Last Name __________________ Last Name __________________ Matricola __________________

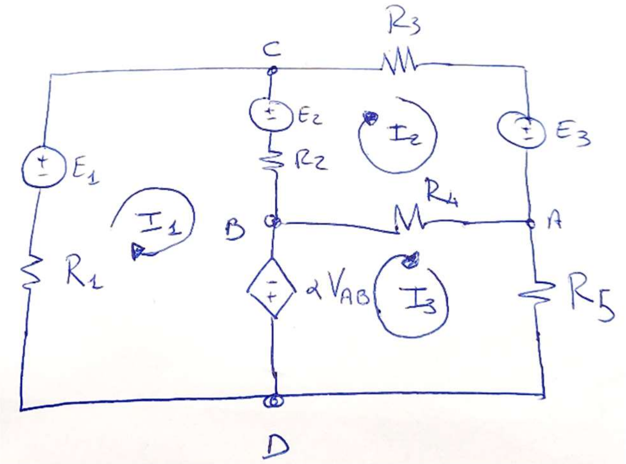
Messina, 22 February 2022

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 I_1, I_2 and I_3, 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 $\alpha = 2$;



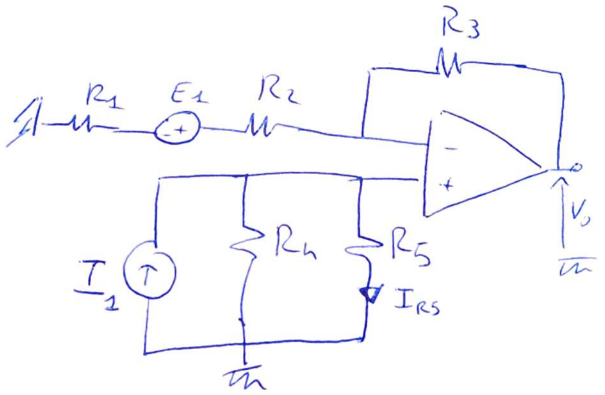
Exercise 2

Solve the given circuit below.

a) Compute analytically the expression of the V_0 as a function of I_1 and E_1.

b) Compute the value of V_0 considering the following parameters $R_1 = 2\ \Omega$, $R_2 = 1\ \Omega$, $R_3 = 10\ \Omega$, $R_4 = 5\ \Omega$, $R_5 = 3\ \Omega$, $I_1 = 2$ A, and $E_1 = 14$ V.

c) Compute the value of I_{R5} considering the same values for the devices as reported in the point b).



Exercise 3

For a given an RC circuit with R=1Ω and C=0.1 F. Compute the voltage of across the Capacitor after 200 ms $v_C(200\text{ ms})$ considering that the voltage at t=0s across the Capacitor equal to 1V ($v_C(0)$=1V).

Sign here ____

Exercise 1:

a)

b)

Exercise 2:

a)

b)

c)

Exercise 3:

Solution 1

a)

$$\begin{pmatrix} R_1+R_2 & -R_2 & 0 \\ -R_2 & R_2+R_3+R_4 & -R_4 \\ 0 & -R_4 & R_4+R_5 \end{pmatrix}\begin{pmatrix} I_1 \\ I_2 \\ I_3 \end{pmatrix} = \begin{pmatrix} E_1-E_2+\alpha V_{AB} \\ E_2-E_3 \\ -\alpha V_{AB} \end{pmatrix}$$

$$V_{AB} = R_4 I_2 - R_4 I_3$$

$$\begin{pmatrix} R_1+R_2 & -R_2 & 0 \\ -R_2 & R_2+R_3+R_4 & -R_4 \\ 0 & -R_4 & R_4+R_5 \end{pmatrix}\begin{pmatrix} I_1 \\ I_2 \\ I_3 \end{pmatrix} = \begin{pmatrix} E_1-E_2+\alpha R_4 I_2-\alpha R_4 I_3 \\ E_2-E_3 \\ -\alpha R_4 I_2+\alpha R_4 I_3 \end{pmatrix}$$

$$\begin{pmatrix} R_1+R_2 & -R_2-\alpha R_4 & \alpha R_4 \\ -R_2 & R_2+R_3+R_4 & -R_4 \\ 0 & -R_4+\alpha R_4 & R_4+R_5-\alpha R_4 \end{pmatrix}\begin{pmatrix} I_1 \\ I_2 \\ I_3 \end{pmatrix} = \begin{pmatrix} E_1-E_2 \\ E_2-E_3 \\ 0 \end{pmatrix}$$

b) I_1 = 1.3 A; I_2 = -0.6 A; I_3 = -1.2 A

Solution 2

a) This is a difference amplifier. V_0 is given by

$$V_0 = -\left(\frac{R_3}{R_1+R_2}\right)E_1 + \left(1+\frac{R_3}{R_1+R_2}\right)V^-$$

$$V^- = V^+$$

$$V^+ = I_1\frac{R_4 R_5}{R_4+R_5}$$

$$V_0 = -\left(\frac{R_3}{R_1+R_2}\right)E_1 + \left(1+\frac{R_3}{R_1+R_2}\right)\frac{R_4 R_5}{R_4+R_5}I_1$$

b) V0=-30.42 V

c) $I_{R5} = I_1\dfrac{R_4}{R_4+R_5} = 1.25A$

Solution 3

$$v(t) = v(0)e^{-t/\tau} = 1e^{-2} = 0.14V$$

$$\tau = RC = 0.1s$$

$$t = 200ms$$