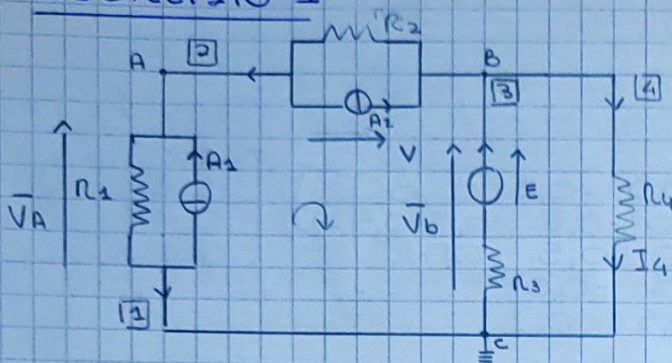


19.09.2011

ESERCIZIO 1



$A_2 = 8A$
 $E = 25V$
 $R_1 = 5\Omega$
 $R_2 = 2\Omega$
 $R_3 = 6\Omega$
 $R_4 = 3\Omega$

CASO 1: $A_2 = 8A$

$$C = \begin{bmatrix} 1 & -1 & 0 & 0 \\ 0 & 1 & -1 & 1 \end{bmatrix}$$

$$A = \begin{bmatrix} -10 \\ -8 \\ 0 \\ 0 \end{bmatrix}$$

$$G = \begin{bmatrix} 0,2 & 0 & 0 & 0 \\ 0 & 0,5 & 0 & 0 \\ 0 & 0 & 0,17 & 0 \\ 0 & 0 & 0 & 0,33 \end{bmatrix}$$

$$E = \begin{bmatrix} 0 \\ 0 \\ -25 \\ 0 \end{bmatrix}$$

$$\bar{G} = \begin{bmatrix} 0,7 & -0,5 \\ -0,5 & 1 \end{bmatrix}$$

$$\bar{I} = C \cdot G \cdot E - C \cdot A$$

$$\bar{I} = \begin{bmatrix} 0 \\ 4,25 \end{bmatrix} - \begin{bmatrix} -2 \\ -8 \end{bmatrix} = \begin{bmatrix} 2 \\ 12,25 \end{bmatrix}$$

$$\bar{V} = \bar{G}^{-1} \cdot \bar{I}$$

$$\bar{V} = \begin{bmatrix} 2,22 & 1,11 \\ 1,11 & 1,55 \end{bmatrix} \begin{bmatrix} 2 \\ 12,25 \end{bmatrix} = \begin{bmatrix} 17,8 \\ 21,2 \end{bmatrix}$$

$$V_A = 17,8V \quad V_B = 21,2V$$

$$V = V_B - V_A \quad P_{A2} = V \cdot A_2 = 25,5W$$

CASO 2: $A_2 = R \cdot I_4$

con $R = 1$

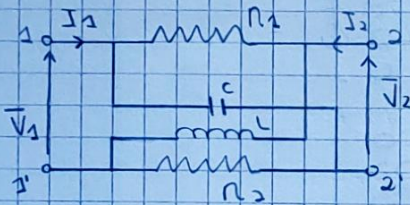
$$G = \begin{bmatrix} 0,2 & 0 & 0 & 0 \\ 0 & 0,5 & 0 & -1 \\ 0 & 0 & 0,14 & 0 \\ 0 & 0 & 0 & 0,33 \end{bmatrix}$$

$$\bar{G} = Cr \cdot G \cdot Cr^T$$

$$\bar{G} = \begin{bmatrix} 0,2 & -0,5 & 0 & 1 \\ 0 & 0,5 & -0,14 & -0,67 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ -1 & 1 \\ 0 & -1 \\ 0 & 1 \end{bmatrix}$$

$$\bar{G} = \begin{bmatrix} 0,7 & 0,5 \\ -0,5 & 0 \end{bmatrix}$$

ESENCIZIO 2



$$R_1 = 1 \Omega$$

$$R_2 = 6 \Omega$$

$$C = 400 \mu F$$

$$L = 9 mH$$

$$\omega = 500 \text{ rad/s}$$

$(R_1 \parallel C)$ in serie $(R_2 \parallel L)$

$V_2 = 0$ sono in cortocircuito.

$$Z_1 = R_1 = 1 \Omega$$

$$Z_L = j\omega L = 4,5j \Omega$$

$$Z_2 = R_2 = 6 \Omega$$

$$Z_C = -\frac{j}{\omega C} = -5j \Omega$$

$$Z_{11} = \left(\frac{1}{R_1} + \frac{1}{Z_C} \right)^{-1} + \left(\frac{1}{R_2} + \frac{1}{Z_L} \right)^{-1}$$

$$Z_{11} = h_{11} = 3,13 + 2,69j \Omega$$

$$V_1 = h_{11} \cdot I_1 + h_{12} \cdot V_2$$

$$I_2 = h_{21} I_1 + h_{22} V_2$$

Se $V_2 = 0 \Rightarrow h_{11} = \left(\frac{V_1}{I_1} \right)_{V_2=0}$

$$h_{21} = -h_{12}$$

Se $I_1 = 0 \Rightarrow h_{22} = \left(\frac{I_2}{V_2} \right)_{I_1=0}$

$$h_{22} = \frac{1}{Z_{eq22}}$$

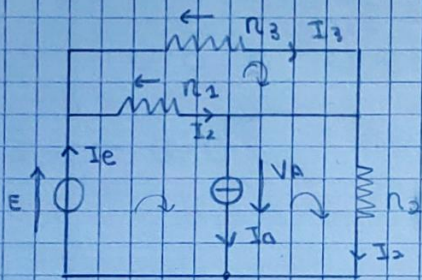
$$(R_1 + C) \parallel (R_2 + L)$$

$$Z_{22} = 4,31 - 3,33j \Omega$$

$$h_{22} = 0,15 + 0,11j \Omega^{-1}$$

22.02.2011

ESERCIZIO 1



$$\begin{aligned} E &= 12V \\ R_1 &= 2\Omega \\ R_2 &= 4\Omega \\ R_3 &= 6\Omega \end{aligned}$$

