Transistors Sec.1

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Module	**EE1616 Electronics Workshop**
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Introduction and aims:

To do some simulates based on **Bipolar Junction Triode (BJT).**

To determine the transistor's gain and other features from its collector characteristics.

Through this simulation experiment, try to familiar with the characteristics of transistors.

Task description:

1. Familiar with the theory which we learned before. Understand the typical collector characteristics for a bipolar transistor.
2. Test the characteristic of transistor. $\boldsymbol{I_b}$ and $\boldsymbol{V_{ce}}$ as variable, find the characteristic of the curve. Distinguish between saturation region and amplification region.
3. Connect the DC voltage source to collector directly. Draw the circuit diagram and simulate as required. In addition, comments on your results.

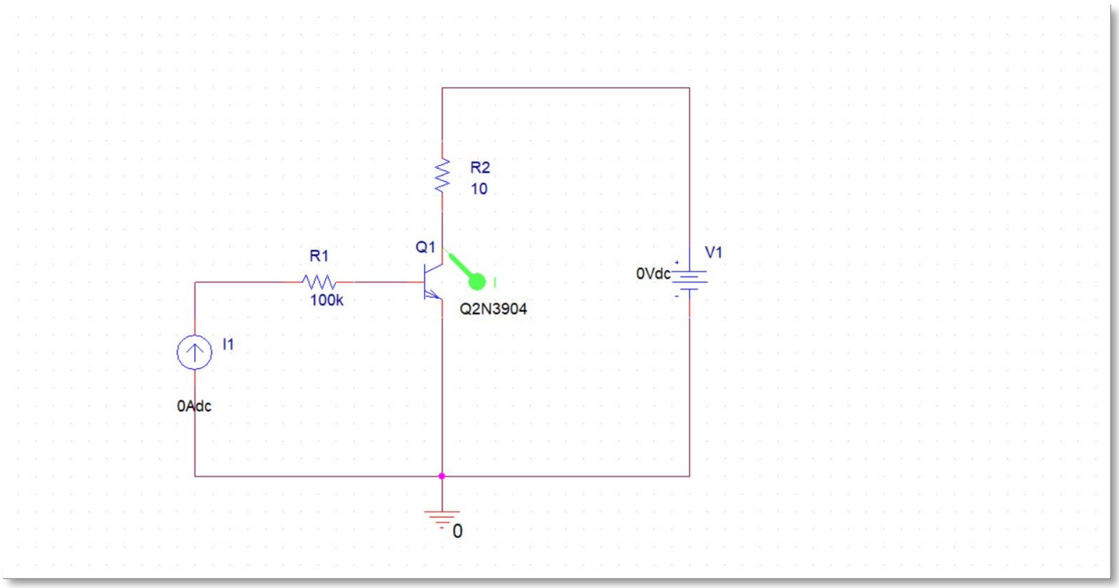
Experiment method:

1. Review the characteristics and the theorem of transistors. Be sure to understand the saturation region and amplification region.
2. Simulate the circuit diagram. Record several groups of data, comments the results. Analysis why is the result like this.

Result and observations:

