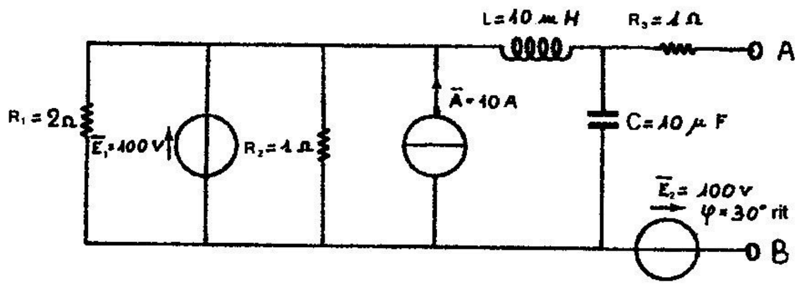
1)

GEN. EQUIV. – TRASF. GEN.

Determinare il circuito equivalente serie e quello equivalente parallelo $f = 50\ Hz$



$\omega = 2\pi f \simeq 314\ rad/s$

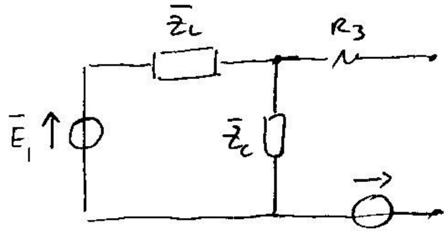
$X_L = \omega L = 314 \cdot 10^{-2} = 3{,}14\ \Omega$

$X_C = -\frac{1}{\omega C} = -\frac{1}{314 \cdot 10^{-5}} \simeq -318\ \Omega$

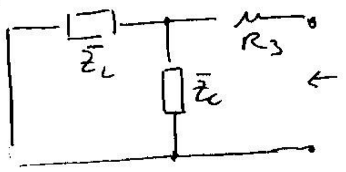
$\bar{Z}_L = j\,3{,}14\ \Omega \quad (j\pi\ \Omega)$

$\bar{Z}_C = -j\,318\ \Omega \quad (-j\frac{10^3}{\pi}\ \Omega)$

$\bar{E}_2 = 100\ \underline{/-30^\circ} = 86{,}6 - j50\ V$



RETE INERTE $\rightarrow \bar{Z}_{TH}$

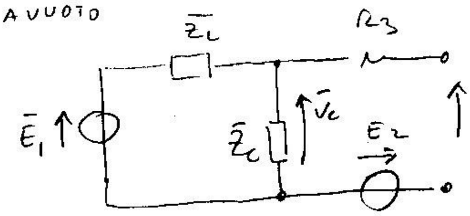


$\bar{Z}_{TH} = R_3 + \bar{Z}_L // \bar{Z}_C = 1 + \frac{jX_L \cdot jX_C}{j(X_L + X_C)} = 1 - j\frac{1000}{-314{,}86} \simeq 1 + j\,3{,}1729\ \Omega$

$\bar{Z}_{LC} = \frac{j\,3{,}14 \cdot (-j\,318)}{j\,3{,}14 - j\,318} = j\,3{,}1729\ \Omega$

$\left(\bar{Z}_{LC} = \frac{j\pi \cdot (-j\frac{10^3}{\pi})}{j(\pi - \frac{10^3}{\pi})} = \frac{-j\,10^3\pi}{\pi^2 - 10^3} = j\,3{,}1729\ \Omega\right)$

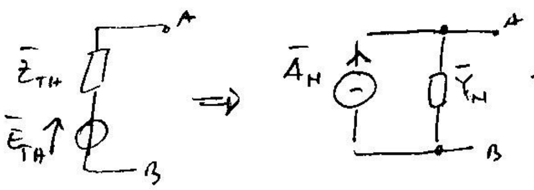
RETE A VUOTO $\rightarrow \bar{E}_{TH}$



$\bar{E}_{TH} = \bar{V}_C - \bar{E}_2$

$\bar{V}_C = \bar{E}_1 \cdot \frac{\bar{Z}_C}{\bar{Z}_L + \bar{Z}_C} = \frac{\bar{E}_1}{\bar{Z}_L} \cdot \bar{Z}_{LC} = 100 \cdot \frac{j\,3{,}1729}{j\,3{,}14} = 101\ V$

$\bar{E}_{TH} = \bar{V}_C - \bar{E}_2 = 101 - 86{,}6 - j50 = 14{,}4 + j50\ V$



$\bar{Y}_N = \bar{Z}_{TH}^{-1} = 0{,}0904 - j\,0{,}28675 \quad \begin{cases} R_P = \frac{1}{0{,}0904} = 11{,}06\ \Omega \\ B_L = -\frac{1}{\omega L} \rightarrow L_P = -\frac{1}{\omega B} = 11\ mH \end{cases}$

T.G.

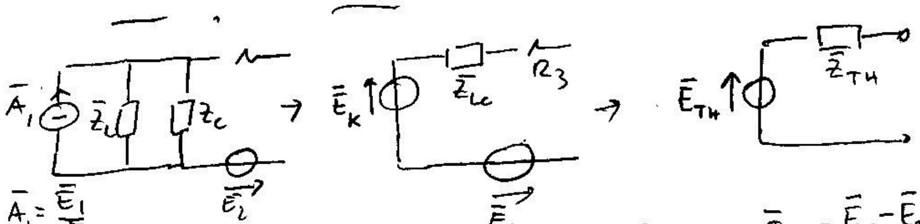
$\bar{A}_N = \frac{\bar{E}_{TH}}{\bar{Z}_{TH}} = 15{,}6357 + j\,0{,}3895\ A$

IL GEN. EQUIV. PARALL. (GEN. NORTON) SI PUÒ OTTENERE MEDIANTE TRASFORMAZIONE DAL GEN. EQUIV. SERIE (GEN. THÉVENIN) OPPURE DALLA RETE, DETERMINANDO LA CORR. DI C.TO C.TO TRA I MORSETTI AB –

$\bar{Z}_{TH} = 1 + j\,3{,}1729\ \Omega$

$R_S = 1\ \Omega$

$X_L = \omega L \rightarrow L_S = \frac{X_L}{\omega} = 10\ mH$



$\bar{A}_1 = \frac{\bar{E}_1}{\bar{Z}_L}$

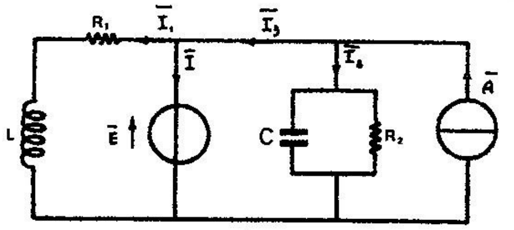
$\bar{E}_K = \bar{A}_1 \cdot \bar{Z}_{LC} = \frac{\bar{E}_1}{\cancel{\bar{Z}_L}} \cdot \frac{\cancel{\bar{Z}_L} \cdot \bar{Z}_C}{\bar{Z}_L + \bar{Z}_C}$

$\bar{E}_{TH} = \bar{E}_K - \bar{E}_2 = \frac{\bar{E}_1 \cdot \bar{Z}_C}{\bar{Z}_L + \bar{Z}_C} - \bar{E}_2$

$\bar{Z}_{TH} = \bar{Z}_{LC} + R_3$

2) PSCE

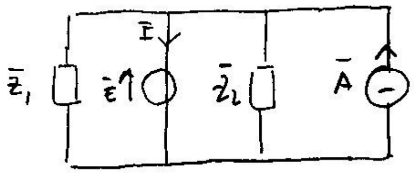
Determinare per il circuito sotto riportato la corrente $\bar{I}$



$R_1 = 5\,\Omega$
$R_2 = 10\,\Omega$
$L = 1{,}6\,mH$
$C = 3{,}3\,\mu F$
$\bar{E} = 10\,V$
$\bar{A} = 5\,A$
$f = 50\,Hz$