- CASO 1: $A = 3A$

- effetto di A

$$V_3 = V_1 \quad R_3 I_3 = R_1 I_1$$

$$V_1 = V_A \quad R_1 I_1 = V_A$$

$$V_A = -V_2 \quad V_A = -R_2 I_2$$

$$R_3 I_3 = R_1 (I_e - I_3) \quad I_3 = \frac{1}{4} I_e$$

$$R_1 (I_e - I_3) = -R_2 (I_e - A)$$

$$R_1 (I_e - \frac{1}{4} I_e) = -R_2 I_e + 12$$

$$(\frac{3}{2} + 4) I_e = 12$$

$$I_e = 2,18A$$

$$A + I_2 = I_e$$

$$I_e = I_3 + I_1$$

$$I_2 = I_e - A \quad I_2 = -0,82A$$

$$I_3 = 0,55A$$

$$I_1 = I_e - I_3 \quad I_1 = 1,63A$$

- effetto E

$$I_e = \frac{E}{R_{eq}} \quad R_{eq} = \frac{11}{2} \Omega$$

$$I_e = 2,18A$$

$$I_1 = I_e \frac{R_3}{R_1 + R_3}$$

$$I_2 = I_e = 2,18A$$

$$I_1 = 2,18 \cdot \frac{6}{8} = 1,63A$$

$$I_e = I_3 + I_1 \quad I_3 = 0,55A$$

$$I_E = 4,36A \quad I_2 = 1,36A$$

$$I_1 = 3,26A \quad I_3 = 1,09A$$

$$V_A^A = 3,26 \text{ V}$$

$$V_A^E = V_A - E$$

$$V_A^E = R_1 I_1 - E = -5,48 \text{ V}$$

$$P_A = -16,4 \text{ W utuzatore}$$

$$P_{R1} = 21,4 \text{ W}$$

$$P_{R2} = 7,4 \text{ W}$$

$$P_{R3} = 7,1 \text{ W}$$

$$P_E = E \cdot I_{e_{\text{tot}}} = 50,32 \text{ W generator}$$

$$\bullet \text{ CASO 2: } A = 0,2 \cdot V_A$$

$$R_1 I_1 = R_3 I_3$$

$$E - R_1 I_1 + V_A = 0$$

$$V_A = -R_2 I_2$$

$$G_m = 0,2 \text{ S}$$

$$I_e = I_3 + I_1$$

$$A + I_2 = I_e$$

$$G_m V_A + I_2 = I_e$$

$$I_3 = I_1 \frac{R_1}{R_3}$$

$$I_e = I_1 + I_1 \frac{R_1}{R_3} \Rightarrow I_e = \frac{4}{3} I_1$$

$$G_m R_1 \cdot I_1 + I_2 = \frac{4}{3} I_1$$

$$I_2 = \left(\frac{4}{3} - \frac{1}{5} \cdot 2 \right) \cdot I_1$$

$$I_2 = \frac{14}{15} I_1$$

$$V_A = -R_2 \cdot \frac{14}{15} \cdot I_1$$

$$E + R_1 I_1 - R_2 \frac{14}{15} I_1 = 0$$

$$I_1 \left(R_1 + R_2 \frac{14}{15} \right) = +12$$

$$I_1 = 2,09 \text{ A}$$

$$I_e = 2,8 \text{ A}$$

$$A = \frac{2}{10} \cdot R_1 \cdot I_1$$

$$A = \frac{2}{10} \cdot 2 \cdot 2,09 = 0,836 \text{ A}$$

$$I_2 = 1,964 \text{ A}$$

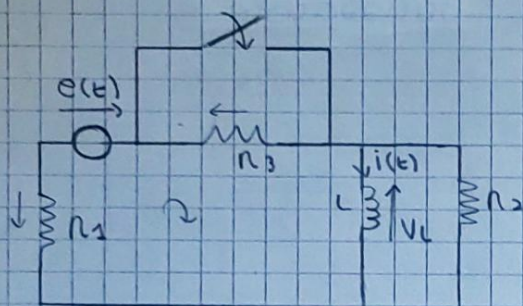
$$V_A = -7,856 \text{ V}$$

$$V_1 = 8,7 \text{ V}$$

$$P_A = -6,6 \text{ W}$$

$$P_E = 33,6 \text{ W}$$

ESERCIZIO 2



$$\begin{aligned} R_1 &= 3 \Omega \\ R_2 &= 4 \Omega \\ R_3 &= 9 \Omega \\ L &= 40 \text{ mH} \end{aligned}$$

• $e(t) = 8 \text{ V}$

$$E - R_3 I_e - R_1 I_e = 0$$

$$I_e = \frac{E}{R_1 + R_3} \quad I_e = \frac{8}{12} = 0,67 \text{ A}$$

$$I(0^-) = I(0^+) = 0,67 \text{ A}$$

$$I(\infty) = \frac{E}{R_1} = 2,67 \text{ A}$$

$$I_L(t) = K e^{-t/\tau} + I_L(\infty)$$

$$K = -2$$

$$\tau = 23 \text{ ms}$$

$$I_L(t) = -2 e^{-t/\tau} + I_L(\infty)$$

$$I_L(2\tau) = -2 e^{-2} + 2,67 = 2,4 \text{ A}$$

$$V_L(0^+) = -R_{eq} \cdot I_L(0^+)$$

$$V_L(0^+) = -1,14 \text{ V}$$

• $e(t) = 10\sqrt{2} \cos(314t) \text{ V}$

$$\omega = 314 \text{ rad/s}$$

$$\bar{E} = 10 \angle 0^\circ \text{ V}$$

$$Z_L = j\omega L = 12,56j \Omega$$

$$\begin{cases} I_L = I_1 + I_2 \\ -V_1 + E - V_3 - V = 0 \\ V = V_2 = R_2 I_2 = Z_L I_L \end{cases}$$

$$-R_1 I_1 + E - R_3 I_1 - V = 0$$

$$-I_1(R_1 + R_3) + E - Z_L I_L = 0$$

$$-\left(I_L + \frac{Z_L \cdot I_L}{R_2}\right)(R_1 + R_3) + E - Z_L I_L = 0$$

$$-I_L \left[1 + \frac{12,56j}{4} \right] \cdot 12 - 12,56j \cdot I_L = -12$$

$$-I_L \left\{ \left[1 + \frac{12,56j}{4} \right] \cdot 12 - 12,56j \right\} = -12$$

$$-(12 + 37,68j) I_L - 12,56j I_L = -12$$

$$I_L = 0,19 \angle -76,56^\circ \text{ A}$$

$$i(t) = 0,19\sqrt{2} \cos(314t - 0,43\pi) \text{ A}$$

$$i(0^-) = i(0^+) = 0,06 \text{ A}$$

per trovare $i(0^-) = i(0^+)$
 SOSTITUISCO $t=0$ in
 $i(t) = 0,19\sqrt{2} \cos(\omega t + \varphi)$

$$t \rightarrow \infty$$

$$V_3 = 0 \text{ V}$$

$$\begin{cases} -V_1 + E - V = 0 \end{cases}$$

$$\begin{cases} V = V_2 = R_2 I_2 = 20 \cdot I_2 \end{cases}$$

$$\begin{cases} I_1 = I_2 + I_3 \end{cases}$$

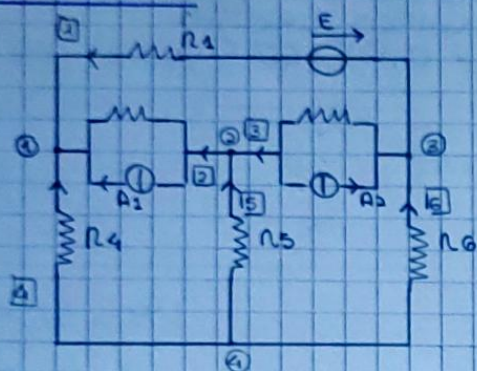
$$-R_1 \left(I_2 + \frac{20 \cdot I_2}{R_2} \right) + E - 20 \cdot I_2 = 0$$

$$I_2 \left[-R_1 - \frac{R_1 \cdot 20}{R_2} \right] - 20 = -10$$

$$I_2 = 0,45 \text{ A} \quad i(t) = 0,45\sqrt{2} \cos(314t - 0,45\pi) \text{ A}$$

15.07.2014

ESERCIZIO 1



$E = 8V$
 $A_1 = 9V$
 $A_2 = 9V$
 $R_1 = 1 \Omega$
 $R_2 = 1 \Omega$
 $R_3 = 5 \Omega$
 $R_4 = 4 \Omega$
 $R_5 = 5 \Omega$
 $R_6 = 7 \Omega$

$$C_r = \begin{bmatrix} -1 & -1 & 0 & -1 & 0 & 0 \\ 0 & 1 & -1 & 0 & -1 & 0 \\ 1 & 0 & 1 & 0 & 0 & -1 \end{bmatrix}$$

$$A = \begin{bmatrix} 0 \\ 9 \\ -9 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$G = \begin{bmatrix} 1 & & & & & \\ & 1 & & & & \\ & & 0,2 & & & \\ & & & 0,25 & & \\ & & & & 0,2 & \\ & & & & & 0,14 \end{bmatrix}$$

$$E = \begin{bmatrix} 8 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\bar{G} = \begin{bmatrix} 2,25 & -1 & -1 \\ -1 & 1,4 & -0,2 \\ -1 & -0,2 & 1,34 \end{bmatrix}$$

$$\bar{I} = G \cdot G \cdot E - G \cdot A$$

$$\bar{I} = \begin{bmatrix} -1 & -1 & 0 & -0,25 & 0 & 0 \\ 0 & 1 & -0,2 & 0 & -0,2 & 0 \\ 1 & 0 & 0,2 & 0 & 0 & -0,14 \end{bmatrix} \begin{bmatrix} 8 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} - \begin{bmatrix} -9 \\ 18 \\ -9 \end{bmatrix}$$

$$\bar{I} = \begin{bmatrix} -8 \\ 0 \\ 8 \end{bmatrix} - \begin{bmatrix} -9 \\ 18 \\ -9 \end{bmatrix} = \begin{bmatrix} 1 \\ -18 \\ 17 \end{bmatrix}$$

$$\bar{V} = \bar{G}^{-1} \cdot \bar{I} \Rightarrow \bar{V} = \begin{bmatrix} 1,8526 & 1,5539 & 1,6145 \\ 1,5539 & 2,0332 & 1,4631 \\ 1,6145 & 1,4631 & 2,1695 \end{bmatrix} \begin{bmatrix} 1 \\ -18 \\ 17 \end{bmatrix}$$

$$\bar{V} = \begin{bmatrix} 1,3 \\ -10,2 \\ 12,2 \end{bmatrix}$$

$$V = G^T \cdot \bar{V}$$

$$I = A + G(V - E)$$

$$V = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 1 & 0 \\ 0 & -1 & 1 \\ -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} 1,3 \\ -10,2 \\ 12,2 \end{bmatrix} = \begin{bmatrix} 10,9 \\ -11,5 \\ 22,4 \\ -1,3 \\ 10,2 \\ -12,2 \end{bmatrix} \begin{matrix} V_1 \\ V_2 \\ V_3 \\ V_4 \\ V_5 \\ V_6 \end{matrix}$$

$$PA_1 = 103,5 \text{ W } G$$

$$PA_2 = 201,6 \text{ W } U$$

$$I = \begin{bmatrix} 0 \\ 9 \\ -9 \\ 0 \\ 0 \\ 0 \end{bmatrix} + \begin{bmatrix} 2,9 \\ -11,5 \\ 4,48 \\ -0,325 \\ 2,04 \\ -1,704 \end{bmatrix} = \begin{bmatrix} 2,9 \\ -2,5 \\ -4,62 \\ -0,325 \\ 2,04 \\ -1,704 \end{bmatrix}$$

$$PE = 23,2 \text{ W } U$$

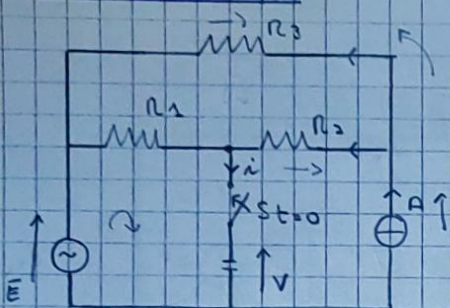
$$E = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$I_{cc} = \frac{E}{n_1} = -8A$$

$$A = \begin{bmatrix} -8 \\ 9 \\ -9 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$G_N = \frac{1}{n_1} = 1S$$

