UM-SJTU Joint Institute

ELECTRONIC CIRCUIT LABORATORY

(ECE3110J)

Laboratory Report

Lab 2

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Date: 20 June 2024

Contents

1 Objectives

Have better understanding towards BJT circuits.

2 Experimental Results

2.1 The Early Effect Voltage

The circuit to measure the early effect voltage is as follows:

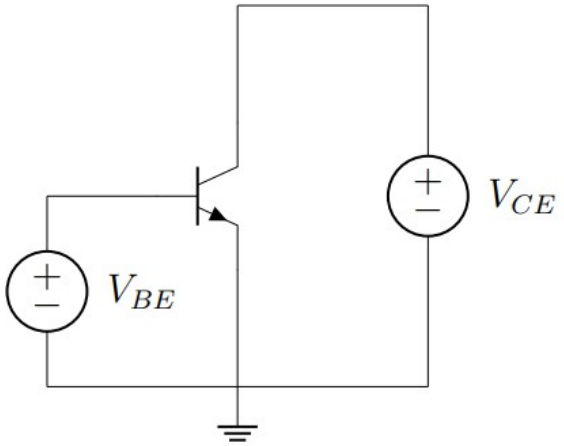

Figure 1: The Early Effect Voltage Measurement Circuit

In the experiment, our results is shown below:

$V_{BE} \setminus V_{CE}$	1.2V	2.0V	2.7V	3.4V	4.1V	5.0V
0.7V	4.77mA	5.05mA	5.43mA	5.87mA	6.59mA	7.80mA

According to the equation that $i_C = \frac{I_s V_{BE}}{V_T}(1 + \frac{V_{CE}}{V_A})$, $k = \frac{I_s V_{BE}}{V_T V_A}$.
We can calculate the early effect voltage: $V_A = 4.50V$.

2.2 The Common-Emitter Amplifier

2.2.1

The simulation circuit to test the voltage gain and perform DC sweep is as follows:

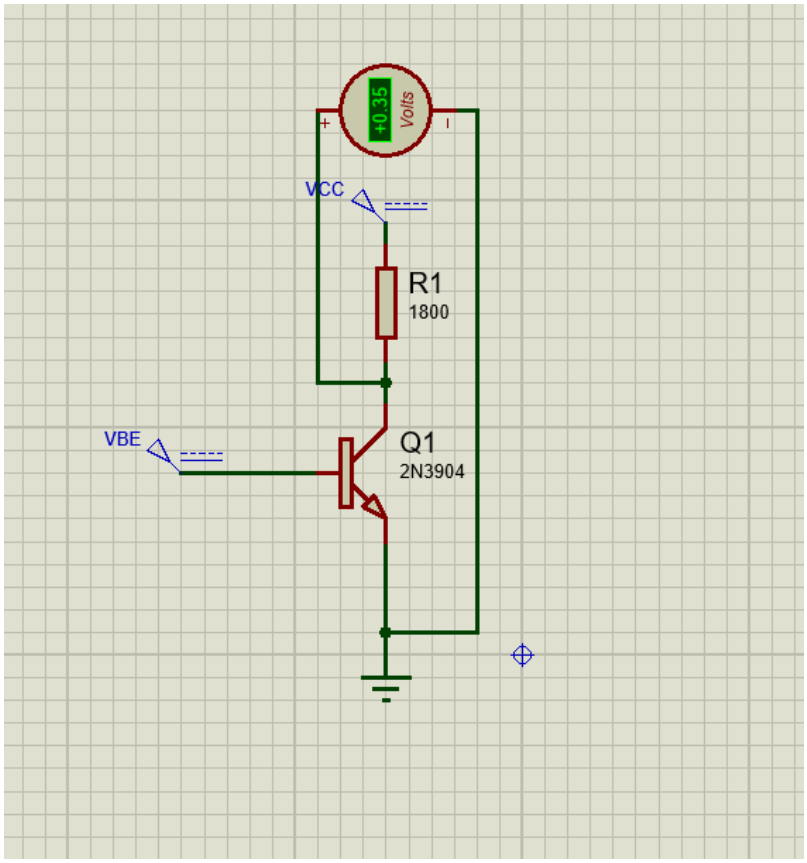

Figure 2: DC Sweep Circuit

The simulation result is shown below:

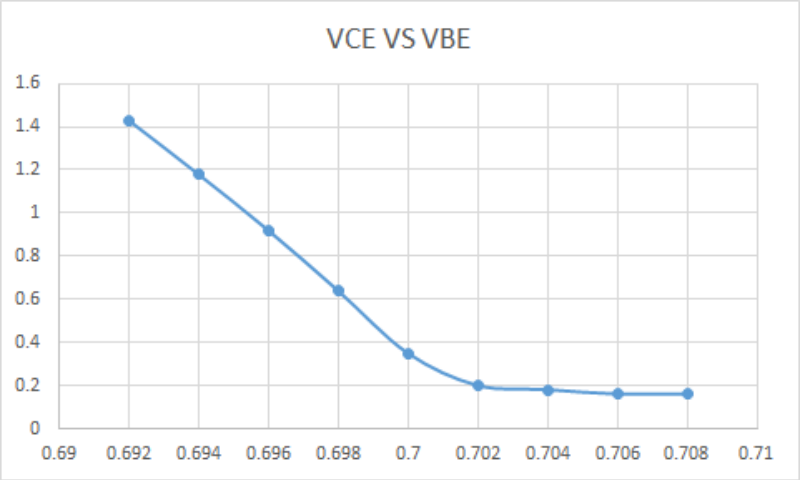

Figure 3: V_{OUT} vs. V_{IN}

According to the data and the plot, $|A_v| = |\frac{V_{OUT}}{V_{IN}}| = 100 > 10$ is satisfied before $V_{IN} = 0.70V$ as it reaches the saturation area.

2.2.2

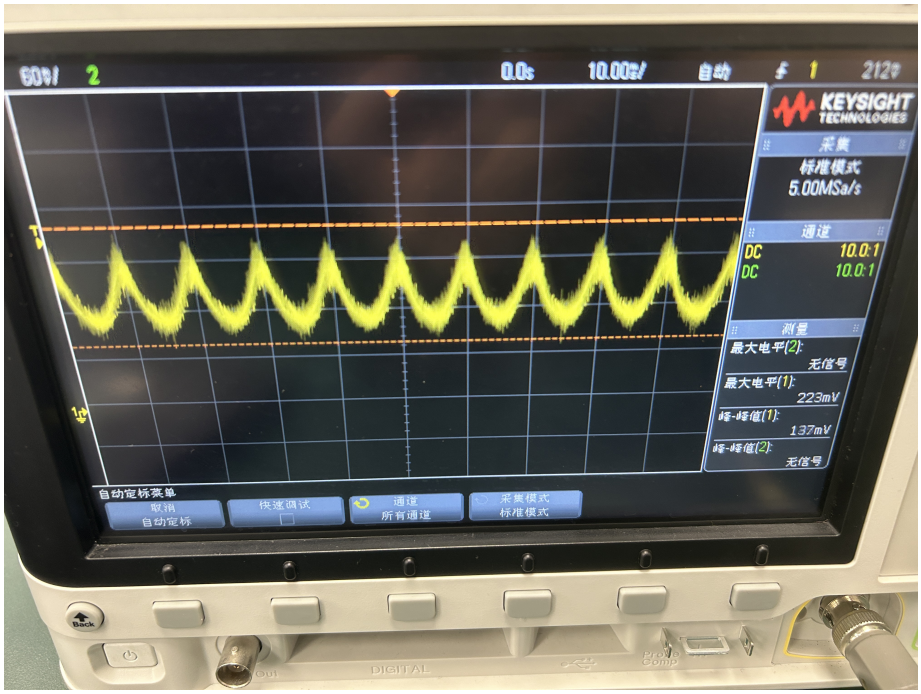

Figure 4: Amplified signal(100Hz)

According to the result of the experiment, the corresponding gain amplitude is $|A_V| = \frac{0.137}{2\times0.01} = 6.85$. However, in simulation, we have a gain equal to 76.25, which is close to 100(as we calculated in 2.2.1). However, the experimental result is much smaller than the actual result.

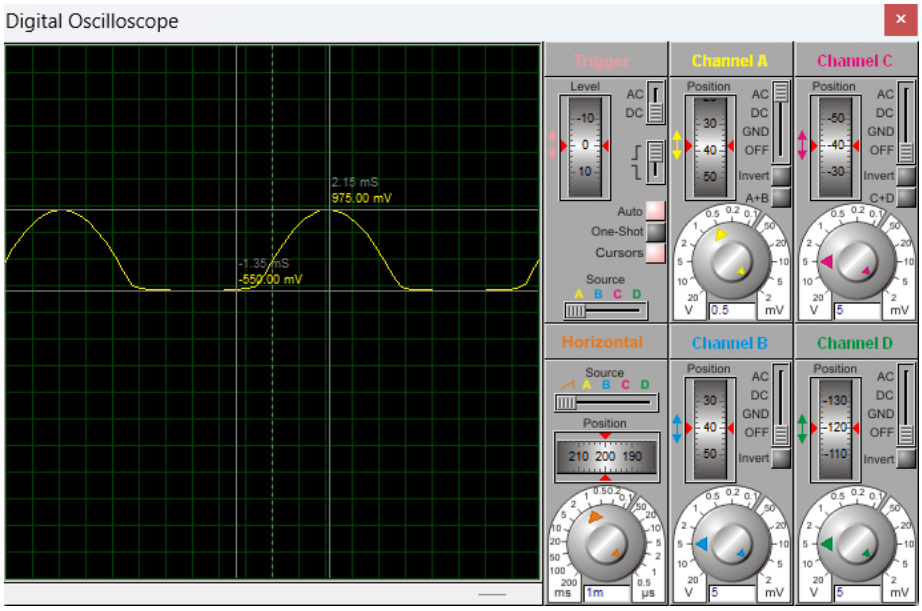

Figure 5: Amplified signal(100Hz)(Simulation)

