TÉCNICO LISBOA

Circuit Theory and Electronics Fundamentals

Masters of Aeroespace Engineer, Técnico, University of Lisbon

Laboratory Report

Group 37

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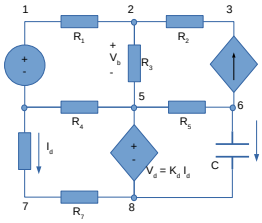
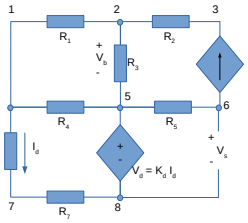
1 Introduction

In this laboratory assignment we study a circuit containing various elements, amongst them a capacitor, resistances and dependent and independent sources of voltage and current in order to accomplish various objectives. At first we analyse the circuit when t¡0, using the nodal method to determine the voltages in all nodes and currents in all branches. Then, in order to find the R_eq, we change the circuit into what is displayed in Figure 2, and with this new circuit, we'll find the total solution of the voltage V_s. To finalize, we are going to determine the frequency responses of the voltage in the capacitor and in the node 6.



(a) First Circuit



(b) Second Circuit

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.

2 Theoretical Analysis

2.1 1

$$\begin{pmatrix} 1 & 0 & 0 & -1 & 0 & 0 & 0 & 0 \\ -G1 & G1+G2+G3 & -G2 & 0 & -G3 & 0 & 0 & 0 \\ 0 & -G2-Kb & G2 & 0 & Kb & 0 & 0 & 0 \\ G1 & -G1 & 0 & G4+G6 & -G4 & 0 & -G6 & 0 \\ 0 & 0 & 0 & -Kd*G6 & 1 & 0 & Kd*G6 & 0 \\ 0 & Kb & 0 & 0 & -G5-Kb & G5 & 0 & 0 \\ 0 & 0 & 0 & -G6 & 0 & 0 & G6+G7 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} V1 \\ V2 \\ V3 \\ V4 \\ V5 \\ V6 \\ V7 \\ V8 \end{pmatrix} = \begin{pmatrix} V5 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

Octave - Voltages (V)	
V1	5.216040e+00
V2	4.939074e+00
V3	4.361415e+00
V4	0.000000e+00
V5	4.978786e+00
V6	5.853598e+00
V7	-2.001094e+00
V8	-2.978754e+00

Table 1: Octave solution (Voltages)

2.2 2

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 1 & 0 & -1 \\ -G1 & G1+G2+G3 & -G2 & 0 & -G3 & 0 & 0 & 0 \\ 0 & -G2-Kb & G2 & 0 & Kb & 0 & 0 & 0 \\ G1 & -G1 & 0 & G4+G6 & -G4 & 0 & -G6 & 0 \\ 0 & 0 & 0 & -Kd*G6 & 1 & 0 & Kd*G6 & 0 \\ 1 & 0 & 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -G6 & 0 & 0 & G6+G7 & -G7 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} V1 \\ V2 \\ V3 \\ V4 \\ V5 \\ V6 \\ V7 \\ V8 \end{pmatrix} = \begin{pmatrix} Vx \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

R_{eq} (Ω)	
R_{eq}	-1.316042e-03

Table 2: Octave solution (R_{eq})

