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

EE105 Lab Experiments

Prelab 4: Single Stage BJT Amplifiers: Common Emitter

Name:

Lab Section:

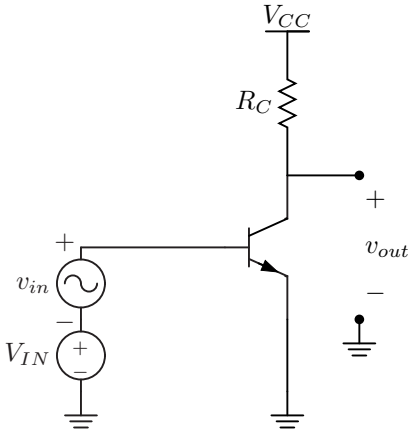


Figure 1: Common emitter amplifier

1. Let's analyze this common emitter amplifier! See Figure 1. Let $V_{CC} = 5\,\text{V}$, $V_T = 26\,\text{mV}$, $I_S = 26.03\,\text{fA}$, $V_A = 90.7\,\text{V}$, $R_C = 1\,\text{k}\Omega$, and $\beta = 270$.

   (a) For this transistor draw a graph (found on the next page) of I_C vs. V_{CE} for $V_{BE} = 600\,\text{mV}$, 620 mV, 640 mV, 660 mV, 680 mV, and 700 mV. Take care drawing this graph as it will be used in answering some of the following questions. Assume the boundary between deep saturation and forward active occurs at $V_{CE} = 400\,\text{mV}$. You can use a piecewise linear model for this graph.

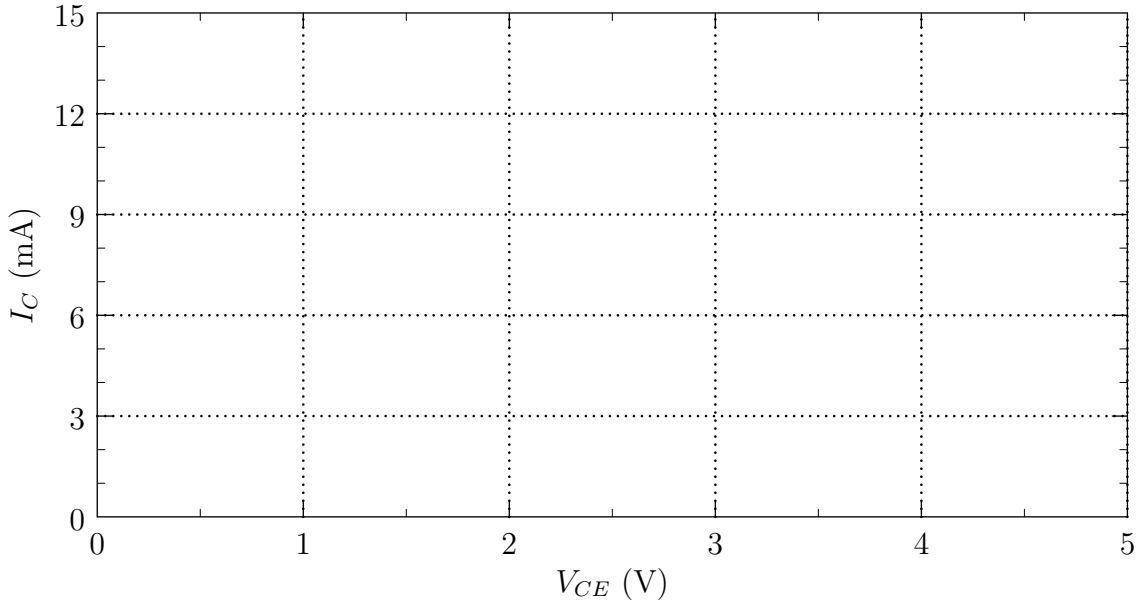
   (b) On this graph, draw the load line for R_C in this circuit.

