Brunel University London | 重慶郵電大學 CHONGQING UNIVERSITY OF POSTS AND TELECOMMUNICATIONS

Transistors Sec.2

Team	Autumn, 2022
Module	**EE1616 Electronics Workshop**
Class	34092102
Brunel ID	2161047
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Introduction and aims:

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

Do some experiments. Find the characteristics of BJT. Understand the two operations of the transistors: **switch and amplifier**.

Task description:

1. Familiar with the theory which we learned before. Understand the typical collector characteristics for a bipolar transistor.
2. Draw and simulate the circuit. Observe the characteristic at the CUT-OFF region and SATURATION region.
3. Simulate the circuit under the condition of sinusoidal signal (vsin). Set and adjust the value of **VOFF** and **VAMPL**, observe and describe the phenomenon.

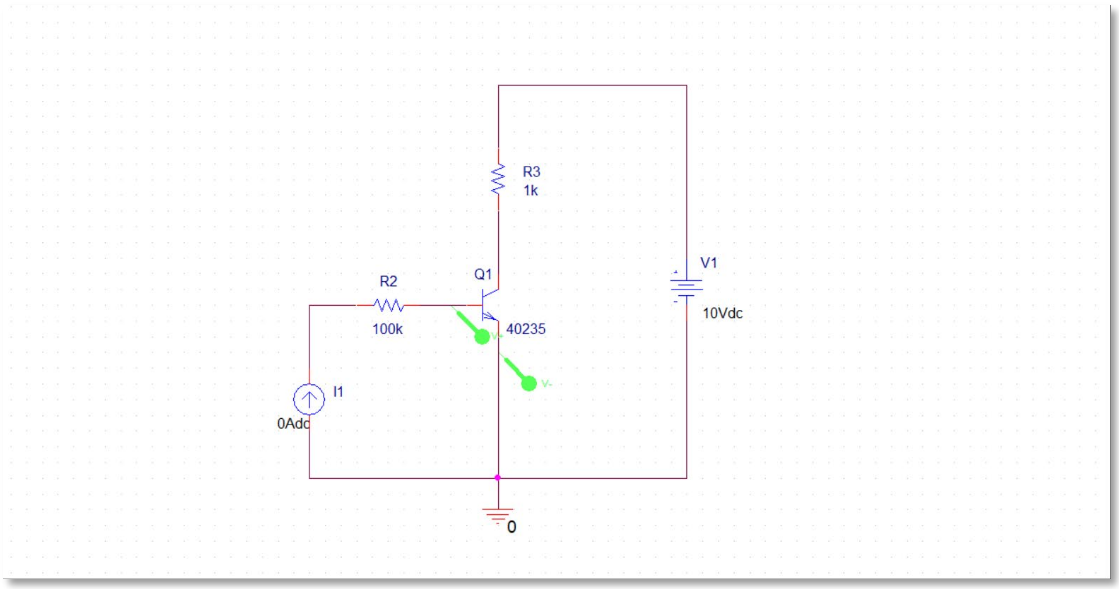
Experiment method:

1. Review the characteristics and the theorem of transistors. Be sure to understand the saturation region and amplification region.
2. Simulate the circuit. Record the result.
3. Replace DC current source with AC voltage source. Adjust the parameter to satisfy the requirement.

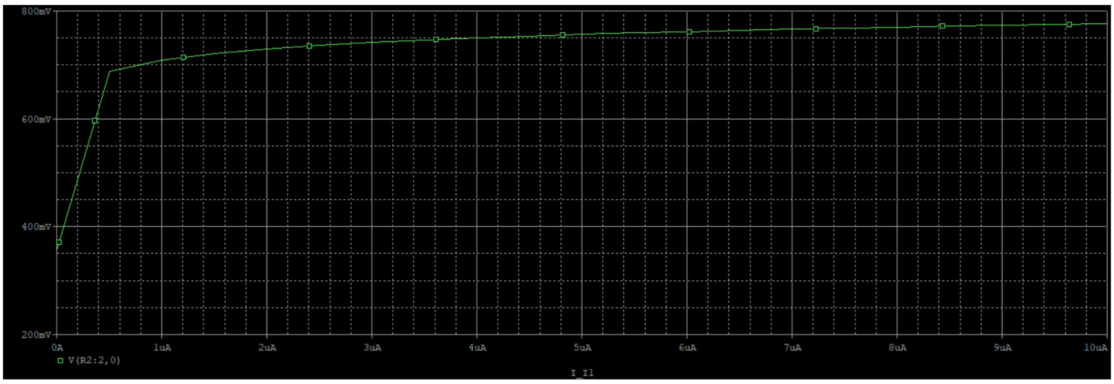
Result and observation:

1. Operation as a switch

1.1.

