118mV	2.382V	2.382mA
3.0	2.0V	1.002V	1.002mA	128mV	2.872V	2.872mA
5.0	4.0V	1.002V	1.002 mA	202mV	4.798V	4.798mA
10.0	9.0V	1.002V	1.002mA	5.0V	4.995V	4.995mA
15.0	14.0V	1.002V	1.002mA	10.0V	4.995V	4.995mA
20.0	19.0V	1.002V	1.002mA	15.0V	4.995V	4.995mA

Graphs:

Input Characteristics Graph:

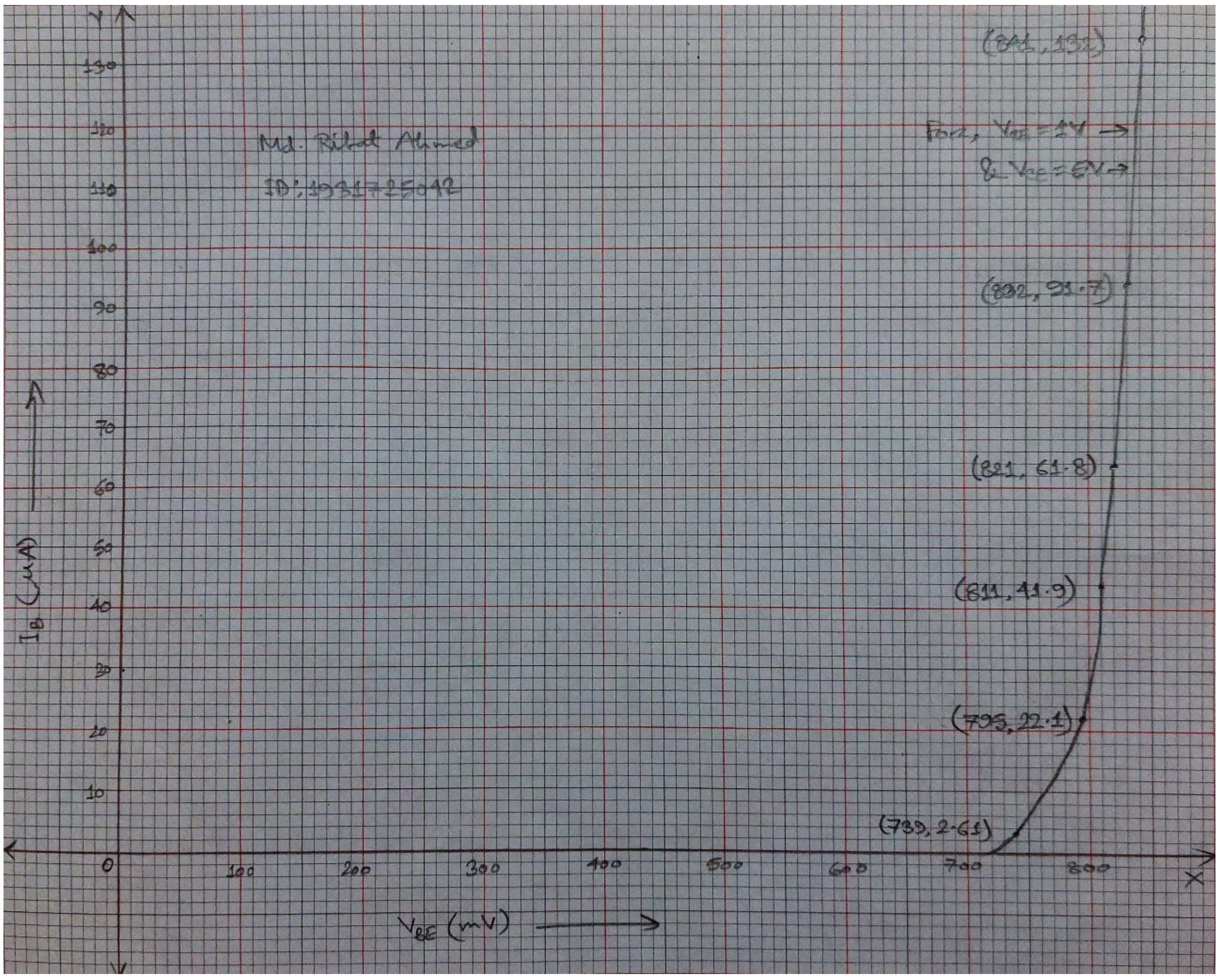


Figure 4 – Input Characteristics Graph of BJT for V_{CE} = 1V & 5V

Here, we got the same values of I_B and V_{BE} for the given points for both V_{CE} = 1V & 5V while simulating so the same line is representating both of them.