$X_L = \omega L \simeq 0{,}5\,\Omega \quad \bar{Z}_L = j\,0{,}5\,\Omega$

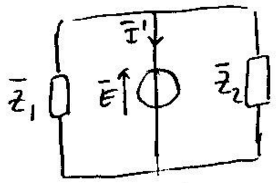
$X_C = -\frac{1}{\omega C} \simeq -1000\,\Omega \quad \bar{Z}_C = -j\,1000\,\Omega$



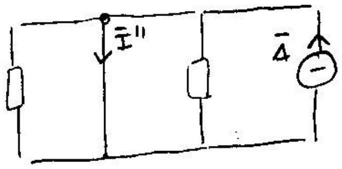
$\bar{Z}_1 = R_1 + \bar{Z}_L = 5 + j\,0{,}5\,\Omega$

$\bar{Z}_2 = \left(R_2^{-1} + \bar{Z}_C^{-1}\right)^{-1} \simeq 10 - j\,0{,}1\,\Omega \quad \left[\frac{10\cdot(-j1000)}{10-j1000}\right]$

PSE



$\bar{I}' = -\frac{\bar{E}}{\bar{Z}_1} - \frac{\bar{E}}{\bar{Z}_2} = -\frac{10}{5+j0{,}5} - \frac{10}{10-j0{,}1} \simeq -2 + j0{,}2 - 1 - j0{,}01 = -3 + j0{,}19\,A$



$\bar{I}'' = \bar{A} = 5\,A$

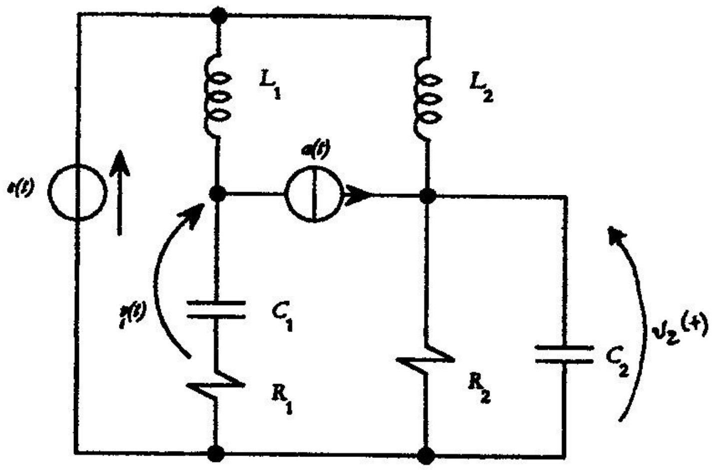
$\bar{I} = \bar{I}' + \bar{I}'' = -3 + j0{,}19 + 5 = 2 + j0{,}19\,A$

3)

Determinare le tensioni $v_1(t)$ e $v_2(t)$

- PSCE
- PARTITORE TENS.
- PARTITORE CORR.

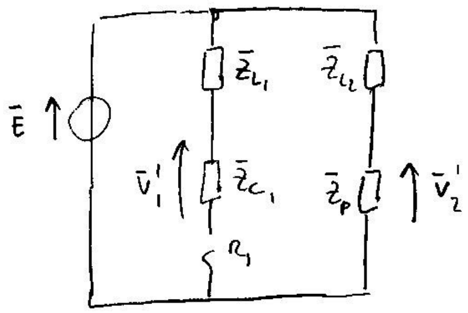
Dati: $R_1=R_2=2\ \Omega$; $L_1=L_2=2$ mH; $C_1=C_2=1$ mF.
$e(t)=10\sqrt{2}\cdot\cos(\omega_1 t)$ V con $\omega_1=1000$ rad/s.
$a(t)=\sqrt{2}\cdot\sin(\omega_2 t)$ A con $\omega_2=500$ rad/s.



$\bar{E} = 10\sqrt{2}$

$\bar{A} = -j\sqrt{2}$

PSE



$$\bar{Z}_{L_1} = j\omega_1 L_1 = j\,10^3\cdot 2\cdot 10^{-3} = j2\ \Omega = \bar{Z}_{L_2}$$

$$\bar{Z}_{C_1} = -j\frac{1}{\omega_1 C_1} = -j\frac{1}{10^3\cdot 10^{-3}} = -j\ \Omega = \bar{Z}_{C_2}$$

$$\bar{Z}_P = \left(R_2^{-1} + \bar{Z}_{C_2}^{-1}\right)^{-1} = 0{,}4 - j0{,}8\ \Omega$$

PARTITORE DI TENS.

$$\bar{V}_1' = \frac{\bar{E}\cdot\bar{Z}_{C_1}}{\bar{Z}_{L_1}+\bar{Z}_{C_1}+R_1} = \frac{10\sqrt{2}(-j)}{2+j} = \sqrt{2}(-2-j4)\ \text{V}$$

$$\bar{V}_2' = \frac{\bar{E}\cdot\bar{Z}_P}{\bar{Z}_P+\bar{Z}_{L_2}} = \frac{10\sqrt{2}(0{,}4-j0{,}8)}{0{,}4+j1{,}2} = \sqrt{2}(-5-j5)\ \text{V}$$

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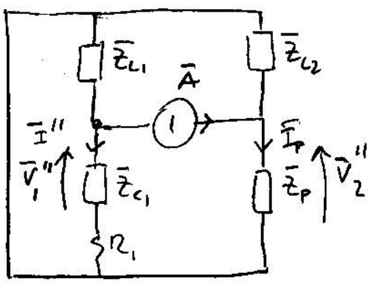


$$\bar{Z}_{L_1} = j\omega_2 L_1 = j\frac{10^3}{2}\cdot 2\cdot 10^{-3} = j\ \Omega = \bar{Z}_{L_2}$$

$$\bar{Z}_{C_1} = -j\frac{1}{\omega_2 C_1} = -j\frac{1}{\frac{10^3}{2}\cdot 10^{-3}} = -j2\ \Omega = \bar{Z}_{C_2}$$

$$\bar{Z}_P = \left(R_2^{-1} + \bar{Z}_{C_2}^{-1}\right)^{-1} = 1-j\ \Omega$$

PART. DI CORR.

$$\bar{I}'' = -\frac{\bar{A}\cdot\bar{Z}_{L_1}}{\bar{Z}_{L_1}+\bar{Z}_{C_1}+R_1} = +\frac{j\sqrt{2}\cdot(j)}{j-2j+2} = \sqrt{2}(-0{,}4-j0{,}2)\ \text{A}$$

$$\bar{I}_P = \frac{\bar{A}\cdot\bar{Z}_{L_2}}{\bar{Z}_P+\bar{Z}_{L_2}} = \frac{-j\sqrt{2}\cdot(j)}{1-j+j} = \sqrt{2}$$

$$\bar{V}_1'' = \bar{Z}_{C_1}\cdot\bar{I}'' = -j2\cdot\sqrt{2}(-0{,}4-j0{,}2) = \sqrt{2}(-0{,}4+j0{,}8)\ \text{V}$$

$$\bar{V}_2'' = \bar{Z}_P\,\bar{I}_P = (1-j)\cdot\sqrt{2} = \sqrt{2}(1-j)\ \text{V}$$

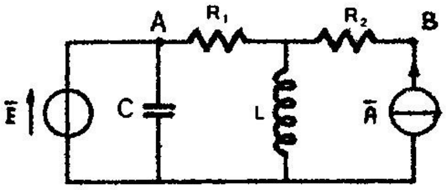
— · —

$$v_1(t) = -2\sqrt{2}\cos\omega_1 t + 4\sqrt{2}\sin\omega_1 t - 0{,}4\sqrt{2}\cos\omega_2 t - 0{,}8\sqrt{2}\sin\omega_2 t \quad ✓$$

$$v_2(t) = -5\sqrt{2}\cos\omega_1 t + 5\sqrt{2}\sin\omega_1 t + \sqrt{2}\cos\omega_2 t + \sqrt{2}\sin\omega_2 t \quad ✓$$

