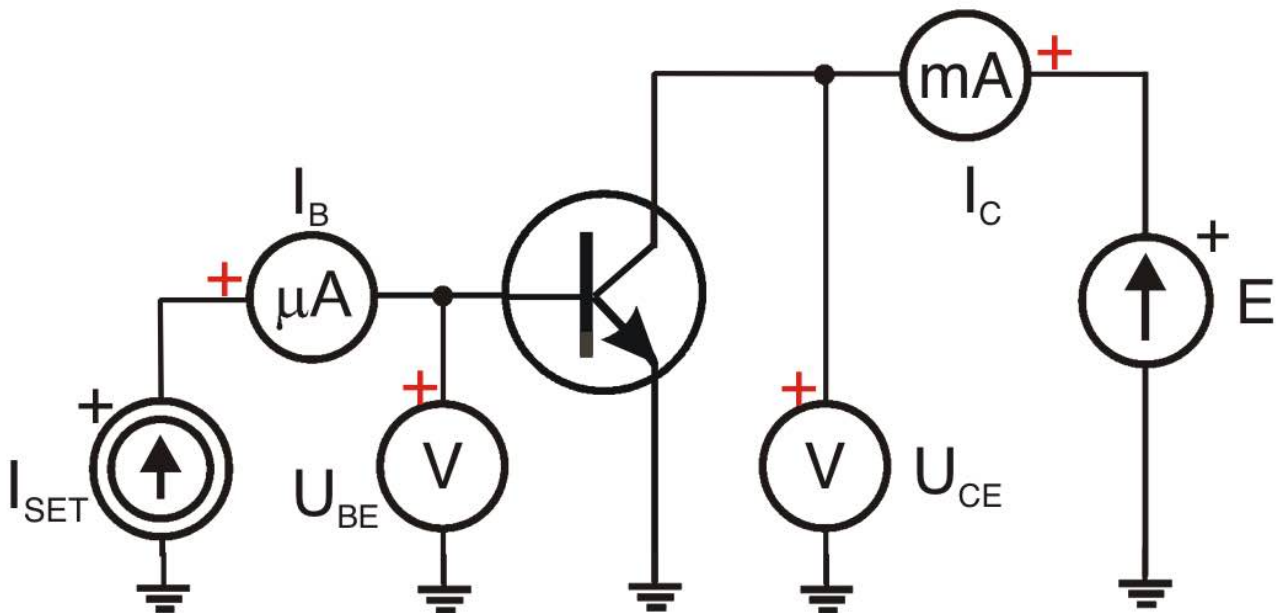


1) Goal

The main goal of this experiment is to investigate the behavior of a bipolar junction transistor (BJT) under different operating conditions, using a BCP54 type transistor. The experiment focuses on studying the current-voltage characteristics, specifically how the collector-emitter voltage U_{CE} and the base current I_B affect the collector current I_C . A key part of the experiment involves deriving the small-signal parameters of the transistor (h_{ije}) for various operating points and analyzing its small-signal equivalent circuit. The aim is to compare these values with typical characteristics of the BCP54 transistor and gaining a deeper understanding of its behavior.