ESERCIZIO 2



$$A = 10 \text{ A}$$

$$e(t) = 30\sqrt{2} \cos(250t - \frac{\pi}{3}) \text{ V}$$

$$C = 4 \text{ mF}$$

$$R_1 = 4 \Omega$$

$$R_2 = 3 \Omega$$

$$R_3 = 2 \Omega$$

$$V(0^-) = 0 \text{ V}$$

$$V(0^-) = V(0^+) = 0 \text{ V}$$

$$i_1(0^+) = i_2(0^+) = A \cdot \frac{R_3}{R_3 + R_2} = 10 \cdot \frac{2}{5} = 4 \text{ A}$$

} contributo di A

$$V(0^+) = 0 \text{ V}$$

$$E(0^+) = 15\sqrt{2} \text{ V}$$

$$R_{eq} = \left(\frac{1}{5} + \frac{1}{4} \right)^{-1}$$

} contributo di E

$$I_e(0^+) = i(0^+) = 9,55 \text{ A}$$

$$\tau = R_{eq} \cdot C \quad \tau = 8,9 \text{ ms}$$

$$i(\infty) = 0 \text{ A}$$

$$I_2 = 10 \cdot \frac{2}{9} = 2,22 \text{ A}$$

$$I_3 = 7,78 \text{ A}$$

$$V_A = V_3 = R_3 I_3$$

$$V = V_A - V_2 = R_3 I_3 - R_2 I_2 = 8,89 \text{ V}$$

$$E = 30 \angle -60^\circ \text{ V}$$

$$Z_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2 + R_3} \right)^{-1} + Z_C = 2,22 - j \Omega$$

$$I_E = I_C = \frac{E}{Z_{eq}} = 12,31 \angle -35,77^\circ \text{ A}$$

$$Z_C = -j \Omega$$

$$V = Z_C \cdot I_C = 12,31 \angle -125,77^\circ \text{ V}$$

$R_{TH} = R_{eq}$ ai capi dell'aperto

$$R_{TH} = 2,22 \Omega$$

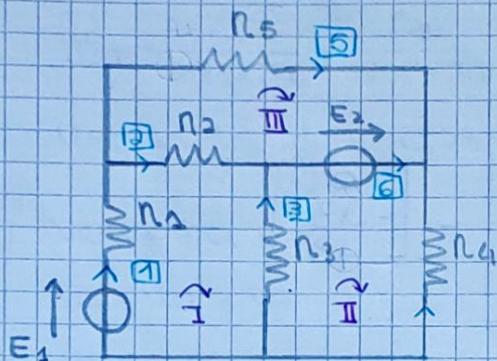
$V_{TH} = V$ quando si ha l'aperto

$$V_{TH} = 8,89 \text{ V}$$

$$V_{TH2} = 30 \angle -60^\circ \text{ V}$$

25/01/2013

ESENCIA 10.1



$E_1 = 15$

$E_2 = 13V$

$R_1 = 5 \Omega$

$R_2 = 3 \Omega$

$R_3 = 1 \Omega$

$R_4 = 4 \Omega$

$R_5 = 6 \Omega$

$$M_r = \begin{bmatrix} 1 & 1 & -1 & 0 & 0 & 0 \\ 0 & 0 & 1 & -1 & 0 & 1 \\ 0 & -1 & 0 & 0 & 1 & -1 \end{bmatrix}$$

$$R = \begin{bmatrix} 5 & & & & & \\ & 3 & & & & \\ & & 1 & & & \\ & & & 4 & & \\ & & & & 6 & \\ & & & & & 0 \end{bmatrix}$$

$$\tilde{R} = \begin{bmatrix} 9 & -1 & -3 \\ -1 & 5 & 0 \\ -3 & 0 & 9 \end{bmatrix}$$

$$E = \begin{bmatrix} -15 \\ 0 \\ 0 \\ 0 \\ 0 \\ -13 \end{bmatrix}$$

$$A = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\bar{V} = M_r \cdot R \cdot A - M_r \cdot E$$

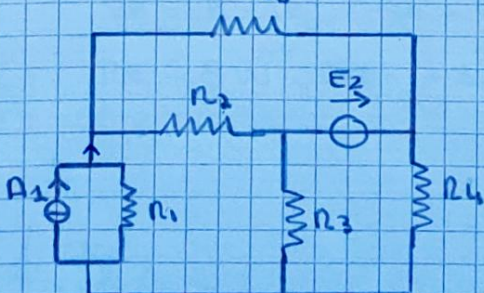
$$\bar{V} = - \begin{bmatrix} -15 \\ -13 \\ 13 \end{bmatrix} = \begin{bmatrix} 15 \\ 13 \\ -13 \end{bmatrix}$$

$$\bar{I} = \tilde{R}^{-1} \cdot \bar{V}$$

$$\bar{I} = \begin{bmatrix} 0,128 & 0,025 & 0,0427 \\ 0,026 & 0,205 & 8,5 \cdot 10^{-3} \\ 0,043 & 8,5 \cdot 10^{-3} & 0,125 \end{bmatrix} \begin{bmatrix} 15 \\ 13 \\ -13 \end{bmatrix}$$

$$\bar{I} = \begin{bmatrix} 1,7 \\ 2,9 \\ -0,88 \end{bmatrix}$$

$A_1 = 10A, R_1 = 4 \Omega$



La matrice M_r non cambia

$$\tilde{R} = \begin{bmatrix} 8 & -1 & -3 \\ -1 & 5 & 0 \\ -3 & 0 & 9 \end{bmatrix}$$

$$A = \begin{bmatrix} 10 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$E = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ -13 \end{bmatrix}$$

$$\bar{R} = \begin{bmatrix} 4 & & & & & \\ & 3 & & & & \\ & & 1 & & & \\ & & & 4 & & \\ & & & & 6 & \\ & & & & & 0 \end{bmatrix}$$

$$\bar{V} = \begin{bmatrix} 4 & 3 & -1 & 0 & 0 & 0 \\ 0 & 0 & 1 & -4 & 0 & 0 \\ 0 & -3 & 0 & 0 & 6 & 0 \end{bmatrix} \begin{bmatrix} 10 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} - \begin{bmatrix} 0 \\ -13 \\ 13 \end{bmatrix}$$

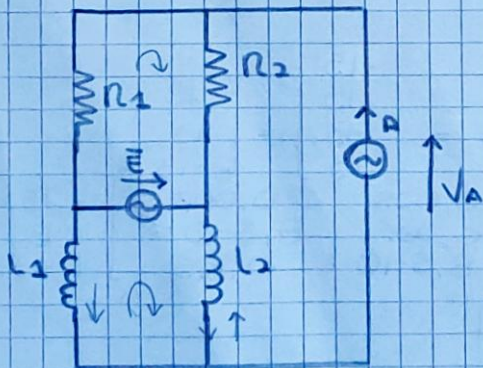
$$\bar{V} = \begin{bmatrix} 40 \\ 0 \\ 0 \end{bmatrix} - \begin{bmatrix} 0 \\ -13 \\ 13 \end{bmatrix} = \begin{bmatrix} 40 \\ 13 \\ -13 \end{bmatrix}$$

$$\bar{I} = \bar{R}^{-1} \cdot \bar{V}$$

$$\bar{I} = \begin{bmatrix} 0,147 & 0,0294 & 0,049 \\ 0,0294 & 0,2058 & 9,8 \cdot 10^{-3} \\ 0,049 & 9,8 \cdot 10^{-3} & 0,1274 \end{bmatrix} \begin{bmatrix} 40 \\ 13 \\ -13 \end{bmatrix}$$

$$\bar{I} = \begin{bmatrix} 5,63 \\ 3,73 \\ 0,43 \end{bmatrix}$$

ESENCIZIO 2



$$\bar{E} = 4 \angle 20^\circ \text{ V}$$

$$\omega = 300 \text{ rad/s}$$

$$\bar{A} = 4 \angle 70^\circ \text{ A}$$

$$L_1 = 20 \text{ mH}$$

$$L_2 = 10 \text{ mH}$$

$$R_1 = 1 \Omega$$

$$R_2 = 4 \Omega$$

$$Z_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2} \right)^{-1} + \left(\frac{1}{j\omega L_1} + \frac{1}{j\omega L_2} \right)^{-1}$$