4)

Per il circuito determinare la tensione $\bar{V}_{AB}$
per le frequenze $f = 50\ Hz$, $f = 0$



$R_1 = 1\Omega$
$R_2 = 100\Omega$
$L = 6{,}6 mH$
$C = 1 mF$
$\bar{E} = 100 V$
$\bar{A} = 1 A$

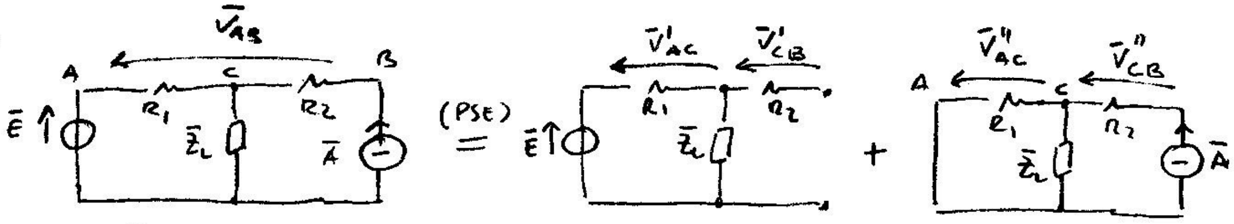
$f = 50 Hz$

$\bar{Z}_L = j100\pi \cdot 6{,}6 \cdot 10^{-3} = j0{,}66\pi\ \Omega$
$(\bar{Z}_L \simeq j2\Omega)$

$f = 0 Hz$

$\bar{Z}_L = 0$

$f = 50 Hz$



$\bar{V}_{AB} = \bar{V}_{AC} + \bar{V}_{CB}$

$\bar{V}'_{AC} = \frac{\bar{E} \cdot R_1}{R_1 + \bar{Z}_L} = \frac{\bar{E}}{\bar{Z}_L} \cdot (R_1 // \bar{Z}_L)$

$\bar{V}'_{CB} = 0$

$\bar{V}''_{AC} = -\bar{A}(R_1 // \bar{Z}_L)$

$\bar{V}''_{CB} = -\bar{A} R_2$

$\bar{V}_{AC} = \bar{V}'_{AC} + \bar{V}''_{AC}$

$\bar{V}_{CB} = \bar{V}'_{CB} + \bar{V}''_{CB} = \bar{V}''_{CB}$

$\bar{Z}_p = R_1 // \bar{Z}_L = (R_1^{-1} + \bar{Z}_L^{-1})^{-1} = 0{,}8113 + j0{,}3913\ \Omega$

$\left(\bar{Z} = \frac{1 \cdot (j2)}{1 + j2} = 0{,}8 + j0{,}4\ \Omega\right)$

$\bar{V}'_{AC} = 18{,}8708 - j39{,}1276\ V$

$\left(\bar{V}'_{AC} = \frac{100 \cdot 1}{1 + j2} = 20 - j40\ V\right)$

$\bar{V}''_{AC} = -1 \cdot \bar{Z}_p = -0{,}8113 - j0{,}3913\ V$

$(\bar{V}''_{AC} = -0{,}8 - j0{,}4\ V)$

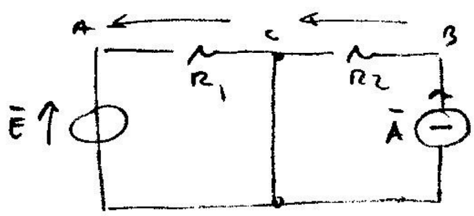
$\bar{V}''_{CB} = -1 \cdot R_2 = -100 V$

$\bar{V}_{AC} = \bar{V}'_{AC} + \bar{V}''_{AC} = 18{,}0595 - j39{,}5189\ V$

$\bar{V}_{AB} = -81{,}9405 - 39{,}5189\ V = 90{,}9725 V \angle -154{,}2526°$

$(\bar{V}_{AB} = 20 - j40 - 0{,}8 - j0{,}4 - 100 = -80{,}8 - j40{,}4 V = 90{,}3 V \angle -153°)$

$f = 0 Hz \quad \bar{Z}_L = 0$

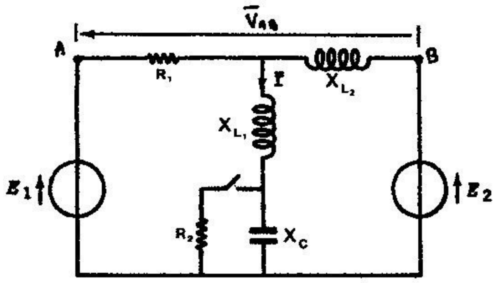


$V_{AB} = V_{AC} + V_{CB} = E - AR_2 = 100 - 100 = 0 V$

5)

Determinare la tensione $\bar{V}_{AB}$ e la corrente $i(t)$

1) ad interruttore T aperto
2) ad interruttore T chiuso



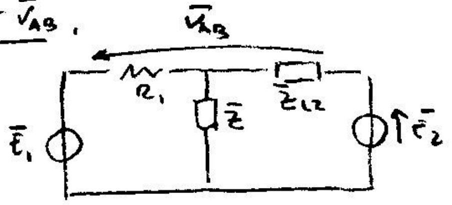
$R_1 = 1\,\Omega$
$R_2 = 5\,\Omega$
$X_{L_1} = 5\,\Omega$
$X_{L_2} = 3\,\Omega$
$X_C = -5\,\Omega$
$E_1 = E_M \sin(\omega t + \phi)$ V
$E_2 = E_M \sin \omega t$ V
$E_M = 100$ V
$\phi = 30°$ rit.

$\bar{Z}_{L_1} = j5\,\Omega$
$\bar{Z}_{L_2} = j3\,\Omega$
$\bar{Z}_C = -j5\,\Omega$

$\rightarrow \bar{E}_1 = -jE_M e^{j\phi} = -j100\, e^{-j30°}$ V
$= -j100\left(\frac{\sqrt{3}}{2} - j\frac{1}{2}\right) = -50 - j50\sqrt{3}$ V

$\bar{E}_2 = -jE_M = -j100$ V

TENSIONE $\bar{V}_{AB}$,



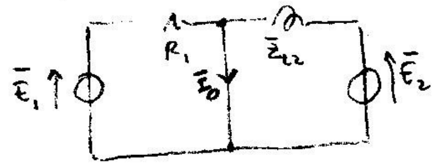
Ad interruttore aperto o chiuso la tensione $\bar{V}_{AB}$ non cambia.

LKT) $\bar{V}_{AB} = \bar{E}_1 - \bar{E}_2 = -50 - j50\sqrt{3} + j100 = -50 + j13{,}3975$ V $=$
$= 51{,}7638$ V $\underline{/165°}$

$v_{AB}(t) = 51{,}7638 \cos(\omega t + 165°) = -50 \cos \omega t - 13{,}3975 \sin \omega t$ V

CORRENTE $\bar{I}$

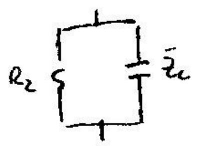
1) INTERR. APERTO



PSE) $\bar{I}_0 = \frac{\bar{E}_1}{R_1} + \frac{\bar{E}_2}{\bar{Z}_{L2}} = -50 - j50\sqrt{3} + j\frac{100}{j3} = -83{,}3333 - j86{,}6025$ A
$= 120{,}1850$ A $\underline{/-13{,}8979°}$

$i_0(t) = -83{,}3333 \cos \omega t + 86{,}6025 \sin \omega t =$
$= 120{,}1850 \cos(\omega t - 13{,}8979°)$ A