2.2.3

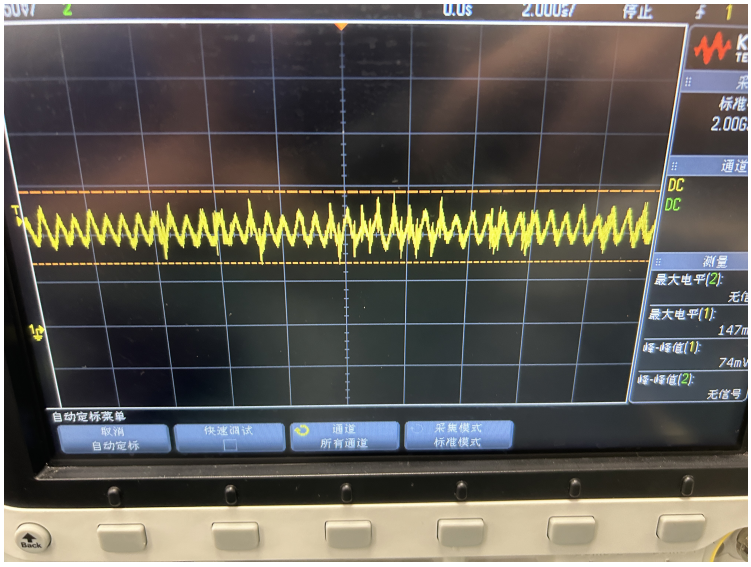

Figure 6: Amplified signal($2 * 10^6$Hz)

According to the result of the experiment, the corresponding gain amplitude is $|A_V| = \frac{0.074}{2\times0.01} = 3.7$. However, in simulation, we have a gain equal to 58.75, which is smaller than 100(as we calculated in 2.2.1). However, the experimental result is much smaller than the actual result.

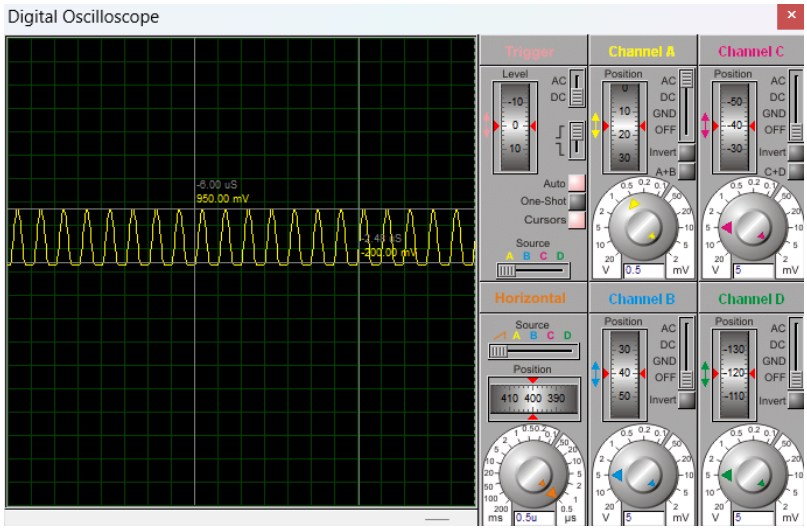

Figure 7: Amplified signal($2 * 10^6$Hz)(Simulation)

3 Error Analysis

3.1 The Early Effect Voltage

During the measurement of the early effect voltage, we observed fluctuations that can primarily be attributed to temperature variations. The early effect voltage is highly sensitive to changes in temperature, causing instability in the readings. Even minor environmental temperature changes can significantly impact the measurement, leading to the observed voltage fluctuations and preventing a perfectly linear relationship.

3.2 The Common-Emitter Amplifier

In the measurement of the voltage gain of the common emitter amplifier, consistently obtaining values less than 10, when it should be above 10, could be due to several factors. One possible reason is parasitic capacitance or inductance affect-

ing the high-frequency response, and loading effects from connected measurement instruments can further reduce the observed gain. These factors together contribute to the lower than expected voltage gain in the amplifier.

4 Discussion

4.1 The Early Effect Voltage

The early effect voltage exhibited fluctuations during our measurements, which highlights the sensitivity of this parameter to environmental conditions. These fluctuations suggest that even minor variations in temperature can significantly influence the early effect voltage, impacting the stability and reliability of the readings.

4.2 The Common-Emitter Amplifier

The performance of the common-emitter amplifier is influenced by several critical factors. The beta plays a significant role. The structure of the BJT is equivalent to the existence of a capacitor connected in the circuit, if the input frequency is too high, the capacitance impedance is about 0, resulting in the BJT behaving as a wire, making the gain decrease.

5 Conclusions

Overall, the experiment was successful and provided us with a deeper understanding of the early effect and common-emitter amplifier's principles. The insights gained from this experiment have enhanced our knowledge of the BJT's behavior and its impact on transistor performance.

6 Reference

[1] ECE3110J_2024SU_Lab2Manual, ECE3110J Teaching Group

[2] 2N3904_datasheet, On Semiconductor®.