TÉCNICO LISBOA

Circuit Theory and Electronics Fundamentals MEAer Example

Laboratory Report March 25, 2021

Contents

1 Introduction **1**

2 Theoretical Analysis **1**
2.1 Nodal method 1
2.2 Mesh method 4

3 Simulation **4**
3.1 Operating Point Analysis 4

4 Conclusion **5**

1 Introduction

The objective of this laboratoty is to study the behaviour of the circuit using nodal method and mesh method.The curcuit contains both dependent and independent current and voltage source, I_b,I_d,V_c and V_a respectively.The circuit also has resistors with known resistance.The circuit can be seen in figure 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.

2 Theoretical Analysis

This section, the circuit shown in Figure 1 is analysed theoretically, in terms of nodal and mesh method.

2.1 Nodal method

$R_1 = 1.0216234171$
$R_2 = 3.0213296603$
$R_4 = 4.17287588373$
$R_5 = 3.07453996538$
$R_6 = 2.06761158432$
$R_7 = 7.0023872588$
$I_d = 1.00202530449$

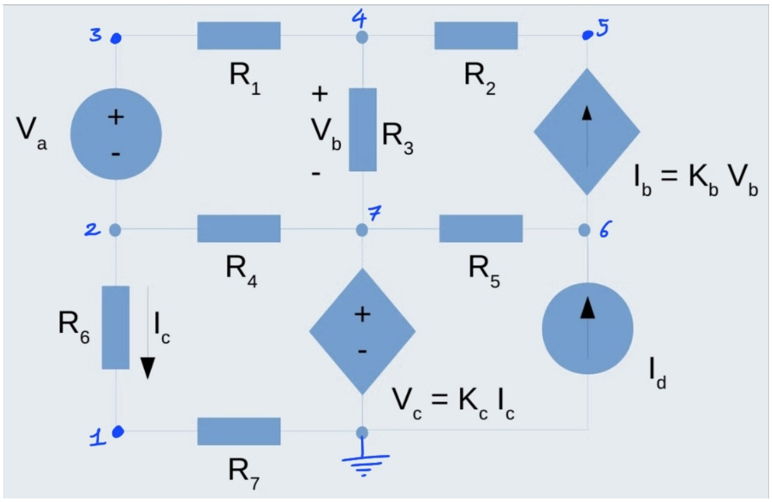

Figure 1: Dependent and Independent sources circuit.

$K_b = 1.00202530449$
$K_c = 8.38330387808$
The circuit has 7 nodes,labeled as 1 to 7.Node 0 is chosen as ground($V_0 = 0$).Using KCL for essential nodes(node 1,4,5,and 6),we have:
Node 1: $\frac{V_1}{R_7} + \frac{V_2 - V_1}{R_6}$
Using conductance, $G = \frac{1}{R}$, we get:
$V_1 G_7 + (V_2 - V_1) - G_6$..(1)
Node 4:
$(V_3 - V_4)G_1 - (V_4 - V_7)G_3 + (V_5 - V_4)G_2$..................................(2)
Node 5:
$I_b = (V_5 - V_4)G_2$...(3)
Node 6:
$I_d - I_b = (V_6 - V_7)G_5$..(4)
For node 7, $V_7 = V_c = K_c I_c$
Using octave to find the nodes voltages we get:

$V_1 = C_3$

$V_4 = \frac{G_3C_3+I_b}{G_1+G_3}$

$V_5 = \frac{G_2G_3C_3+I_b(G_1+G_2+G_3)}{G_2(G_1+G_3)}$

$V_6 = C_3 + \frac{I_d}{G_5}$

Substituting with the known values we have:

$V_1 = 3.02$

$C_3 + 3.0745 = V_b$

$V_6 = 6.09$

$0.68C_3 + I_b = V_5$

$0.68(3.02) + I_b = V_5$

$V_5 = 2.05 + I_b$

$0.25(C_3 + I_b) = V_4$

$0.25(3.02 + I_b) = V_4$

$0.76 + 0.76I_b = V_4$

$\frac{-V_5-V_4}{R_2} + I_b$

$\frac{-2.05-I_b0.76-0.76I_b}{2.01} = -I_b$

$\frac{-2.70I_b-0.76}{2.01} = -I_b$

$-2.70I_b - 0.76 = -2.01I_b$

$0.69I_b = 0.76$

$I_b = -1.10mA$

$V_5 = 2.05 - 1.10$

$V_5 = 0.95v$

$V_4 = -0.076v$

$V_4 = 0.076v$

$V_6 = 6.09V$

$V_1 = 3.02v$

2.2 Mesh method

Using KVL to find the currents in a circuit in Figure **??**,we have:

Mesh 1:
$I_1 = -I_b = -K_b V_b$..(1)
Mesh 2:
$I_2 = -I_d$...(2)
Mesh 3:
$-I_3(R_7 + R_6 + R_4) + R_4 - I_4 = V_c$...(3)
Mesh 4:
$I_1 R_3 + I_3 R_4 - I_4(R_1 + R_3 + R_4) = -V_a$
Using octave we get the values of currents as:
$I_1 = -I_b$

$I_2 = I_d$

$I_3 = \frac{I_b R - 3R_4 - R_4 V_a + V_c(R_1+R_3+R_4)}{R_4^2 - (R_1+R_3+R_4)(R_4+R_6+R_7}$

$I_4 = \frac{I_b R_3(R_4+R_6+R_7) + R_4 V_c - V_a(R_4+R_6+R_7)}{R_4^2 - (R_1+R_3+R_4)(R_4+R_6+R_7}$

Sustituting and doing algebra we get values I as:
$I_1 = 1.10mA$
$I_2 = 1mA$
$I_3 = 0.65mA$
$I_4 = 1.44mA$

Current that is flowing in each resister is:

$I_{R_1} = 1.44mA$
$I_{R_2} = 1.00mA$
$I_{R_3} = 0.34mA$
$I_{R_4} = 0.79mA$
$I_{R_5} = 0.1mA$
$I_{R_6} = 0.65mA$
$I_{R_7} = 0.65$

3 Simulation

3.1 Operating Point Analysis

Table 1 shows the simulated operating point results for the circuit under analysis. Compared to the theoretical analysis results, one notices the following differences:

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci

Name	Value [mA and V]
@gb[i]	-1.68378e-01
@id[current]	1.000000e+00
@r1[i]	-1.68378e-01
@r2[i]	-1.68378e-01
@r4[i]	-2.66153e-01
@r5[i]	-1.16838e+00
@r6[i]	-9.77754e-02
@r7[i]	-9.77754e-02
a	-5.41101e+00
b	-5.31323e+00
c	-5.10986e+00
d	1.201401e-01
e	-5.16055e-02
f	-3.90045e-01
g	-4.13079e-01
h	-4.00000e+00

Table 1: Operating point. A variable preceded by @ is of type *current* and expressed in mA; other variables are of type *voltage* and expressed in Volt.

eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

4 Conclusion

In this laboratory assignment the objective of analysing the circuit has been achieved. Voltage and currents of resistors have been performed both theoretically using the Octave maths tool and by circuit simulation using the Ngspice tool. The simulation results does not matched the theoretical results precisely. The reason for this may be due to the errors been made during theoretical analysis when doing algebra and computing the equations.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.