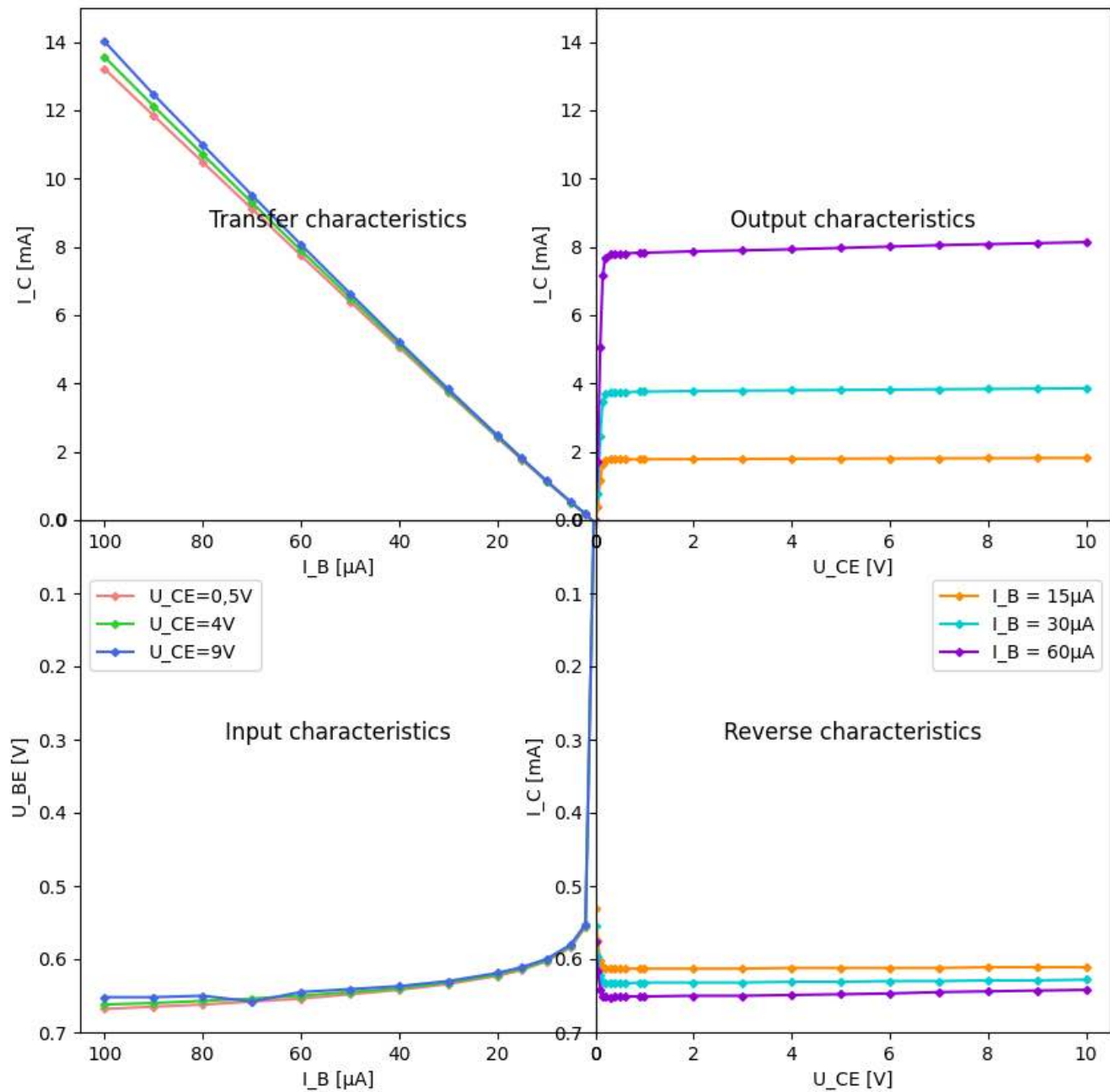
Furthermore, the experiment aims to analyze the transistor's saturation characteristics by examining U_{CEsat} as a function of I_B . Through this, we will calculate the β_N parameter, which indicates the transistor's current gain in saturation, providing insight into its switching behavior. A final objective is to graphically represent the transistor's input, output, transfer and reverse characteristics and discuss these findings in relation to theory.

2) Measurement scheme



The BJT was connected in a common-emitter configuration. The measured quantities included base current I_B , collector current I_C , base-emitter voltage U_{BE} , and collector-emitter voltage U_{CE} .

3) Results



The combined transfer and input characteristics were plotted for the base current I_B and collector current I_C at three different collector-emitter voltages [$U_{CE} = 0.5V, 4V, 9V$]. The transfer characteristic shows a linear increase in I_C with I_B for each value of U_{CE} .

The small-signal parameters were calculated for the following operating points:

- For $U_{CE} = 4V$ and $I_B = 15\mu A$:

$$h_{fe} = 117.27, \quad h_{ie} = 2950 \Omega, \quad h_{oe} = 0.0116 \text{ mS}, \quad h_{re} = 0.0118$$

- For $U_{CE} = 4V$ and $I_B = 30\mu A$:

$$h_{fe} = 123.33, \quad h_{ie} = 2567 \Omega, \quad h_{oe} = 0.03 \text{ mS}, \quad h_{re} = 0.0154$$

