Universidade do Vale do Itajaí
Computer Engineering
Basic Electronics

Ninth Assignment for Basic Electronics

Student: Lucas Mateus Gonçalves
Teacher Advisor: Walter Antonio Gontijo

October
2021

Universidade do Vale do Itajaí
Computer Engineering
Basic Electronics

Ninth Assignment for Basic Electronics

Ninth Assignment for Basic Electronics presented for the class of the Twenty Second of October, 2021.

Student: Lucas Mateus Gonçalves

Teacher Advisor: Walter Antonio Gontijo

October
2021

Contents

1 Objective **1**

2 Introduction **1**

2.1 Uses of transistors 1

3 Circuit Analysis **1**

3.1 Separation of routes 2

3.1.1 *Collector* to *Emmiter* Route 2

3.1.2 *Base* to *Emmiter* Route 3

3.1.3 Joining the routes 3

3.2 Simulation 4

1 Objective

Analysis of circuits containing *NPN* transistors and their simulations.

2 Introduction

This paper will describe, analyse and simulate a simple circuit containing an *NPN* transistor.

2.1 Uses of transistors

A transistor can be used as a switch or an amplifier depending on the current through it's nodes.

Simply put, if the current from *emitter* to the *base* is reversed, the transistor is on, and can either amplify the signal on the *collector* or serve as a switch if the *collector* to *base* current isn't reversed.

3 Circuit Analysis

The following circuit will be analysed.

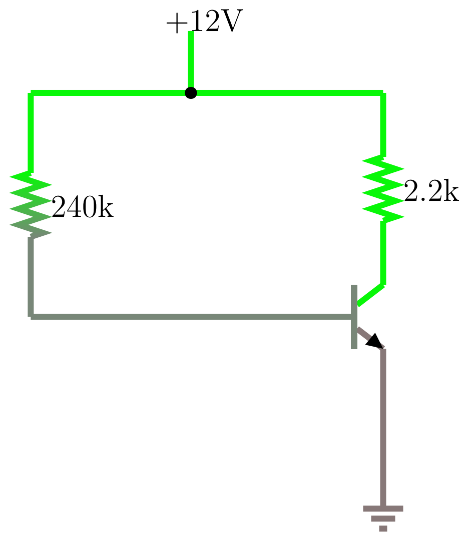

Figure 1: A simple *NPN* amplifier circuit, known $\beta = 50$

3.1 Separation of routes

To analyse this circuit one can simply separate the routes and calculate their parameters and join them after. In this case the *base* to *emitter* and the *collector* to *emitter* can be their own routes, calculated separately.

3.1.1 ***Collector* to *Emmiter* Route**

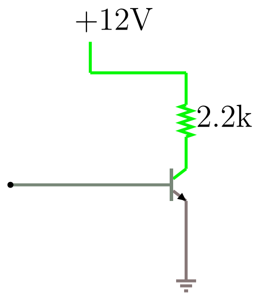

Figure 2: *Collector* to *emitter* route

This route can find the *Collector* current independent of the *Base*, as well as the voltage difference between the nodes of the transistor.

The following equations can be used here. Keeping in mind that these equations expect a series resistor, and it is likely that any circuit would have one since it's absence would cause a short between the supply and ground.

$$I_C = \beta \times I_B$$

$$V_{CE} + I_C \times R_C - V_{supply} = 0$$

Though the value for I_B is currently unknown, the following route will provide it.

3.1.2 ***Base*** to ***Emmiter*** Route

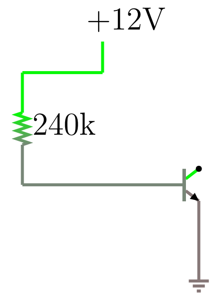

Figure 3: *Base* to *emitter* route

The following equations expect a constant of V_{BE} to be known, in silicon *NPN* transistors the value should be $0.7V$.

A resistor is also expected in the base to eliminate the possibility of a short.

$$V_{supply} - I_B \times R_B - V_{BE} = 0$$

The necessary parameter I_B can be found from the equation above.

$$I_B = \frac{V_{supply} - V_{BE}}{R_B}$$

Since all these values are known, the equation becomes as follows.

$$I_B = \frac{12 - 0.7}{240 \times 1000} = 0.000047A = 47\mu A$$

3.1.3 Joining the routes

Since I_B was the pre-requisite to find the other parameters, their values will be as follows.

$$I_B = 47,48\mu A$$

$$I_C = \beta \times I_B = 50 \times 47,48\mu = 2,35mA$$

$$V_{CE} = V_{supply} - I_C \times R_C = 6,83V$$

$$V_{BC} = V_{BE} - V_{CE} = -6,13V$$

3.2 Simulation

The following simulation was done with the simulation tool *Falstad Circuit Simulator*.

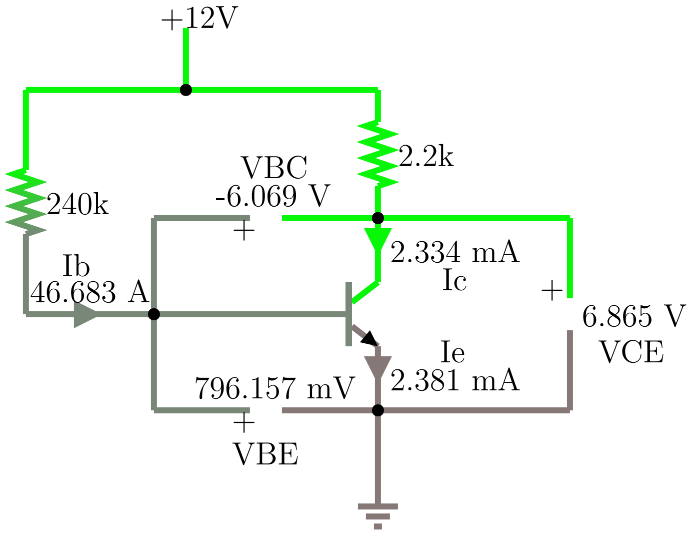

Figure 4: Simulation wit the constant $V_{BE} = 0,796V$

The simulation tool does not allow for a direct value change to the V_{BE} constant, however it is close enough that the calculated values can be noted on the simulation.

	$V_{BE} = 0,7V$	$V_{BE} = 0,796V$
I_B	47,08μA	46,683μA
I_C	2,35mA	2,334mA
V_{CE}	6,83V	6,864V
V_{BC}	-6,13V	-6,069V