Last Name __________________ Last Name __________________ Matricola __________________

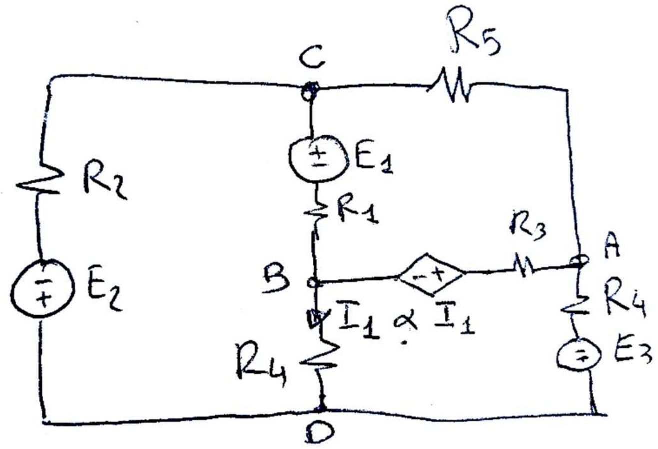
Messina, 15 June 2022

Exercise 1

Solve the given circuit below by using the mesh analysis for the three currents as indicated.

a) Write the R matrix in analytical form.

b) Compute the value of the mesh currents J_1, J_2 and J_3 (clockwise sense) using the following values for $R_1 = 4\ \Omega$, $R_2 = 6\ \Omega$, $R_3 = 4\ \Omega$, $R_4 = 8\ \Omega$, $R_5 = 4\ \Omega$, $E_1 = 2$ V, $E_2 = 5$ V, $E_3 = 4$ V, and $\alpha = -2\ \Omega$; [J_1 → C-B-D-C; J_2 → C-A-B-C; J_3 → A-D-B-A]

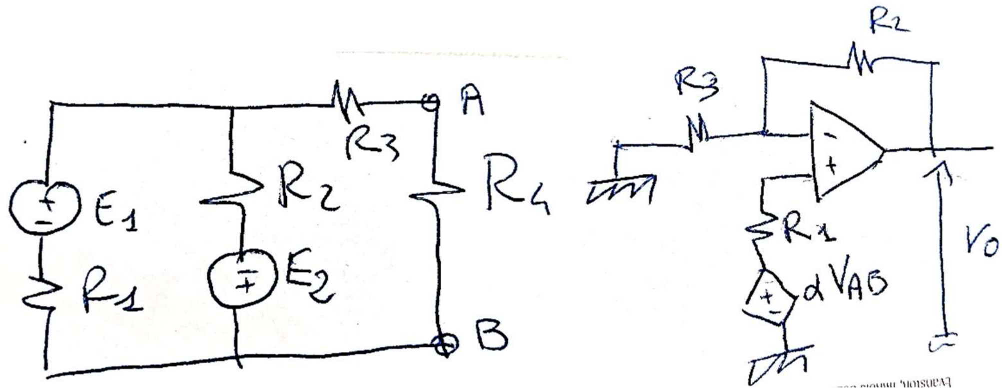


Exercise 2

Solve the given circuit below.

a) Compute analytically the expression of the V_0 (help use the Millman theorem)

b) Compute the value of V_0 considering the following parameters $R_1 = 1\ \Omega$, $R_2 = 1\ \Omega$, $R_3 = 5\ \Omega$, $R_4 = 2\ \Omega$, $\alpha = 1$, $E_1 = 10$ V and $E_2 = -5$ V.



Exercise 3

a) For a given an RL circuit with $R=2\Omega$ and $L=0.5$ H. Compute the current flowing into the inductor L after 100 ms $i_L(100\text{ ms})$ considering that the current at t=0s flowing into the inductor is equal to 1A ($i_L(0)=1A$).

Sign here ____

Exercise 1:

a)

b)

Exercise 2:

a)

b)

Exercise 3:

a)

Solution 1

a)

$$\begin{pmatrix} R_1+R_2+R_4 & -R_1 & -R_4 \\ -R_1 & R_1+R_3+R_5 & -R_3 \\ -R_4 & -R_3 & 2R_4+R_3 \end{pmatrix}\begin{pmatrix} J_1 \\ J_2 \\ J_3 \end{pmatrix}=\begin{pmatrix} -E_1-E_2 \\ -\alpha I_1+E_1 \\ \alpha I_1+E_3 \end{pmatrix}$$

$$I_1 = J_1 - J_3$$

$$\begin{pmatrix} R_1+R_2+R_4 & -R_1 & -R_4 \\ -R_1 & R_1+R_3+R_5 & -R_3 \\ -R_4 & -R_3 & 2R_4+R_3 \end{pmatrix}\begin{pmatrix} J_1 \\ J_2 \\ J_3 \end{pmatrix}=\begin{pmatrix} -E_1-E_2 \\ -\alpha J_1+\alpha J_3+E_1 \\ \alpha J_1-\alpha J_3+E_3 \end{pmatrix}$$

$$\begin{pmatrix} R_1+R_2+R_4 & -R_1 & -R_4 \\ -R_1+\alpha & R_1+R_3+R_5 & -R_3-\alpha \\ -R_4-\alpha & -R_3 & 2R_4+R_3+\alpha \end{pmatrix}\begin{pmatrix} J_1 \\ J_2 \\ J_3 \end{pmatrix}=\begin{pmatrix} -E_1-E_2 \\ E_1 \\ E_3 \end{pmatrix}$$

b) J_1 = -0.31 A; J_2 = 0.08 A; J_3 = 0.14 A

Solution 2

a) First of all we need to evaluate the V_{AB}. I will apply the Millman theorem and the voltage divider over the resistance R_3 and R_4. The voltage V_{AB} is given by

$$V_{AB}=\left(\frac{E_1/R_1-E_2/R_2}{1/R_1+1/R_2+1/(R_3+R_4)}\right)\frac{R_4}{(R_3+R_4)}$$

The circuit with the OP AMP is a noninverting amplifier then we have

$$V_0=\alpha V_{AB}\left(1+\frac{R_2}{R_3}\right)$$

V_0 is given by

b) V_0= 2.4 V

Solution 3

$$\tau = R/L = 4s$$
$$t = 100ms$$
$$i_L(t)=i_L(0)e^{-t/\tau}=1e^{-0.1/4}=0.98V$$