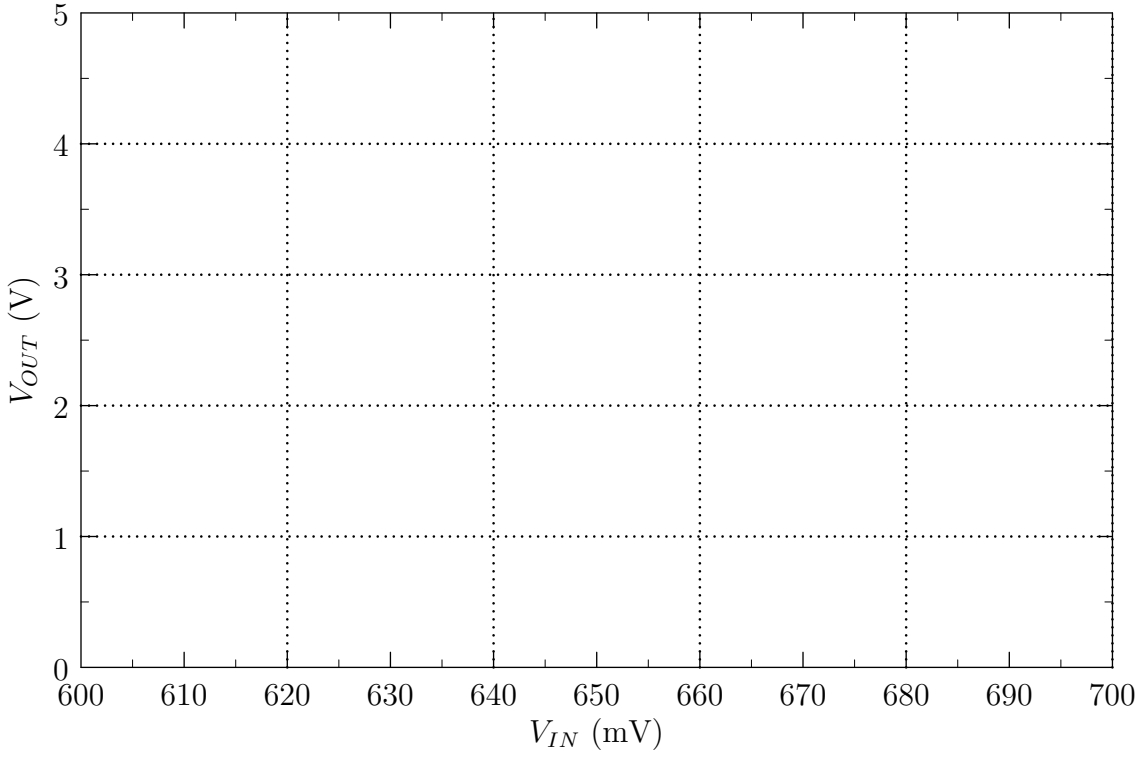
   (c) Using the intersection points, draw a graph (also found on the next page) of V_{OUT} vs. V_{IN}. What is this graph useful for?

   (d) What is the gain for $V_{IN} = 650\,\text{mV}$? What is the region of operation of the transistor?

2. Now that we've analyzed the large-signal properties of the amplifier, let's analyze some of its small-signal properties. Assume $V_{IN} = 650\,\text{mV}$ for the rest of the prelab.

   (a) Draw the small signal model of the amplifier (answer space provided on next page).


15
12
9
6
3
0
I_C (mA)
0
1
2
3
4
5
V_{CE} (V)


5
4
3
2
1
0
V_{OUT} (V)
600
610
620
630
640
650
660
670
680
690
700
V_{IN} (mV)

(b) Calculate the following (be sure to include the Early effect):

- V_{OUT}
- I_C
- Transconductance g_m
- Output impedance R_{out}
- Input impedance R_{in}
- Gain A_v. Does this gain match your answer to question 1(d)?

(c) If we change the bias point, which of the above properties change?

3. Let's explore what happens when we change the bias point by adding a load resistor.

(a) Add a load of 5 kΩ to the output of the circuit. Intuitively, how do you think this will affect the gain and why?

(b) Draw the new load line on the graph you made for question 1(a) (be sure to label which load line goes with which question).

(c) If we keep the same bias point (i.e., the same V_{BE} value), is the transistor still in forward active mode?

(d) What happens to the gain? How about the output voltage swing? *Note: The output voltage swing is the maximum and minimum values of v_{OUT} for which all transistors stay in forward active.*

(e) What is the load resistance value for which the amplifier's BJT begins to transition between forward active mode and deep saturation (i.e., where $V_{CE} = 400\,\text{mV}$)?