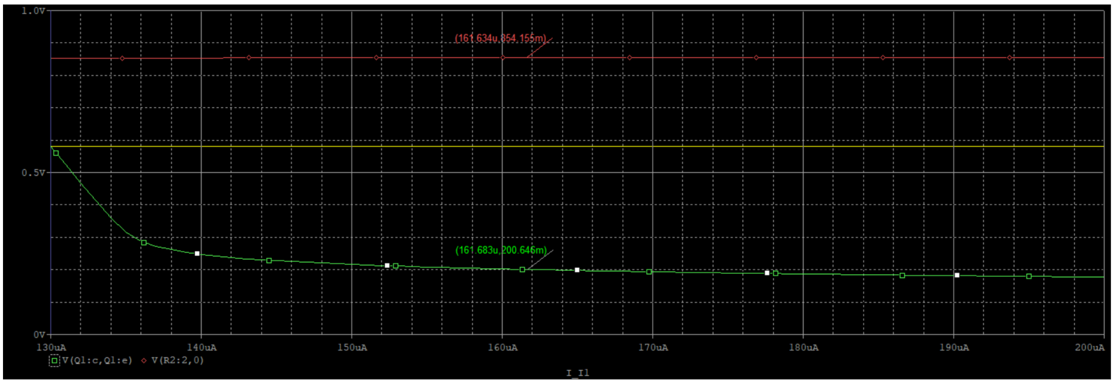


This is the circuit diagram.



This is the relationship of I_b and V_{be}. The X-axis is **base current,** and the Y-axis is the **voltage**. If $I_b \leq 0$, then we say the transistor is CUT-OFF. In this condition, there is no current flow through collector. Thus, when cut-off, we considered transistor can be used as **OFF switch**.

1.2.



At this point, $I_b = 161.683\mu A, V_{ce} = 0.2V$.

I can find that any further increase in I_b does not appreciably alter V_{ce}. Thus, I_c also remains essentially unchanged. The transistor is said to be SATURATED.

1.3.

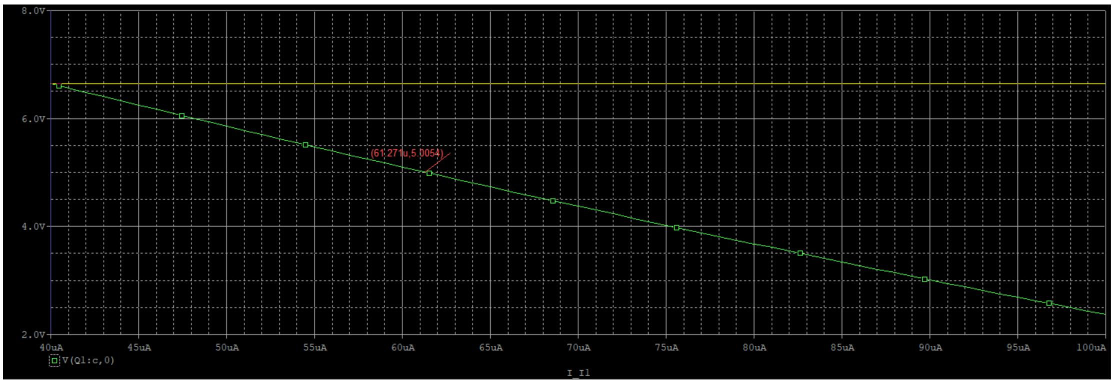
If the transistor is in **CUT-OFF state**, switch is off, current is not existed in collector and V_{ce} is very large.

If the transistor is in **SATURATION state**, switch is on, current can flow through the collector. V_{ce} will not change significantly. In addition, V_{ce} is nearly to 0.

Thus, the requirement for cut-off and saturation **is agree with** my observed characteristics.

2. Operation as an Amplifier

2.1.

