## Lab 9
BJT Differential Pair Amplifiers

In this lab you will build and characterize two different differential pair amplifiers and measure their characteristics.

Pre-Lab

1. Compute the values of R_{EE} and R_C in step 1, and get V_C.

2. Design the current source in step 6.

Differential pair biased with resistor

In this section you will build the differential pair amplifier biased with a emitter resistor instead of a current source. Use $V_{CC} = 10\,\text{V}$, $V_{EE} = -10\,\text{V}$.
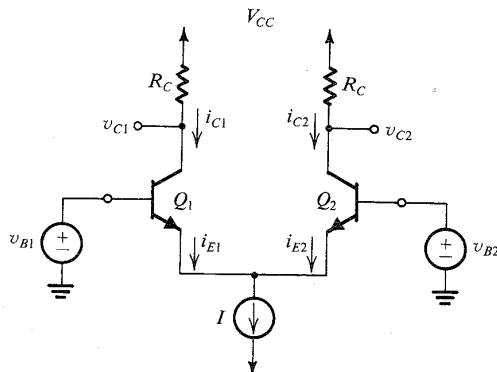

FIGURE 7.12 The basic BJT differential-pair configuration.

1. Build the differential pair amplifier biased with a resistor, R_{EE}, in place of the current source. Choose R_{EE} such that $I_C = 1\,\text{mA}$ when $V_{B1} = V_{B2} = 0\,\text{V}$, and choose R_C to obtain a differential gain $A_{dd} = 200$. What is V_C compared with theory?

2. Measure the common-mode gain, A_{cc} by attaching the function generator to both inputs and measuring the outputs. Verify that the two outputs are (nearly) identical and measure the common-mode gain. You can measure the common-mode output directly by attaching a scope probe to two identical very large resistors ($\gg R_C$) to the two outputs.

3. Measure the differential mode gain, A_{dd}, by attaching one base to ground and the other to the function generator. This results in a combination common- and differential-mode input. Attach the scope probes to the two outputs and use math mode to get the differential output. If common-mode output results in a differential mode output that is not negligible then you will need to take that effect into account, but hopefully you will not see such an effect.

4. Compute the CMRR and compare with a theoretical calculation.

5. **EXTRA CREDIT:** Measure the two gains A_{dc} and A_{cd}, the coupling from a differential mode input to a common-mode output (use two identical large resistors as in step 2), and from a common-mode input to a differential mode output (use math mode as in step 3). Ideally they should be very small.

Differential pair biased with current source

In this section you will measure the characteristics of a differential-pair amplifier biased with a current source.
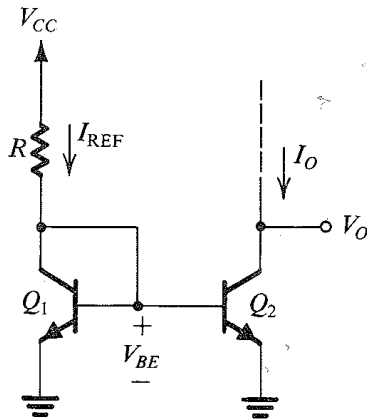
FIGURE 6.10   A simple BJT current source.

6. Replace R_{EE} with the 1 mA current source. If you have difficulty getting the current mirror to function it may help to add small additional resistances, $R_e \gg r_e$, on the two emitters, and make R adjustable.

7. Repeat the measurements from the previous section. You will also get extra credit if you measure A_{cd} and A_{dc}.

8. Compare the results for the differential amplifier biased with a resistor and with a current sources, and discuss.