$$Z_{eq} = 2,15 \angle 68,20^\circ$$

• effetto di A: $V_A = Z_{eq} \cdot A$

$$V_A = 8,61 \angle 138,20^\circ \text{ V}$$

$$I_e = I_{n2} + I_2$$

$$I_e = 1,86 \angle 70^\circ \text{ A}$$

• effetto di E

$$Z_{eq} = \left(\frac{1}{R_1 + R_2} + \frac{1}{Z_{L1} + Z_{L2}} \right)^{-1}$$

$$Z_{eq} = 4,37 \angle -29,05^\circ \Omega$$

$$Y_{eq} = \frac{1}{R_1 + R_2} + \frac{1}{Z_{L1} + Z_{L2}}$$

$$I_E = \frac{E}{Z_{eq}}$$

$$Y_{eq} = \frac{1}{5} + \frac{1}{9j} = 0,23 \angle -29,05^\circ S$$

$$I_E = 0,91 \angle -9,05^\circ A$$

$$V_{R1} + V_{R2} = E$$

$$I_{R2} = I_{R1}$$

$$V_2 - V_{R2} = V_A$$

$$I_1 = -I_2$$

$$V_1 + E - V_2 = 0$$

$$E = V_2 - V_1$$

$$E = Z_2 \cdot I_2 - Z_1 \cdot I_1$$

$$E = Z_2 \cdot I_2 + Z_1 \cdot I_2$$

$$I_2 = \frac{E}{Z_2 + Z_1} = 0,44 \angle -70^\circ$$

$$R_1 I_{R1} + R_2 I_{R2} = E$$

$$(R_1 + R_2) I_{R1} = E$$

$$I_{R1} = \frac{4 \angle 20^\circ}{5} = 0,8 \angle 20^\circ = I_{R2}$$

$$R_2 \cdot I_{R2} - Z_2 \cdot I_2 = V_A$$

$$V_A = (0,15 - 0,47j) 3j - 4(0,75 + 0,273j)$$

$$V_A = 1,87 \angle -160^\circ V$$

$$V_A^{Tot} = 9,63 \angle 148,04^\circ V$$

$$S_A = V_A \cdot A^* \quad S_A = 9,63 \angle 148,04^\circ \cdot 4 \angle -70^\circ = 8 + 37,7j VA$$

$$P_A = 8 W \quad Q_A = 37,7 VAR$$

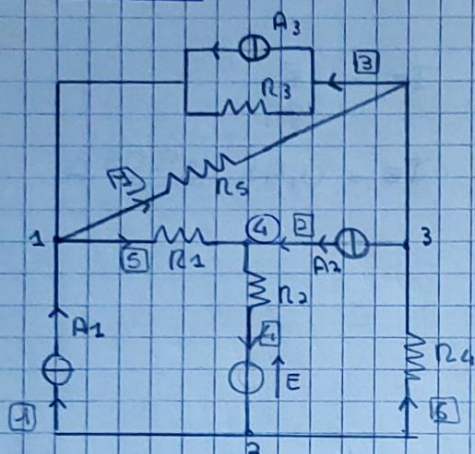
$$I_E^{Tot} = 2,22 \angle 16,27^\circ A$$

$$S_E = E \cdot I_E^* \quad S_E = 4,96 - 3,93j VA$$

$$P_E = 8 W \quad Q_E = -3,9 VAR$$

16/10/2017

ESERCIZIO 1



Nodo 4 come riferimento

$$\begin{aligned} E &= 12 \text{ V} \\ A_1 &= 1 \text{ mA} \\ A_2 &= 1 \text{ mA} \\ A_3 &= 1 \text{ mA} \end{aligned}$$

$$\begin{aligned} R_1 &= 1000 \, \Omega \\ R_2 &= 1000 \, \Omega \\ R_3 &= 3000 \, \Omega \\ R_4 &= 1000 \, \Omega \\ R_5 &= 2000 \, \Omega \end{aligned}$$

$$C_r = \begin{bmatrix} -1 & 0 & -1 & 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & -1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 & 0 & -1 & -1 \end{bmatrix}$$

$$G = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0,33 \cdot 10^{-3} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0,33 \cdot 10^{-3} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 10^{-3} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 10^{-3} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 10^{-3} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0,5 \cdot 10^{-3} \end{bmatrix}$$

$$\bar{G} = \begin{bmatrix} G_3 + G_5 + G_1 & 0 & -G_3 - G_5 \\ 0 & G_2 + G_4 & -G_4 \\ -G_3 - G_5 & -G_4 & G_4 + G_3 + G_5 \end{bmatrix}$$

$$\bar{G} = \begin{bmatrix} 1,83 \cdot 10^{-3} & 0 & -0,83 \cdot 10^{-3} \\ 0 & 2 \cdot 10^{-3} & -10^{-3} \\ -0,83 \cdot 10^{-3} & -10^{-3} & 1,83 \cdot 10^{-3} \end{bmatrix}$$

$$A = \begin{bmatrix} 10^{-3} \\ 10^{-3} \\ 10^{-3} \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \quad E = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 12 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\bar{I} = C_r \cdot G \cdot E - G \cdot A$$

$$\bar{I} = \begin{bmatrix} 0 \\ -12 \cdot 10^{-3} \\ 0 \end{bmatrix} - \begin{bmatrix} -2 \cdot 10^{-3} \\ 10^{-3} \\ 2 \cdot 10^{-3} \end{bmatrix} = \begin{bmatrix} 2 \cdot 10^{-3} \\ -13 \cdot 10^{-3} \\ -2 \cdot 10^{-3} \end{bmatrix}$$

$$\bar{V} = \bar{G}^{-1} \cdot \bar{I}$$

$$\bar{V} = \begin{bmatrix} 462,178 & 237,822 & 475,645 \\ 237,822 & 462,178 & 524,355 \\ 475,645 & 524,355 & 1048,711 \end{bmatrix} \begin{bmatrix} 2 \cdot 10^{-3} \\ -13 \cdot 10^{-3} \\ -2 \cdot 10^{-3} \end{bmatrix}$$

$$\bar{V} = \begin{bmatrix} -2,52 \\ -10,48 \\ -7,96 \end{bmatrix}$$

$$V = G^T \cdot \bar{V}$$

$$V = \begin{bmatrix} -1 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & 0 & 1 \\ 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & -1 \\ 1 & 0 & -1 \end{bmatrix} \begin{bmatrix} -2,52 \\ -10,48 \\ -7,96 \end{bmatrix} = \begin{bmatrix} -7,96 \\ -7,96 \\ -5,44 \\ 10,48 \\ -2,52 \\ -2,52 \\ 5,44 \end{bmatrix}$$

$$I = A + G(V-E)$$

$$I = \begin{bmatrix} 10^{-3} \\ 10^{-3} \\ 10^{-3} \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} - \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0,33 \cdot 10^{-3} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 10^{-3} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 10^{-3} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 10^{-3} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 10^{-3} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0,5 \cdot 10^{-3} \end{bmatrix} \begin{bmatrix} -7,96 \\ -7,96 \\ -5,44 \\ 10,48 \\ -2,52 \\ -2,52 \\ 5,44 \end{bmatrix}$$

$$I = \begin{bmatrix} 10^{-3} \\ 10^{-3} \\ 10^{-3} \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} - \begin{bmatrix} 0 \\ 0 \\ -1,79 \cdot 10^{-3} \\ 1,52 \cdot 10^{-3} \\ -2,52 \cdot 10^{-3} \\ -2,52 \cdot 10^{-3} \\ 2,72 \cdot 10^{-3} \end{bmatrix} = \begin{bmatrix} 10^{-3} \\ 10^{-3} \\ 2,79 \cdot 10^{-3} \\ -1,52 \cdot 10^{-3} \\ 2,52 \cdot 10^{-3} \\ 2,52 \cdot 10^{-3} \\ -2,72 \cdot 10^{-3} \end{bmatrix}$$