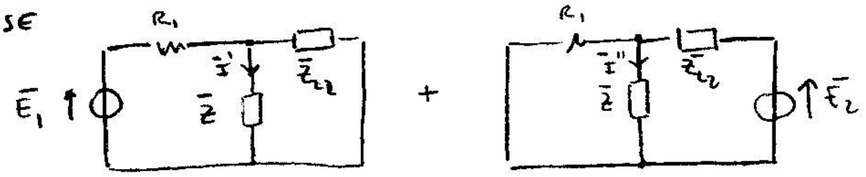
2) INTER. CHIUSO



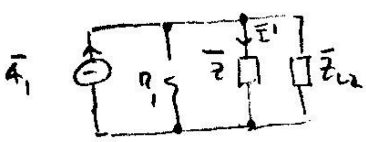
$\bar{Z}_P = (R_2^{-1} + \bar{Z}_C^{-1})^{-1} = 2{,}5 - j2{,}5\,\Omega$

$\bar{Z} = \bar{Z}_{L_1} + \bar{Z}_P = j5 + 2{,}5 - j2{,}5 = 2{,}5 + j2{,}5\,\Omega$

PSE



$\bar{I} = \bar{I}' + \bar{I}''$



$\bar{A}_1 = \frac{\bar{E}_1}{R_1}$ $\qquad \bar{I}' = \frac{\bar{A}_1 \cdot \bar{Y}}{G_1 + \bar{Y} + \bar{Y}_{L2}}$ $\qquad \bar{I}'' = \frac{\bar{E}_2}{\bar{Z}_{L2}} \cdot \frac{\bar{Y}}{G_1 + \bar{Y} + \bar{Y}_{L2}}$

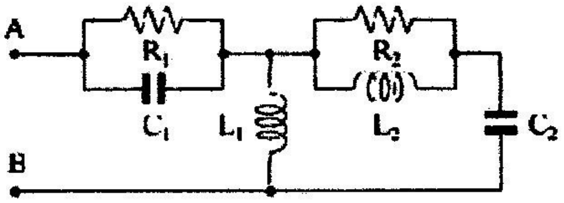
$\bar{K} = \frac{\bar{Y}}{G_1 + \bar{Y} + \bar{Y}_{L2}} = \underbrace{(R_1^{-1} + \bar{Z}^{-1} + \bar{Z}_{L2}^{-1})^{-1}}_{0{,}6959 + j0{,}3093\,\Omega} \cdot \bar{Z}^{-1} = 0{,}2010 - j0{,}0773$

$\bar{I}' = \frac{\bar{E}_1}{R_1} \bar{K} = -16{,}7476 - j13{,}5438$ A $\qquad \bar{I}'' = \frac{\bar{E}_2}{\bar{Z}_{L2}} \cdot \bar{K} = -6{,}7010 + j2{,}5773$ A

$\bar{I} = \bar{I}' + \bar{I}'' = -23{,}4486 - j10{,}9665$ A $\quad \left(\bar{I} = \bar{I}_0 \bar{K} = -23{,}4486 - j10{,}9665\text{ A} = 25{,}8863\text{ A } \underline{/-154{,}9354°}\right)$

$i(t) = -23{,}4486 \cos \omega t + 10{,}9665 \sin \omega t = 25{,}8863 \cos(\omega t - 154{,}9354°)$ A

Determinare il circuito equivalente serie e parallelo ai morsetti A-B



$R_1 = 10\ \Omega$ $\quad C_1 = 100\ \mu F$

$R_2 = 8\ \Omega$ $\quad C_2 = 250\ \mu F$

$L_1 = 16\ mH$

$L_2 = 16\ mH$ $\quad \omega = 500\ rad/s$

$\omega = \frac{10^3}{2}$

REATTANZE E SUSCETTANZE → IMPEDENZE E AMMETTENZE

$X_{L1} = \omega L_1 = \frac{10^3}{2} \cdot 16 \cdot 10^{-3} = 8\,\Omega \quad \bar{Z}_{L1} = j8\,\Omega \quad \bar{Y}_{L1} = -j0{,}125\,S \quad \left(B_{L1} = -\frac{1}{X_{L1}}\right)$

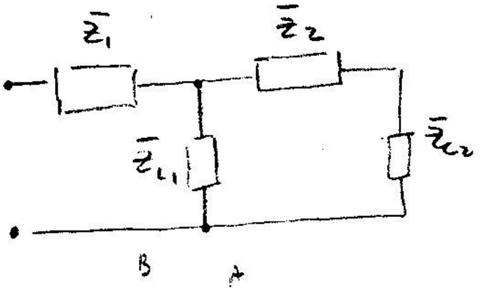
$X_{L2} = \omega L_2 = \frac{10^3}{2} \cdot 16 \cdot 10^{-3} = 8\,\Omega \quad \bar{Z}_{L2} = j8\,\Omega \quad \bar{Y}_{L2} = -j0{,}125\,S \quad \left(B_{L2} = -\frac{1}{X_{L2}}\right)$

$B_{C1} = \omega C_1 = \frac{10^3}{2} \cdot 0{,}1 \cdot 10^{-3} = 0{,}05\,S \quad X_{C1} = -\frac{1}{B_{C1}} = -20\,\Omega \quad \bar{Y}_{C1} = j0{,}05\,S \quad \bar{Z}_{C1} = -j20\,\Omega$

$B_{C2} = \omega C_2 = \frac{10^3}{2} \cdot 0{,}25 \cdot 10^{-3} = 0{,}125\,S \quad X_{C2} = -\frac{1}{B_{C2}} = -8\,\Omega \quad \bar{Y}_{C2} = j0{,}125\,S \quad \bar{Z}_{C2} = -j8\,\Omega$

$G_1 = R_1^{-1} = 0{,}1\,S$

$G_2 = R_2^{-1} = 0{,}125\,S$



$\bar{Y}_2 = G_2 + \bar{Y}_{L2} = 0{,}125 - j0{,}125\,S$

$\bar{Z}_2 = \bar{Y}_2^{-1} = 4 + j4\,\Omega \quad \bar{Z}_2 = \frac{R_2 \cdot \bar{Z}_{L2}}{R_2 + \bar{Z}_{L2}} = 4 + j4\,\Omega$

$\bar{Z}_A = \bar{Z}_2 + \bar{Z}_{C2} = 4 + j4 - j8 = 4 - j4\,\Omega$

$\bar{Y}_A = \bar{Z}_A^{-1} = 0{,}125 + j0{,}125\,S$

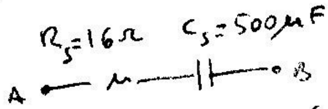
$\bar{Y}_B = \bar{Y}_A + \bar{Y}_{L1} = 0{,}125 + j0{,}125 - j0{,}125 = 0{,}125\,S$

$\bar{Z}_B = \bar{Y}_B^{-1} = 8\,\Omega \quad \bar{Z}_B = \frac{\bar{Z}_{L1} \cdot \bar{Z}_A}{\bar{Z}_{L1} + \bar{Z}_A}$

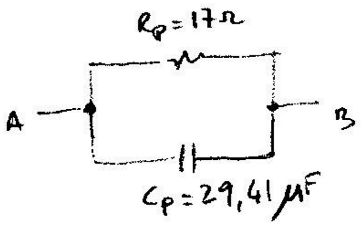
$\bar{Y}_1 = G_1 + \bar{Y}_{C1} = 0{,}1 + j0{,}05\,S$

$\bar{Z}_1 = \bar{Y}_1^{-1} = 8 - j4\,\Omega \quad \bar{Z}_1 = \frac{R_1 \cdot \bar{Z}_{C1}}{R_1 + \bar{Z}_{C1}} = \left(R_1^{-1} + \bar{Z}_{C1}^{-1}\right)^{-1} = 8 - j4\,\Omega$

$\bar{Z}_{AB} = \bar{Z}_1 + \bar{Z}_B = 8 - j4 + 8 = 16 - j4\,\Omega \quad \begin{cases} R_S = 16\,\Omega \\ X_S = -4\,\Omega < 0 \end{cases} \quad X_S = -\frac{1}{\omega C_S} \quad C_S = -\frac{1}{\omega X_C} = 500\,\mu F$



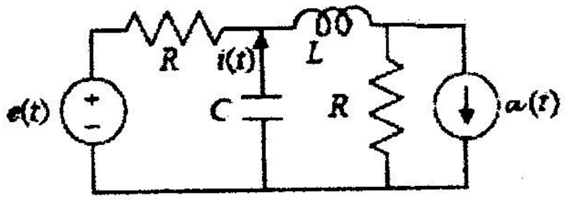
$\bar{Y}_{AB} = \bar{Z}_{AB}^{-1} = 58{,}8235 + j14{,}7059\,mS \begin{cases} G_P = 58{,}8235\,mS \to R_P = 17\,\Omega \\ B_P = 14{,}7059\,mS > 0 \quad B_P = \omega C_P \end{cases} \quad C_P = \frac{B_P}{\omega} = 29{,}41\,\mu F$



7)

- TRASF. GEN.
- PART. CORR.