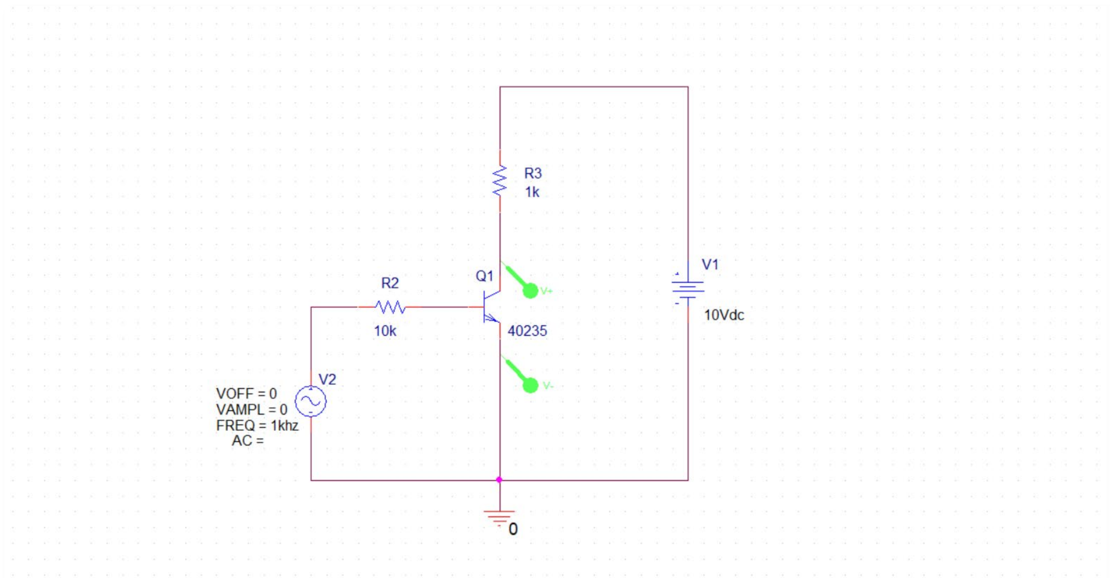


This is the relationship between V_{ce} and I_b. The X-axis is I_b and Y-axis is V_{ce}.

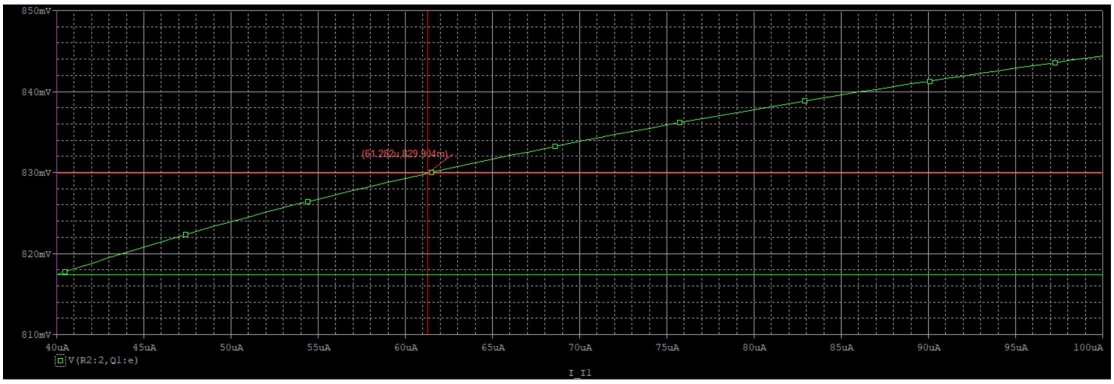
When $V_{ce} = 5V, I_b = 61.271\mu A$.

2.2.