Output Characteristics Graph:

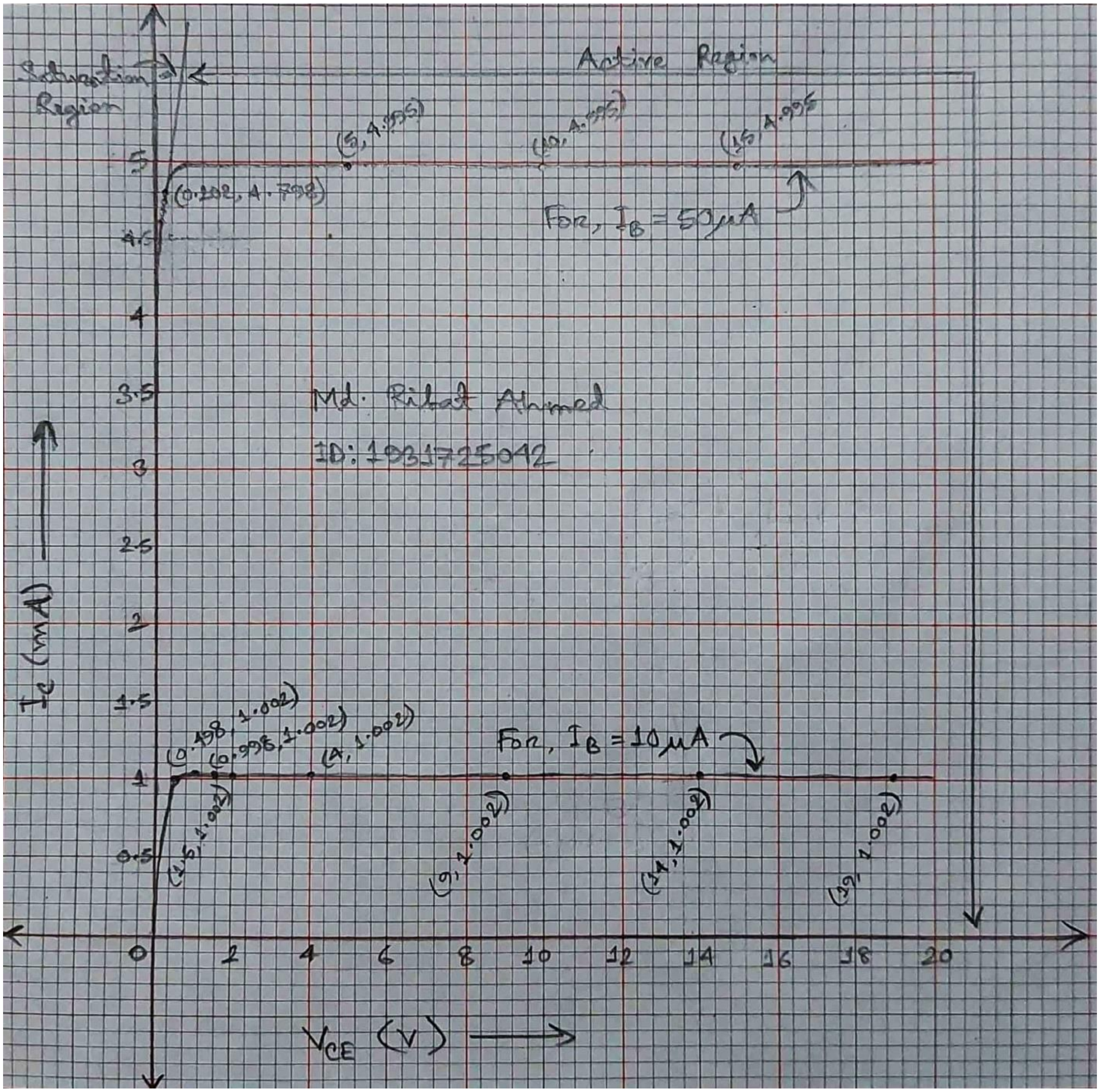


Figure 5 – Output Characteristics Graph of BJT for I_B = 10μA & 50μA

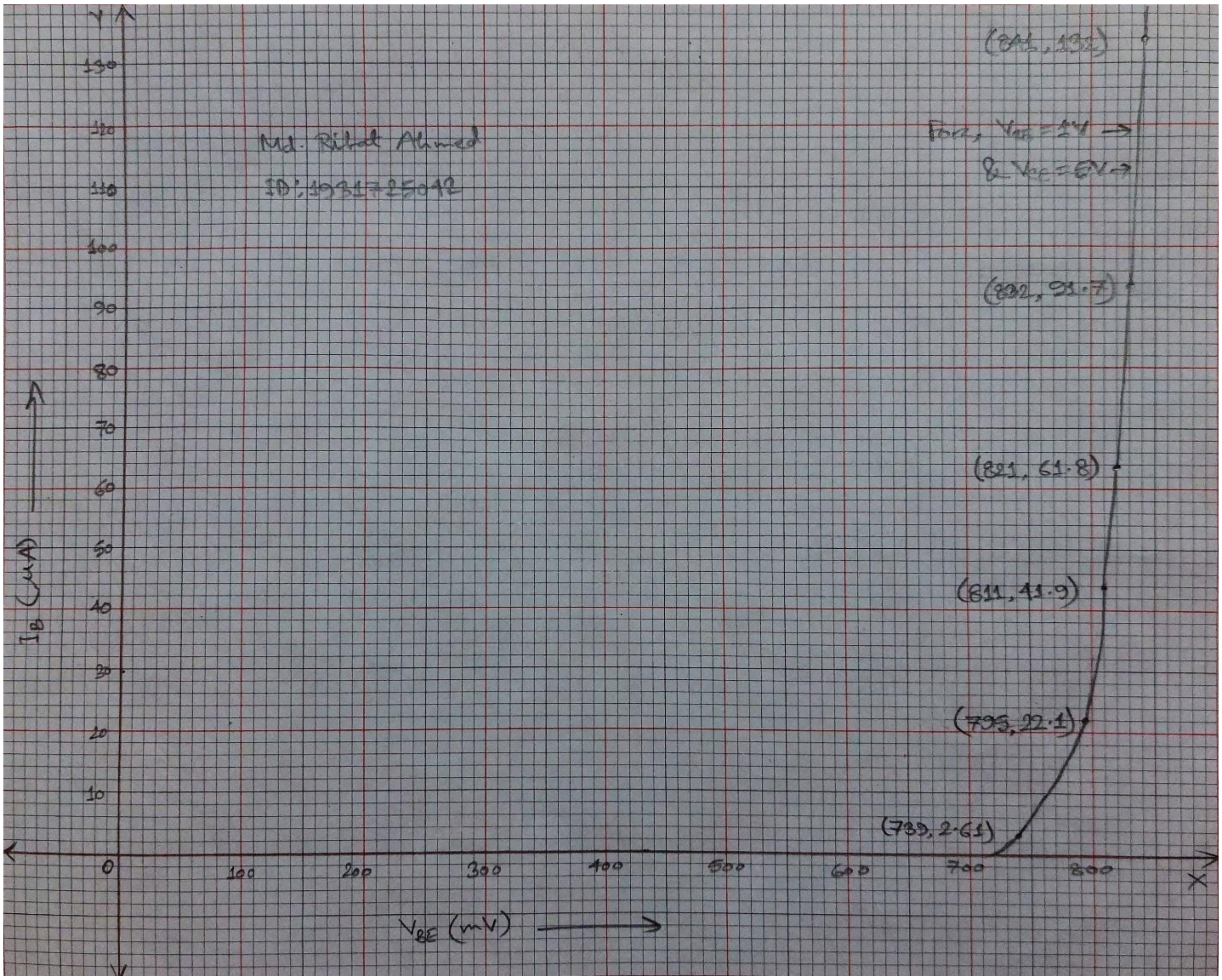
Result Analysis & Discussion:

In this experiment we have learn about the Input Output characteristic of common emitter. Basically, a transistor is made of these 3 parts called base, collector and emitter. Base is the gate controller for the large electrical supply. Collector is the main power source and the Emitter is the outlet for that power supply. Basically, the input characteristic describes the relation between input current or base current with the input voltage. From the input characteristic we have seen that the base emitter voltage and the base current are 1V and 5V. If we increase V_{BB} from 1V we have find out the active region and V_{BB} is constant there. And the output characteristic describes the relation between output current and the output voltage. In terms of output characteristic, we have seen the effects on Collector Emitter voltage V_{CE}. By slowly increasing V_{CC}, we get the reading for the output curve and there are two region there saturation region where it doesn't conduct and the active region where we get the output curves.

Questions / Answers:

Answer to question 1:

