ECE 311 - Fundamentals of Electronics Lab

Department of Electrical and Computer Engineering
University of Idaho

Title: Design of a Common-Emitter amplifier with a small-signal emitter resistance

Objective: To Design, simulate, build, and test a common-emitter amplifier with a small-signal emitter resistance.

Preliminary: (Due at the beginning of the next laboratory period):
Design the amplifier shown in Figure 1 to meet the following specifications:

- □ VCC = 15V, VB = 5V, VC = 10V
- □ IC = 1mA and the DC current through RB1 and RB2 is about 0.1mA
- □ β= 200, VBE = 0.7V, and ignore the effects of ro.
- □ vo/vi (the gain of the circuit from base to output) is about -12.5V/V.
- □ RLOAD = 5.1kΩ, CC1 = CC2 = 1μF and CB = 10μF.
- □ All resistors must be standard 5% tolerance values. A total of 6 resistors including RLOAD but not Rsig may be used. Rsig is the source resistance of the function generator and is not part of the design.

You will not be able to meet these specifications exactly but the design must be as meet the specifications as close as possible. Your design will be graded relative to other designs. You will need to derive the expression for the gain of the amplifier.

(1) Find the expected values of VB, VC, VE, IRB1, IRB2, and IC for the amplifier using the standard values you've chosen for the resistors.
(2) Derive the expressions for and find the expected values of Rin and Rout for the amplifier.
(3) Derive the expression for and the value of vo/vsig.
(4) Derive the expression for and find the value of vo/vi (the voltage gain from the base to the output) using the standard resistor values you've chosen for the resistors. This value should ideally be -12.5 V/V as specified.
(5) Simulate the design using LTSpice to verify that it meets specs. Use the ECE310 model for the 2N3904. Turn in the following:
    a. Schematic drawn in LTSpice with nodes labeled as shown in Figure 2.
    b. Perform a DC operating point analysis to verify all DC voltages and currents are close to the calculated expected values determined for your design.
    c. Perform an AC analysis generating a plot that verifies the value for vo/vi is close to the calculated expected value.
    d. Perform an AC analysis generating a plot that verifies the value for Rin is close to the calculated expected value.
    e. Perform an AC analysis generating a plot that verifies the value for Rout is close to the calculated expected value.

(6) Bring a copy of your calculations and expressions to use in the laboratory.

