Lab 9 Report

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1 Introduction

In this lab we are studying the DC biasing of an NPN transistor. Refer to Figure 1 to see the circuit that we are building today. Via analysis of the circuit we will select resistor values that allow us to force this transistor to operate in the active and saturation regions.

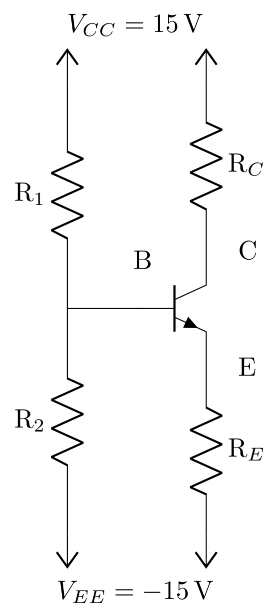

Figure 1: NPN Transistor Circuit

2 Active Region

We are tasked to design the circuit such that it follows the requirements shown in Figure 2.

I$_C$	1 mA
V$_B$	0 V
V$_C$	5 V

Figure 2: Table showing required values for NPN transistor in the Active Region.

Using the value for β that we got in the last lab ($\beta = 161.02$) we are able to determine the relationships between some currents through the transistor. We found i_B by using the equation $i_B = \frac{i_C}{\beta} = 6.21\,\mu\mathrm{A}$. These leaves the equation $i_E = i_C + i_B$. $i_E = 1.006\,21\,\mathrm{mA}$.

We now have enough information to determine the values of R_C and R_E. Using Ohm's Law over the resistors, and knowing that the values of V_C and V_E are 5 V and −0.7 V respectively, we could calculate the resistor values. $R_C = 10\,\mathrm{k\Omega}$ and $R_E = 14.2\,\mathrm{k\Omega}$. I used a script that I wrote to find resistors values that are within 1 percent of the required values using a combination of resistors available in the lab.

After an analysis of the left side of the circuit, we can find the resistor values that allow close to $6.21\,\mu\mathrm{A}$ of current to flow through the base terminal of the transistor. We selected a resistor R_1 that allows a current about 200 times the size of the base current through R_1. The selected resistor value was $12.137\,\mathrm{k\Omega}$, and this was done so that small variations in the current through R_1 will still result in enough current to flow through the base of the transistor.

Using KCL and some algebra we are able to find an expression for R_2 in terms in R_1.

$$R_2 = \frac{15\,\mathrm{V} R_1}{15\,\mathrm{V} - 6.21\,\mu\mathrm{A} R_1}$$

Using our selected value for R_1 we can find a value for R_2. We selected $R_2 = 12.198\,\mathrm{k\Omega}$. Because the values for R_1 and R_2 are very close together (within the tolerance of the resistors available to us in the lab), controlling the amount of current going through the base will be difficult, and we can basically achieve the same result by selecting identical resistors within the same order of magnitude. Because of that we selected a resistor value of $15\,\mathrm{k\Omega}$ because there were plenty available in our lab.