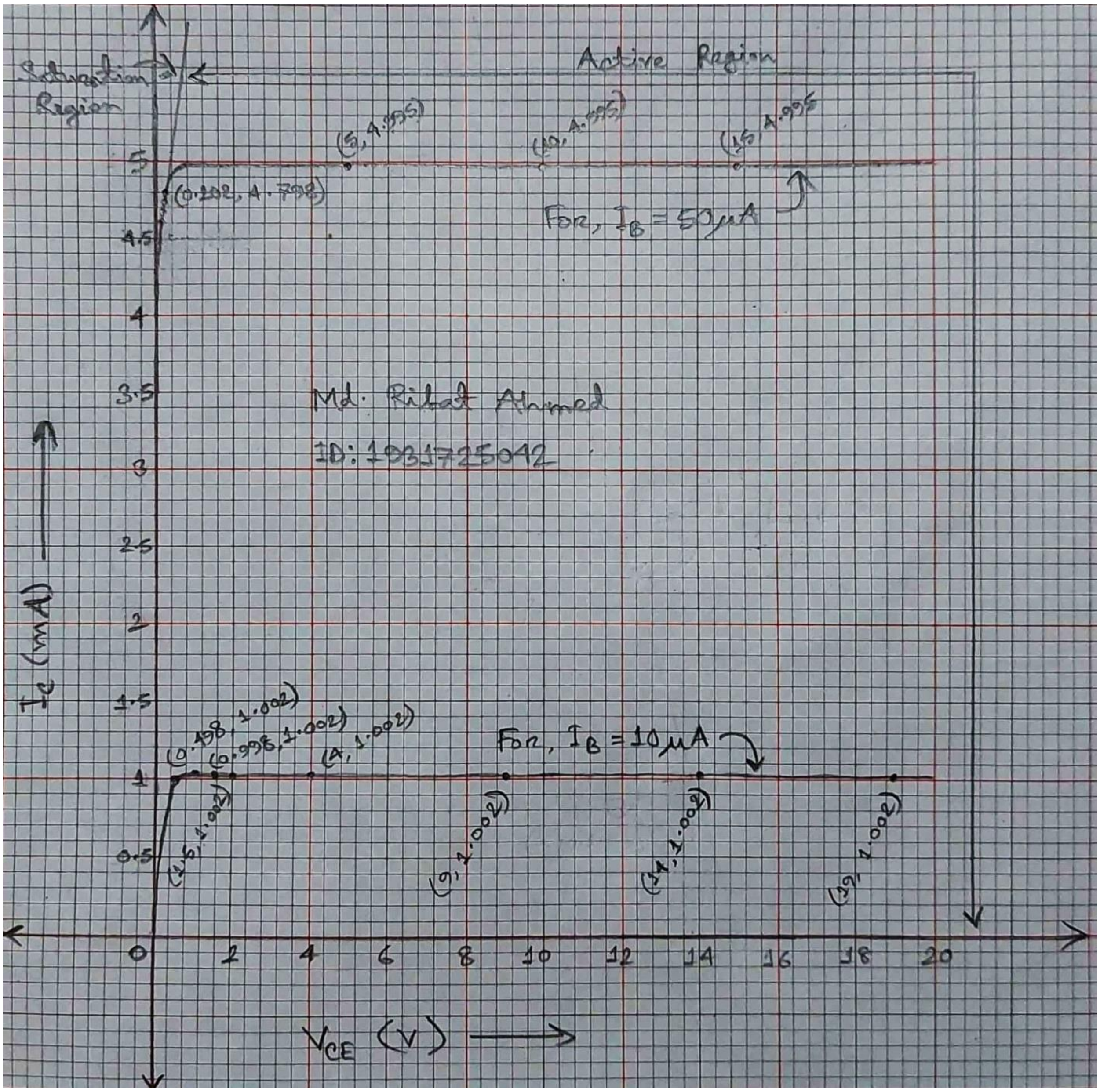
Plotting I_B vs V_{BE} graph for different V_{CE}:



Here, we got the same values of I_B and V_{BE} for the given points for both V_{CE} = 1V & 5V while simulating so the same line is representating both of them.

Answer to question 2:

Plotting I_C vs V_{CE} graph for different I_B:



Answer to question 3:

Finding β for each I_B in the active region:

(3) $I_B = 10 \mu A$

when

$$B = \frac{1.002}{10} = 0.1002 A.$$

$$= 0.1002$$

~~when~~ $I_C = 1.002$ mA

$$B = \frac{1.002}{10} = 0.1002 A$$

when

$I_C = 1.002$ mA

$$B = \frac{1.002}{10} = 0.1002 A$$

when $I_B = 50\ \mu A$

$I_C = 1.403\ mA$

$$B = \frac{I_C}{I_B} = \frac{1.403}{50} = 0.02806\ A$$

when,

$I_C = 1.892\ mA$

So, $B = \frac{1.892}{50} = 0.03784\ A$

when

$I_C = 2.382\ mA$

$$B = \frac{2.382}{50} = 0.0476\ A.$$

when $I_C = 2.872\ mA.$

$$B = \frac{2.872}{50} = 0.05744\ A$$

when $\cancel{I_C}$ $B = \frac{4.798}{50} = 0.09596\ A.$

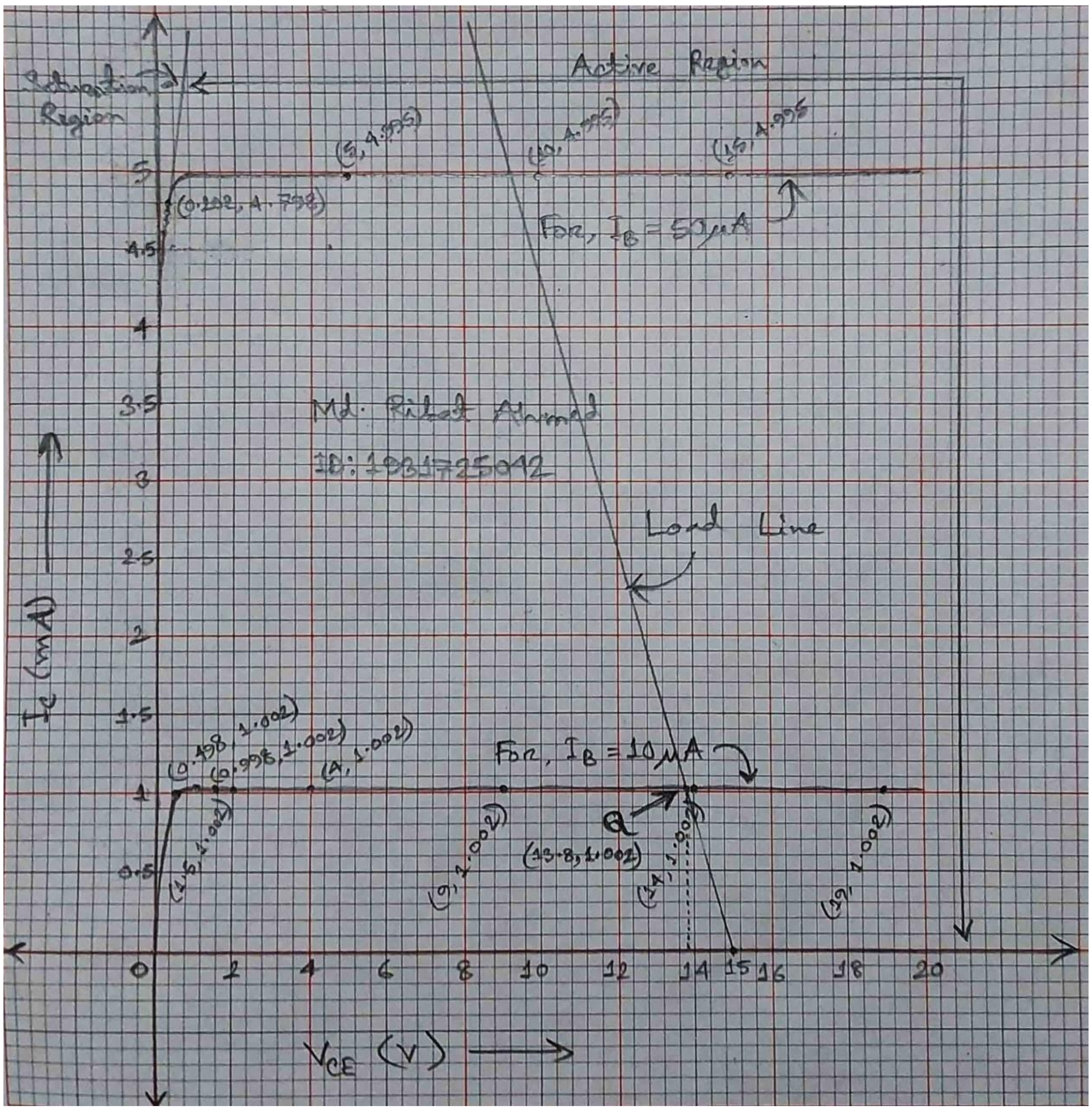
Answer to question 4:

Calculation to get the Load Line for V_{CC} = 15V:

$I_{Cmax} = V_{CC}/R_C$ where, V_{CE} = 0V [$V_{CE} = V_{CC} - I_C R_C$]
So, I_{Cmax} = 15V/1kΩ = 15mA

& $V_{CEmax} = V_{CC}$ where, I_C = 0A
So, V_{CEmax} = 15V

For V_{CC} = 15V, drawing the load line:



From the Graph we get the Q-Point: (13.8V, 1.002mA)

Answer to question 5:

(5) In saturation region region both the collector base region and the emitter base region are in forward biased and heavy current flow through the junction. And the region in which both ~~juction~~ junctions of transistor are in ~~revesed~~ reversed biased is called the cut off.

Answer to question 6:

(6) If the ~~tan~~ transistor is used as a switch then for open switch the Q-point is in the cut off region and for the close switch, the Q-point is in the saturation region. The Q-point lies in the middle of the line. for the transistor which operates as an amplifier.

Contributions:

Name & ID	Contribution
Md. Rifat Ahmed – 1931725042 (**Report Writer)**	Data & Table, Graphs, Attachment
Yusuf Abdullah Tonmoy – 1620456042	Circuit Diagram
Fardin Bin Islam - 1721588642	Theory, Equipment List
Md Kawser Islam – 1912296642	Questions/Answers
Tusher Saha Nirjhor - 1921793642	Result Analysis & Discussion

Attachment:

Task 01:

Table 1: Input Characteristics of BJT

V_{CE} = 1 V				V_{CE} = 5V			
V_{BB} **(Volts)**	V_{BE} **(Volts)**	V_{RB} **(Volts)**	$I_B = V_{RB}/R_B$ **(µA)**	V_{BB} **(Volts)**	V_{BE} **(Volts)**	V_{RB} **(Volts)**	$I_B = V_{RB}/R_B$ **(µA)**
0.1	100mV	0V	0A	0.1	100mV	0V	0A
0.2	200mV	0V	0A	0.2	200mV	0V	0A
0.3	300mV	0V	0A	0.3	300mV	0V	0A
0.5	200mV	24.844mV	0A	0.5	500mV	24.444mV	0A
0.7	677mV	23.168mV	0A	0.7	677mV	23.168mV	0A
1.0	739mV	260.573mV	2.61µA	1.0	739mV	260.573mV	2.61µA
3	795mV	2.205V	22.1µA	3	795mV	2.205V	22.1µA
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Here, we're considering 0V and 0A for values that are too small like nV, pA, nA.

