EXPERIMENT 6: BIPOLAR JUNCTION TRANSISTOR (BJT) CHARACTERISTICS

Objectives

The objective of this experiment is to obtain DC characteristics of BJT transistors and to learn the operation of bipolar transistors practically.

Components Required:

DC Voltage Source

Multimeter

Transistor: BC237 transistor

Resistors: 120kΩ, 1kΩ,100Ω

Preliminary Work:

1. Find and examine the datasheet of the BC237 transistor on the Internet.
2. Research how to extract and use the transistor's transfer and output characteristics.
3. Identify the operating regions of a BJT transistor. How are the operating regions determined? Explain.
4. What are the signs (positive or negative) of I_E, I_C, I_B, V_{CB} and V_{EB} for a PNP transistor operating in the active area?
5. What are the signs (positive or negative) of I_E, I_C, I_B, V_{CB} and V_{EB} for an NPN transistor operating in the active area?
6. An NPN - BJT is used as a switch. Write the necessary conditions for BJT to be operated in saturation or in cut-off.
7. Setup the circuit given in Figure 1 in OrCAD. Use BC237 (in Zetex Library) transistor model. Plot input characteristic of the transistor (VBE–IB). You can select the analysis type as 'DC Sweep' and options as 'Primary Sweep'. Sweep input voltage (VBB) from 0 to 6V in steps of 0.1V. Specify critical points on the plot and comment about your simulation result.
8. Setup the circuit given in Figure 2 in OrCAD. Use BC237 transistor model. Plot output characteristic of the transistor (VCE–IC). You can select the analysis type as 'DC Sweep' and options just as 'Primary Sweep'. Sweep input voltage (VCC) from 0 to 15V in steps of 1V. Specify critical points on the plot and comment about your simulation result.
9. Setup the circuit given in Figure 2 in OrCAD. Use BC237 transistor model. Plot output characteristic of the transistor (VCE–IC). You can select the analysis type as 'DC Sweep' and options as 'Primary Sweep' with 'Secondary Sweep'. Primary Sweep

input voltage (VCC) from 0 to 15V in steps of 1V. Secondary Sweep input voltage (VBB) from 0 to 3V in steps of 1V. What is the relationship between IC and IB according to the results? What is the relationship between VCE and IC according to the result? Specify critical points on the plot and comment about your simulation result.

10. Set up the circuits given in Figure 1 and Figure 2 in TincerCAD and add the results to the report.

11. Add the tables (Table 1, Table 2 and Table 3) to your report.

Experimental Work:

1. Set up the circuit in Figure 1 and measure the V_B, V_C, and V_E voltages for the V_S values given in Table 1 and write them in Table 1. Calculate the values of I_B, I_C, I_E, β, V_{BE}, V_{CE} according to the measured values and write them down in Table 2.
2. Set up the circuit in Figure 2 and measure the V_B, V_C, and V_E voltages for V_{CC} values given in Table 3. Calculate the values of I_B, I_C, and V_{CE} and write them in Table 3.
3. Draw the $I_C - V_{CE}$, $I_C - I_B$, $I_B - V_{BE}$ curves using the calculated data in the tables.

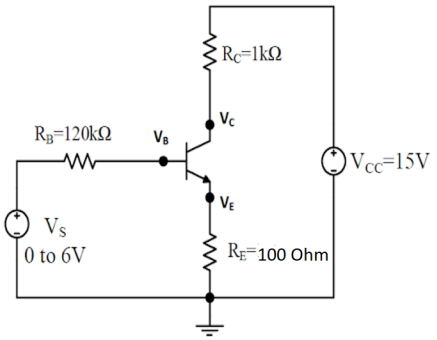


Figure 1

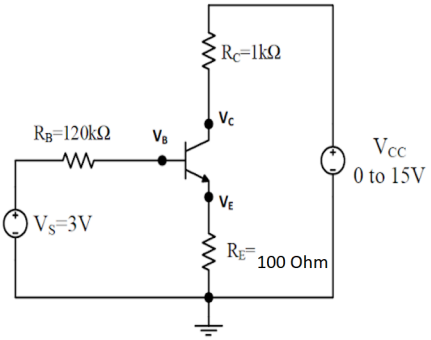


Figure 2

Table 1: Measurements according to the given V_S voltages

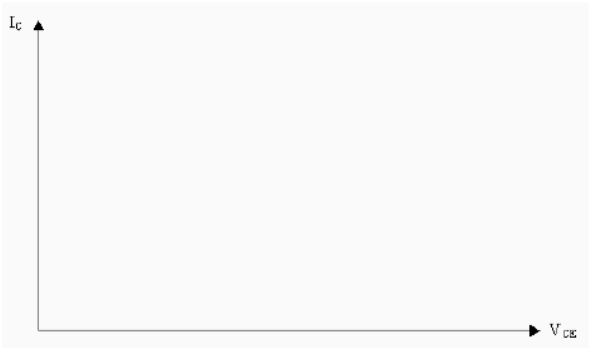
V_S (V)	V_S	V_B	V_E	V_C
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				
3.5				
4.0				
4.5				
5.0				
5.5				
6.0				

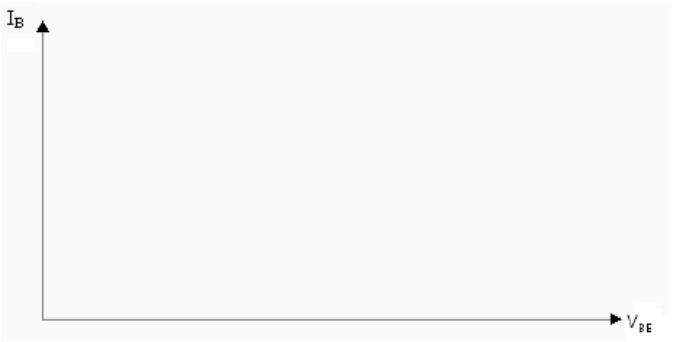
Table 2: The values below will be calculated according to the table above!

V_S (V)	I_B	I_C	I_E	β	V_{BE}	V_{CE}
0.5						
1.0						
1.5						
2.0						
2.5						
3.0						
3.5						
4.0						
4.5						
5.0						
5.5						
6.0						

Table 3: Measurements according to the given V_{CC} voltages

V_{CC}	V_B	V_E	V_C	I_B	I_C	V_{CE}
0.2						
1						
3						
5						
6						
8						
10						
15						




I_B
V_{BE}