VE311 Lab 2

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1. Common-Emitter Amplifier

(a) In this part, we first build the circuit below (Figure 1) in Proteus. Our group chose $R_c = 100\ \mathrm{k\Omega}$.

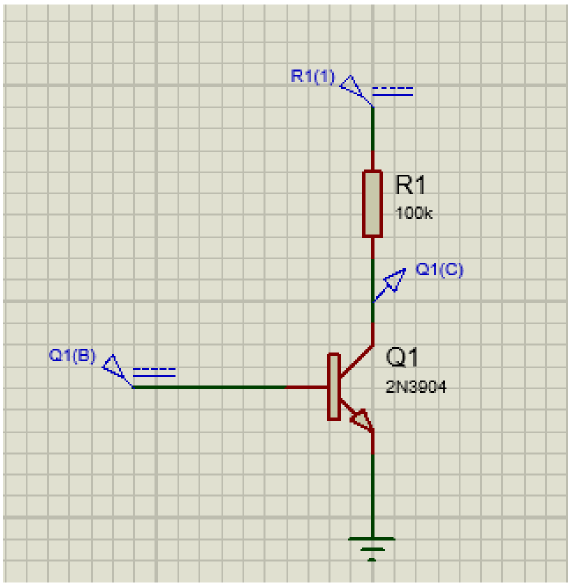

Figure 1. Proteus circuit

Then, we use DC sweep in Proteus to get V_{OUT} vs V_{IN} (Figure 2).

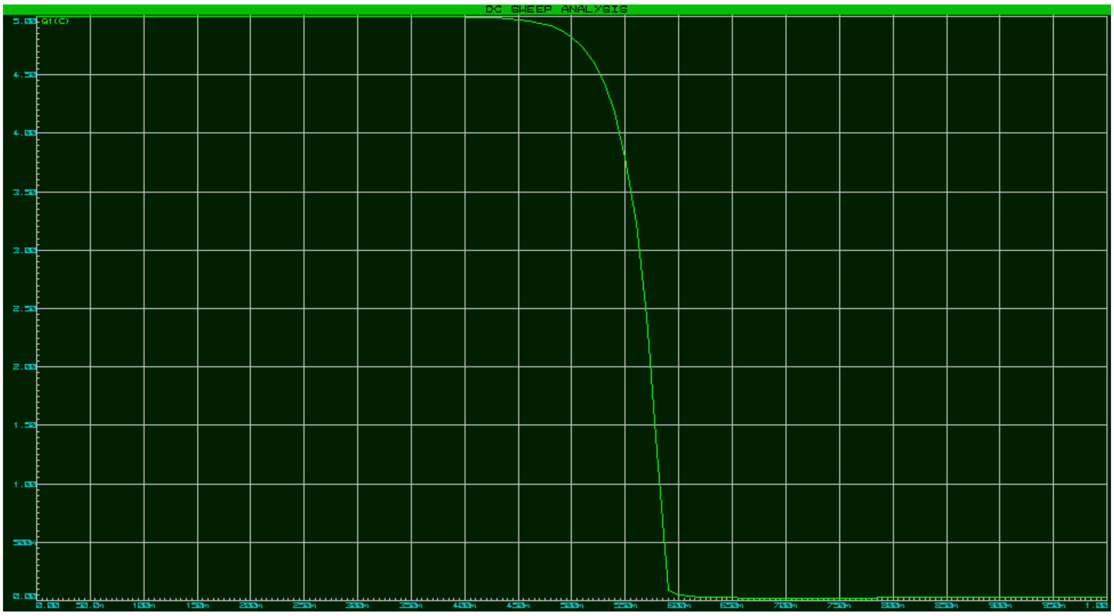

Figure 2. DC sweep

From the figure, we can get (0.549, 3.831), (0.551, 3.737), we can get

$$|\mathrm{slope}_{0.55}| = \left|\frac{3.737 - 3.831}{0.551 - 0.549}\right| = 47 > 10$$

In the lab, we get the following points (Table 1).

V_{IN} (V)	V_{OUT} (V)
0.2	5
0.3	4.99
0.35	4.64
0.36	4.22
0.37	3.298
0.38	2.156
0.39	1.368
0.4	0.89

Table 1. Measurement result

And we can get the following plot (Figure 3).