Table 2: Output Characteristics of BJT

	I_B = 10 **μA**			I_B = 50 **μA**		
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3.0	2.0V	1.002V	1.002mA	128mV	2.872V	2.872mA
5.0	4.0V	1.002V	1.002 mA	202mV	4.798V	4.798mA
10.0	9.0V	1.002V	1.002mA	5.0V	4.995V	4.995mA
15.0	14.0V	1.002V	1.002mA	10.0V	4.995V	4.995mA
20.0	19.0V	1.002V	1.002mA	15.0V	4.995V	4.995mA

Task 02:

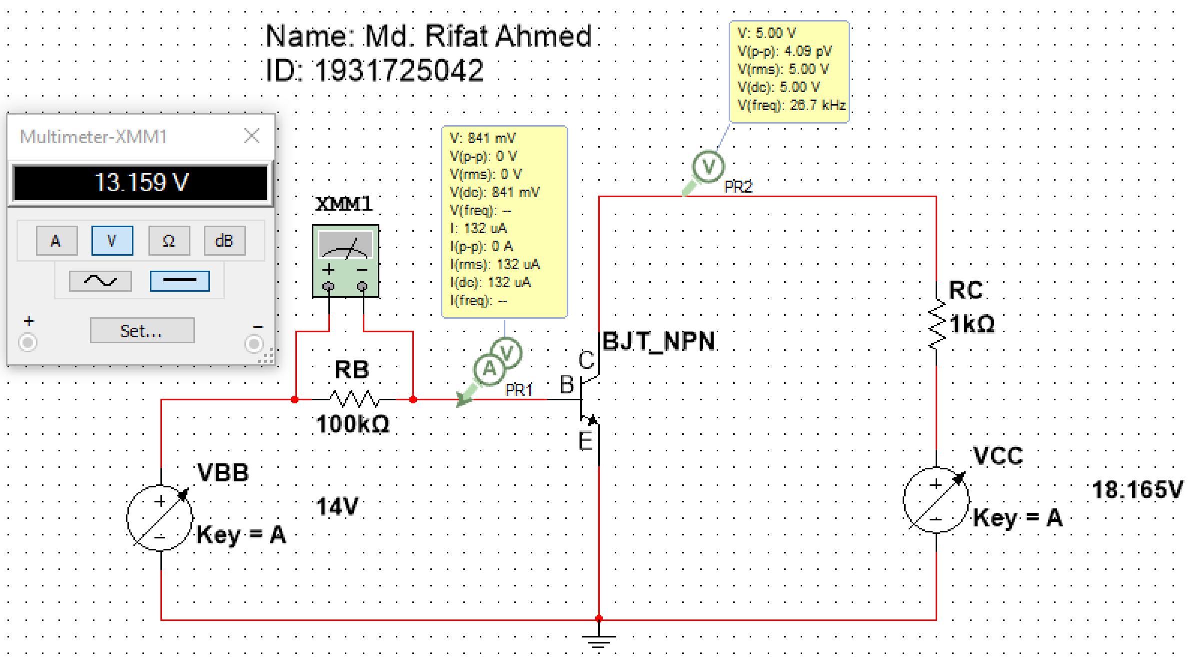