1. Transistors characteristics testing

1.1

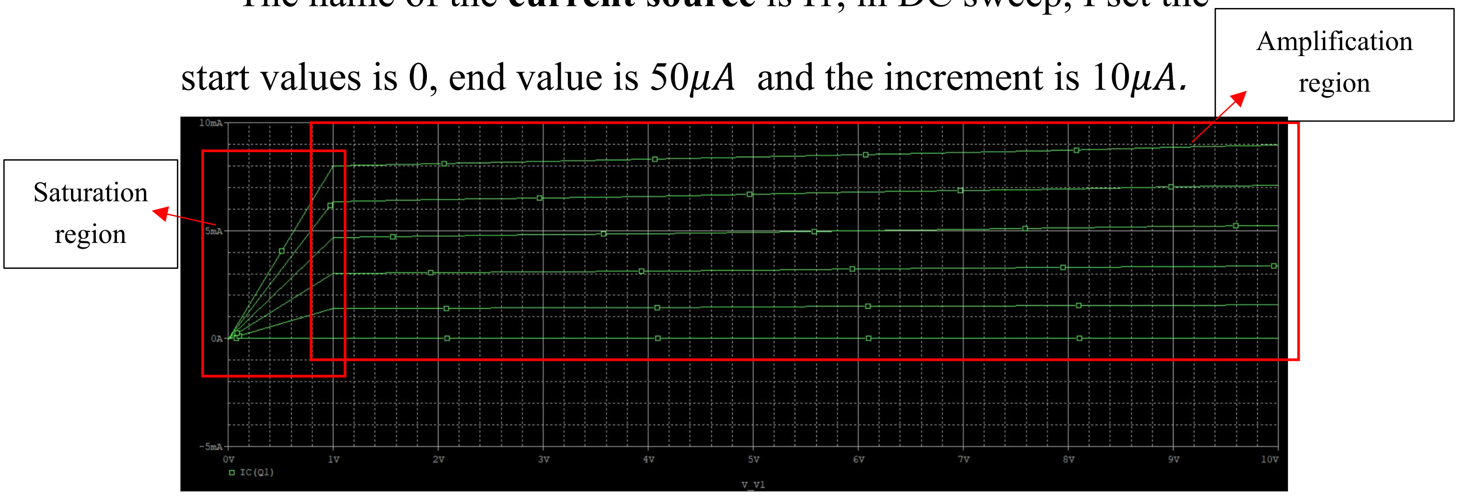


This is the circuit diagram.

1.2

The name of the **voltage source** is V1, in DC sweep, I set the start value is 0, end value is 10 and the increment is 2.

The name of the **current source** is I1, in DC sweep, I set the start values is 0, end value is $50\mu A$ and the increment is $10\mu A$.