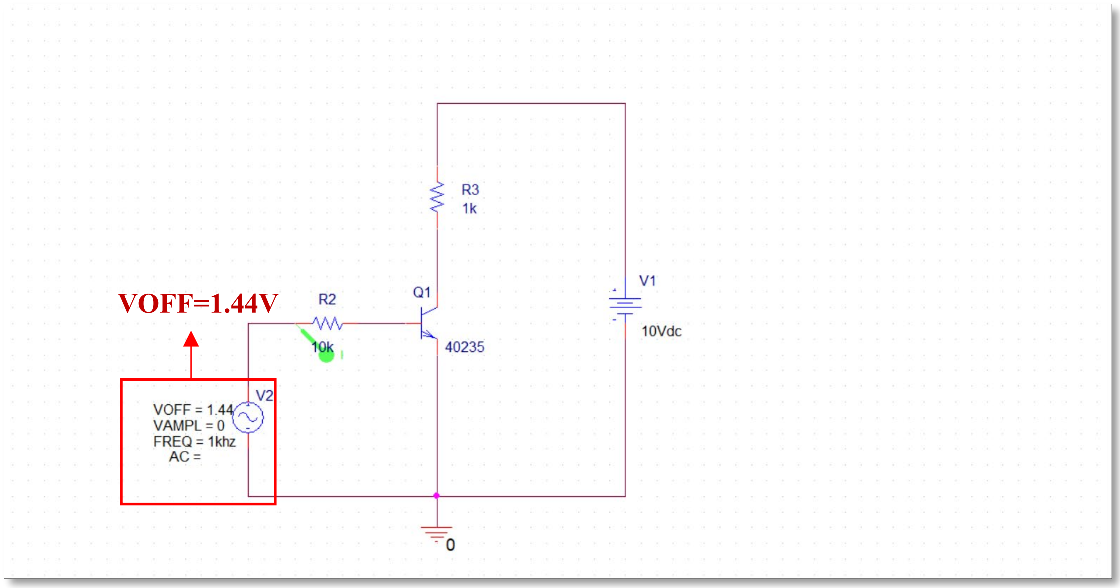
Replace sinusoidal signal with DC current source.

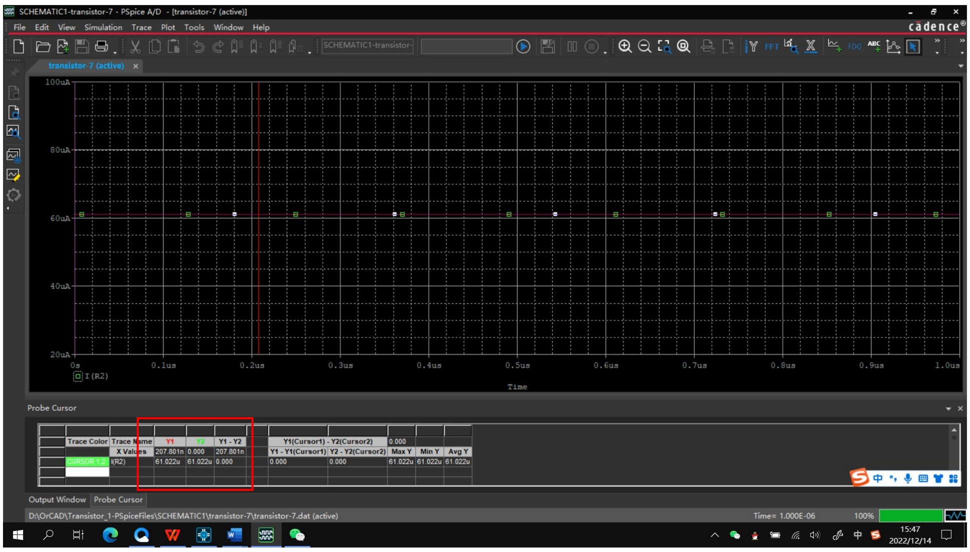


2.3.



This is the relationship between V_{be} and I_b. If I_b is nearly to $61\mu A, V_{be} = 829.904mV$.

