UNIVERSITY OF CALIFORNIA AT BERKELEY
College of Engineering
Department of Electrical Engineering and Computer Sciences

EE105 Lab Experiments

Experiment 5: Single Stage BJT Amplifiers: Common Collector and Common Base

1 Objective

In the previous lab, we explored the properties of a common emitter amplifier. However, even though it had an extremely high gain, its output impedance prevented it from properly amplifying a signal to drive a speaker. In this lab, we will investigate the properties of two other single-stage amplifier configurations: the common collector and the common base. You will be applying the same techniques learned from the previous lab to extract the input impedance, output impedance, and gain for both of these amplifier configurations. By the end of this lab, you should be able to model any single stage amplifier using its two-port model and identify the strengths and weaknesses of each single-stage amplifier configuration.

2 Materials

Component	Quantity
2N4401 NPN BJT	1
8 Ω speaker	1
100 Ω resistor	1
1 kΩ resistor	1
10 kΩ resistor	1
10 µF capacitor	1
10 kΩ potentiometer	1

Table 1: Components used in this lab

3 Procedure

3.1 The Common Base Amplifier

For a common base amplifier, the base acts as the common terminal to the input and output, hence the name "common base." The input is applied at the emitter and the output is taken at the collector.

1. Similar to the CE amplifier, the CB amplifier can also be used as a voltage amplifier. Set up the configuration shown in Figure 1. Let $V_{CC} = 12$ V, $R_C = 1$ kΩ, and $V_B = 640$ mV.
2. Using ICS, perform a sweep of V_{IN} from -0.1 V to 0.1 V and plot V_{OUT} vs. V_{IN}. Find the voltage gain from the slope at $V_{IN} = 0$ V (when the input has no DC offset).
3. Find the input impedance by sweeping V_{IN} from -0.1 V to 0.1 V and plotting I_{IN}.
4. Find the output impedance using the same method used in the previous lab.
5. Suppose the source resistance of V_{IN} is 50 Ω. Would the CB amplifier amplify a signal from this source well? Why?

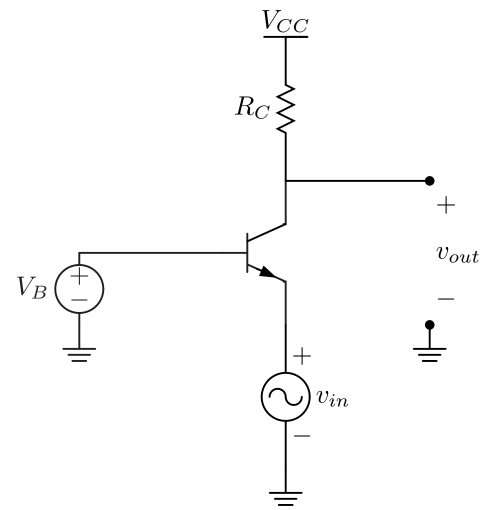

Figure 1: CB amplifier

3.2 The Common Collector Amplifier

The common collector amplifier gets its name from the fact that the collector is common to both the input and output of the amplifier. Similar to the CE amplifier, the input is applied at the base. However, the output is taken at the emitter terminal of the BJT.

1. Build the circuit shown in Figure 2, a simple common collector amplifier with no load attached. Note the R_S resistor in series with the function generator. This is to simulate the presence of a large source resistance. Let $R_S = 10\ \text{k}\Omega$, $R_E = 100\ \Omega$ and $V_{CC} = 12$ V.

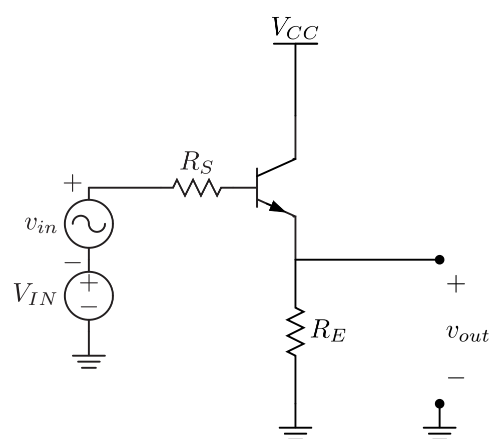

Figure 2: CC amplifier

2. A common collector amplifier is typically biased in the region that would give the greatest output voltage swing. Based on this criteria, find the DC bias voltage for V_{IN}. Record V_{OUT} and the output voltage swing.

3. Find the voltage gain, input impedance, and output impedance using the same methods as in the previous lab. Remove the R_S resistor when finding the gain and input impedance.

4. Another name for the CC amplifier is the emitter follower. Based on the gain that you have found, why do you think it is called that?

3.3 The World's Second Worst Speaker Amplifier

This part will demonstrate the capabilities of your CC amplifier on a physically observable load.

1. Apply a 1 kHz, 1 V amplitude sine wave directly to the two terminals of the speaker using the function generator. Measure the voltage drop across the speaker using the oscilloscope and qualitatively observe how loud it is.

2. Build the circuit shown in Figure 2. Let $R_E = 100\ \Omega$ and $C = 10\ \mu\text{F}$.

3. Bias V_{IN} to achieve the maximum output voltage swing (you should have the bias voltage from a previous part) and apply a 1 kHz, 1 V amplitude sine wave at the input. Attach the speaker to the output (indicated by R_L in the diagram), measure the output waveform, and observe how loud it is. Is this louder, quieter, or about the same as when the signal was directly applied using the function generator? Why? *Hint: The output impedance of the function generator is* $50\ \Omega$.

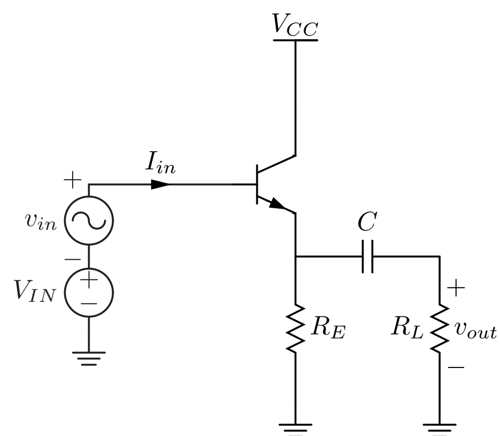

Figure 3: CC amplifier with load speaker attached