**Bipolar Junction Transistor Current-Voltage Characteristics**

# ECE2200L

**Lab 6 Report**

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**Station #**

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Experiment #6

Bipolar Junction Transistor Current-Voltage Characteristics

**Executive Summary:**

When we apply two power sources to our BJT and a small change occurs on the power supply across the base and emitter we gain a large current. When the base and emitter power supply is unchanged and the collector emitter voltage increases, the transistor is in saturation.

**Objective:**

To measure and investigate the static input, static output and static transfer characteristics of BJTs.

**Procedure:**

Review the particular BJT characteristics which are related to the circuit configuration and biasing mode. The circuit configuration, shown in Figure 1, identifies the lead that is common to the input and output of the circuit. The biasing mode indicates the polarity of bias voltages applied to the emitter-base and collector-base junctions, as given in Table 1. In analog applications such as amplification, common-emitter configuration in forward-active mode is most common. In digital applications such as switching, the most important circuit is common-emitter configuration with the BJT switching between cut-off and saturation modes. Examples of the common-emitter input and output characteristics are displayed in Figure 2 for PNP transistors and in Figure 3 for NPN transistors.

2) Measure input characteristics using the circuit shown in Figure 3 below.

3) Measure the IC vs. VCE characteristics for at least 3 different values of IB. From these plots, determine the value of β \_for your transistor. Plot IC vs. VCE manually before leaving the lab. This figure will be the central result of your lab report. You should also measure the IB vs VBE curve. This figure will also appear in your written report. For your measurement circuit, I suggest you use the circuit shown in Figure 3 below. Depending on your transistor, this may not be the best measurement circuit. If you can think of a better measurement circuit, then by all means do. Be sure to document what circuit you used in your manual.

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Figure 1 BJT Circuit

**Data:**

Table 1 BJT Vce=5V

|  |  |  |  |
| --- | --- | --- | --- |
| Vbe (V) | Vr(V) | Ib(mA) | Vbe(V) |
| 0 | 0 | 0 | 0.00001 |
| 0.2 | 0 | 0 | 0.198 |
| 0.4 | 0.000333 | 0.03171428571 | 0.402 |
| 0.6 | 0.014 | 1.333333333 | 0.5 |
| 0.8 | 0.135 | 12.85714286 | 0.6 |
| 1 | 0.295 | 28.0952381 | 0.67 |
| 1.2 | 0.47 | 44.76190476 | 0.68 |
| 1.4 | 0.621 | 59.14285714 | 0.69 |
| 1.6 | 0.778 | 74.0952381 | 0.7 |
| 1.8 | 0.9556 | 91.00952381 | 0.701 |
| 2 | 1.1139 | 106.0857143 | 0.7 |

Table 2 BJT Vce=10V

|  |  |  |  |
| --- | --- | --- | --- |
| Vbe (V) | Vr(V) | Ib(mA) | Vbe(V) |
| 0 | 0 | 0 | 0.00033 |
| 0.2 | 0.216 | 20.57142857 | 0.2 |
| 0.4 | 0.386 | 36.76190476 | 0.396 |
| 0.6 | 0.581 | 55.33333333 | 0.583 |
| 0.8 | 0.812 | 77.33333333 | 0.65 |
| 1 | 1 | 95.23809524 | 0.67 |
| 1.2 | 1.2 | 114.2857143 | 0.677 |
| 1.4 | 1.42 | 135.2380952 | 0.682 |
| 1.6 | 1.59 | 151.4285714 | 0.681 |
| 1.8 | 1.8 | 171.4285714 | 0.684 |
| 2 | 1.99 | 189.5238095 | 0.677 |

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Figure 2 Vbe vs. Ib Characteristics Constant Vce

Table 3 Ic Current Measurements with Ib=0.174mA

|  |  |
| --- | --- |
| Vce (V) | Ic(mA) |
| 0 | 0.01 |
| 1 | 3.098 |
| 2 | 3.124 |
| 3 | 3.158 |
| 4 | 3.188 |
| 5 | 3.223 |
| 6 | 3.256 |
| 7 | 3.289 |
| 8 | 3.32 |
| 9 | 3.351 |
| 10 | 3.394 |
| 11 | 3.432 |
| 12 | 3.479 |
| 13 | 3.511 |
| 14 | 3.554 |
| 15 | 3.6 |

Table 4 Ic Current Measurements with Ib=0.2293mA

|  |  |
| --- | --- |
| Vce (V) | Ic(mA) |
| 0 | 0.025 |
| 1 | 9.176 |
| 2 | 9.364 |
| 3 | 9.462 |
| 4 | 9.633 |
| 5 | 9.792 |
| 6 | 9.943 |
| 7 | 10.089 |
| 8 | 10.253 |
| 9 | 10.4 |
| 10 | 10.606 |
| 11 | 10.732 |
| 12 | 10.943 |
| 13 | 11.34 |
| 14 | 11.35 |
| 15 | 11.537 |

Table 5 Ic Current Measurements with Ib=0.2907mA

|  |  |
| --- | --- |
| Vce (V) | Ic(mA) |
| 0 | 0.034 |
| 1 | 12.59 |
| 2 | 12.787 |
| 3 | 13.025 |
| 4 | 13.352 |
| 5 | 13.55 |
| 6 | 13.755 |
| 7 | 14.045 |
| 8 | 14.348 |
| 9 | 14.605 |
| 10 | 15.036 |
| 11 | 15.34 |
| 12 | 15.735 |
| 13 | 16.021 |
| 14 | 16.447 |
| 15 | 17.021 |

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Figure 3 Vce vs. Ic Characteristics Constant Vbe

**Analysis:**

The BJT circuit was set up as shown in Figure 1 in the procedure where the power supply across the collector was kept constant at 5 volts, the power supply across the base and emitter was gradually increased with increments of 0.2 volts from 0 to 2 volts. The voltmeter was positioned across the 4.9k resistor and the current was calculated by dividing the voltage measured by resistance. We can see these values in table 1. After we collected data points for the voltage across the collecor and emitter we repeated the procedure with the baseemitter voltage gradually increasing from 0 to 2V by .2V increments and that data can be seen in table 2. Once we were done with data points for those two screnarios the voltage for the base and emitter was plotted against the current Ib shown in Figure 2. When the power across our collector and emitter increased, as expected we experienced a rapid current growth.The BJT has the same current traveling from Ic to Ie thus a voltmeter was placed across the 10Ω resistor and the voltage was divided by the resistance to measure the current while the Vbe was held constant. The Vce was steadily increased from 0 to 15 volts in 1 volt increments and the current across the resistor was measured. The first circuit the Ib was set to 0.174mA with a constant voltage of 0.85V across the base and emitter, the measured current Ic is shown in Figure 3. The base and emitter voltage was increased to 1.12 volts and an Ib of 0.2293mA, the measurements for the current Ic was shown in Table 4. Finally the voltage across the base and emitter was increased to 1.42V with an Ib of 0.2907mA, the measurements of Ic are listed under Table 5. After the currents for Ic were measured for three different Ib values they were all plotted in Figure 3, the plot shows how the current rapidly raises in the saturation region and steadily increases when reaching the Linear region.

**Discussion:**

The intended BJT for this experiment was 2N3904, however the transistor used instead was 2N3641. Both are BJTs and share similar characteristics. The nominal and actual values of the often differ, the resistors had a nominal resistance of 4.99kΩ and an actual resistance of 4.884kΩ, a 2.17% percent difference. The experiment also called for another resistor with a nominal resistance of 10 Ω and an actual resistance of 10.05Ω, a 0.5% percent difference.