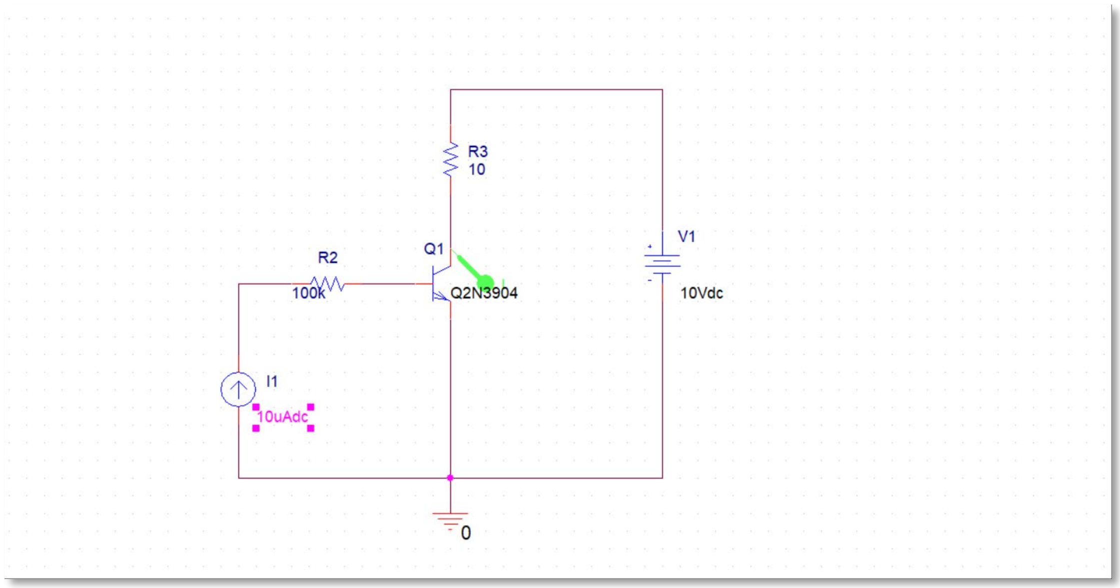


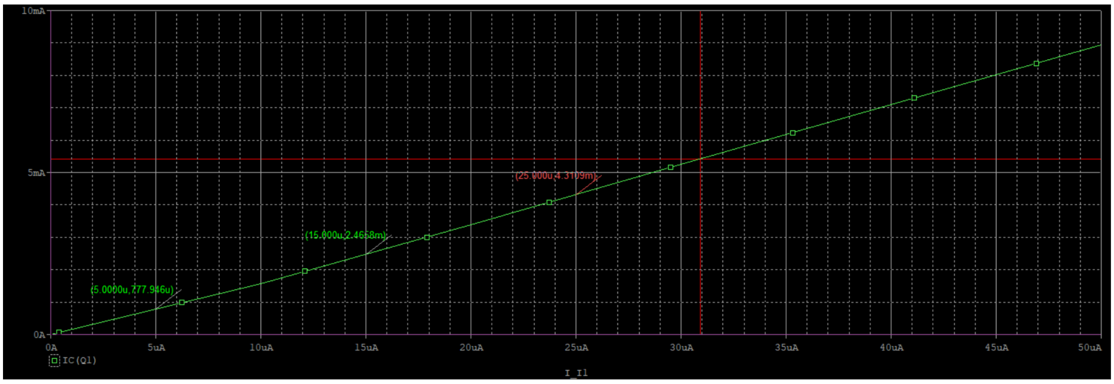
This is the simulate result. The simulation results are consistent with the theory

1.3

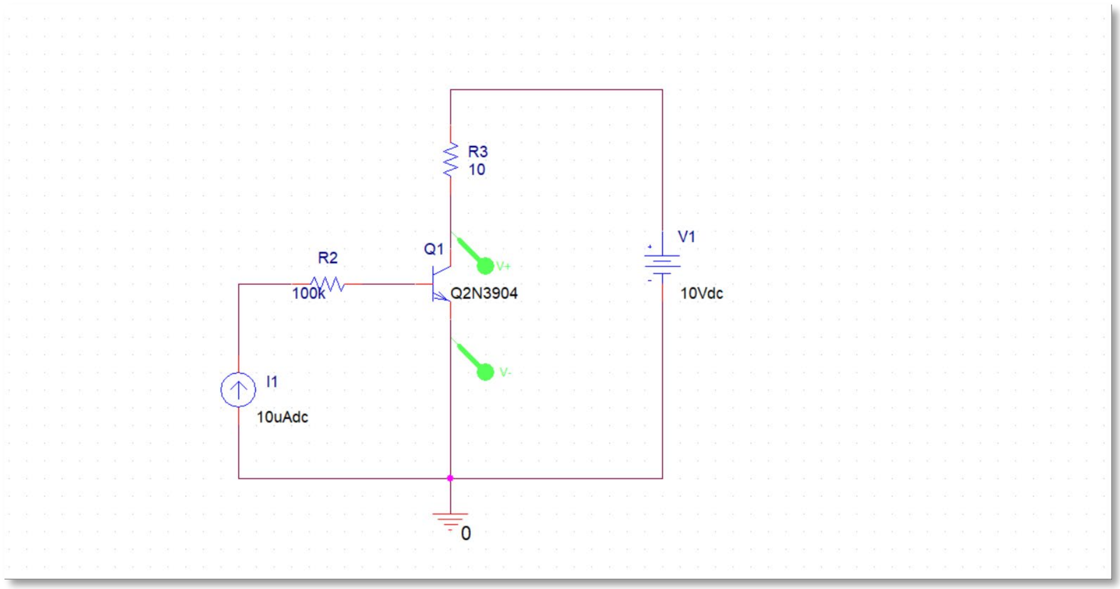
In this part, the power supply is a constant: **10V**. And I need test 3 variables: $\boldsymbol{I_b}, \boldsymbol{I_c}$ ***and*** $\boldsymbol{V_{ce}}$.

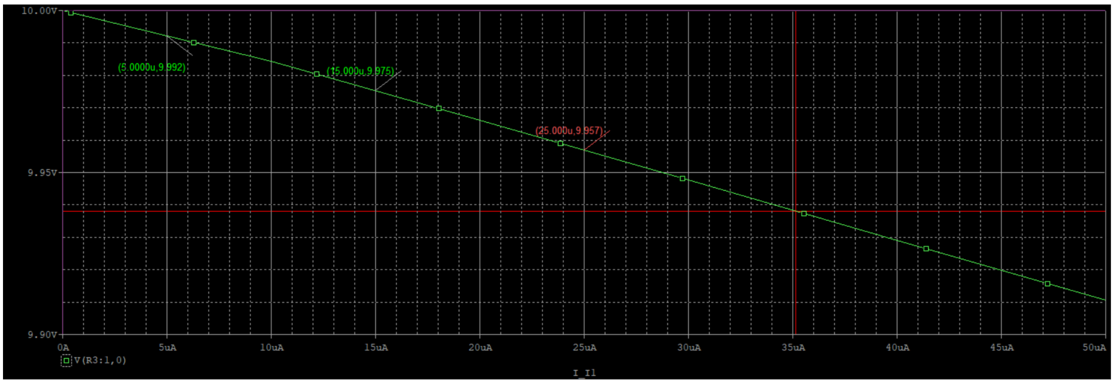
Measure current $\boldsymbol{I_c}$ against $\boldsymbol{I_b}$.