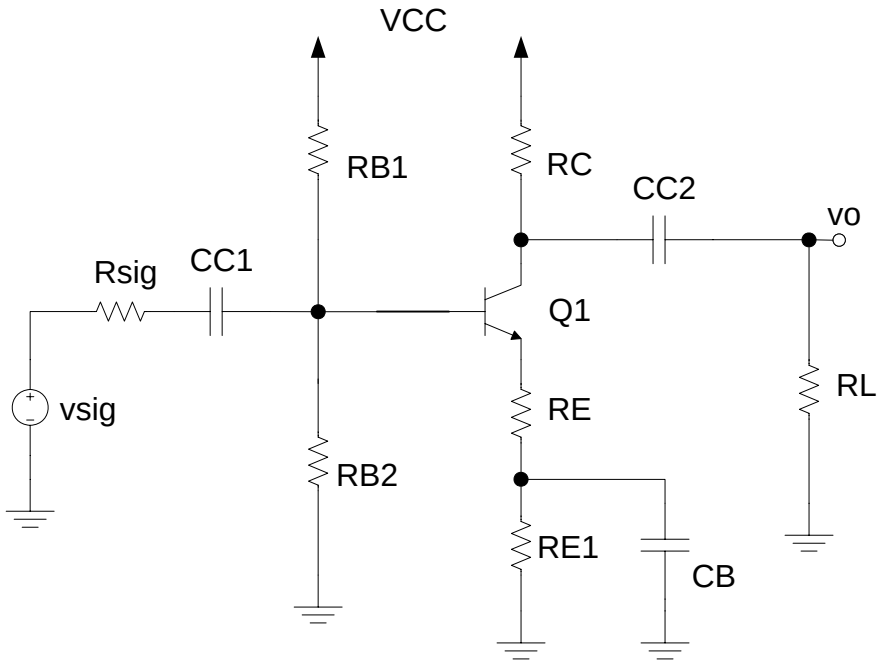

Figure 1: Schematic for a Common-Emitter Amplifier with emitter resistance

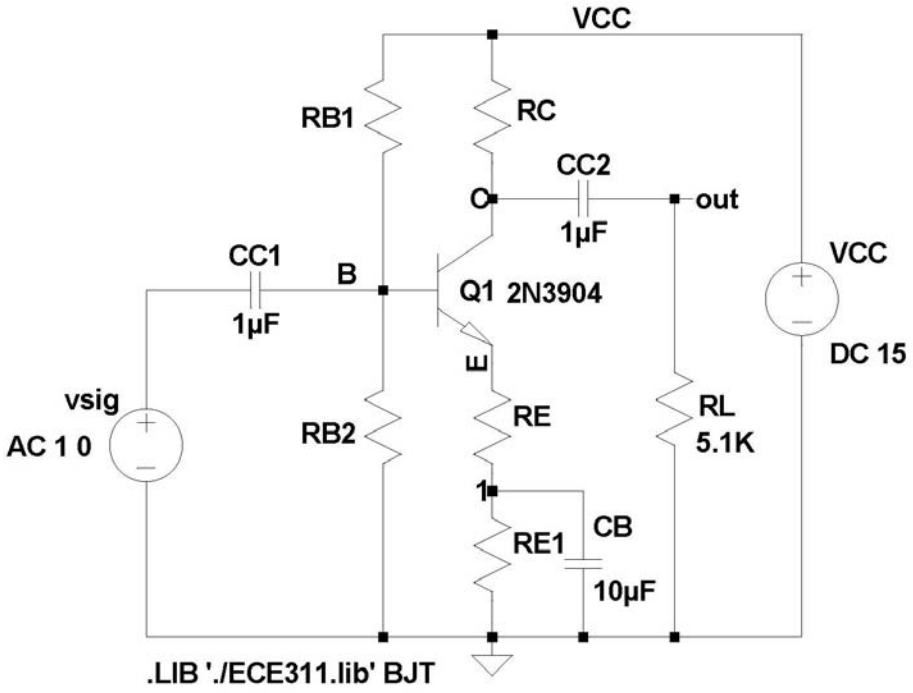

Figure 2: LTSpice Schematic

Laboratory Procedure:

1. Measure and record the values of your resistors for the amplifier.

2. Construct the circuit in Figure 1 using the resistor values found in the preliminary without the capacitors and function generator.

3. Measure and record VB, VC, and VE.

4. From the measured voltages found in step 3, calculate and record in your lab notebook IE, IC, IB, IRB1, IRB2, and VBE. Calculate the approximate β for your transistor.

5. Using your measured resistance values from step 1 and the values of β and VBE from step 4, calculate in your lab notebook the following VB, VC, VE, IB, IC, IE, IRB1, and IRB2.

6. Using the DC calculations in step 5, determine the values of the small-signal parameters for the BJT.

7. Using the calculated small-signal parameters from step 6, calculate the gains vi/vsig, vo/vi, and vo/vsig. Also, calculate the peak values for vo, vc, and vi for vsig = 10mV peak.

8. Set vsig = 10mV peak at a frequency of 10kHz. Measure the peak values of vo, vc, and vi. Use the oscilloscope to view these waveforms, but use the multimeter to measure the voltages. Determine vi/vsig, vo/vi, and vo/vsig from these measurements.

9. Compare the measured peak voltages and gains found in step 8 to the predicted values found in step 7.

10. From the DC calculations in step 5, calculate Rin and Rout for the amplifier.

11. Measure and record Rin and Rout.

12. Compare the measured to the calculated values found in steps 10 and 11 for Rin and Rout.