

ECE 327: *Electronic Devices and Circuits Laboratory I*

Lab 1: The Bipolar (Junction) Transistor Quiz B (10 points)

Description. This quiz tests your comprehension of what you've read on bipolar junction transistors (BJTs). Complete this quiz with **closed book** and **closed notes**.

The following questions refer to Figure Q1-1, where (a) refers to Figure Q1-1(a) and (b) refers to Figure Q1-1(b).

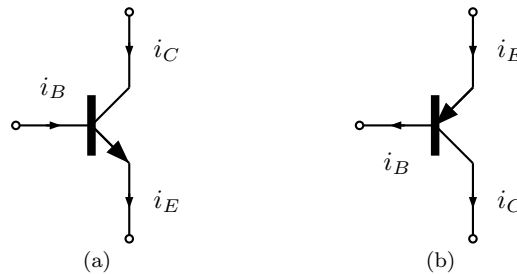


Figure Q1-1: BJT Transistors

Problem Q1-1: Transistor Terms

What do the current subscripts B , C , and E stand for? (3 points)

Solution

Base, Collector, and Emitter

Problem Q1-2: Transistor Types

Fill in the blanks with either (a) or (b). (1 point)

An *npn* transistor is depicted in (a). (emitter arrow is **not** pointing in)

A *npn* transistor is depicted in (b). (emitter arrow **points in** proudly)

Problem Q1-3: *npn* Charge Injection

Fill in the blanks. (1 point)

In active mode, the *emitter* in an *npn* transistor injects negative ly-charged electrons into the transistor, so it must be at a lower potential than the other two pins of the transistor.

Problem Q1-4: *npn* Charge Injection

Fill in the blanks. (1 point)

In active mode, the *emitter* in a *npn* transistor injects positive ly-charged “holes” into the transistor, so it must be at a higher potential than the other two pins of the transistor.

Problem Q1-5: Transistor Gain

Assume the transistors above are in *active* mode with current gain β . Express i_C and i_E in terms of β and i_B . (4 points)

Solution

By the Ebers–Moll model of a transistor, the collector current $i_C = \beta i_B$, and the emitter current $i_E = i_B + i_C$. So

$$\begin{aligned}i_E &= i_B + i_C \\ &= i_B + \beta i_B \\ &= \boxed{(\beta + 1)i_B}.\end{aligned}$$

Problem Q1-6: Limit of a Current (BONUS)

Assume that the transistors above are in *active* mode with current gain β , and assume that the emitter current i_E is *fixed*. The following questions refer to [Equation \(Q1-6.1\)](#).

$$\lim_{\beta \rightarrow \infty} i_B \tag{Q1-6.1}$$

6.1. What is the value of [Equation \(Q1-6.1\)](#)? (3 bonus points possible)

Solution

Using the values from [Problem Q1-5](#),

$$\lim_{\beta \rightarrow \infty} i_B = \lim_{\beta \rightarrow \infty} \frac{i_E}{\beta + 1} = \boxed{0}.$$

6.2. What does the answer to [6.1](#) mean about i_B when β is very large (i.e., $\beta \gg 1$)? (3 bonus points possible)

Solution

When $\beta \gg 1$, $i_B \approx 0$. In other words, we often assume that there is no current going into or out of the base of the transistor. In particular, we assume that i_B is negligibly small relative to i_C and i_E , and so $i_C \approx i_E$.