Measure voltage V_{ce} against I_b.





Finally, I get 3 groups of data.

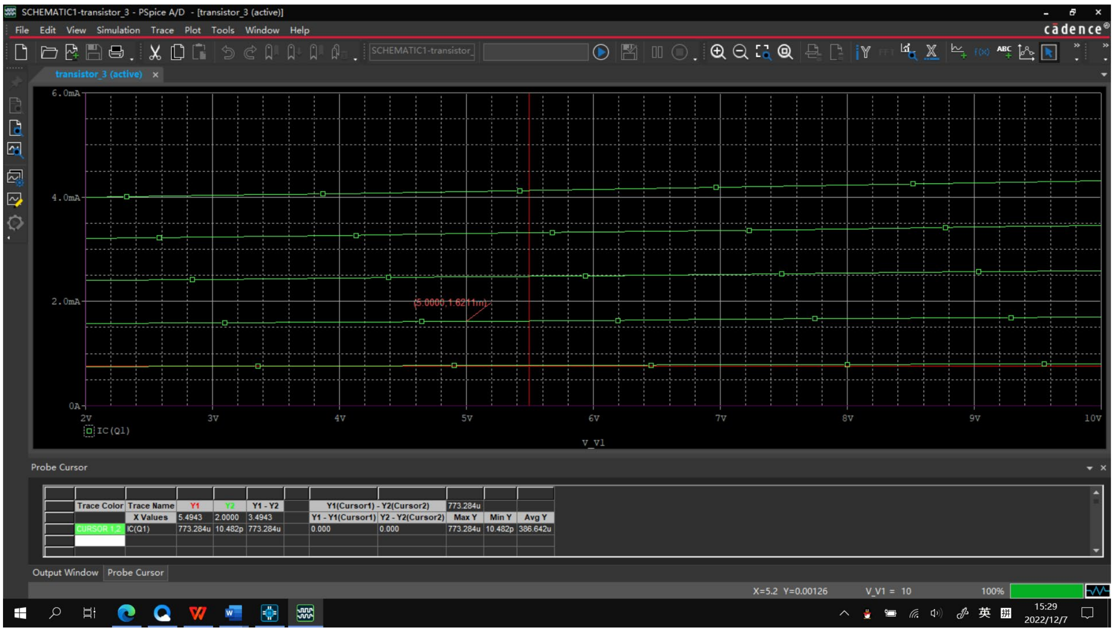
I_b	I_c	V_{ce}
5uA	0.7779mA	9.92V
15uA	2.4658mA	9.975V
25uA	4.3109mA	9.957V

2.Comments on your results

2.1 Obtain experimental answers to Example questions 1 to 3 for your transistor (i.e. determine the collector current, the change in

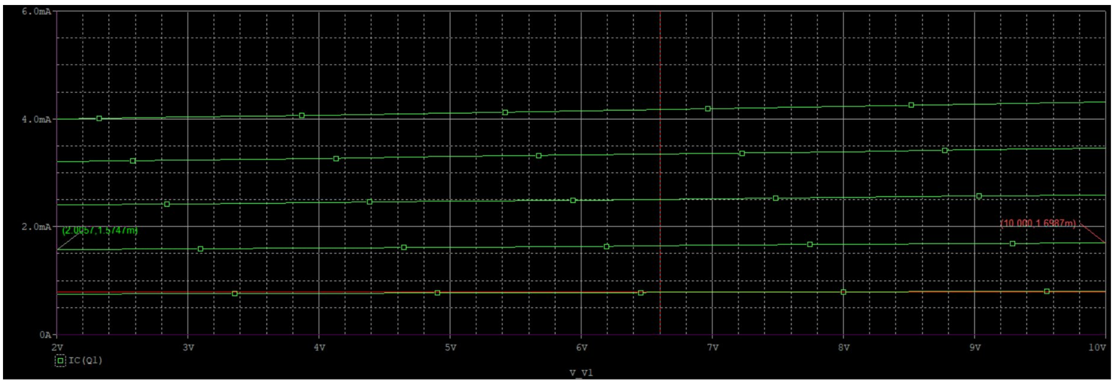
I_C when V_{ce} is changed from 2 volts to 10 volts and the current gain of the transistor).