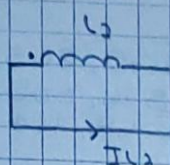
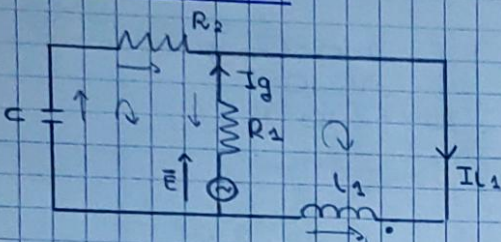
$$PA_1 = 7,96 \cdot 10^{-3} \text{ W utilizzatore}$$

$$PA_2 = 7,96 \cdot 10^{-3} \text{ W utilizzatore}$$

$$PA_3 = 5,44 \cdot 10^{-3} \text{ W utilizzatore}$$

$$PE = 48,24 \cdot 10^{-3} \text{ W generatore}$$

ESERCIZIO 2



$$\begin{aligned} E &= 220 \text{ V} \\ f &= 50 \text{ Hz} \\ R_1 &= 8 \text{ } \Omega \\ R_2 &= 5 \text{ } \Omega \\ C &= 120 \text{ } \mu\text{F} \\ L_1 &= 150 \text{ mH} \\ L_2 &= 120 \text{ mH} \end{aligned}$$

$$\omega = 628.32 \text{ rad/s}$$

$$\exists \epsilon_q = ((n_2 + c) \parallel l_1) + n_1$$

$$Z_{eq} = 14,7 - 15,01j \Omega$$

$$I_g = \frac{E}{Z_{eq}} \quad I_g = \frac{220 \angle -30^\circ}{14,7 - 15,01j} = 10,1 + 2,8j \text{ A}$$

$$2C \cdot I_C + n_2 \cdot I_C + n_1 \cdot I_g = E$$

$$I_c (\beta_c + \beta_2) = E - \beta_1 I_g$$

$$I_c = \frac{E - n_1 I_g}{Z_c + n_2} \quad I_c = 11,47 - 3,95j \text{ A}$$

$$I_{L1} = I_g - I_c$$

$$I_{L1} = -1,4 - 1,15j \text{ A}$$

$$I_{L2} = 0 \text{ A}$$

$$P_E = 1,61 \text{ kW}$$

$$Q_E = -1,64 \text{ kVaz}$$

$$\varphi = \arctan\left(\frac{1644}{1616}\right)$$

$$\cos \varphi = 0,70$$

$$Z_{eq} = \left(\frac{1}{5 - \frac{j}{\omega C}} + \frac{1}{j\omega L_1} \right)^{-1} + 8$$

$$W=10 \quad \exists \text{ eq} = 8$$

$$W \rightarrow \infty \quad \text{deg} = 13$$

$$\omega_{NIS} = \frac{1}{\sqrt{LC}}$$

$$\omega_{ris} = 236 \text{ rad/s}$$

Se $M = 100 \text{ mH}$

$$I_g = I_c + I_1$$

$$I_2 = \frac{I_1 \cdot Z_m}{Z_2}$$

$$E = R_1 I_g + 2L_1 I_1 - 2M I_2$$

$$E = n_2 I_c + n_1 I_g + 2c I_c$$

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$$Z_1 I_1 - \frac{Z_m^2}{Z_2} I_1 = N_2 I_c + Z_c I_c$$

$$I_1 = I_c \left(\frac{N_2 + Z_c}{Z_1 - \frac{Z_m^2}{Z_2}} \right)$$

$$E = N_2 I_c + N_1 I_c + N_1 I_c \left[\frac{N_2 + Z_c}{Z_1 - \frac{Z_m^2}{Z_2}} \right] + Z_c I_c$$

$$I_c = \frac{E}{N_2 + N_1 + N_1 \left(\frac{N_2 + Z_c}{Z_1 - \frac{Z_m^2}{Z_2}} \right) + Z_c}$$

$$I_c = 11,4 + 5j \text{ A}$$

$$I_1 = -3,02 - 2,94j \text{ A}$$

$$I_g = 8,39 + 2,06j \text{ A}$$

$$I_g = 8,64 \angle 13,7^\circ \text{ A}$$

$$I_2 = -2,51 - 2,45j \text{ A}$$

$$P_E = 1,37 \text{ kW}$$

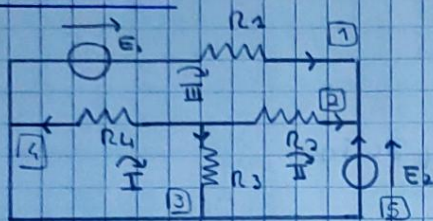
$$Q_E = -1,31 \text{ kVar}$$

$$\varphi = \arctan \frac{1374}{-1313}$$

$$\cos \varphi = 0,68$$

20.06.2012

ESERCIZIO 1



$$\begin{aligned} E_1 &= 15V \\ R_1 &= 1\Omega \\ R_2 &= 2\Omega \\ R_3 &= 0,5\Omega \\ R_4 &= 1\Omega \end{aligned}$$

$E_2 = 6V$

$$M = \begin{bmatrix} 0 & 0 & 1 & -1 & 0 \\ 0 & 1 & -1 & 0 & -1 \\ 1 & -1 & 0 & 1 & 0 \end{bmatrix}$$

$$\bar{V} = M \cdot R \cdot A - M \cdot E$$

$$A = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$E = \begin{bmatrix} -15 \\ 0 \\ 0 \\ 0 \\ -6 \end{bmatrix}$$

$$R = \begin{bmatrix} 1 & & & & \\ & 2 & & & \\ & & 0,5 & & \\ & & & 1 & \\ & & & & 0 \end{bmatrix}$$

$$\bar{R} = \begin{bmatrix} 1,5 & -0,5 & -1 \\ -0,5 & 2,5 & -2 \\ -1 & -2 & 4 \end{bmatrix}$$

$$\bar{V} = - \begin{bmatrix} 0 \\ 6 \\ -15 \end{bmatrix}$$

$$\bar{V} = \begin{bmatrix} 0 \\ -6 \\ 15 \end{bmatrix}$$

$$\bar{I} = \bar{R}^{-1} \cdot \bar{V}$$

$$\bar{I} = \begin{bmatrix} 1,714 & 1,14 & 1 \\ 1,14 & 1,429 & 1 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ -6 \\ 15 \end{bmatrix} = \begin{bmatrix} 8,16 \\ 6,43 \\ 9 \end{bmatrix}$$

$$I = M^T \cdot \bar{I}$$

$$I = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & -1 \\ 1 & -1 & 0 \\ -1 & 0 & 1 \\ 0 & -1 & 0 \end{bmatrix} \begin{bmatrix} 8,16 \\ 6,43 \\ 9 \end{bmatrix} = \begin{bmatrix} 9 \\ -2,57 \\ 1,73 \\ 0,84 \\ -6,43 \end{bmatrix}$$

$P_{E1} = 135W$ generatore

$P_{E2} = -38,58W$ utilizzatore

$$E_2 = R_m \cdot I$$

$$R_m = 1,5 \, \Omega$$

$$R = \begin{bmatrix} 1 & & & & \\ & 2 & & & \\ \emptyset & & 0,5 & & \\ & & & 1 & \\ -1,5 & \emptyset & & & 0 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 & 0 \\ 0 & 0 & 0,5 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ -1,5 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\bar{n} = M \cdot n \cdot M^T$$

$$\bar{n} = \begin{bmatrix} 0 & 0 & 0,5 & -1 & 0 \\ 1,5 & 2 & -0,5 & 0 & 0 \\ 1 & -2 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & -1 \\ 1 & -1 & 0 \\ -1 & 0 & 1 \\ 0 & -1 & 0 \end{bmatrix} = \begin{bmatrix} 1,5 & -0,5 & -1 \\ -0,5 & 2,5 & -0,5 \\ -1 & -2 & 4 \end{bmatrix}$$

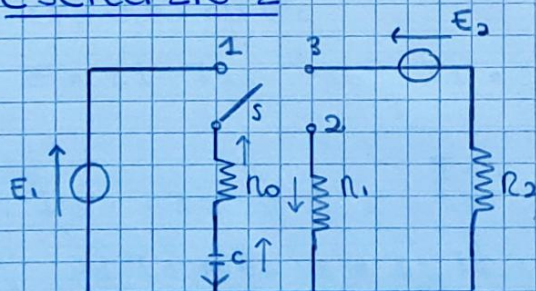
$$A = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \quad E = \begin{bmatrix} -15 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\bar{V} = -M_r \cdot E \quad \bar{V} = \begin{bmatrix} 0 \\ 0 \\ 15 \end{bmatrix}$$

$$\bar{I} = \bar{n}^{-1} \cdot \bar{V}$$

$$\bar{I} = \begin{bmatrix} 1,0285 & 0,4571 & 0,3142 \\ 0,2857 & 0,5714 & 0,1428 \\ 0,4 & 0,4 & 0,14 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 15 \end{bmatrix} = \begin{bmatrix} 4,71 \\ 2,14 \\ 6 \end{bmatrix}$$