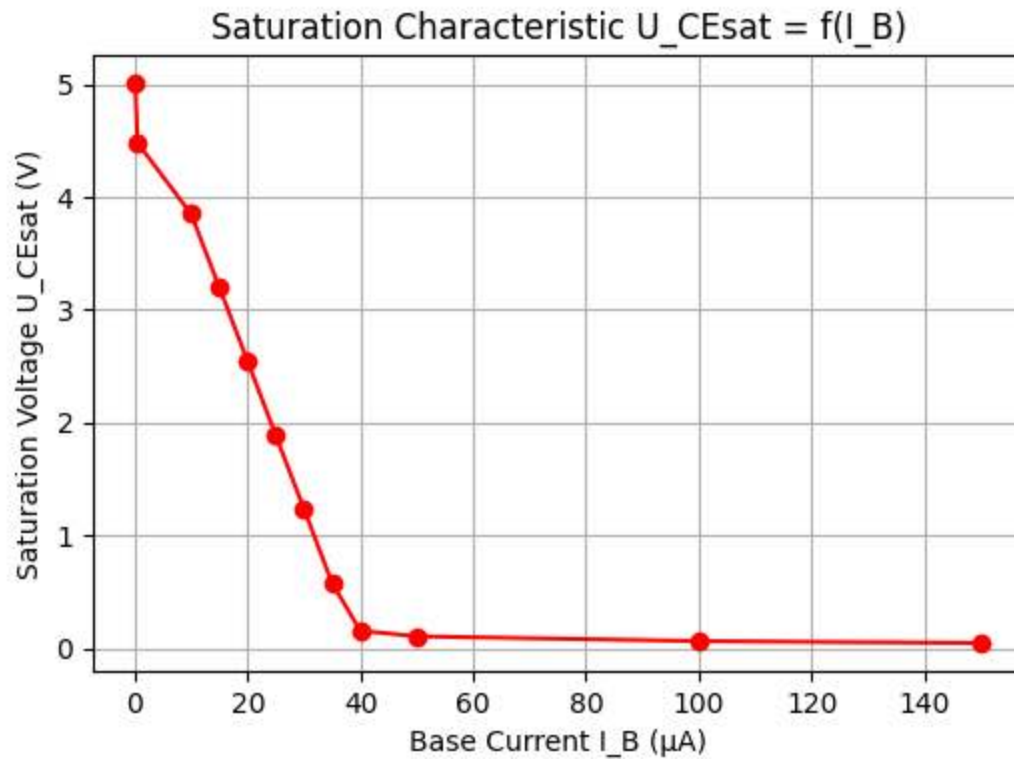
- For $U_{CE} = 9V$ and $I_B = 15\mu A$:

$$h_{fe} = 121.13, \quad h_{ie} = 3800 \Omega, \quad h_{oe} = 0.003 \text{ mS}, \quad h_{re} = 0.057$$

- For $U_{CE} = 9V$ and $I_B = 30\mu A$:

$$h_{fe} = 128.33, \quad h_{ie} = 1367 \Omega, \quad h_{oe} = 0.01 \text{ mS}, \quad h_{re} = 0.041$$

These values were compared with the typical values for the BCP54 transistor and showed consistency within the expected ranges.



The saturation characteristic $U_{CEsat} = f(I_B)$ was plotted. The saturation voltage decreases with increasing base current I_B .

- For $I_B = 20\mu A$, $\beta_N \approx 123$.

Calculations:

The current gain in saturation, β_N , was calculated as:

$$\beta_N = \frac{I_C}{I_B}$$

- For $I_B = 50\mu A$, $\beta_N \approx 98.2$.
- For $I_B = 100\mu A$, $\beta_N \approx 49.6$.
- For $I_B = 150\mu A$, $\beta_N \approx 33.13$.

4) Conclusions

The experiment successfully demonstrated the expected characteristics of a bipolar junction transistor, particularly the relationship between the base current I_B and the collector current I_C . The graphical representations of the I-V characteristics clearly showed the typical behavior of the transistor in both the active and saturation regions. As predicted, the collector current increased with rising base current, confirming the exponential dependence between I_B and the base-emitter voltage U_{BE} .

In the analysis of small-signal parameters, the derived values for the transistor's h_{ije} parameters were consistent with the typical values of a BCP54 transistor. This confirms the transistor's capacity to function as an amplifier and provides a deeper understanding of its characteristics.

The saturation characteristics were also observed as expected, with the U_{CEsat} values decreasing as I_B increased, marking the transition into saturation. The calculated β_N parameter demonstrated an appropriate current gain in saturation, further validating the transistor's expected behavior in switching applications.

Overall, the experiment provided clear, reliable data that aligned well with theoretical predictions. Minor discrepancies in measurements could be attributed to experimental limitations or environmental factors, but these did not significantly impact the overall results. The findings give valuable insights into the behavior of BJTs.