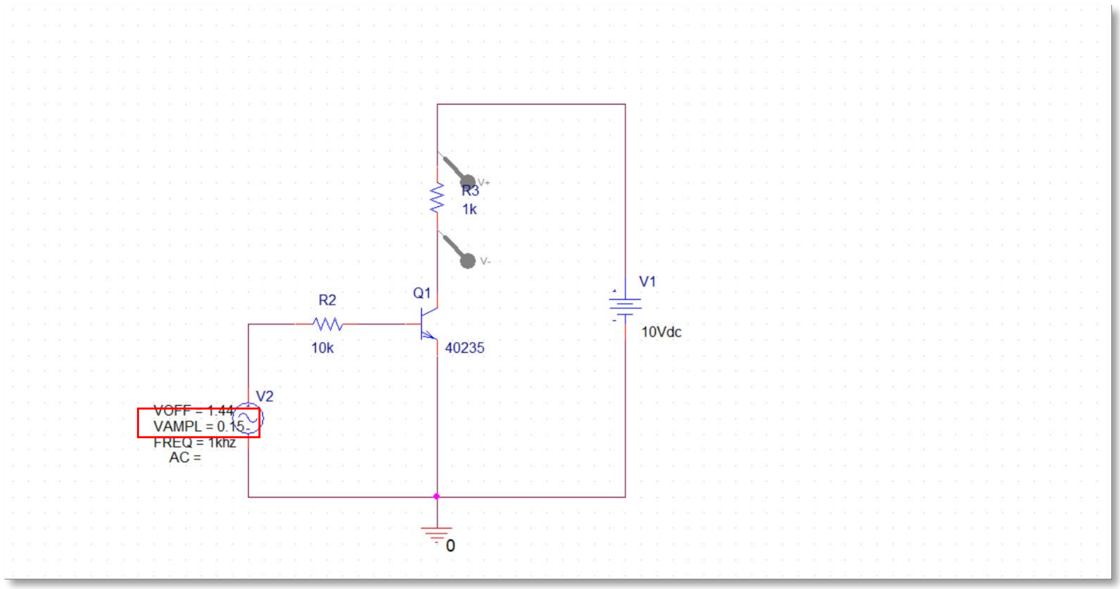


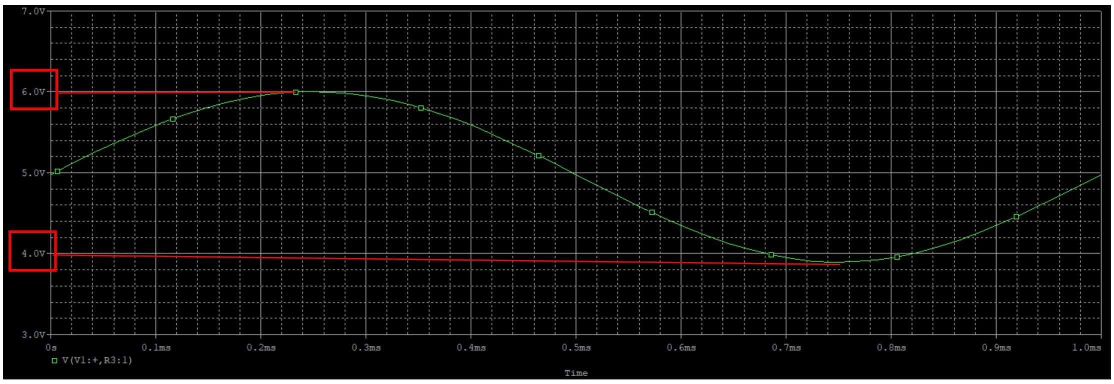


$$I_b = \frac{V_s - V_{be}}{R_2} \tag{1}$$

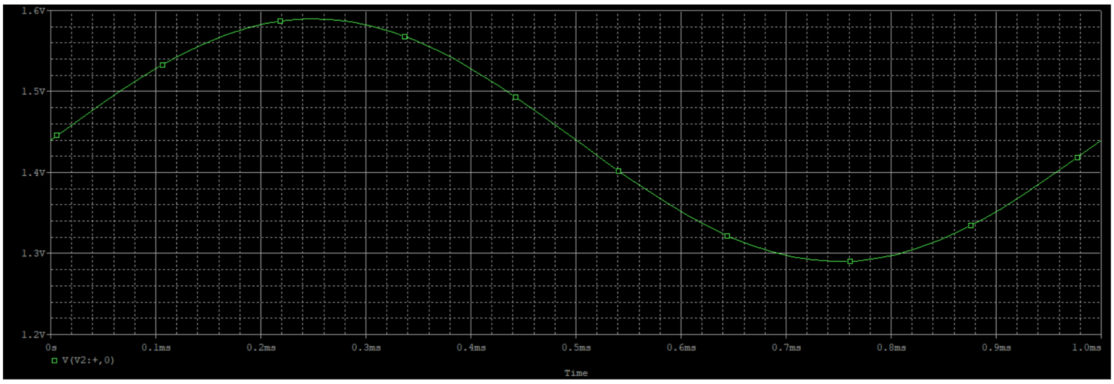
VOFF means bias voltage, in the formula (1), it can be considered as V_s . $I_b = 61\mu A, V_{be} = 0.83mV \ and \ R_2 = 10k\Omega$. Thus, $V_s = 1.44V$.

2.4.