Figure 1 – Circuit to get the values for the Input characteristics of BJT

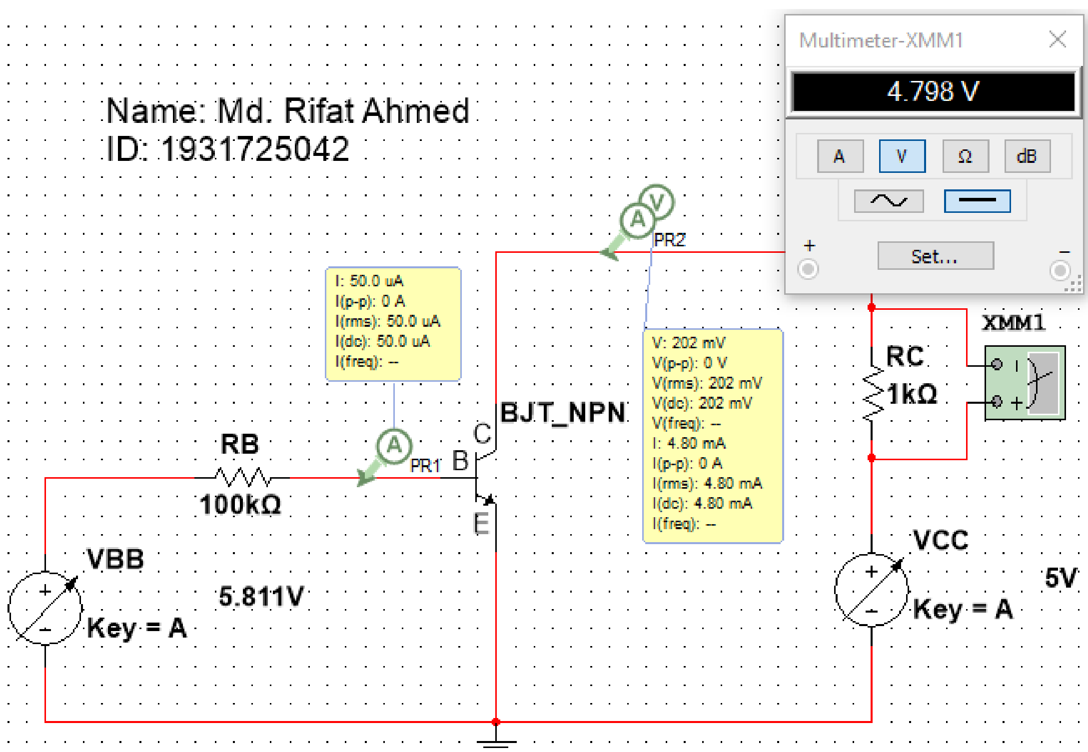

Figure 2 – Circuit to get the values for the Output characteristics of BJT

Task 03:

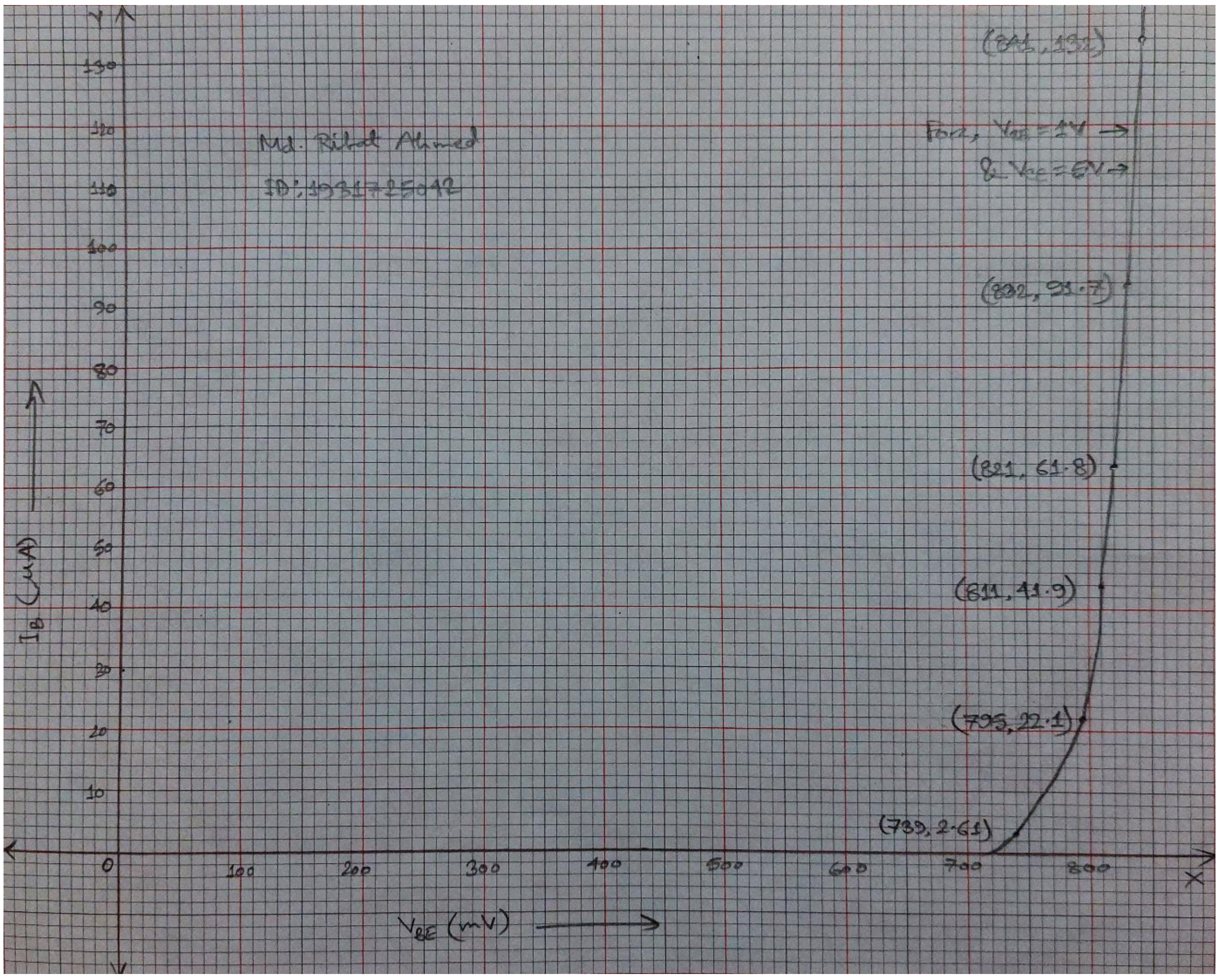

Figure 3 – Input Characteristics Graph of BJT for V_{CE} = 1V & 5V

Here, we got the same values of I_B and V_{BE} for the given points for both V_{CE} = 1V & 5V while simulating so the same line is representating both of them.