(1)What is the collector current *Ic* when the collector-emitter voltage *Vce* is 5 volts and the base current *Ib* is 20 μA?



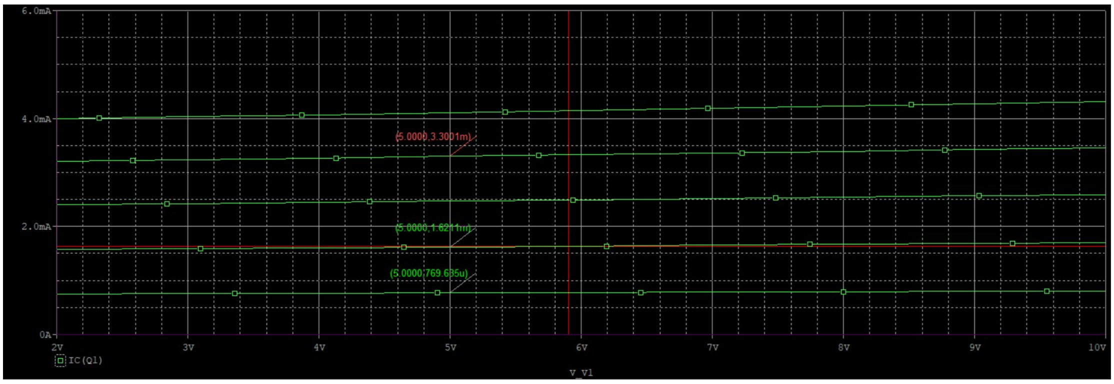
I_c is 1.6211mA.

(2) At *Ib* = 20 μA, how much does *Ic* change when *Vce* is changed from 2 to 10 volts?



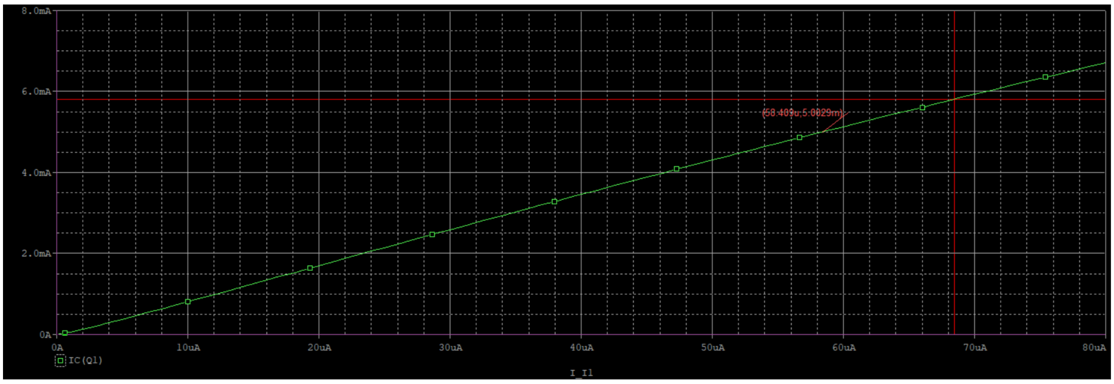
ΔI_c=1.6987-1.5747=0.124mA

(3) What are the current gains (*Ic Ib*=β) at *Vce* = 5 volts, when *Ib* is 10, 20 and 40 μA?