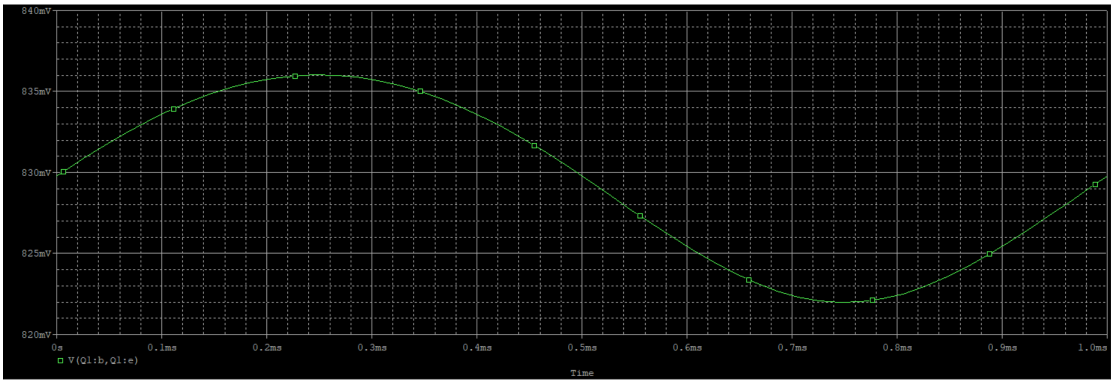




I set the value of **VAMPL** is 0.15V. In the simulation, I can verify the value is correct.