Valutare la corrente che circola nel condensatore



$a(t) = 2\sqrt{2}\sin(2\pi f t + 0.12)\ A$

$e(t) = 10\sqrt{2}\cos(2\pi f t)\ V,\ f = 50\ Hz$

$R = 1\,\Omega,\ C = 1\,mF,\ L = 3\,mH$

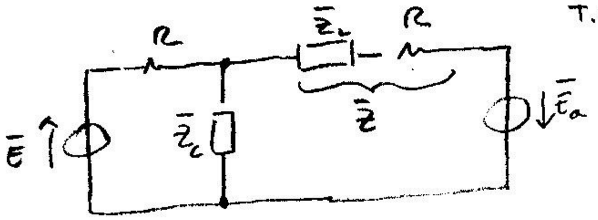
FASORI E IMPEDENZE

$\bar{A} = -j\,2\sqrt{2}\,e^{j0,12} = -j\,(2\sqrt{2})\angle(0,12\cdot 180/\pi) = 0,3386 - j\,2,8081\,A$

$\bar{E} = 10\sqrt{2} = 14,1421\,V$

$\bar{Z}_L = j\omega L = j\,100\pi\cdot 3\cdot 10^{-3} = j\,0,3\pi\,\Omega = j\,0,9425\,\Omega$

$\bar{Z}_C = -j\frac{1}{\omega C} = -j\frac{10^3}{100\pi} = -j\frac{10}{\pi} = -j\,3,1831\,\Omega$



T.G.

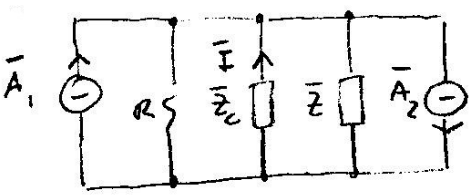
$\bar{E}_a = R\bar{A} = 0,3386 - j\,2,8081\,V$

$\bar{Z} = R + \bar{Z}_L = 1 + j\,0,9425\,\Omega$

$\bar{Z}_x = \bar{Z}\,//\,\bar{Z}_c = 1,6830 + j\,0,5878\,\Omega$

$\bar{Z}_T = R\,//\,\bar{Z}_x = 0,6444 + j\,0,0779\,\Omega$

$\frac{\bar{Z}_T}{\bar{Z}_c} = -0,0245 + j\,0,2024$



T.G

$\bar{A}_1 = \frac{\bar{E}}{R} = 14,1421\,A$

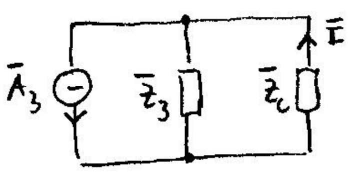
$\bar{A}_2 = \frac{\bar{E}_a}{\bar{Z}} = -1,2223 - j\,1,6561\,A$

P.C.

$$\bar{I} = (\bar{A}_2 - \bar{A}_1)\frac{\frac{1}{\bar{Z}_c}}{\frac{1}{R} + \frac{1}{\bar{Z}_c} + \frac{1}{\bar{Z}}} = (\bar{A}_2 - \bar{A}_1)\cdot\bar{Z}_c^{-1}\cdot\left(R^{-1} + \bar{Z}_c^{-1} + \bar{Z}^{-1}\right)^{-1} =$$

$$= (-15,3644 - j\,1,6561)(-0,0245 + j\,0,2024) = 0,7113 - j\,3,0697\,A$$

OPPURE



$\bar{A}_3 = \bar{A}_2 - \bar{A}_1 = -15,3644 - j\,1,6561\,A$

$\bar{Z}_3 = \frac{R\cdot\bar{Z}}{R + \bar{Z}} = \left(R^{-1} + \bar{Z}^{-1}\right)^{-1} = 0,5909 + j\,0,1928\,\Omega$

$\bar{I} = \bar{A}_3\cdot\frac{\bar{Z}_3}{\bar{Z}_3 + \bar{Z}_c} = \bar{A}_3\cdot(-0,0245 + j\,0,2024) = 0,7113 - j\,3,0699\,A$

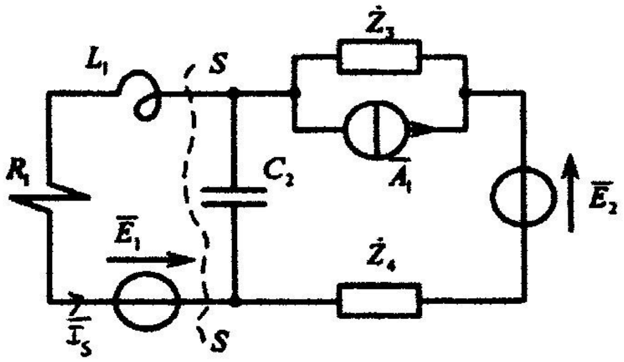
$= 3,1512\,A\ \underline{/-76,9553^\circ}$

$$i(t) = \Re\left[\bar{I}\,e^{j2\pi f t}\right] = 0,711\cos 100\pi t + 3,070\sin 100\pi t\ A$$

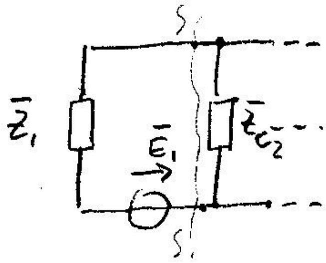
$$= 3,15\cos(100\pi t - 76,96^\circ)\ A$$

8)

DETERMINARE $\overline{E}_1$ TALE CHE $\overline{I}_S = 1\,A$ (THEVENIN)

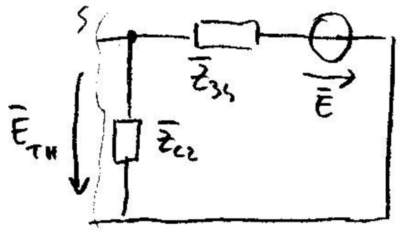


$\overline{E}_1 =$ ***incognito***
$\overline{E}_2 = 95 + j29\,\mathrm{V}$
$\overline{A}_1 = j5\,\mathrm{A}$
$R_1 = 15\,\Omega$
$L_1 = 50\,\mathrm{mH}$
$C_2 = 75\,\mu\mathrm{F}$
$\dot{Z}_3 = 10 + j12\,\Omega$
$\dot{Z}_4 = 4 - j3\,\Omega$
$f = 50\,\mathrm{Hz}$



