

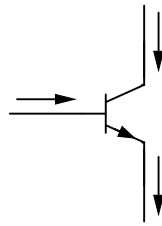
EE105 Lab Experiments

# Prelab 3: Bipolar Junction Transistor Characterization

Name:

Lab Section:

1. For the NPN device shown below in Figure 1, fill in  $I_C$ ,  $I_B$ , and  $I_E$  next to the current arrows.



**Figure 1:** A simple NPN device for warming up

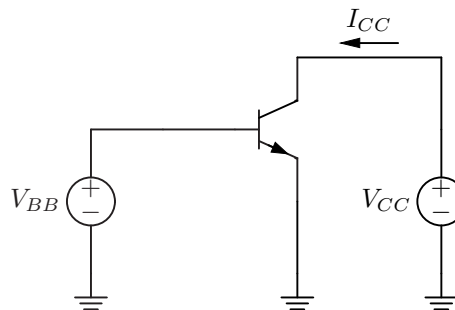
2. What is  $\beta$  in terms of  $I_C$  and  $I_B$ ? What is  $\alpha$  in terms of  $I_C$  and  $I_E$ ? Express  $\alpha$  in terms of  $\beta$ .

$\beta(I_C, I_B) =$

$\alpha(I_C, I_E) =$

$\alpha(\beta) =$

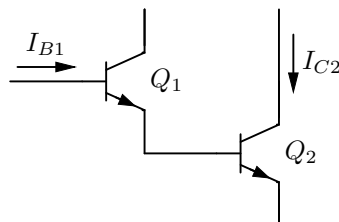
3. SPICE



**Figure 2:** Circuit to simulate in SPICE

- Write a SPICE netlist for the BJT test circuit shown in Figure 2. Refer to the *HSPICE Tutorial* if you have trouble with SPICE.
- Use the 2N4401 SPICE model provided on the course website.

- Using the `.dc` command, sweep  $V_{CC}$  from 0 V to 5 V in 0.01 V increments and step  $V_{BB}$  from 0.6 V to 0.7 V in 0.025 V increments.
  - Run the simulation and check the output file for any errors.
  - If there are no errors, plot  $I_{CC}$  versus  $V_{CC}$  and print out a copy of the plot. *Note: If you notice that  $I_{CC}$  is negative, use `Awaves` to plot the absolute value of  $I_{CC}$ .  $I_{CC}$  appears to be negative because `SPICE` defines  $I_{CC}$  to be going out of the BJT.*
4. The configuration shown below in Figure 3 is known as the Darlington pair. Assume  $Q_1$  has a DC current gain of  $\beta_1$  and  $Q_2$  has a DC current gain of  $\beta_2$ . Derive the overall current gain,  $\beta_{tot} = I_{C2}/I_{B1}$ , as a function of  $\beta_1$  and  $\beta_2$ . Do not neglect any currents.



**Figure 3:** Darlington configuration

$\beta_{tot} =$
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