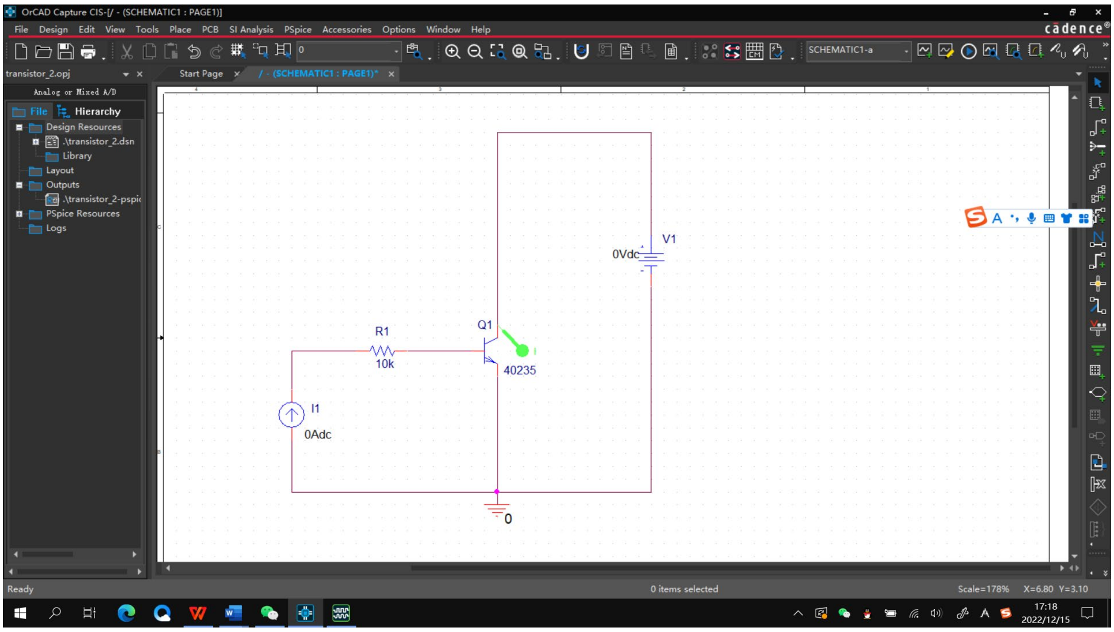


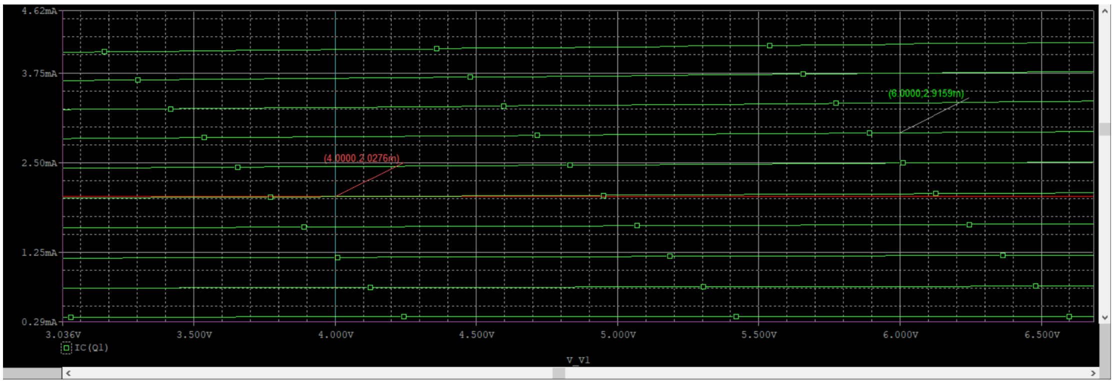
The vsin voltage (V_s)



The base voltage (V_{be})

2.5.

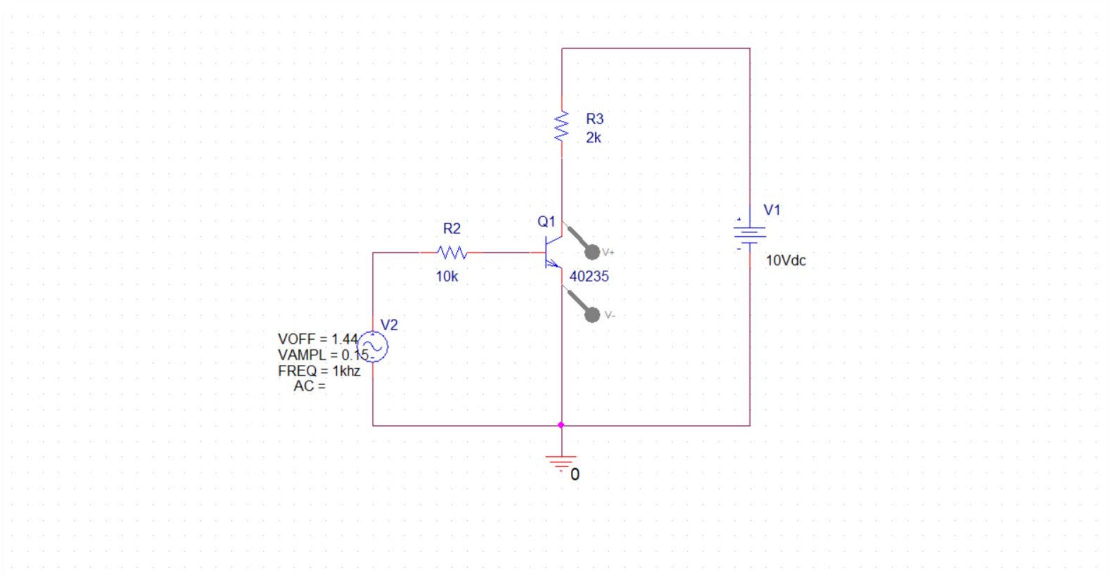




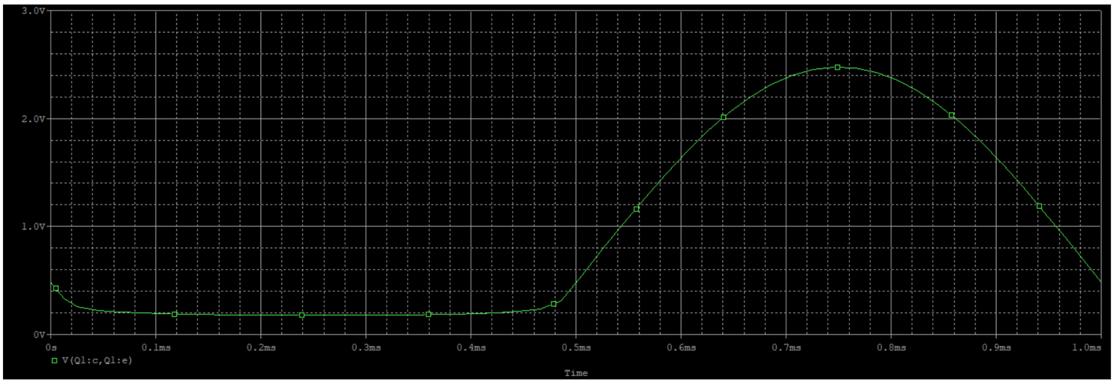
When $V_{ce} = 4V, I_c = 2mA, I_b = 25\mu A$.

