Circuit Theory and Electronics Fundamentals

Department of Electrical and Computer Engineering, Técnico, University of Lisbon

March 24, 2021

Laboratory Assignment - T1

Grupo nº59

José Miguel Goulão - 95814
Lourenço Pacheco - 95817
André Gomes - 96352

Contents

1 Introduction

The objective of this laboratory assignment is to study a circuit containing:

- seven resistors (R_1-R_7)
- one voltage source (V_a)
- one current source (I_d)
- one voltage-controlled current source (I_b)
- one current-controlled voltage source (V_c)

Circuit T1 is presented in Figure 1. All components, including nodes ($N1$-$N8$) and ground(GND or 0), are identified with their respective names. Note that I_b is also refered to as G_1 and V_c as H_1 (explanation can be found in Subsection 3.1).

In Section 2, a theoretical analysis of the circuit is presented. In Section 3 , the circuit is analysed by simulation, and the results are compared to the theoretical results obtained in Section 2. The conclusions of this study are outlined in Section 4.

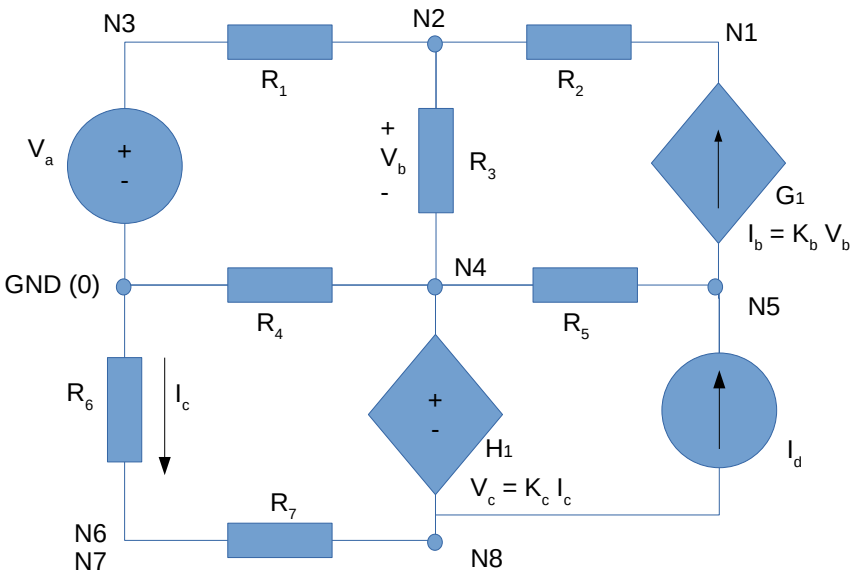

Figure 1: Circuit T1

For this laboratory assignment, the values considered for all the varibles can be found on Table 1. They were obtained through a Python script, by inserting the lowest student id number in our group (95814).

Name	Value
$R1$	1.00359089673
$R2$	2.04298963569
$R3$	3.02503141993
$R4$	4.05647775356
$R5$	3.07781188185
$R6$	2.01277040929
$R7$	1.01993304256
V_a	5.11402517827
I_d	1.03896393154
K_b	7.23768458527
K_c	8.33526265782

Table 1: Values provided by the Python sript.

2 Theoretical Analysis

In this section, the circuit in Figure 1 is analysed theoretically.

A precise description of the procedure used to compute all the values is presented. Furthermore, the equations that were aplied and the attained results are also shown.

2.1 Methodology

$$Ri(t) + v_O(t) = v_I(t). \tag{1}$$

2.2 Computed results

All the results are organized and displayed in Table 2.

Name	Value [A or V]
V_b	-4.752955e+00
V_c	7.657904e+00
$@I_b$	-2.957272e-01
$@I_c$	9.187358e-01
$@I_d$	1.038964e+00

Table 2: Values computed by Octave. Variables identified with a '@' have a corresponding value in Ampere (A). The others are expressed in Volts (V).

3 Simulation Analysis

In this section, Circuit T1 is reproduced with the help of Ngspice.

Firstly, the outcome of the simulation is shown, as well as a brief explanation on how it was achived. Afterwards, a comparison is done between those values and the ones attained in Subsection 2.2.

3.1 Simulated results

Table 3 shows the simulated operating point results for the circuit under analysis. Compared to the theoretical analysis results, one notices the following differences: describe and explain the differences.

Name	Value [A or V]
@g1[i]	-2.95727e-01
@id[current]	1.038964e+00
@r1[i]	-2.82220e-01
@r2[i]	-2.95727e-01
@r3[i]	1.350709e-02
@r4[i]	-1.20096e+00
@r5[i]	-1.33469e+00
@r6[i]	9.187358e-01
@r7[i]	-9.18736e-01
n1	4.226624e+00
n2	4.830792e+00
n3	5.114025e+00
n4	4.871651e+00
n5	8.979579e+00
n6	-1.84920e+00
n7	-1.84920e+00
n8	-2.78625e+00
v(n2,n4)	-4.08594e-02
v(n4,n8)	7.657904e+00

Table 3: Values given by Ngspice. Variables identified with a '@' have a corresponding value in Ampere (A). The others are expressed in Volts (V).

3.2 Values comparison

For this comparison, note that

With all that considered, we observe that all the absolute values displayed in Table 3 are identical to the ones shown in Table 2.

4 Conclusion

For this laboratory assignment, we were given a circuit composed by 7 resistors, 1 independent voltage source, 1 independent current source, 1 current-dependent voltage source, 1 voltage-dependent current source and had the objective of analyzing it, which we did successfully.

Static analyses were performed theoretically and by circuit simulation, using the Octave math tool and Ngspice tool, respectively. The simulation results matched the theoretical results very precisely, despite the circuit having dependent voltage and current sources (which could have caused some discrepancies in the results).