Lab-4
Analog Circuits

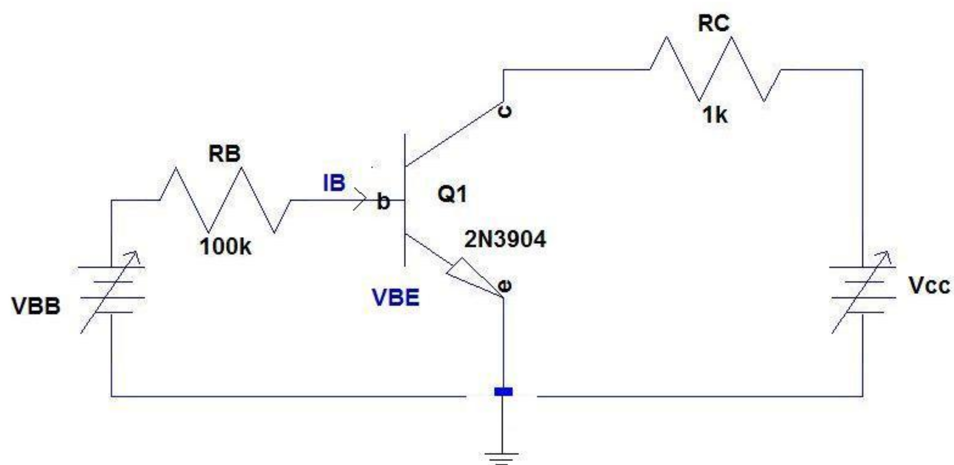
Bipolar Junction Transistor (BJT): Experiment List

In this session you will perform BJT based practical's using LTSpice. Based on the class lecture perform the following exercises. In your lab-book, remember to write your steps/methods, and the observations/results. The TA's shall sign and grade at the end of each lab. Discuss with your group mates. If you have any difficulty, you may consult TAs.

Note: LTSpice graphs data can be exported to excel sheet using the **export command.** You can then draw the graph as per requirement. Use 2N3904 npn for all the exercises.

1. Simulate a BJT circuit to get the input and output characteristics curves.

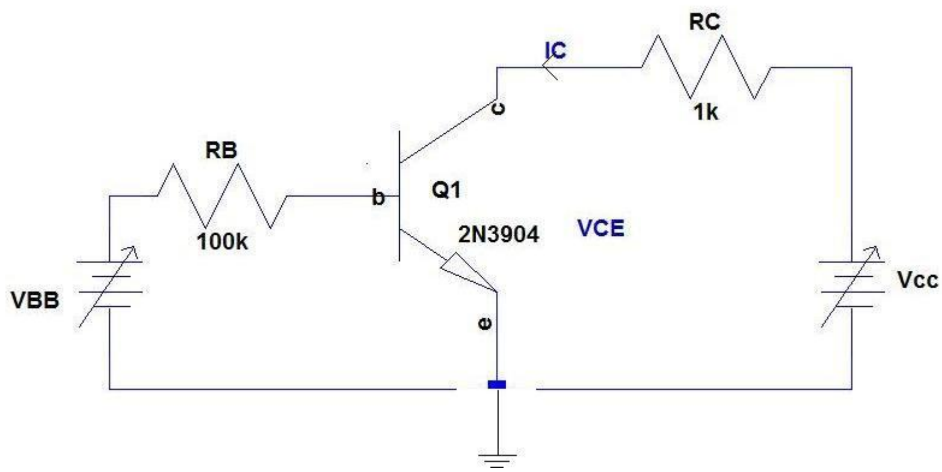
(A) Circuit setup for input characteristics:



i. Hook up the circuit as shown in the figure above.
ii. Keep Vcc fix at 0V (Or do not connect Vcc)
iii. Increase V_{BB} from 0V to 20V, note down readings of base current I_B and base to emitter voltage V_{BE} in the observation table.
iv. Repeat above procedure for Vcc = +5V and Vcc = +10V
v. Draw input characteristics curve. Plot V_{BE} on X axis and I_B on Y axis.

Note: In the analysis type select DC Sweep.

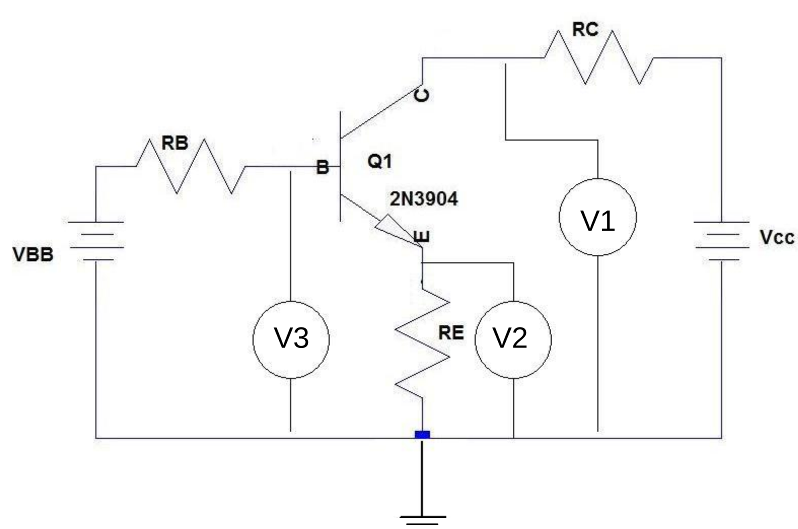
(B) Circuit setup for output characteristics:



i. Connect circuit as shown in the circuit diagram.
ii. Keep base current fix (Initially 0)
iii. Increase V_{CC} from 0V to 20V, note down readings of collector current Ic and collector to emitter voltage V_{CE} in the observation table.
iv. Repeat above procedure for base currents I_B = 5µA, 50 µA, 100 µA. Increase base current by increasing V_{BB} .
v. Draw output characteristics curve. Plot V_{CE} on X axis and I_C on Y axis.

