Lab 8
BJT Single-Stage Amplifiers

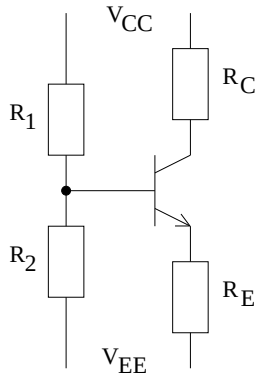
In this lab you will investigate single-stage amplifier linearity and measure amplifier input and output resistances.

Pre-Lab

1. Pick resistor values for steps 1 (approximate), 3, and 4.
2. Estimate the input and output resistance in step 7.
3. Estimate the output resistance R_{out} for both small and large values of R_S in step 9. Understand what constitutes large and small values for R_S.

Linearity and gain

In this section you will look at how gain can be traded for linearity in the common-emitter amplifier. You will work with the following circuit with $V_{CC} = 15\,\text{V}$ and $V_{EE} = 0\,\text{V}$:



1. Make $R_E = 0$ and pick R_1 and R_2 (use the $10\,\text{k}\Omega$ pot for adjustment) to get $I_C = 1\,\text{mA}$ ($0.5\,\text{mA} < I_C < 2\,\text{mA}$ is fine), then pick R_C to get $V_C = 7\,\text{V}$. Make sure you pick R_1 and R_2 so that the current through the voltage divider is much larger than the current into the base.
2. Apply a AC input through a capacitor directly to the base (make the frequency high enough to not attenuate the signal). Make the amplitude large enough to saturate at the top and the bottom. Compare the input and output for linearity.
3. Next insert a resistor between the source and the capacitor large enough to make $G_{vo} = 2$, and again compare the input and output for linearity.
4. Remove the resistor and instead adjust R_1 and R_2 and R_E to make $G_{vo} = A_{vo} = 2$. Explain that you do this by making $V_E = 3\,\text{V}$, $V_C = 9\,\text{V}$ (keeping $I_C = 1\,\text{mA}$). Attach the source to the capacitor and again compare the input and output for linearity.

5. Comment on the relationship between gain and linearity.

Input resistance of the Common-Emitter Amplifier

Here you will measure the input resistance of the common-emitter amplifier. One way to do that is to measure the gain with and without a resistor of similar size to the expected input resistance.

6. Build the common-emitter amplifier with dual base bias resistor R_1 and R_2 of total resistance $10\,\mathrm{k\Omega}$ and $I_C = 1\,\mathrm{mA}$, $V_C = 7\,\mathrm{V}$, $V_{CC} = 15\,\mathrm{V}$, and $V_{EE} = 0\,\mathrm{V}$, and couple input and output through capacitors. Be sure to use a sufficiently high frequency signal.

7. Estimate the input resistance and measure it by measuring the gain v_o/v_s with and without the estimated resistor in place. Compare.

Output Resistance of the Emitter Follower Amplifier

Here you will measure the output resistance of the common emitter amplifier and its dependence on the source resistance. Remember that the emitter follower is non-unilateral.

8. Build the emitter follower with $R_E = 5\,\mathrm{k\Omega}$ and $I_C = 1\,\mathrm{mA}$, and $R_1 + R_2 = 10\,\mathrm{k\Omega}$, $V_{CC} = 15\,\mathrm{V}$, and $V_{EE} = 0\,\mathrm{V}$.

9. Estimate the output resistance for large and small value of R_S.

10. Measure the output resistance with a large value of R_S and and small value of R_S and compare with the theory.