2.3 3

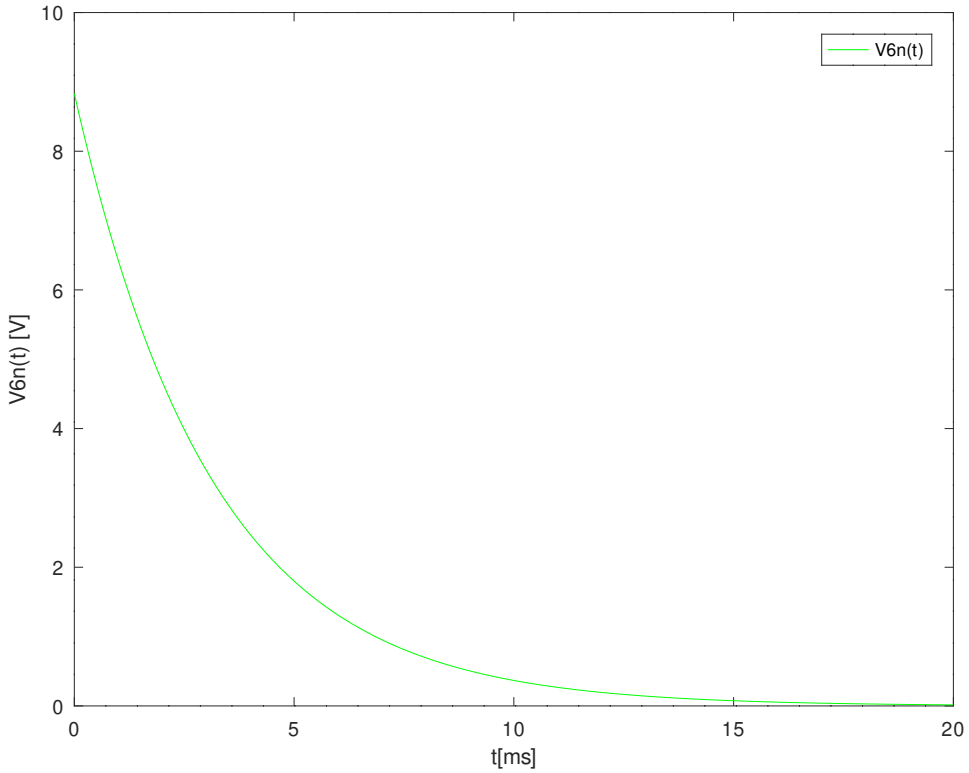


Figure 2: Natural Response

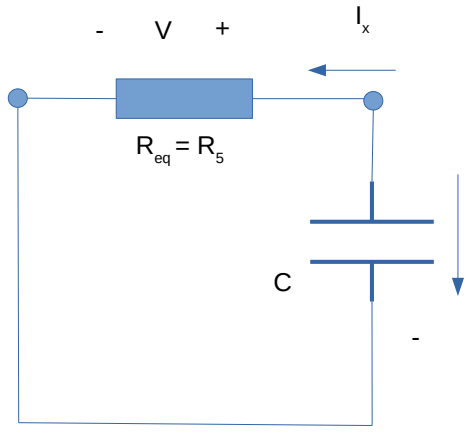


Figure 3: Circuit3

2.4 4

Complex Amplitudes(V)	
V1	1.000000e+00 + i(-1.549812e-33)
V2	9.469010e-01 + i(-1.466518e-17)
V3	8.361543e-01 + i(5.184518e-16)
V4	0.000000e+00 + i(-1.549812e-33)
V5	9.545144e-01 + i(-5.131501e-17)
V6	-5.667484e-01 + i(-8.549146e-02)
V7	-3.836423e-01 + i(2.062473e-17)
V8	-5.710758e-01 + i(3.070122e-17)

Table 3: Octave solution (Complex Amplitudes)

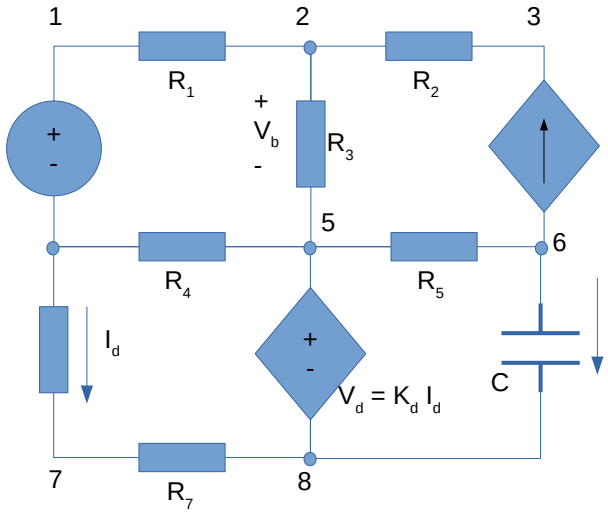


Figure 4: Circuit1

$$\begin{pmatrix} 1 & 0 & 0 & -1 & 0 & 0 & 0 & 0 \\ -G1 & G1+G2+G3 & -G2 & 0 & -G3 & 0 & 0 & 0 \\ 0 & -G2-Kb & G2 & 0 & Kb & 0 & 0 & 0 \\ G1 & -G1 & 0 & G4+G6 & -G4 & 0 & -G6 & 0 \\ 0 & 0 & 0 & -Kd*G6 & 1 & 0 & Kd*G6 & -1 \\ 0 & Kb & 0 & 0 & -G5-Kb & G5+\frac{1}{Z_c} & 0 & -\frac{1}{Z_c} \\ 0 & 0 & 0 & -G6 & 0 & 0 & G6+G7 & -G7 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} V1 \\ V2 \\ V3 \\ V4 \\ V5 \\ V6 \\ V7 \\ V8 \end{pmatrix} = \begin{pmatrix} V_s(t) \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