2. Determining the Operating Region of a BJT.

Specify the operating region of the transistor in the following cases. Use LTSpice measurements or manual calculation where required.

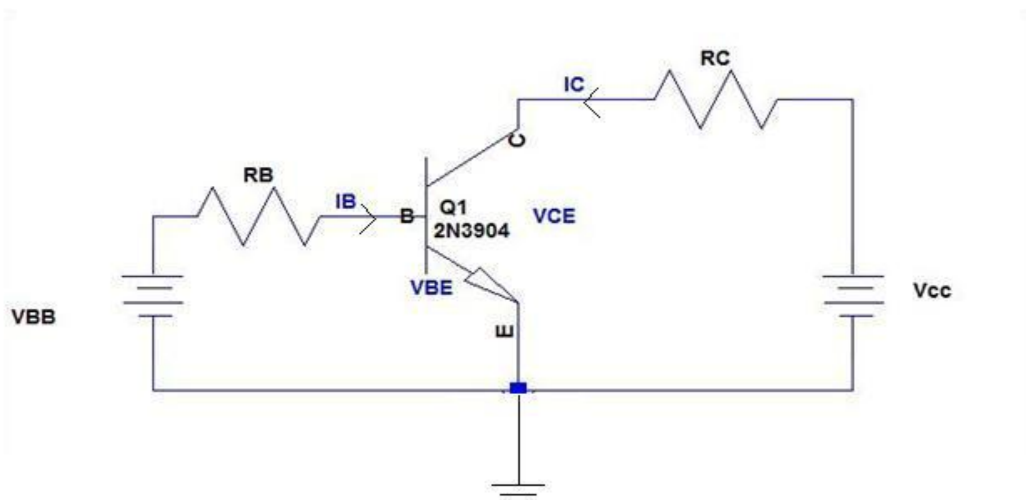


(A) V_{BB} = 4 V, V_{CC} = 12 V, R_B = 40 kΩ, R_C = 1kΩ, R_E = 321 Ω, Measure V_1, V_2 an dV_3.

(B) V_{BB} = 0, V_{CC} = 12 V, R_B = 40 kΩ, R_C = 1kΩ, R_E = 500 Ω.

(C) Data: $V_1 = V_B$ = 2.7 V, $V_2 = V_E$ = 2 V, $V_3 = V_C$ = 2.3 V.

3. (A) Determine the DC operating point of the BJT amplifier in the circuit below.



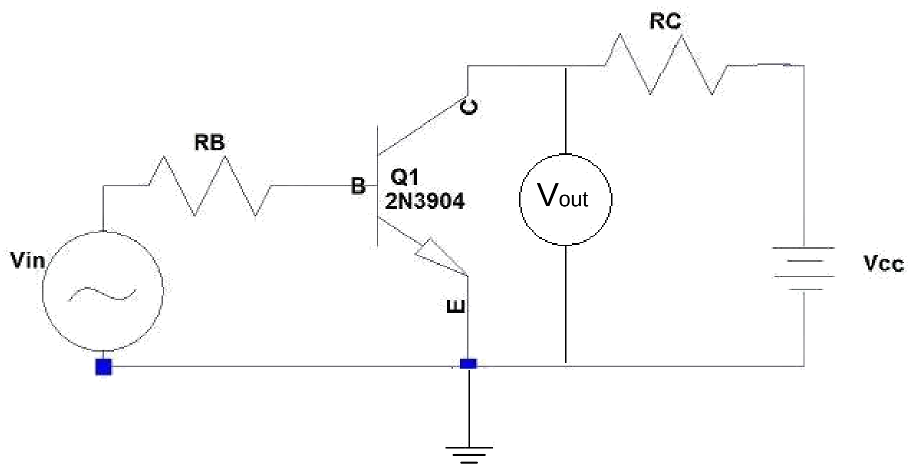
Data: R_B = 62 .7 k Ω, R_C = 375 Ω, V_{BB} = 10 V, V_{CC} = 15 V.

Hint: First write the load line equation for the collector circuit. To determine the Q point, find the collector curve (from V_{CE} vs I_C graph) that intersects the load line. To do so, you must know the base current.

(B) How would the Q point change if the base current is changed to 100 μ A?

4. **Built a BJT amplifier.**

(A) Connect the circuit as shown below. R_B = 5k Ω, V_{CC} = 8 V, and a 0.65V DC input voltage with a 10 mV 10kHz sine wave on top. Perform a transient analysis lasting about 1ms with 1μs time steps.



Plot V_{out} and V_{in} waveforms. The output waveform should be an amplified version of the input wave.

(B) Explain why and what happens if you change (increase and decrease) the DC voltage for either V_{in} or V_{CC}?

(C) Explain why and what happens if you change the resistor value?

(D) Explain why and what happens if you change the transistor model or change to a pnp transistor?