EECS2210: Electronic Devices and Circuits

Lab #*3*

BJT Characteristics

Introduction and Objective

The objective of this lab experiment is to explore basic Bipolar Junction Transistor (BJT) properties and applications, including I-V characteristics, amplifiers and other practical circuits.

Lab Preparation

In this part you will find the working regions of transistors.

1. In Fig.1 Calculate I_C and V_{CE} and determine if the transistor operates in the linear (active) mode (assume β =100 and V_{BE}=0.7V).
2. Run a DC operating point Simulation of the circuit in LTspice and measure V_{CE}, I_C, and I_B of the transistor. Select 2N3904 as the model of the transistor.
3. Considering a β=300 for this transistor, is the $I_C = \beta I_B$ formula valid for this operating point region?
4. In case the transistor is in the active region, calculate g_m and r_π for this condition.
5. Change R_C so that I_C=1.2mA and V_{CE}=1V.
6. Repeat steps1 to 4 with the R_C calculated in part 5.

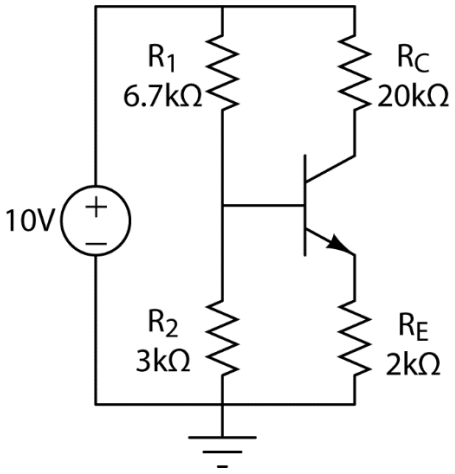

Figure 1. A simple circuit including BJT

Lab Experiment

1. Test the transistor using a multimeter and confirm that the transistor is working properly.
2. Using the 2N3904 transistor and the four resistors, implement the circuit shown in Fig.1.
3. Using a voltmeter (or an oscilloscope), measure I_C, I_B, and V_{CE} and determine if the transistor is working in the linear operating region.
4. In case the transistor is in active region, calculate g_m, r_π and β.
5. Change the value of R_C to which has been calculated in part 5 of the hand calculation.
6. Repeat steps 3 to 5 with this new R_C.
7. Generate a 1mVp-p, 1kHz sinusoidal waveform using the waveform generator and apply that to the base terminal of your transistor in the way shown in the last slide of Week 6's lecture (that is, through a big capacitor). Then probe the collector terminal of the transistor and verify if you see an amplified version of the input. To see both the input and the output at the same time, you can use two channels of the oscilloscope.
   - Is the gain negative or positive? How can you tell using the waveforms on the scope?
   - How close is the gain to what you expect it to be (i.e., approximately, $-g_m \times R_C$).
   - What could be the reason for the discrepancy?