2.5 5

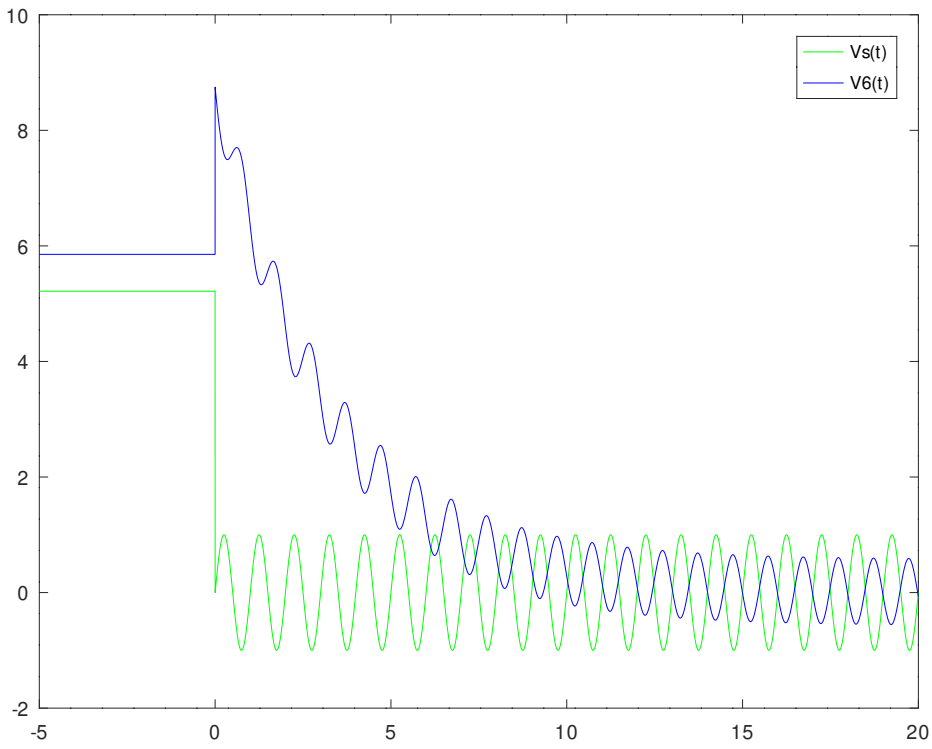


Figure 5: Natural and forced response

2.6 6

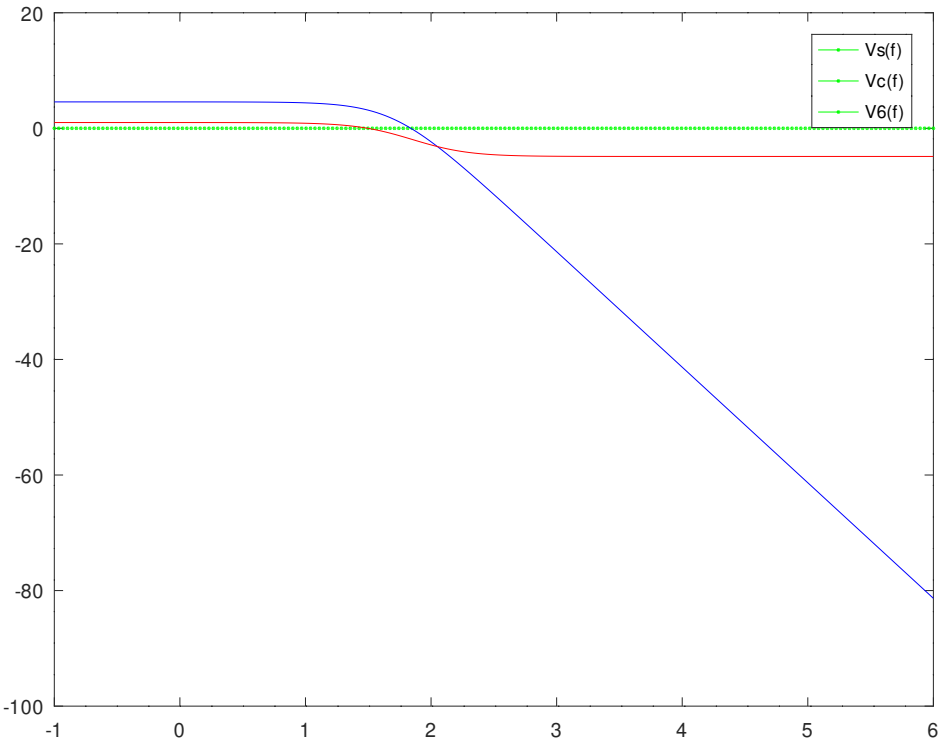


Figure 6: Amplitude

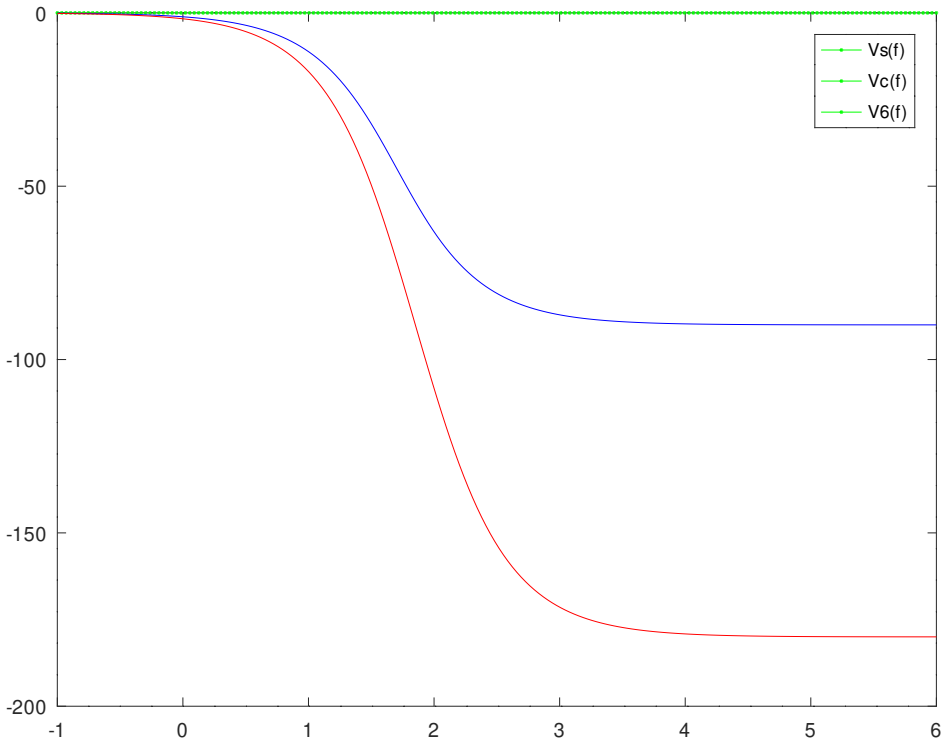


Figure 7: Arguments

3 Simulation Analysis

3.1 1

The results obtained from the simulation are shown in the table below.

Name	Value [A or V]	Name	Value [A or V]
@gb	-2.86455e-04	V1	5.216040e+00
@R1[i]	2.732478e-04	V2	4.939074e+00
@R2[i]	-2.86455e-04	V3	4.361415e+00
@R3[i]	-1.32073e-05	V5	4.978786e+00
@R4[i]	1.229564e-03	V6	5.853598e+00