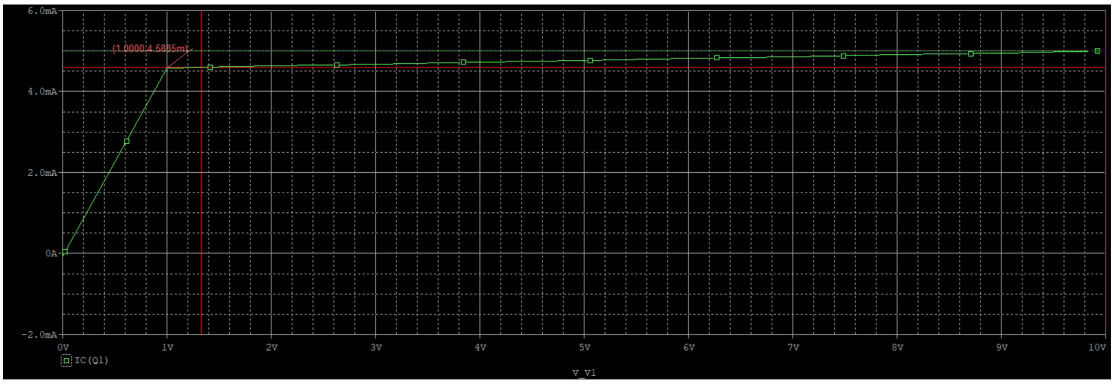
I_b is 10uA, I_c is 769.635uA β =76.97
I_b is 20uA I_c is 1.6211mA $\beta = 77.19$
I_b is 40uA I_c is 3.3001mA $\beta = 82.50$

2.2 Now set *Vce* to 10 volts and make *Ic* = 5 mA by varying *Ib*.



$I_b = 58.4\mu A$.

2.3

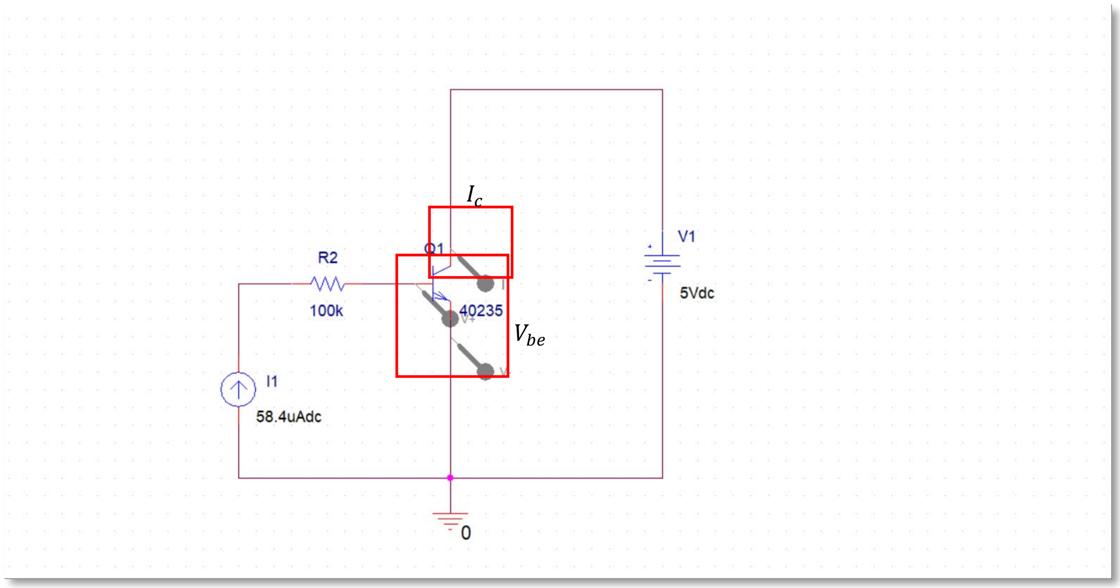


I_c decreased from 4.5885mA to 0.

2.4

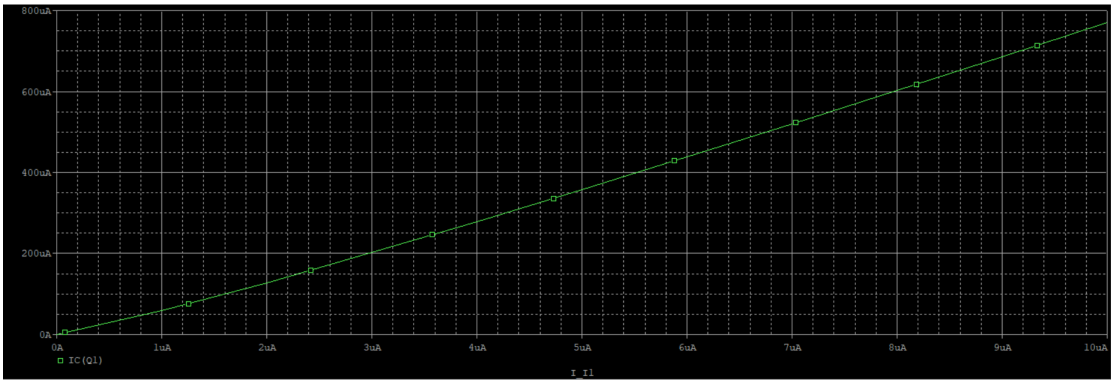
If the value of V_{ce} below 1V, the fall of I_c becomes rapid

