Circuit Theory and Electronics Fundamentals MEAer Example

Laboratory Report March 25, 2021

Contents

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 **??**, 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 **??**.

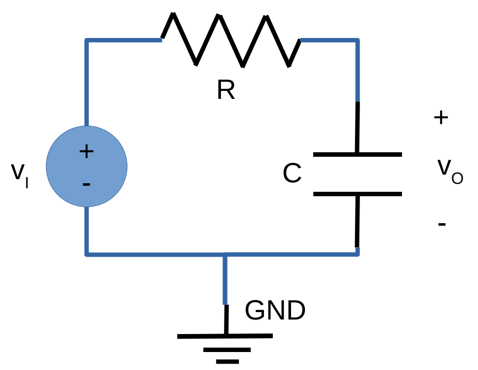

Figure 1: Dependent and Independent sources circuit.

2 Theoretical Analysis

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

3 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
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:

$V_1 = C_3$
$V_4 = \frac{G_3 * C_3 + I_b}{G_1 + G_3}$
$V_5 = \frac{G_2 * G_3 * C_3 + I_b * (G_1 + G_2 + G_3)}{G_2 * (G_1 + G_3)}$
$V_6 = C_3 + \frac{I_d}{G_5}$

Substituting with the known values we have:

$V_1 = 3.02$
$C_3 + 3.0745 = V_b$
$V_6 = 6.09$
$0.68 * C_3 + I_b = V_5$
$0.68(3.02) + I_b = V_5$
$V_5 = 2.05 + I_b$
$0.25(C_3 + I_b) = V_4$
$0.25(3.02 + I_b) = V_4$
$0.76 + 0.76 * I_b = V_4$
$\frac{-V_5 - V_4}{R_2} + I_b$
$\frac{-2.05 - I_b * 0.76 - 0.76 * I_b}{2.01} = -I_b$
$\frac{-2.70 * I_b - 0.76}{2.01} = -I_b$
$-2.70 * I_b - 0.76 = -2.01 * I_b$
$0.69 * I_b = 0.76$
$I_b = -1.10mA$
$V_5 = 2.05 - 1.10$

$V_5 = 0.95v$
$V_4 = -0.076v$
$V_4 = 0.076v$
$V_6 = 6.09V$
$V_1 = 3.02v$

4 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:
$I_1 = -I_b$
$I_2 = I_d$
$V_3 = \frac{I_b * R - 3 * R_4 - R_4 * V_a + V_c(R_1 + R_3 + R_4)}{R_4^2 - (R_1 + R_3 + R_4) * (R_4 + R_6 + R_7}$
$V_4 = \frac{I_b * R_3 * (R_4 + R_6 + R_7) + R_4 * V_c - V_a(R_4 + R_6 + R_7)}{R_4^2 - (R_1 + R_3 + R_4)(R_4 + R_6 + R_7}$