@R5[i]	1.316042e-03	V7	-2.00109e+00
@R6[i]	9.563162e-04	V8	-2.97875e+00
@R7[i]	9.563162e-04	V9	0.000000e+00

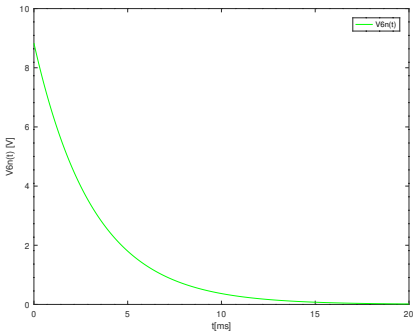
Table 4: NgSpice simulation results 1

3.2 2

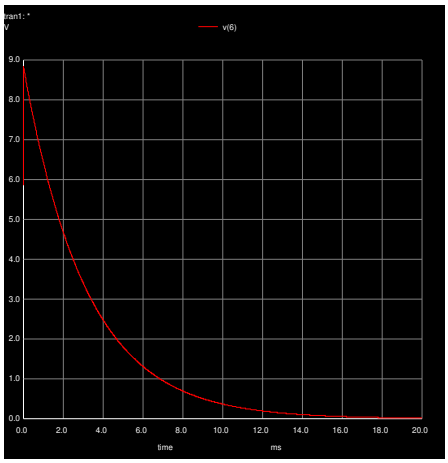
Name	Value [A or V]	Name	Value [A or V]
@gb	0.000000e+00	V1	0.000000e+00
@R1[i]	0.000000e+00	V2	0.000000e+00
@R2[i]	0.000000e+00	V3	0.000000e+00
@R3[i]	0.000000e+00	V5	0.000000e+00
@R4[i]	0.000000e+00	V6	5.000000e+01
@R5[i]	-1.63724e-02	V7	0.000000e+00
@R6[i]	0.000000e+00	V8	0.000000e+00
@R7[i]	0.000000e+00	V9	0.000000e+00

