UM-SJTU Joint Institute

VE311

Laboratory Report

Excercise 2

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[rev4.1]

1 Experiment Results

1.1 The Early Effect

In this section, we build the following circuit.

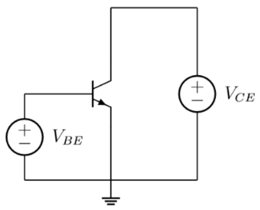

Figure 2: BJT Early Effect Voltage Measurement Circuit

Figure 1: Circuit

Then we have got the following result.

Table 1: Measured i_C

	$V_{CE1}(1.2V)$	$V_{CE2}(2.2V)$	$V_{CE3}(2.8V)$	$V_{CE4}(3.4V)$	$V_{CE5}(4.1V)$	$V_{CE6}(5V)$
$V_{BE} = 0.7V$	0.033	0.068	0.093	0.117	0.142	0.168
$V_{BE} = 0.8V$	0.055	0.092	0.116	0.149	0.206	0.242

According to the formula

$$i_C = \frac{I_s V_{BE}}{V_T}\left(1 + \frac{V_{CE}}{V_A}\right)$$

Then, plug in the data, we can plot the relationship between $V_C E$ and i_C

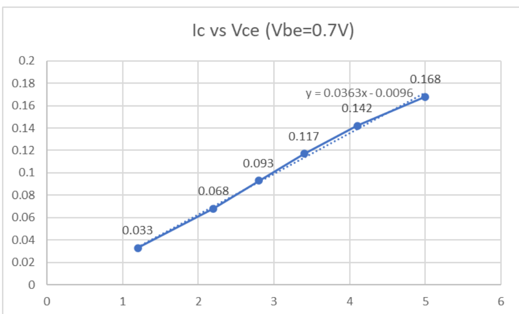

Figure 2: i_C VS V_{CE} $(V_{BE} = 0.7V)$

Then, we can calculate that $V_A = \frac{3.012+3.781}{2} = 3.397V$

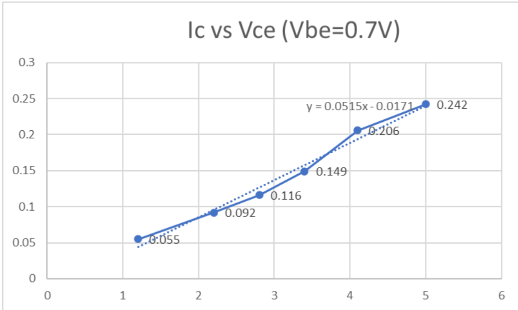

Figure 3: i_C VS V_{CE} ($V_{BE} = 0.8V$)

1.2 The Common-Emitter Amplifier

1.2.1

We can construct the following simulation circuit.

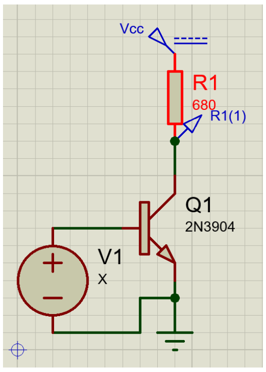

Figure 4: Simulation Circuit

Then, we can use DC Sweep to explore the relationship between V_{in} and V_{out}. From the figure, we can see that when $V_{in} < 7.3V$, $Av = 80 > 10$.

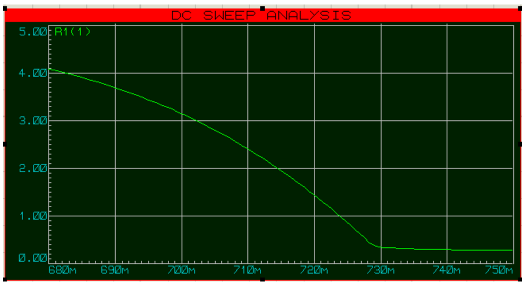

Figure 5: Simulation Result

When $V_{in} > 7.3V$, it reaches the saturation area.

1.2.2

In the lab, we have the measured data: According to our calculation, Av

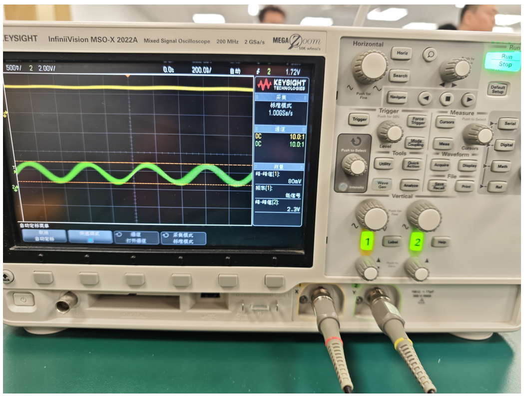

Figure 6: Measured data

should be equal to $\frac{2.3}{0.02} = 115$, which is close to 80, we can claim that our result is accurate.

1.3

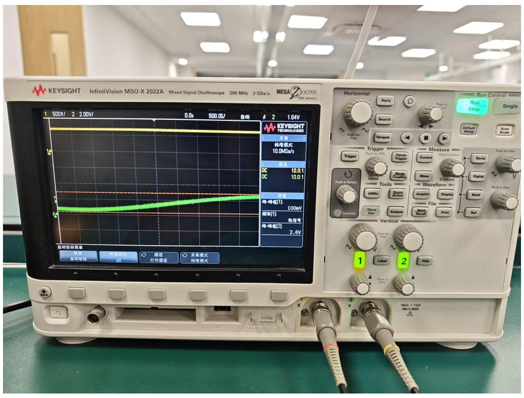

Figure 7: Measured Data

Similarly, we can calculate $Av = \frac{2.6}{0.02} = 130$, which is also close to 80, showing that our result is accurate.

2 Discussion

2.1 The Early Effect

The characterization of the Early Voltage (V_A) for the 2N3904 BJT revealed the inherent sensitivity of this parameter. During the measurement process, which involved applying a constant V_{BE} while varying V_{CE} , any observed fluctuations in the collector current directly impact the graphically extrapolated value of V_A. These inconsistencies underscore the necessity of stable environmental conditions, as factors like temperature can alter the semiconductor's properties and, consequently, the measurement's stability and reliability.

2.2 The Common-Emitter Amplifier

The performance of the designed common-emitter amplifier is fundamentally limited by the intrinsic properties of the BJT, particularly at high frequencies. The design successfully achieved a voltage gain greater than 10 at a low frequency by selecting an appropriate bias point and load resistance (R_C). At high frequencies, the impedance of these capacitances becomes minimal, effectively creating a shunt path for the signal, which bypasses the amplification mechanism and leads to a reduced output voltage amplitude.

3 Conclusion

In conclusion, we have explored some useful properties of BJTs in this lab, which helps me understand such electronic components better.