Circuit Theory and Electronics Fundamentals

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Example Laboratory Report

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Contents

1 Introduction

The objective of this laboratory assignment is to study a circuit containing a sinusoidal voltage source V_I connected to a resistor R and a capacitor C in series. The circuit can be seen if Figure 1.

In Section 2, a theoretical analysis of the circuit is presented. In Section 5, 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 6.

2 Theoretical Analysis

In this section, the circuit shown in Figure 1 is analysed theoretically, in terms of voltages and currents in each node and branches respectively.

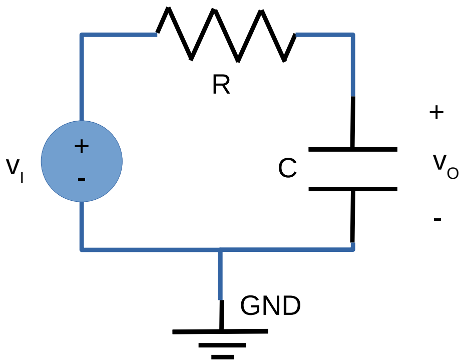

Figure 1: Voltage driven serial RC circuit.

3 Nodal Method

4 Mesh Method

By analysing the circuit in terms of the elementar meshes, we started by assuming that we have 4 unknown quantities: I_a, I_b, I_c, I_d (four meshes). With no effort, we realized that the current in the mesh of the lower right corner is defined by the current source I_d. Using the fact that the voltage-controlled current source presented in the mesh of I_b only belongs to this elementar mesh and that $I_b = K_b V_b$ (formula developed in 3), there is no need in writing an equation for the loop of current I_b. As a result, we are left with 2 independent variables: I_b and I_c and the following equations:

$$(R_1 + R_2 + R_4)\frac{K_b R_3 - 1}{K_b R_3} - R_3 - R_4 = -Va \tag{1}$$

$$-R_4 \frac{K_b R_3 - 1}{K_b R3} R_4 + R_6 + R_7 - K_c = 0 \tag{2}$$

During the derivation of the previous equations, the next restrition equations were used:

$$I_a = \frac{K_b R_3 - 1}{K_b R_3} I_b \tag{3}$$

$$V_c = K_c I_c \tag{4}$$

By solving equations with a script of *Octave*, we got following results presented in the table 1

Explain the currents, signals 'nd voltages

5 Simulation Analysis

5.1 Operating Point Analysis

Table 2 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]
I1	-1.184755e-05
I2	1.220737e-03
I3	-1.291422e-03
I4	9.670671e-04
I5	9.670671e-04
V1	7.956569e+00
V2	3.950179e+00
V3	3.643913e-02
V4	-4.955412e+00
V5	-6.947923e+00
V6	5.782312e-01
V7	-2.284139e-01
V8	-4.955412e+00

Table 1: Results of Mesh Analysis

6 Conclusion

In this laboratory assignment the objective of analysing an RC circuit has been achieved. Static, time and frequency analyses have been performed both theoretically using the Octave maths tool and by circuit simulation using the Ngspice tool. The simulation results matched the theoretical results precisely. The reason for this perfect match is the fact that this is a straightforward circuit containing only linear components, so the theoretical and simulation models cannot differ. For more complex components, the theoretical and simulation models could differ but this is not the case in this work.

Name	**Value [A or V]**
@gib[i]	-2.65517e-04
@id[current]	1.025904e-03
@r1[i]	-2.53670e-04
@r2[i]	-2.65517e-04
@r3[i]	-1.18476e-05
@r4[i]	1.220737e-03
@r5[i]	-1.29142e-03
@r6[i]	9.670671e-04
@r7[i]	9.670671e-04
v(1)	-7.95657e+00
v(2)	3.950179e+00
v(3)	-3.64391e-02
v(4)	-4.95541e+00
v(5)	-6.94792e+00
v(6)	-5.78231e-01
v(7)	2.284139e-01
v(8)	-4.95541e+00

Table 2: Operating point. A variable preceded by @ is of type *current* and expressed in Ampere; other variables are of type *voltage* and expressed in Volt.