Physics 323

Experiment # 6 - Transistor Characteristics

Purpose

You will take several sets of data in order to plot the diode-like input characteristic of a bipolar junction transistor and the controlled current-source-like output characteristic in what is known as the "common emitter" configuration. The data you take today will be used in Experiments 7 and 8 when you design a small signal amplifier. All of which will form the basis for your formal report.

References: Storey 4e Ch. 18 pp. 387-392, 393-399
A. Ferendeci *Physical Foundations of Solid State and Electron Devices* pp.208-232
R. Dunlap *Experimental Physics: Modern Methods* pp. 53-59

Introduction

You will be using the 2N1305 transistor for this series of experiments. It is a 'pnp' transistor so if we stick with the convention that voltage labels such as V_{CB} mean that the *C*ollector voltage is measured relative to the *B*ase voltage then the voltages (and currents) will be negative. Sometimes the negative signs are just dropped for convenience and it is assumed you aren't running the transistor backwards.

You could consult the GE Transistor Manual for the data on this transistor (line number 1069) but for your convenience I will repeat them here. The specifications are: maximum power dissipation 150 mW, breakdown V_{CBO}=30 V, breakdown V_{EBO}=25 V, max I_C=300 mA, I_{CBO}=6 μA at max V_{CB}. Do not exceed any of the maxima listed there. This is the same actual transistor you will use for experiments # 6 → # 8 (not just the same model, the same transistor, so don't just throw it back in the drawer!).

Connect the transistor in the following circuit:

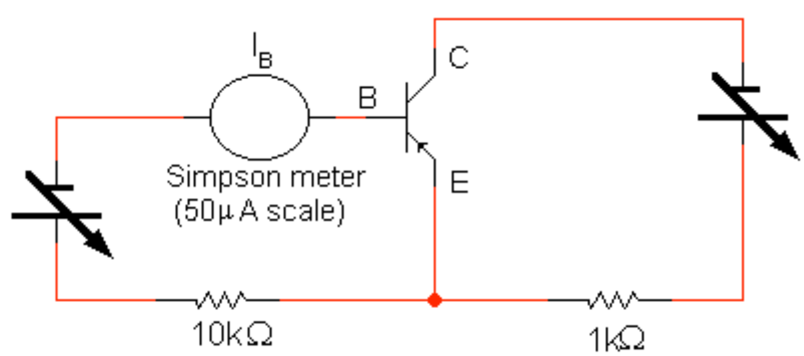

Figure 1: Circuit for measuring BJT characteristics in the common emitter configuration.

(Remember the longer plate on the variable voltage supply symbol refers to the positive terminal.) Don't let the age of the Simpson meter fool you. They are extremely good at measuring small currents. Connect the positive lead (where current enters) to the "10 A 50 μA 250 mV" terminal on the meter and the negative lead (where current exits) to the "COMMON" terminal and then wire into the circuit. Turn the dial on the front of the meter to "50 V μAMPS". You will make readings on the analog dial from the "0 10 20 30 40 50" row with 50 μA being full scale.

Prelab

Sketch the I_B vs V_{BE} and I_C vs V_{CE} curves for a pnp germanium transistor i.e. the input and output characteristics. Be clear about the polarities!

Lab

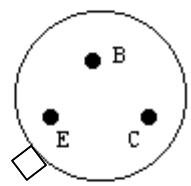

Figure 2 View of transistor from the bottom.

With a DVM (and the Simpson meter for I_B) measure V_{CE}, I_C, I_B and V_{BE} so that you may plot curves of:

(1) Output Characteristic: I_C vs V_{CE} for $I_B = 0, 8, 16, 24$ μA.
(when you change V_{CE} you will have to slightly readjust V_{BE} to keep I_B constant; you will likely forget at least once). See Fig. 3.

BUT AT THE SAME TIME…

(2) Input Characteristic: I_B vs V_{BE} for V_{CE}= 1, 5 or 10 volts. See Fig. 4.

(i.e. when V_{CE}= 1, 5 or 10 volts read V_{BE} so that you generate the data for both plots in one series of measurements).

These measurements are tedious! You might want to make a few measurements at the endpoints first. There are regions that are roughly linear but there are regions that aren't so it takes quite a few points to define the curves. The main thing that makes the procedure very annoying is that you aren't setting either V_{BE} or V_{CE}; instead you will tend to adjust the voltage supplies. You can set either V_{BE} or V_{CE} if you wish by cleverly watching the voltmeter rather than the voltage on the front of the power supplies. (and also watch that base current stays constant!)

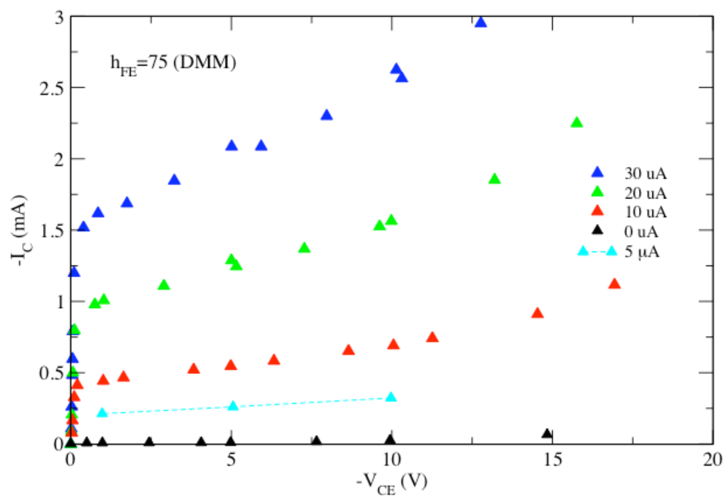

Figure 3: Example of output characteristic data

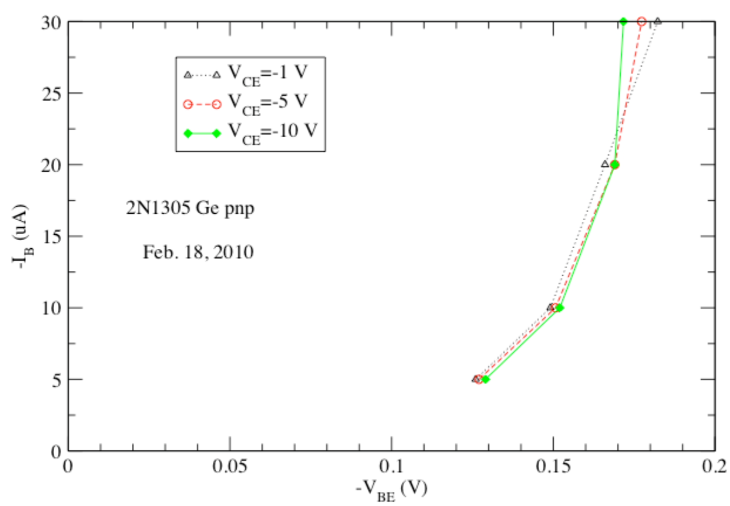

Figure 4: Example of input characteristic data

Why do the I_B vs V_{BE} curves vary slightly for different V_{CE}?
Remember: don't put the transistor back in the parts cabinet!