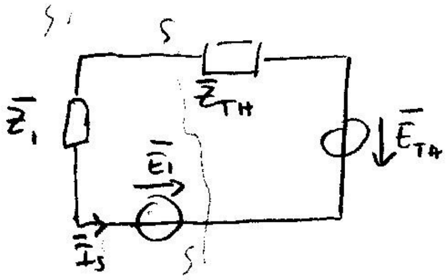
$$\overline{Z}_1 = R_1 + j\omega L_1 = 15 + j\,100\pi \cdot 50 \cdot 10^{-3} = 15 + j5\pi\ \Omega$$

$$\overline{Z}_{C_2} = -j\frac{1}{\omega C_2} = -j\frac{10^6}{100\pi \cdot 75} = -j\frac{10^3}{7{,}5\pi} = -j42{,}4413\ \Omega$$



$$\overline{Z}_{34} = \overline{Z}_3 + \overline{Z}_4 = 10 + j12 + 4 - j3 = 14 + j9\ \Omega$$

$$\overline{E} = \underbrace{\overline{A}_1 \cdot \overline{Z}_3}_{T.G.} - \overline{E}_2 = j5(10 + j12) - (95 + j29) = -155 + j21\ \mathrm{V}$$



$$\overline{Z}_{TH} = \frac{\overline{Z}_{34} \cdot \overline{Z}_{C2}}{\overline{Z}_{34} + \overline{Z}_{C2}} = 19{,}1869 + j3{,}3897\ \Omega$$

$$\overline{E}_{TH} = \overline{E} \cdot \frac{\overline{Z}_{C2}}{\overline{Z}_{C2} + \overline{Z}_{34}} = \frac{\overline{E} \cdot \overline{Z}_{TH}}{\overline{Z}_{34}} = -157{,}8858 + j92{,}7496\ \mathrm{V} = 183{,}1131\ \mathrm{V}\ \angle 149.57^\circ$$

$$\overline{I}_S = 1A \rightarrow \overline{E}_1 = \overline{E}_{TH} + (\overline{Z}_1 + \overline{Z}_{TH})\overline{I}_S = -157{,}8858 + j92{,}7496 + 34{,}1869 + j19{,}0977 =$$

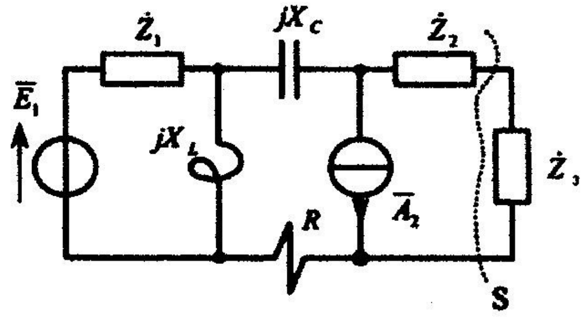
$$-123{,}6989 + j111{,}8473\ \mathrm{V} = 166{,}767\ \mathrm{V}\ \angle 137{,}88^\circ$$

$$e_1 = 166{,}767 \cos(100\pi t + 137{,}88^\circ)\ \mathrm{V} =$$

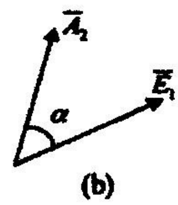
$$= -123{,}699 \cos 100\pi t - 111{,}847 \sin 100\pi t\ \mathrm{V}$$

1) PARTITENS. - TRASF.GEN.

Determinare la corrente che percorre $\dot{Z}_3$ con $\dot{Z}_3 = \underline{Z}_{TH}$ (THEVENIN)



(a)



(b)

$E_1 = 25\,V$

$A_2 = 3\,A$

$\dot{Z}_1 = 6 - j4\,\Omega$

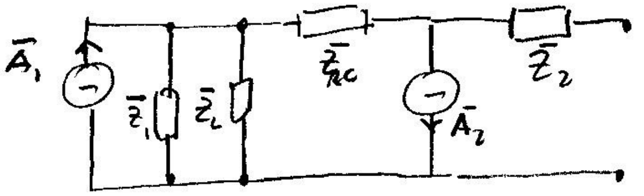
$\dot{Z}_2 = 1 + j2\,\Omega$

$X_L = 2\,\Omega$

$X_C = -3\,\Omega$

$R = 7\,\Omega$

$\alpha = \pi/3$



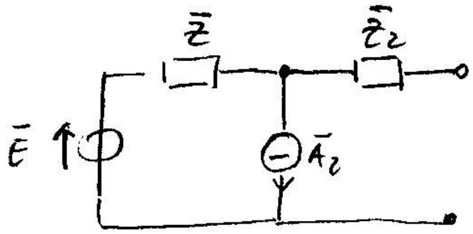
$\overline{E}_1 = E_1 = 25\,V$

$\overline{A}_2 = A_2 e^{j\alpha} = 3A \angle 60^\circ = 1{,}5 + j2{,}5981\,A$

$\overline{Z}_L = jX_L = j2\,\Omega$

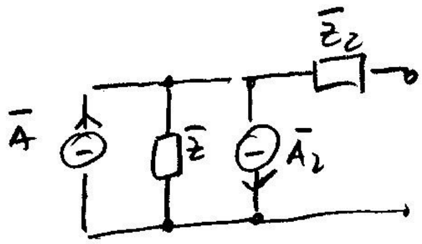
$\overline{Z}_{RC} = R + jX_C = 7 - j3\,\Omega$

$\overline{A}_1 = \dfrac{\overline{E}_1}{\overline{Z}_1} =$

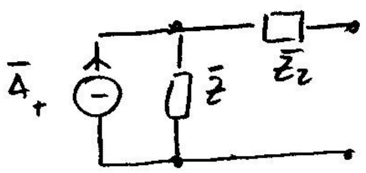


P.T. $\overline{E} = \overline{A}_1 \cdot \dfrac{\overline{Z}_1 \overline{Z}_L}{\overline{Z}_1 + \overline{Z}_L} = \dfrac{\overline{E}_1}{\cancel{\overline{Z}_1}} \dfrac{\cancel{\overline{Z}_1} \overline{Z}_L}{\overline{Z}_1 + \overline{Z}_L} = \dfrac{\overline{E}_1 \overline{Z}_L}{\overline{Z}_1 + \overline{Z}_L} = -2{,}5 + j7{,}5\,V$

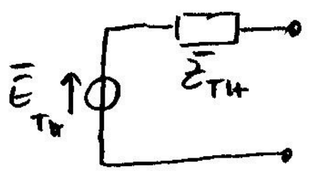
$\overline{Z} = \dfrac{\overline{Z}_1 \cdot \overline{Z}_L}{\overline{Z}_1 + \overline{Z}_L} + \overline{Z}_{RC} = 7{,}6 - j0{,}8\,\Omega$ $(0{,}6 + j2{,}2 + 7 - j3)$



T.G. $\overline{A} = \dfrac{\overline{E}}{\overline{Z}} = -0{,}4281 + j0{,}9418\,A$

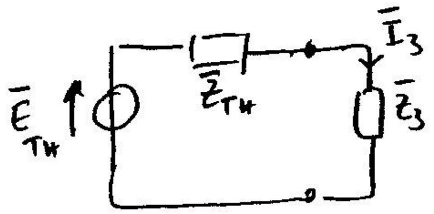


$\overline{A}_T = \overline{A} - \overline{A}_2 = -1{,}9281 - j1{,}6563\,A$



T.G. $\overline{E}_{TH} = \overline{A}_T \cdot \overline{Z} = -15{,}9785 - j11{,}0454\,V$

$\overline{Z}_{TH} = \overline{Z} + \overline{Z}_2 = 8{,}6 + j1{,}2\,\Omega$



$\overline{Z}_3 = \underline{Z}_{TH}^* = 8{,}6 - j1{,}2\,\Omega$

$\overline{I}_3 = \dfrac{\overline{E}_{TH}}{\overline{Z}_{TH} + \overline{Z}_3} = \dfrac{\overline{E}_{TH}}{17{,}2} = -0{,}9290 - j0{,}6422\,A = 1{,}129\,A \angle -145{,}35^\circ$

$i_3(t) = -0{,}929 \cos \omega t + 0{,}642 \sin \omega t = 1{,}129 \cos(\omega t - 145{,}35^\circ)\,A$

Determinare nel tempo l'andamento della tensione $v(t)$ ai capi del condensatore.