ESENCIO 2



$$E_1 = 12V \quad R_0 = 1\Omega \\ E_2 = 24V \quad R_1 = 2\Omega \\ \quad \quad \quad R_2 = 5\Omega$$

$$C = 0,1F \quad T = 0,5s$$

$$\underline{V_C(0^+) = V_C(0^-)}$$

$$i_C(0^-) = 0A$$

$$E = V(0^-) \quad V(0^-) = V(0^+) = 12V$$

$$V(0^+) = -[R_0 I_C(0^+) + R_1 I_C(0^+)]$$

$$I_C(0^+) = - \frac{V_C(0^+)}{R_1 + R_0}$$

$$I_C(0^+) = -4A$$

$$\tau = R_{eq} \cdot C \quad \tau = 0,3$$

$$\alpha = -1/\tau \quad \tau = -3,33 \text{ ms}^{-1}$$

$$\tau = R_{eq} \cdot C$$

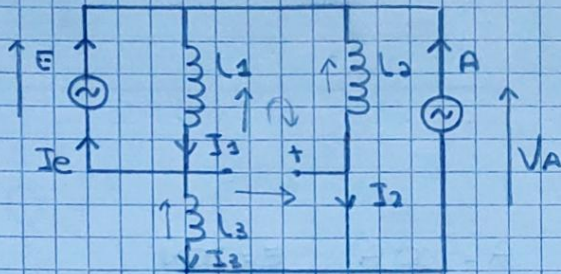
$$\tau = 0,6 \text{ ms}$$

$$\alpha = -1,67 \text{ ms}^{-1}$$

$$V(\infty) = 24 \text{ V}$$

24/01/2012

ESERCIZIO 1



$$L_1 = 3 \text{ mH}$$

$$L_2 = 4 \text{ mH}$$

$$L_3 = 4 \text{ mH}$$

$$\bar{A} = 20 \angle 30^\circ \text{ A}$$

$$E = 10 \angle 90^\circ \text{ V}$$

$$\omega = 628 \text{ rad/s}$$

- effetto di A:

$$Z_3 = Z_2$$

$$E = 0 \quad E = Z_1 I_1 \quad Z_1 I_1 = 0$$

$$I_1 = 0 + 0j \text{ A}$$

$$V_A = Z_2 \cdot I_2$$

$$I_e = -I_3$$

$$A = I_2 + I_3$$

$$Z_3 I_3 = Z_2 I_2$$

$$I_3 = I_2$$

$$A = 2 I_2 \quad I_2 = \frac{A}{2}$$

$$I_2 = 8,66 + 5j \text{ A}$$

$$I_3 = 8,66 + 5j \text{ A}$$

$$I_e = -8,66 - 5j \text{ A}$$

$$V_A = -12,56 + 21,75j \text{ V}$$

- effetto di E:

$$E = Z_1 \cdot I_1$$

$$I_1 = \frac{E}{Z_1}$$

$$I_1 = -4,99 - 1,81j \text{ A}$$

$$I_3 = -I_2$$

$$Z_1 I_1 + Z_3 I_3 = Z_2 I_2$$

$$I_e = I_1 - I_3$$

$$I_e = -6,86 - 2,50j \text{ A}$$

$$Z_1 I_1 - Z_3 I_2 = Z_2 I_2$$

$$Z_1 I_1 = 2 Z_2 I_2$$

$$I_2 = \frac{Z_1 I_1}{2 Z_2}$$

$$I_2 = -1,87 - 0,68j \text{ A}$$

$$I_3 = 1,87 + 0,68j \text{ A}$$

$$V_A = Z_2 \cdot I_2$$

$$V_A = 1,71 - 4,70j \text{ V}$$

$$V_A^{\text{TOT}} = -10,85 + 17,05j \text{ V}$$

$$P_A = -17,4 \text{ W}$$

$$Q_A = 403,8 \text{ Var}$$

$$I_e^{\text{TOT}} = -15,52 - 7,5j \text{ A}$$

$$P_E = 17,38 \text{ W}$$

$$Q_E = 171,49 \text{ Var}$$

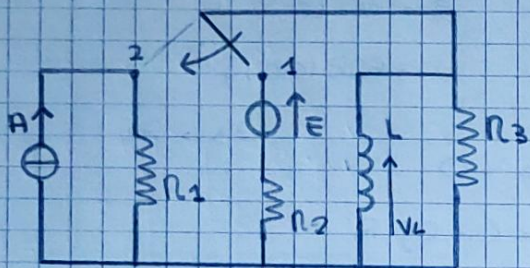
$$U_{TH} = Z_3 I_3^{TOT}$$

$$U_{TH} = 14,27 - 26,45j \text{ V}$$

$$Z_{TH} = \left(\frac{1}{Z_2} + \frac{1}{Z_3} \right)^{-1}$$

$$Z_{TH} = 1,256j \Omega$$

ESENCIZIO 2



$$A = 10 \text{ A} \quad E = 30 \text{ V}$$

$$R_1 = 4 \Omega \quad R_2 = 4 \Omega$$

$$R_3 = 3 \Omega \quad L = 6 \cdot 10^{-3} \text{ H}$$

$$I_L(0^+) = I_L(0^-)$$

$$I_e = \frac{E}{R_2}$$

$$I_e = I_L(0^-) = 4,29 \text{ A}$$

$$I_3(0^-) = 0 \text{ A}$$

$$V_3(0^-) = 0 \text{ V}$$

$$V_3(0^-) = V_L(0^-)$$

$$I_L(0^+) = 4,29 \text{ A}$$

$$V_L(0^-) = 0 \text{ V}$$

$$A - I_L(0^+) = 5,71 \text{ A} = A^*$$

$$I_1 = 5,71 \cdot \frac{R_3}{R_1 + R_3} = 2,45 \text{ A}$$

$$V_L(0^+) = R_1 I_1(0^+)$$

$$V_L(0^+) = 9,8 \text{ V}$$

$$I_3(0^+) = A^* - I_1(0^+)$$

$$I_3(0^+) = 3,26 \text{ A}$$

$$V_L(\infty) = 0 \text{ V}$$

$$I_L(\infty) = A = 10 \text{ A}$$

$$I_3(\infty) = 0 \text{ A}$$

$$\tau = \frac{L}{R_{eq}}$$

$$\tau = \frac{4}{12} \cdot 6 \cdot 10^{-3}$$

$$\tau = 3,5 \text{ ms}$$

$$V_L(t) = K e^{-t/\tau} + V(\infty)$$

$$K = 9,8$$

$$V_L(\tau) = 9,8 e^{-1} = 3,6 \text{ V}$$

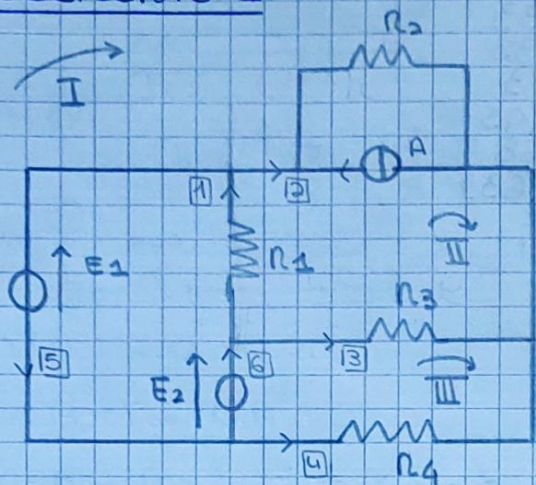
$$I(\tau) = K e^{-t/\tau} + I(\infty)$$

$$K = -5,71$$

$$I(\tau) = 4,9 \text{ A}$$

17/06/2014

ESERCIZIO 1



$$\begin{aligned} I &= 4 \text{ A} \\ E_1 &= 15 \text{ V} \\ E_2 &= 16 \text{ V} \end{aligned}$$

$$\begin{aligned} R_1 &= 3 \, \Omega \\ R_2 &= 2 \, \Omega \\ R_3 &= 1 \, \Omega \\ R_4 &= 6 \, \Omega \end{aligned}$$

$$M_r = \begin{bmatrix} 0 & 1 & 0 & -1 & -1 & 0 \\ 1 & 1 & -1 & 0 & 0 & 0 \\ 0 & 0 & 1 & -1 & 0 & 1 \end{bmatrix}$$

$$n = \begin{bmatrix} 3 & & & & & \\ & 2 & & & & \\ & & 1 & & & \\ & & & 6 & & \\ & & & & 0 & \\ & & & & & 0 \end{bmatrix}$$

$$\tilde{n} = \begin{bmatrix} 8 & 2 & 6 \\ 2 & 6 & -1 \\ 6 & -1 & 4 \end{bmatrix}$$

$$A = \begin{bmatrix} 0 \\ -4 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \quad E = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 15 \\ -16 \end{bmatrix}$$

$$\bar{V} = M \cdot n \cdot A - M \cdot E$$

$$\bar{V} = \begin{bmatrix} 0 & 2 & 0 & -6 & 0 & 0 \\ 3 & 2 & -1 & 0 & 0 & 0 \\ 0 & 0 & 1 & -6 & 0 & 0 \end{bmatrix} \begin{bmatrix} 0 \\ -4 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} - \begin{bmatrix} -15 \\ 0 \\ -16 \end{bmatrix}$$

$$\bar{V} = \begin{bmatrix} -8 \\ -8 \\ 0 \end{bmatrix} - \begin{bmatrix} -15 \\ 0 \\ -16 \end{bmatrix} = \begin{bmatrix} 7 \\ -8 \\ 16 \end{bmatrix}$$

$$\bar{I} = \tilde{n}^{-1} \cdot \bar{V}$$

$$\bar{I} = \begin{bmatrix} 0,68 & -0,33 & -0,63 \\ -0,33 & 0,33 & 0,33 \\ -0,63 & 0,33 & 0,33 \end{bmatrix} \begin{bmatrix} 7 \\ -8 \\ 16 \end{bmatrix}$$

$$\bar{I} = \begin{bmatrix} -2,68 \\ 0,33 \\ 4,63 \end{bmatrix}$$

$$\mathbf{I} = \mathbf{M} \mathbf{r}^T \cdot \bar{\mathbf{I}}$$

$$\mathbf{I} = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 1 & 0 \\ 0 & -1 & 1 \\ -1 & 0 & -1 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -2,68 \\ 0,33 \\ 4,63 \end{bmatrix} = \begin{bmatrix} 0,33 \\ -2,35 \\ 4,3 \\ -1,95 \\ 2,68 \\ 4,63 \end{bmatrix}$$

$$P_{E1} = 40,2 \text{ W}$$

$$P_{E2} = 74,08 \text{ W}$$

$$\mathbf{V} = \mathbf{E} + \mathbf{R}(\mathbf{I} - \mathbf{A})$$

$$\mathbf{V} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 15 \\ -16 \end{bmatrix} + \begin{bmatrix} 3 & & & & & \\ & 2 & & & & \\ & & 1 & & & \\ & & & 6 & & \\ & & & & 0 & \\ & & & & & 0 \end{bmatrix} \begin{bmatrix} 0,33 \\ 4,63 \\ 4,3 \\ -1,95 \\ 2,68 \\ 4,63 \end{bmatrix}$$

