LAB 6.2

PNP I-V Characteristics

(See Sections 6.1–6.2, p. 352 of Sedra/Smith)

OBJECTIVES:

To study PNP transistor I-V curves by:

- Simulating a transistor to investigate the collector current vs. base-to-emitter voltage and collector-to-emitter voltage.
- Implementing a circuit and taking measurements of the I_C vs. V_{EB} and I_C vs. V_{EC} curves.
- Extracting values of β and V_A.

MATERIALS:

- Laboratory setup, including breadboard
- 1 PNP transistor (e.g., NTE2322)
- Several wires

PART 1: SIMULATION

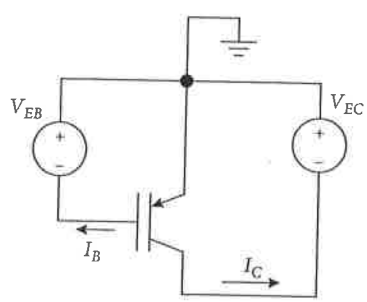

FIGURE L6.2: Transistor measurement circuit.

Consider the circuit in Figure L6.2. Enter the circuit into your simulator's schematic editor, applying DC voltage supplies to the base and collector of the transistor. In the diagram, the emitter is indicated as the reference node (ground). What voltages would you need to apply if another node, e.g., the collector, were labeled as the reference?

I_C vs. V_{EB}

While setting V_{EC} to a constant value of 5 V, sweep the base voltage from 0 V to –0.8 V in increments of 0.1 V. Plot a curve of I_C vs. V_{EB}. At what value of V_{EB} does current begin to conduct? What are the values of I_B and I_C when V_{EB} = 0.7 V? Based on these numbers, what is your estimate of β?

I_C vs. V_{EC}

For three values of V_{EB} (0.6 V, 0.7 V, and 0.8 V), sweep the collector voltage from 0 V to –2 V in increments of 0.1 V. Plot the curves for I_C vs. V_{EC} onto a single graph, clearly indicating the value of V_{EB} next to each curve.

PART 2: MEASUREMENTS

Assemble the circuit from Figure L6.2, using a power supply to generate the DC voltages. You may need to be creative to get the correct polarities! Remember that for a PNP transistor that is on, V_{EB}, V_{EC}, and I_C will be positive quantities, so the base and collector voltages will be negative.

I_C vs. V_{EB}

While setting V_{EC} to a constant value of 5 V, sweep the base voltage from 0 V to –0.8 V in increments of 0.1 V, and measure the collector current using the power supply. Plot a curve of I_C vs. V_{EB}. (*Note*: Not all power supplies allow you to measure current accurately; if this is the case for your lab setup, you may place a small resistor in series with the collector and measure the voltage drop across the resistor.) At what value of V_{EB} does the current turn on? Using small resistors placed in series with the base and collector terminals, measure I_B and I_C for V_{EB} = 0.7 V. Based on these numbers, what is your estimate of β?

I_C vs. V_{EC}

For three values of V_{EB} (0.6 V, 0.7 V, and 0.8 V), sweep V_{EC} from 0 V to 1 V in increments of 0.1 V, and measure the collector current using the power supply. Plot the curves for I_C vs. V_{EC} onto a single graph, clearly indicating the value of V_{EB} next to each curve.

PART 3: POST-MEASUREMENT EXERCISE

Simulation vs. measurement

What are the main differences between your simulated and measured curves? Can you explain the differences?

Early voltage, V_A

Based on your simulated I_C vs. V_{EC} curves for an active transistor, extract the Early voltage V_A. Does V_A change significantly for each value of V_{EB}? What is the average value of V_A?

PART 4 [OPTIONAL]: EXTRA EXPLORATION

If you have access to a semiconductor parameter analyzer, generate the I_C vs. V_{EC} curves using the analyzer. How do they compare to the curves you generated in Part 3? Re-extract values of β and V_A.