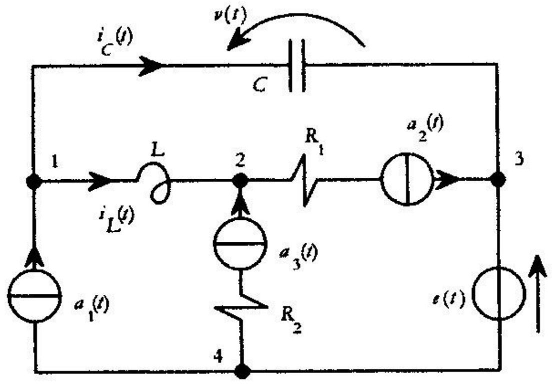
Dati: $R_1 = R_2 = 10\ \Omega$; $L = 10$ mH; $C = 1$ mF; $f = 50$ Hz.

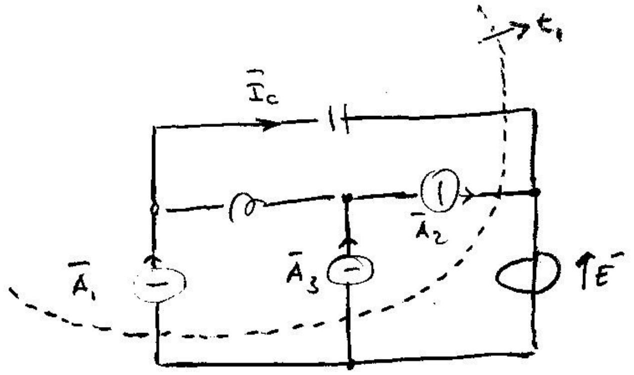
$e(t) = 10\sqrt{2}\cdot \cos(\omega t)$ V.

$a_1(t) = \sqrt{2}\cdot \sin(\omega t)$ A.

$a_2(t) = \sqrt{2}\cdot \cos(\omega t + \pi/2)$ A.

$a_3(t) = \sqrt{2}\cdot \cos(\omega t)$ A.





$\bar{E} = 10\sqrt{2}$ V

$\bar{A}_1 = -j\sqrt{2}$ A

$\bar{A}_2 = j\sqrt{2}$ A

$\bar{A}_3 = \sqrt{2}$ A

$t_1)$ LKC $\quad \bar{I}_c = \bar{A}_1 + \bar{A}_3 - \bar{A}_2 = -j\sqrt{2} + \sqrt{2} - j\sqrt{2} = \sqrt{2}(1-j2)$ A

LΩ $\quad \bar{V}_c = \bar{Z}_c \bar{I}_c$

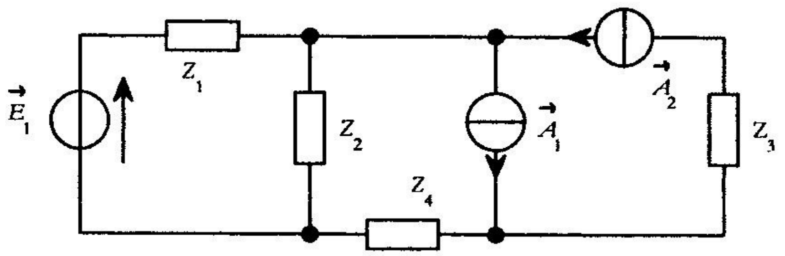
$$\bar{Z}_c = \frac{1}{j\omega C} = \frac{1}{j100\pi 10^{-3}} = -j\frac{10}{\pi}\ \Omega$$

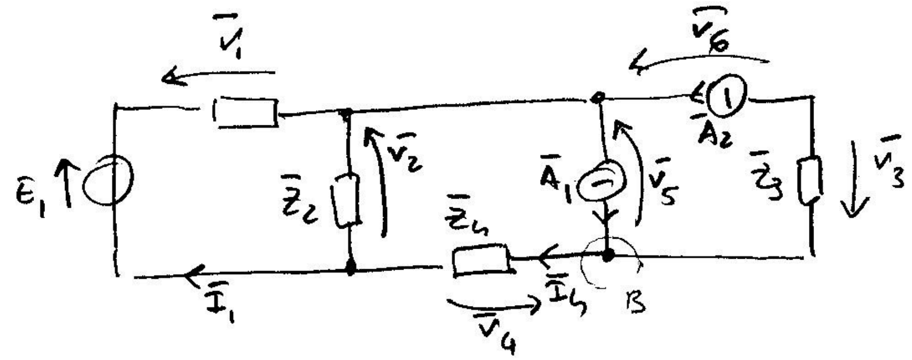
$$= -j\frac{10}{\pi}\cdot\sqrt{2}(1-j2)\ \text{V} = \begin{cases} \frac{10}{\pi}\cdot\sqrt{2}\sqrt{5} = 10{,}0658\ \text{V} \\ -\frac{\pi}{2} - \operatorname{atg} 2 = -2{,}6779\ \text{rad}\ \ (-153{,}43^\circ) \end{cases}$$

$$v(t) = 10{,}0658\cos(\omega t - 2{,}6779)\ \text{V}$$

Determinare le tensioni e le correnti incognite su tutti i bipoli nella rete in corrente alternata in figura.

Dati: $\vec{E}_1 = 100$ V; $\bar{A}_1 = \bar{A}_2 = 10j$ A; $Z_1 = 10+10j\ \Omega$; $Z_2 = 10 - 10j\ \Omega$; $Z_3 = Z_4 = 10\ \Omega$.





LKC B) $\bar{I}_4 = \bar{A}_1 - \bar{A}_2 = 0$

LΩ $\bar{V}_4 = \bar{Z}_4 \bar{I}_4 = 0$

LKT $\bar{V}_2 = \bar{V}_4 + \bar{V}_5 = \bar{V}_5$

$$\bar{I}_1 = \frac{\bar{E}_1}{\bar{Z}_1 + \bar{Z}_2} = \frac{100}{20} = 5A$$

$$\bar{V}_1 = \bar{Z}_1 \bar{I}_1 = 50(1+j)\ V$$

$$\bar{V}_2 = \bar{V}_5 = \bar{Z}_2 \bar{I}_1 = 50(1-j)\ V$$

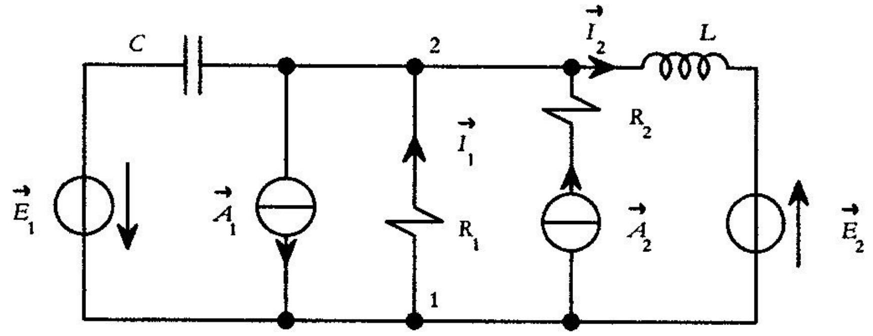
LΩ $\bar{V}_3 = \bar{Z}_3 \bar{A}_2 = 100j\ V$

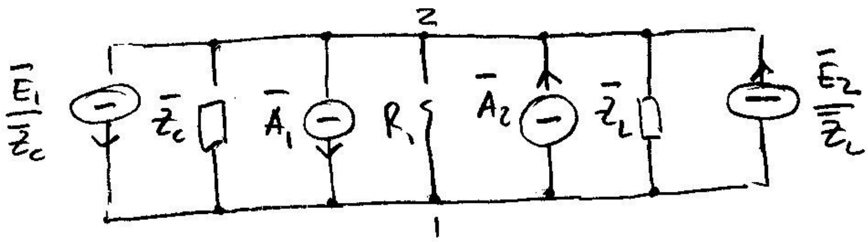
LKT $\bar{V}_6 = \bar{V}_3 + \bar{V}_5 = 100j + 50 - 50j = 50(1+j)\ V$

- TRASF. GEN.