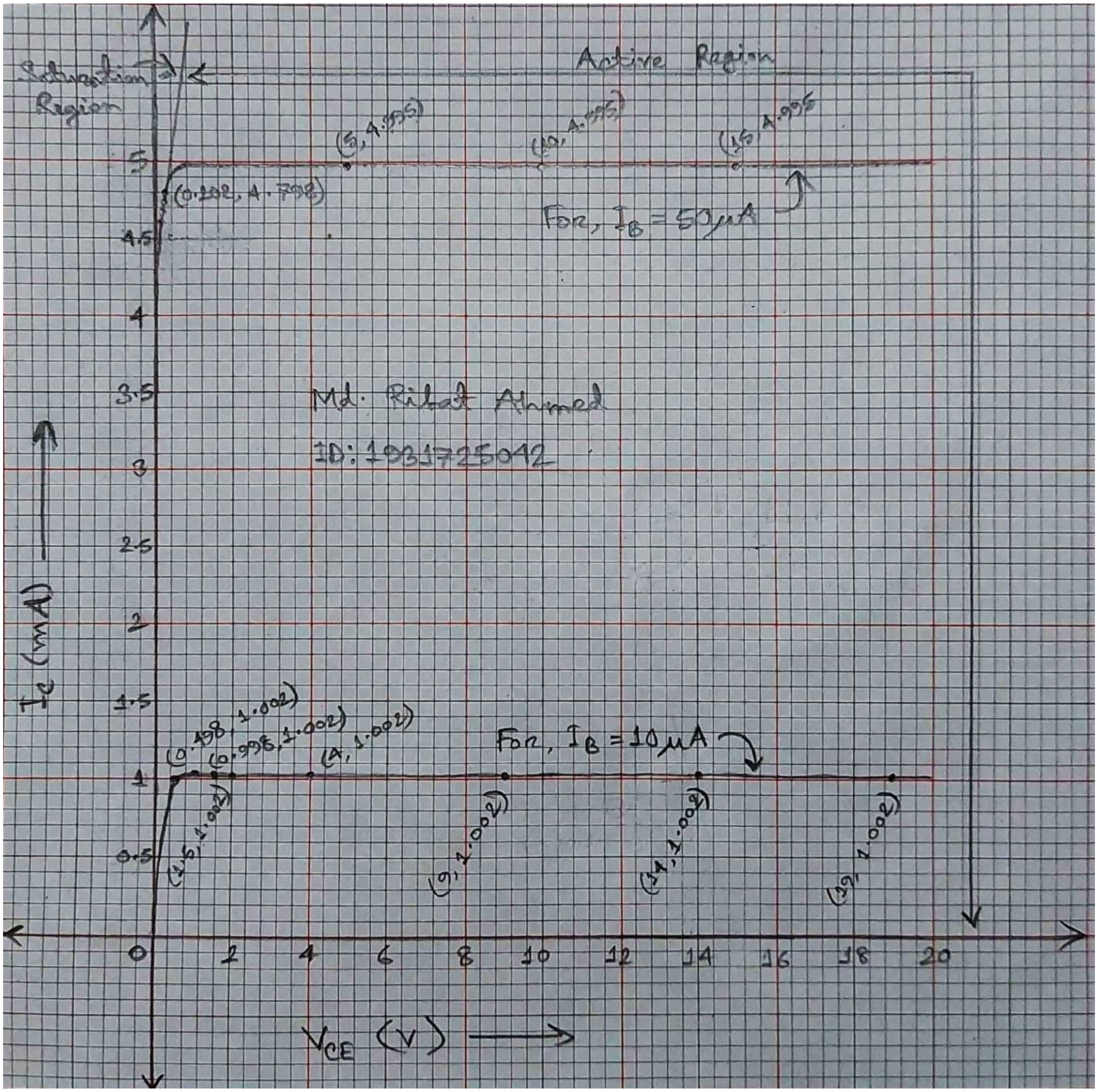

Figure 4 – Output Characteristics Graph of BJT for I_B = 10µA & 50µA

References:

Common Emitter Connection (or CE Configuration) - Input & Output Characteristic Curve - Circuit Globe –
https://circuitglobe.com/common-emitter-connection-or-ce-configuration.html