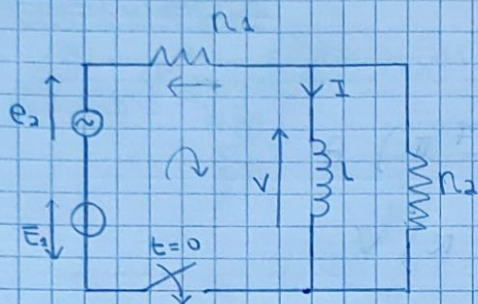
$$\mathbf{V} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 15 \\ -16 \end{bmatrix} + \begin{bmatrix} 0,99 \\ 3,3 \\ 4,3 \\ 11,7 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 0,99 \\ 3,3 \\ 4,3 \\ 11,7 \\ 15 \\ -16 \end{bmatrix}$$

$$P_A = 13,2 \text{ W}$$

$$\mathbf{A} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \quad \mathbf{E} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 15 \\ -16 \end{bmatrix}$$

$$R_{TH} = 2 \, \Omega \quad V_{TH} = 8 \text{ V}$$

ESENCIZIO 2



$$E_1 = 10 \text{ V}$$

$$e_2(t) = 50\sqrt{2} \cos(250t + \frac{\pi}{6}) \text{ V}$$

$$L = 40 \text{ mH}$$

$$n_1 = 4$$

$$n_2 = 3$$

$$Z_L = 10i \Omega$$

$$V(0^-) = 0 \text{ V}$$

$$i(0^-) = 0 \text{ A}$$

$$R_{eq} = n_2$$

$$\tau = \frac{L}{R_{eq}} = 13,33 \text{ ms}$$

$$t = 0^+$$

• Effetto E

$$i(0^+) = 0 \text{ A}$$

$$R_{eq} = n_1 + n_2 = 7 \Omega$$

$$I_e = \frac{E}{R_{eq}} = 1,43$$

$$V = -V_2 \cdot I_e$$

$$V = -4,29 \text{ V}$$

• Effetto di e

$$e(0) = 61,24 \text{ V}$$

$$i(0^+) = 0 \text{ A}$$

$$I_e = 8,75 \text{ A}$$

$$V = V_2$$

$$V = 26,24 \text{ V}$$

$$t > 0$$

$$\tau = \frac{L}{R_{eq}} = \frac{40}{\left(\frac{1}{4} + \frac{1}{3}\right)^{-1}} = 23,33 \text{ ms}$$

$$E_2 = 50\sqrt{30} \text{ V}$$

$$Z_{eq} = \left(\frac{1}{10i} + \frac{1}{3}\right)^{-1} + 4 = 6,8 \text{ } \underline{6,97} \Omega$$

$$I_e = \frac{E}{Z_{eq}} = 7,35 \text{ } \underline{23} \text{ A}$$

$$I = I_e \frac{n_2}{Z_L + n_2}$$

$$I = 2,11 \text{ } \underline{50,73} \text{ A}$$

$$V_1 = I \cdot Z_L$$

$$V_1 = 21,12 \text{ } \underline{39,72} \text{ V}$$

$$I = -\frac{E}{R_1}$$

$$I = -2,5 \text{ A}$$

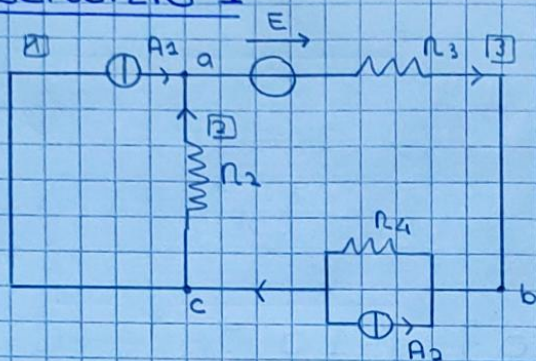
$$V(\infty) = 0 \text{ V}$$

$$i_2(t) = 2,11 \sqrt{2} \cos\left(250t - \frac{50,27}{180} \pi\right) \text{ A}$$

$$V_2(t) = 21,12 \sqrt{2} \cos\left(250t + \frac{39,72}{180} \pi\right) \text{ V}$$

13.07.2011

ESERCIZIO 1



$$\begin{aligned} A_1 &= 10 \text{ A} \\ E &= 15 \text{ V} \\ R_2 &= 0,25 \, \Omega \\ R_3 &= 0,1 \, \Omega \\ R_4 &= 0,4 \, \Omega \end{aligned}$$

• $A_2 = 5 \text{ A}$

$$C_r = \begin{bmatrix} -1 & -1 & 1 & 0 \\ 0 & 0 & -1 & 1 \end{bmatrix}$$

$$G = \begin{bmatrix} 0 & & & \\ & 4 & & \\ & & 10 & \\ & & & 2,5 \end{bmatrix}$$

$$\bar{G} = \begin{bmatrix} 14 & -10 \\ -10 & 12,5 \end{bmatrix}$$

$$A = \begin{bmatrix} 10 \\ 0 \\ 0 \\ -5 \end{bmatrix}$$

$$E = \begin{bmatrix} 0 \\ 0 \\ -15 \\ 0 \end{bmatrix}$$

$$\bar{V} = \bar{G}^{-1} \cdot \bar{I}$$

$$\bar{I} = G \cdot G \cdot E - G \cdot A$$

$$\bar{I} = \begin{bmatrix} 0 & -4 & 10 & 0 \\ 0 & 0 & -10 & 2,5 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ -15 \\ 0 \end{bmatrix} - \begin{bmatrix} -10 \\ -5 \end{bmatrix}$$

$$\bar{I} = \begin{bmatrix} -150 \\ 150 \end{bmatrix} - \begin{bmatrix} -10 \\ -5 \end{bmatrix} = \begin{bmatrix} -140 \\ 155 \end{bmatrix}$$

$$\bar{V} = \begin{bmatrix} -2,7 \\ 10,3 \end{bmatrix}$$

$$\bar{V}_a = -2,7 \text{ V}$$

$$A = 0,75 \cdot I_2$$

$$G = \begin{bmatrix} 0 & & & \\ & 4 & & \\ & & 10 & \\ & -0,75 & & 2,5 \end{bmatrix}$$

$$\bar{G} = C_r \cdot G \cdot C_r^T$$

$$\bar{G} = \begin{bmatrix} -1 & -1 & 1 & 0 \\ 0 & 0 & -1 & 1 \end{bmatrix} \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 4 & 0 & 0 \\ 0 & 0 & 10 & 0 \\ 0 & -0,75 & 0 & 2,5 \end{bmatrix} \begin{bmatrix} -1 & 0 \\ -1 & 0 \\ 1 & -1 \\ 0 & -1 \end{bmatrix}$$

$$\bar{G} = \begin{bmatrix} 0 & -4 & 10 & 0 \\ 0 & -0,75 & -10 & 2,5 \end{bmatrix} \begin{bmatrix} -1 & 0 \\ -1 & 0 \\ 1 & -1 \\ 0 & -1 \end{bmatrix}$$

$$\bar{G} = \begin{bmatrix} 14 & -10 \\ K-10 & 7,5 \end{bmatrix}$$

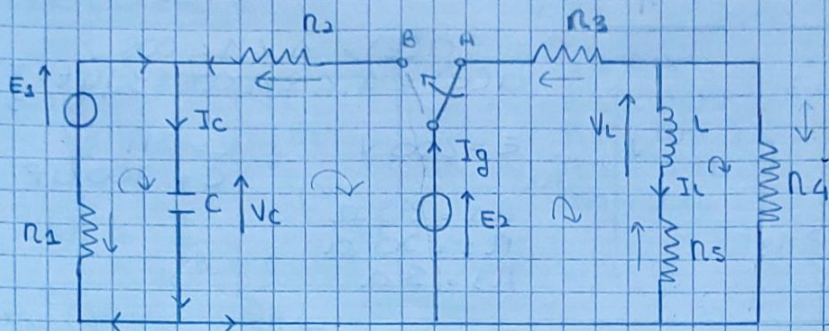
$$\bar{G} = \begin{bmatrix} 14 & -10 \\ -9,25 & 7,5 \end{bmatrix}$$

$$\Delta = 105 + 10K - 100$$

$$K = -\frac{1}{2}$$

Sviluppo il prodotto matrice vettore delle equazioni di maglia mantenendo K come incognita.
 $\Rightarrow$ determinante della matrice $\bar{G}$ e $\bar{u}$.