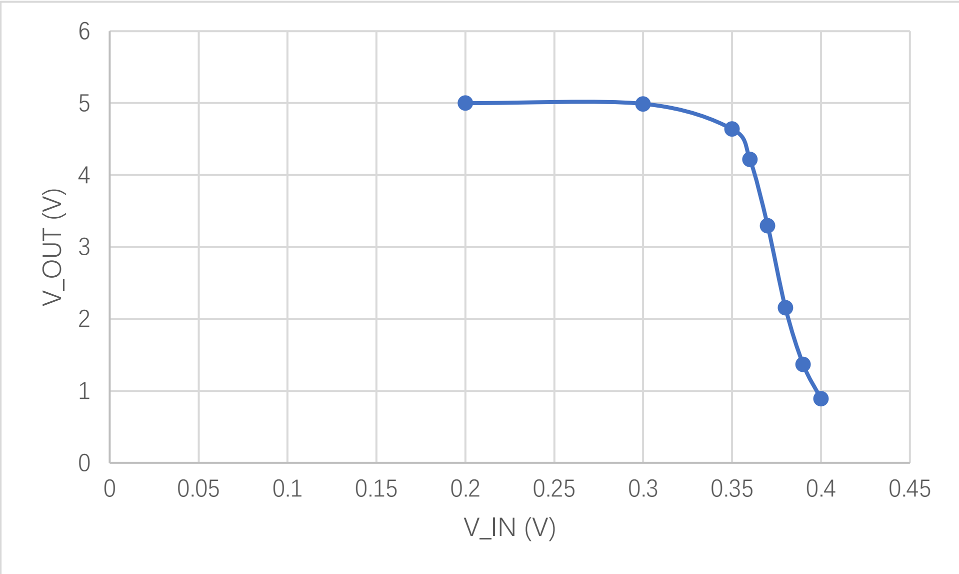

Figure 3. V_{OUT} vs V_{IN} for measurement result

We can calculate the absolute value of slope at 0.375 as

$$|\mathrm{slope}_{0.375}| = \left|\frac{2.156 - 3.298}{0.8 - 0.7}\right| = 114.2 > 10$$

However, the measurement result differs a lot from the theoretical DC sweep. The reasons for the difference may be that the BJT we used in lab is not exactly the same as the one we use in Proteus. Also, the components we used in lab are not the ideal ones. Besides, the readings on the voltage meter sometime changes rapidly and cannot get stable.

(b) In this case, we use $V_{in} = 0.55 + 0.01\sin(2\pi 10^2 \cdot \text{time})$. In Proteus, we can get the following figure (Figure 4).

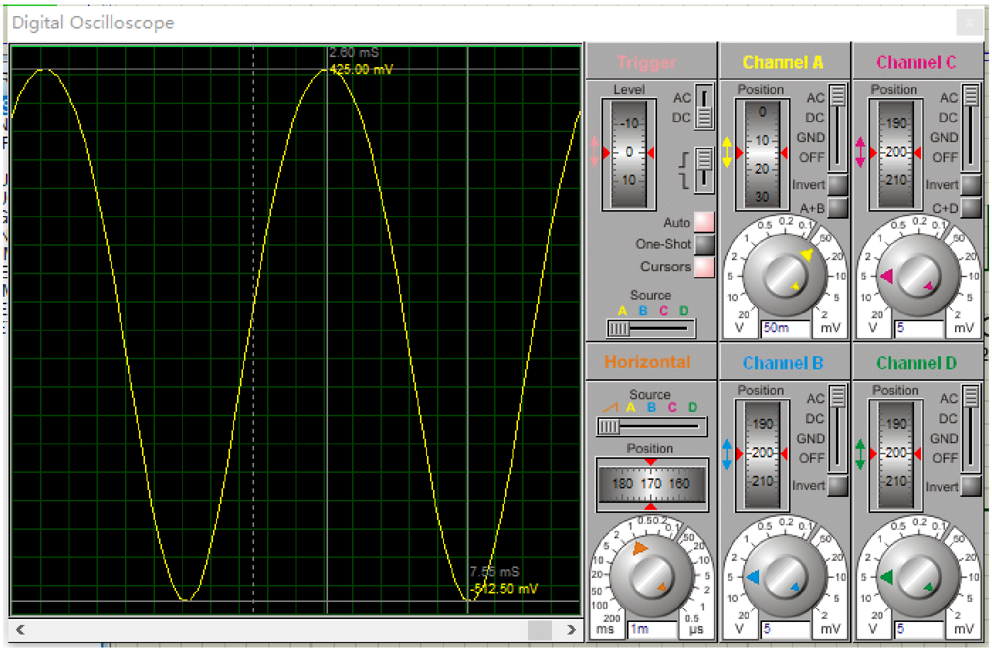

Figure 4. Simulation for 100Hz

From the cursor, we can get

$$v_{out} = \frac{425 + 512.5}{2} = 468.75\ \text{mV} = 0.46875\ \text{V}$$

Also, from **(a)**, we can get

$$0.01 \times A_v = 0.01 \times 47 = 0.47\ \text{V}$$

They are very close, so we can confirm that the amplitude of v_{out} is equal to $0.01 \times A_v$.

In the lab, we get the following figure (Figure 5).