Table 5: NgSpice simulation results 2

3.3 3



(a) Natural Response (Octave)



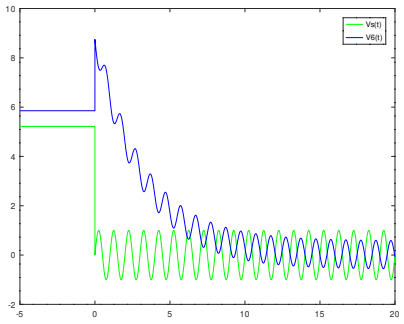
(b) Natural Response (NGSpice)

3.4 4

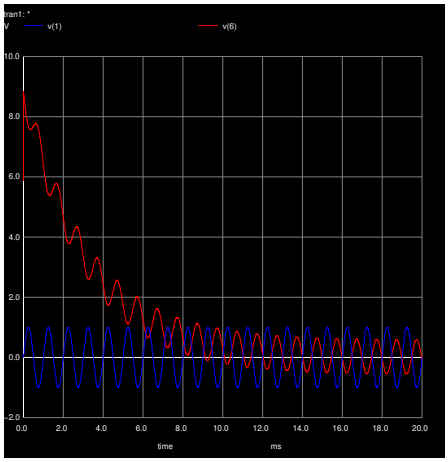
3.5 5

4 Conclusion

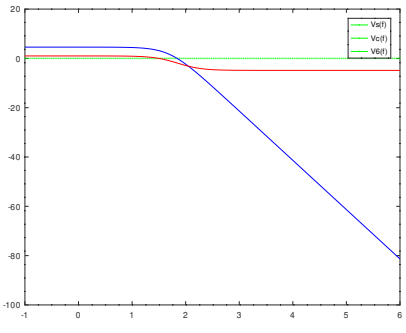
In this laboratory assignment the objective of analysing the circuit especified in the introduction has been achieved. All analyses have been performed both theoretically using the Octave maths tool and by circuit simulation using the Ngspice tool.



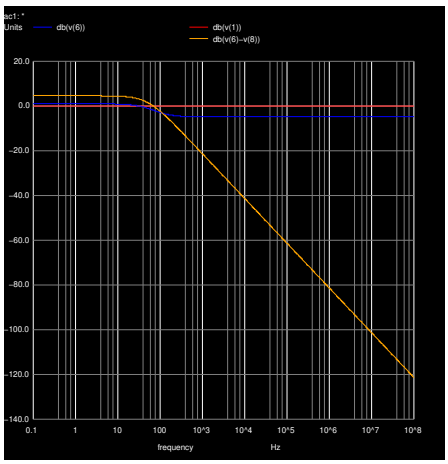
(a) Natural and forced response (Octave)



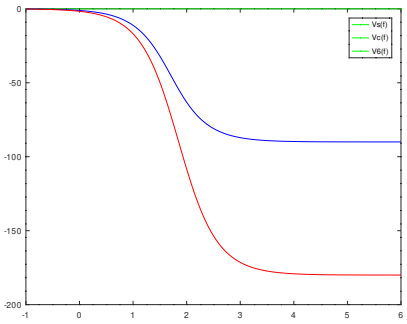
(b) Natural and forced response



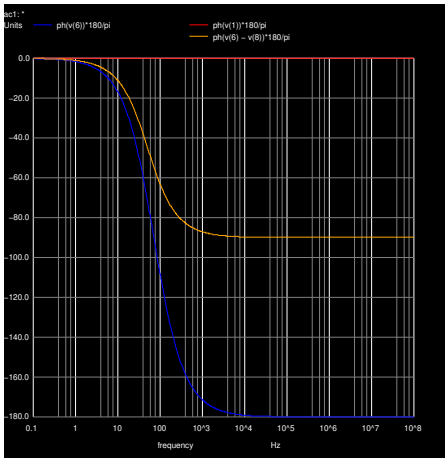
(a) First Circuit



(b) Second Circuit



(a) First Circuit



(b) Second Circuit