

ENGR 305 – Lab #6

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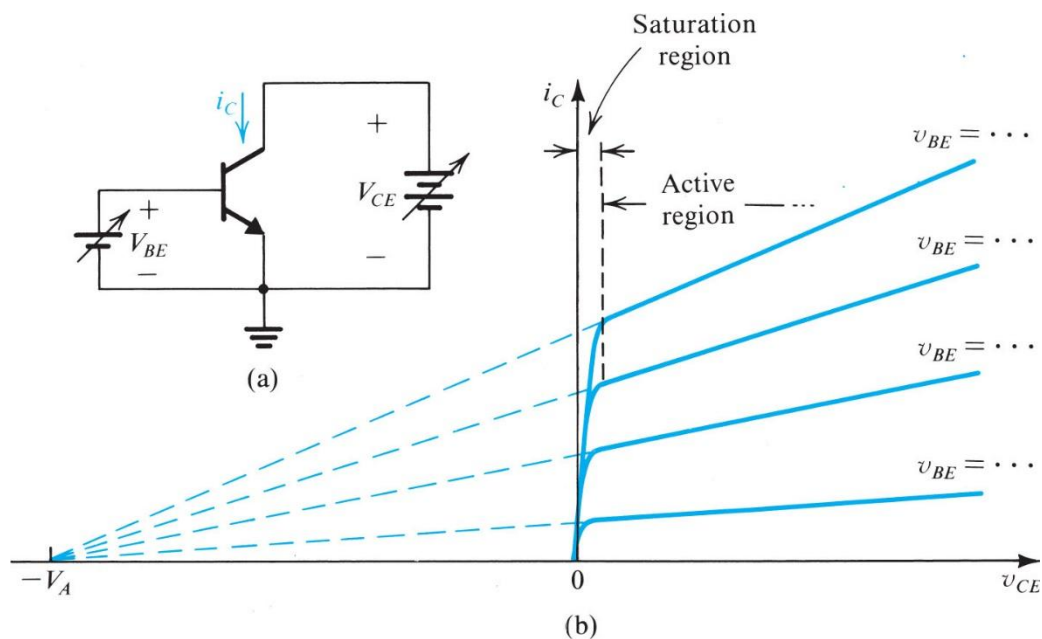
NPN I-V Characteristics

Objectives:

The objectives of this lab are to study the I-V curves of the NPN bipolar junction transistor by (1) implementing a circuit and taking measurements of the I_C vs. V_{BE} and I_C vs. V_{CE} curves and (2) extracting the value of β .

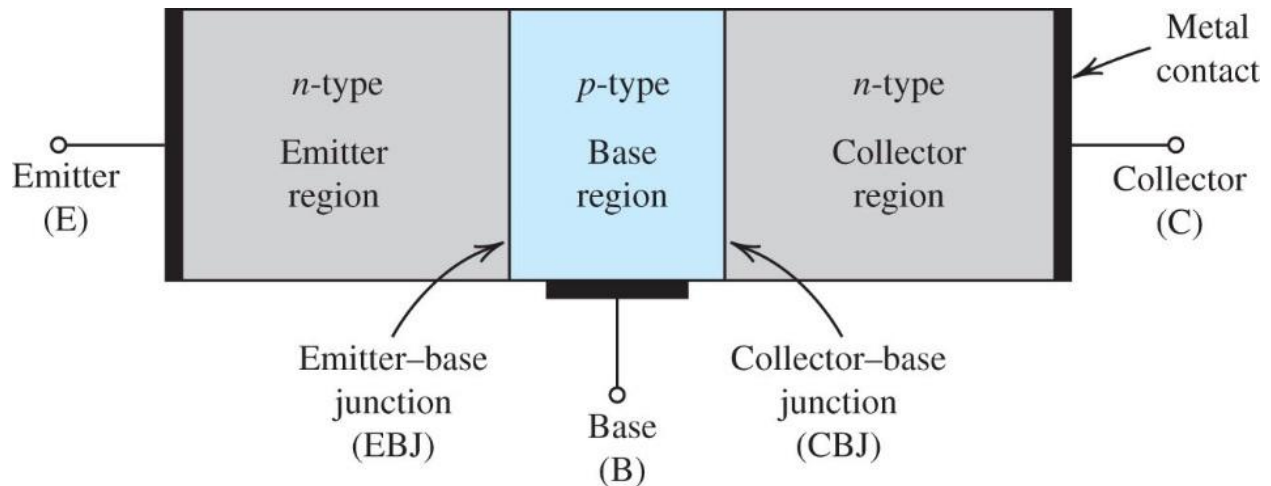
Materials:

- Laboratory setup, including breadboard
- NPN bipolar junction transistor (2N3904)
- Several wires and small resistors ($100\ \Omega$)



The figure shows the transistor measurement circuit as well as the I_C - V_{CE} characteristics of a practical BJT circuit.

The bipolar junction transistor consists of two pn junctions, the **emitter-base junction (EBJ)** and the **collector-base junction (CBJ)**.



The collector current, i_C , is a function of the forward-bias applied to the emitter-base junction.

$$i_C = I_S e^{v_{BE}/V_T}$$

In this lab, you will calculate the **common-emitter current gain**, β , of the transistor. The value of β can be determined from

$$\beta = \frac{i_C}{i_B}$$

Measurements:

I_C vs. V_{BE}

While setting V_{CE} 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 (alternatively, you may place a small resistor in series with the collector and measure the voltage drop across the resistor). Plot a curve of I_C vs V_{BE} . At what value of V_{BE} does the current turn on? Using small resistors placed in series with the base and collector terminals, measure I_B and I_C for $V_{BE} = 0.7V$. **Based on these numbers, what is your estimate of β ?**

I_C vs. V_{CE}

For three values of V_{BE} (0.6V, 0.7V, and 0.8V), sweep V_{CE} from 0 V to 1 V in increments of 0.1 V, and measure the collector current using the power supply. (Note: not all power supplies allow you to accurately measure current; if this is the case, you may place a small resistor in series with the collector and measure the voltage drop across the resistor). Plot the curves for I_C vs V_{CE} onto a single graph, clearly indicating the value of V_{BE} next to each curve.