2.5

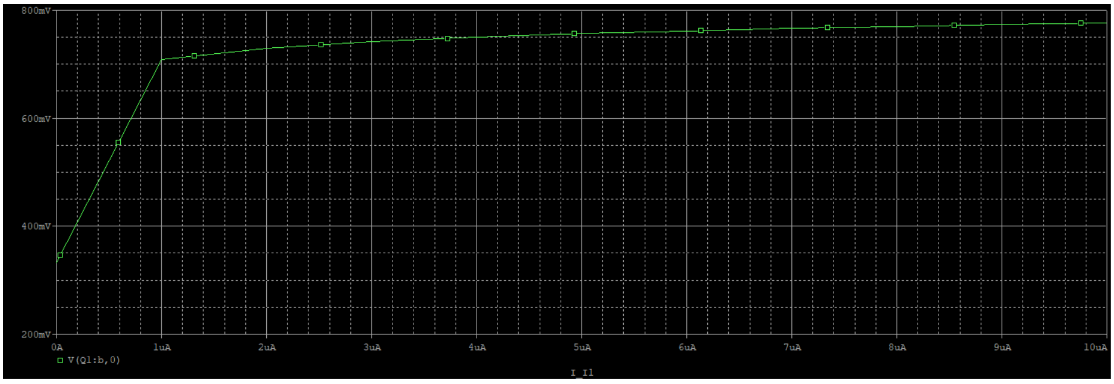


2.6

I_c against I_b:

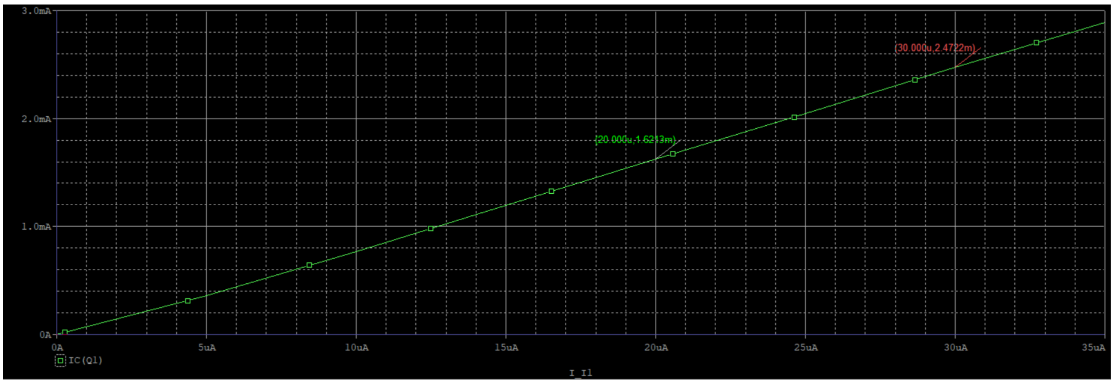


I_b against V_{be}:



2.7

On the premise that the power supply is 5V.



When I_b is $20\mu A$, $I_c = 1.6213mA$

When I_b is $30\mu A$, $I_c = 2.4722mA$

At $I_b = 25\mu A$

$$\frac{\Delta I_C}{\Delta I_b} = \frac{(2.4722 - 1.6213) \times 10^3}{30 - 20} = 85.09 = \beta$$

Conclusion:

In this experiment, I test the characteristic curve of transistor. In the simulation result, I find the saturation region and the amplification region. In addition, I changed some values and simulate the circuit again. This let me know the relationship between I_c, I_b, V_c, V_b.