ESERCIZIO 2



$$\begin{aligned} R_1 &= 4 \, \Omega \\ R_2 &= 1 \, \Omega \\ R_3 &= 2 \, \Omega \\ R_4 &= 8 \, \Omega \\ R_5 &= 2 \, \Omega \end{aligned}$$

$$\begin{aligned} C &= 2 \, \text{F} \\ L &= 1 \, \text{H} \\ E_1 &= 20 \, \text{V} \\ E_2 &= 10 \, \text{V} \end{aligned}$$

$$I_L(0^-) = I_L(0^+)$$

$$V_C(0^-) = V_C(0^+)$$

- $V_C(0^-) = 20 \, \text{V}$
- $V_C(0^+) = 20 \, \text{V}$

$$V_L(0^-) = 0 \, \text{V}$$

$$\tau_2 = C \cdot R_{eq} = C \cdot \left(\frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} \right)$$

$$\tau_2 = 1,6 \, \text{s}$$

$$E_2 = R_3 I_g + R_5 I_L$$

$$R_5 I_L = R_4 I_g - R_4 I_L$$

$$I_L = \frac{R_4}{R_5 + R_4} I_g$$

$$I_g = I_L + I_u$$

$$I_u = I_g - I_L$$

$$\tau_1 = \frac{L}{R_{eq}} = 0,3 \, \text{s}$$

$$E_2 = 2 I_g + R_5 \frac{R_4}{R_5 + R_4} I_g$$

$$2 I_g + 1,6 I_g = 10$$

$$I_g(0^-) = \frac{10}{3,6} = 2,78 \, \text{A}$$

$$I_L(\infty) = 0 \, \text{A}$$

$$\tau_L = 0,1 \, \text{ms}$$

$$I_L(0^-) = 2,22 \, \text{A}$$

$$I_L(0^+) = 2,22 \, \text{A}$$

$$V_L(0^+) = -i_L(0^+) (R_5 + R_4)$$

$$I_g(\infty) = -\frac{E_1}{S} + \frac{E_2}{S}$$

$$I_g(\infty) = -4 + 2 = -2 \, \text{A}$$

$$V_L(0^+) = -22,2 \, \text{V}$$

$$I_C(0^+) = C \cdot D V_C$$

$$V_C = K e^{-t/\tau} + V(\infty)$$

$$K = 8 \quad V'_C = -\frac{8}{1,6} e^{-t/\tau}$$

$$I_{E1} = \frac{E_1}{S} = 4 \, \text{A}$$

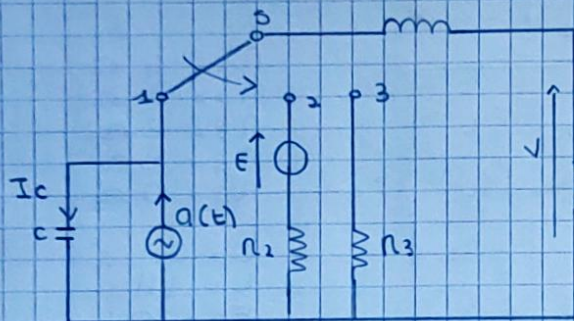
$$I_{TOT} = 2 \, \text{A}$$

$$I_C(0^+) = 2 \cdot -\frac{8}{1,6} = -10 \, \text{A}$$

$$I_{E2} = \frac{E_2}{S} = 2 \, \text{A}$$

$$V_C = R_2 I_{TOT} - E_2 \Rightarrow V_C(\infty) = 12 \, \text{V}$$

3.7.2007 (finire)



$$u(t) = 1,414 \cos(31,4t - \frac{\pi}{3}) \text{ A}$$

$$E = 200 \text{ V}$$

$$L = 5 \text{ H}$$

$$C = 300 \text{ } \mu\text{F}$$

$$R_1 = 30 \text{ } \Omega$$

$$R_2 = 20 \text{ } \Omega$$

$$R_3 = 5 \text{ } \Omega$$

$$T_1 = 0 \text{ s} \quad T_2 = 0,2 \text{ s}$$

$$\omega = 31,4 \text{ rad/s}$$

$$Z_C = -\frac{j}{\omega C}$$

$$Z_C = -106,16j \text{ } \Omega$$

$$Z_L = j\omega L$$

$$Z_L = 157j \text{ } \Omega$$

$$I_L(0^-) = I_L(0^+)$$

$$\bar{Z} = \left(\frac{1}{R_1 + j\omega L} + \frac{1}{-\frac{j}{\omega C}} \right)^{-1}$$

$$\bar{Z} = 97,02 - 270,6j \text{ } \Omega$$

$$\bar{Z} = 287,45 \angle -70,3 \text{ } \Omega$$

$$\bar{A} = \frac{1,41}{\sqrt{2}} \angle -60 \text{ A} \Rightarrow \text{considero il fasore!}$$

$$V_A = Z_C \cdot \bar{I}_C$$

$$\bar{A} \cdot \bar{Z}_{eq} = Z_C \cdot \bar{I}_C$$

$$\frac{\bar{A} \cdot \bar{Z}_{eq}}{Z_C} = \bar{I}_C \quad \bar{I}_C = 2,7 \angle -60,3 \text{ A}$$

$$\bar{I} = \bar{A} - \bar{I}_C \quad \bar{I} = 1,8 \angle 150,5 \text{ A}$$

$$P_A = 96,32 \text{ W}$$

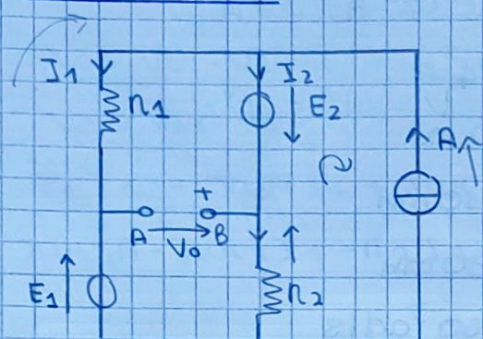
$$Q_C = -773,9 \text{ Var}$$

$$Q_L = 508,7 \text{ Var}$$

$$\begin{aligned} S &= V \cdot I^* \quad [\text{Va}] \\ P &= \text{Re}[S] \quad [\text{W}] \\ Q &= \text{Im}[S] \quad [\text{Var}] \end{aligned}$$

04.09.2014

ESERCIZIO 1



$$\begin{aligned} A &= 8 \text{ A} \\ E_1 &= 10 \text{ V} \\ E_2 &= n_m I_1 \\ n_1 &= 1 \\ n_2 &= 2 \end{aligned}$$

• $R_m = 0$

- effetto di A:

$$I_1 = A \cdot \frac{R_2}{R_2 + R_1} = 5,33 \text{ A}$$

$$I_2 = A - I_1 \quad I_2 = 2,67 \text{ A}$$

$$V_A = R_2 I_2 \quad V_A = 5,33 \text{ V}$$

$$V_0 = R_1 I_1 \quad V_0 = 5,33 \text{ V}$$

$$\begin{aligned} I_e &= -I_1 \\ I_e &= -5,33 \end{aligned}$$

- effetto di E:

$$I_e = -I_1 \quad I_1 = -I_2$$

$$I_e = \frac{E}{R_{eq}} \quad I_e = \frac{10}{3} = 3,3 \text{ A}$$

$$I_1 = -3,33 \text{ A} \quad I_2 = 3,33 \text{ A}$$

$$V_A = 6,67 \text{ V}$$

$$E_1 + V_0 = V_A \quad V_0 = V_A - E_1 \quad V_0 = -3,33 \text{ V}$$

$$P_A = 96 \text{ W}$$

$$P_E = 20 \text{ W}$$

• $R_m = 2 \Omega$

$$I_1 = A - I_2$$

$$E_2 = R_m I_1$$

$$V_A + R_m I_1 = R_2 I_2$$

$$E_1 + R_1 I_1 = V_A$$

$$V_A = R_2 I_2 - R_m I_1$$

$$R_2 (A - I_1) - 2 I_1 = 10 + I_1$$

$$P_{E2} = 16,32 \text{ W}$$

$$\begin{aligned} R_{eq}^{AB} &= \left(\frac{1}{R_2} + \frac{1}{R_1 + R_m} \right)^{-1} \\ R_{eq}^{AB} &= 1,2 \Omega \end{aligned}$$

$$I_1 = \frac{-6}{-5} = 1,2 \text{ A}$$

$$I_2 = 6,8 \text{ A}$$