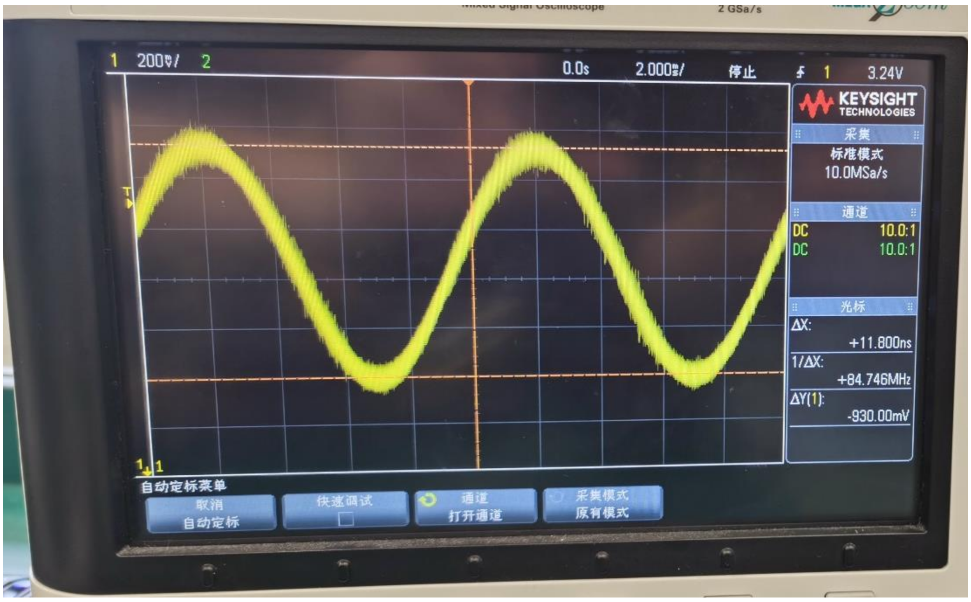

Figure 5. Measurement result for 100 Hz

We can get that $v_{out} = 0.465$ V. And we can calculate $0.01 \times A_v = 0.01 \times 114.2 = 1.142$ V. They are not close to each other, but the components we used in lab are not ideal and the reading of voltage meter changes rapidly, we should mainly rely on the simulation result and conclude that the amplitude of v_{out} equals to $0.01 \times A_v$.

(c) In this case, Proteus stops working at the frequency of 10MHz, so we change it to 1MHz, and use the following input $V_{in} = 0.55 + 0.01\sin(2\pi 10^6 \cdot \text{time})$. The simulation is shown below (Figure 6).

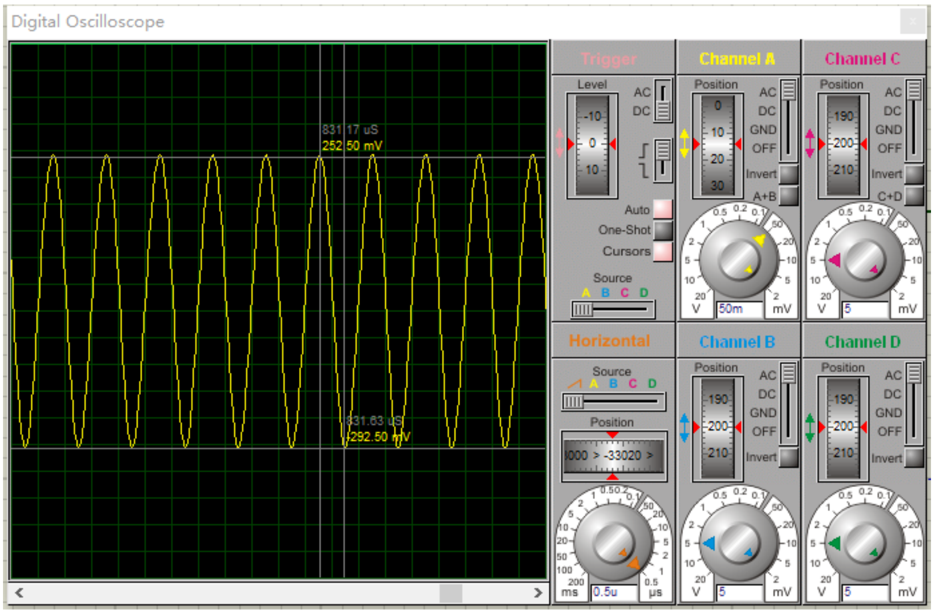

Figure 6. Simulation for 1MHz

From the cursor, we can get

$$v_{out} = \frac{252.5 + 292.5}{2} = 272.5 \text{ mV} = 0.2725 \text{ V}$$

However, $0.01 \times A_v = 0.01 \times 47 = 0.47$ V. They differ from each other a lot. In lab, we still use 10MHz and get the following result (Figure 7).

Figure 7. Measurement for 10MHz

We can get that $v_{out} = 0.4075$ V, which is significantly smaller than $0.01 \times A_v = 0.01 \times 114.2 = 1.142$ V.

Therefore, we can conclude that the amplitude of v_{out} does not equal to $0.01 \times A_v$ in high frequency. The reasons may be that there is internal capacitance is the BJT due to the PN junction of the diode. When the frequency is low, the capacitance will not affect the circuit greatly. However, when the frequency is high, $\frac{1}{j\omega C}$ becomes small and affects the circuit greatly.