When $V_{ce} = 6V, I_c = 3mA, I_b = 35\mu A$.

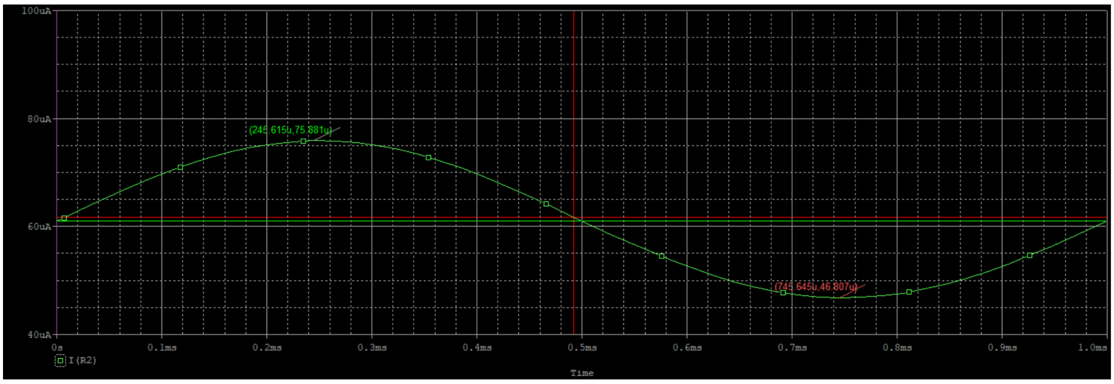
After calculating, I_b changed by $10\mu A$.



Now, I simulate it.



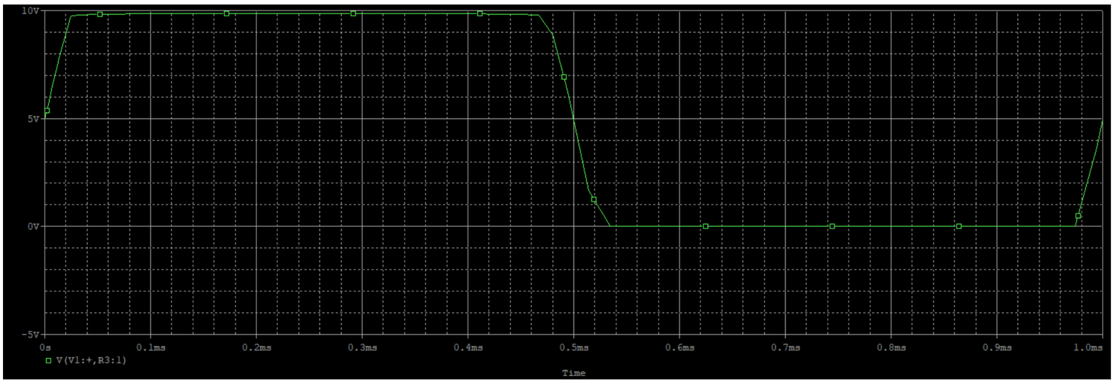
This is the relationship between V_{ce} and time.



This is the relationship between I_b and time.

However, V_{ce} can not reach to 4V, there are some deviations between practice and theory. Due to the change of the value of resistance R_3, the load is increase, and the corresponding voltage on R_3 is increase. Thus, V_{ce} can not reach to the original value. However, the base current can not be influence, so I_b can changed by $10\mu A$.

2.6.



I set the value of **VAMPL** to 5V, so that the waveform is distorted. Because if the signal voltage is too large, transistor will saturation.

Thus, the transistor cannot amplify the signal completely, and the waveform will be distorted.

Conclusion:

This is the last lab. In this experiment, I simulate the circuit of the transistor 40235. I understand the two functions of transistors. As the switch and amplifier. Transistor has three states: cut-off, amplify, and saturation. In the cut-off and saturation region, the transistor can be used as a switch. In the amplify region, the transistor can be used as an amplifier to amplify signal.

Finally, I learned a lot in EE1616. In the several OrCAD labs, I primary understand how to use it and can use it to simulate some circuits. In addition, I further understand the theory which I learned in EE1618. **Combining theory with practice is very helpful to my study!!!**