Nel circuito in regime sinusoidale calcolare lo sfasamento fra le correnti $\vec{I}_1$ ed $\vec{I}_2$ indicate in figura.

Dati: $\vec{E}_1 = (2j - 2)$ V; $\vec{E}_2 = (2 - j)$ V; $\vec{A}_1 = 4$ A; $\vec{A}_2 = 2j - 1$ A; $R_1 = R_2 = 1\ \Omega$; $C = 3$ mF; $L = 0.5$ mH; $\omega = 1000$ rad/s.





$$\bar{Z}_c = \frac{1}{j\omega C} = \frac{1}{j3}\ \Omega$$

$$\bar{Z}_L = j\omega L = j\frac{1}{2}\ \Omega$$

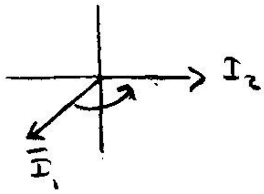
$$\bar{V}_{21} = \left(-\frac{\bar{E}_1}{\bar{Z}_c} - \bar{A}_1 + \bar{A}_2 + \frac{\bar{E}_2}{\bar{Z}_L}\right) \cdot \frac{1}{\frac{1}{\bar{Z}_c} + \frac{1}{R_1} + \frac{1}{\bar{Z}_L}} =$$

$$= \frac{-3j(2j-2) - 4 + 2j - 1 + \frac{2(2-j)}{j}}{3j + 1 + \frac{2}{j}} = \frac{6 + 6j - 4 + 2j - 4j - 2}{3j + 1 - 2j} = \frac{4j}{1+j} = 2(1+j)\ V$$

$$\bar{I}_1 = -\frac{\bar{V}_{21}}{R_1} = -2(1+j)\,A \qquad \angle \bar{I}_1 = -\pi + \mathrm{tg}^{-1}1 = -\frac{3}{4}\pi\ \text{rad}$$

$$\bar{I}_2 = \frac{\bar{V}_{12} - \bar{E}_2}{j\omega L} = 2\,\frac{2(1+j) - (2-j)}{j} = 6\ A \qquad \angle \bar{I}_2 = 0$$

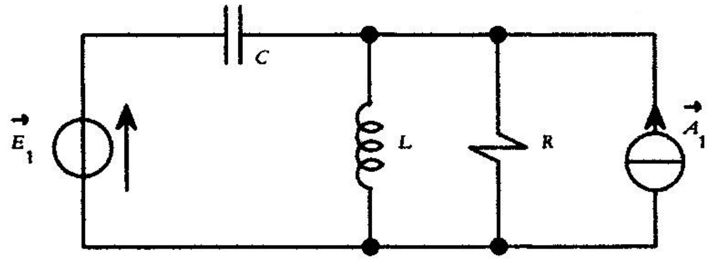
$$\varphi_{21} = \varphi_2 - \varphi_1 = \frac{3}{4}\pi\ \text{rad}$$



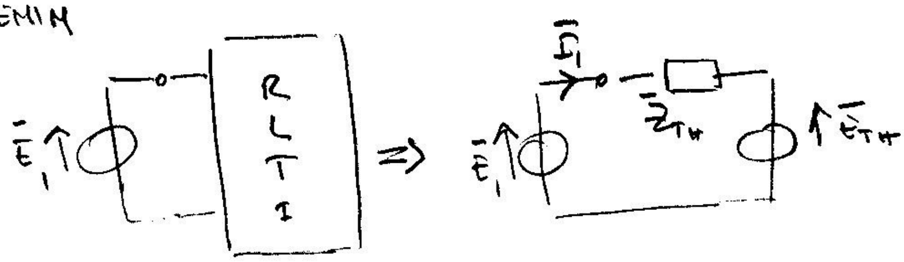
- TEOR. THÉVENIN
- TRASF. GEN.

Determinare la corrente erogata dal generatore $\vec{E}_1$

Dati: R=$|X_C|$=X_L=1 Ω; $|\vec{E}_1|$=10 V; $\angle\vec{E}_1$=0; $|\vec{A}_1|$=5 A; $\angle\vec{A}_1$=−90°.



THEVENIN



$$\bar{Z}_{TH} = \bar{Z}_C + \bar{Z}_L \parallel R = \bar{Z}_C + \frac{1}{\frac{1}{R}+\frac{1}{\bar{Z}_L}}$$

$$\bar{Z}_C = -j\ \Omega$$
$$\bar{Z}_L = j\ \Omega$$

$$= -j + \frac{1}{1-j} = -j + \frac{1}{2}(1+j) = \frac{1}{2}(1-j)\ \Omega$$

T.G. $$\bar{E}_{TH} = \bar{A}_1 \cdot (\bar{Z}_L \parallel R)$$

$$\bar{A}_1 = -5j\ A$$

$$= -\frac{5}{2}j(1+j) = \frac{5}{2}(1-j)\ V$$

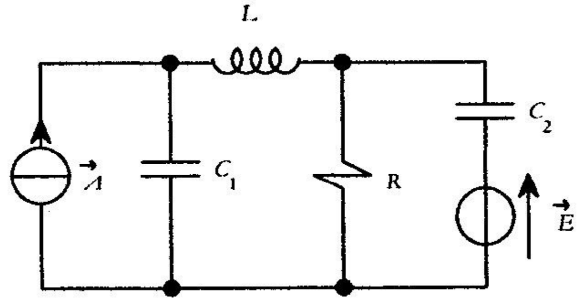
$$\bar{I}_1 = \frac{\bar{E}_1 - \bar{E}_{TH}}{\bar{Z}_{TH}}$$

$$\bar{E}_1 = 10\ V$$

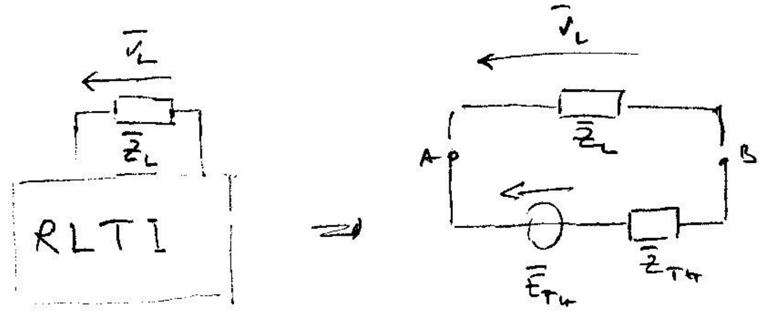
$$= \frac{10-5(1-j)/2}{(1-j)/2} = \frac{5(3+j)}{1-j} = \frac{5(3+j)(1+j)}{2} = 5(1+2j)\ V$$

Nel circuito seguente, in regime sinusoidale, determinare la tensione ai capi dell'induttore.

Dati: R=1 kΩ; C_1=C_2=1 μF; L=50 mH; $\bar{E}$=(2 + j) V; $\bar{A}$ =4 mA; ω=2000 rad/s.

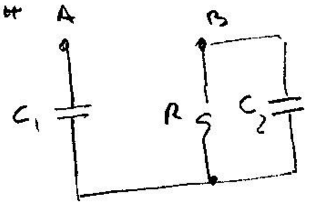


TEOR. THEVENIN



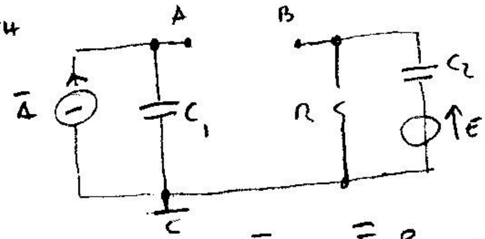
GEN. EQ. TH.

$\bar{Z}_{TH}$



$$\bar{Z}_{TH} = \frac{1}{j\omega C_1} + \frac{1}{\frac{1}{R} + j\omega C_2} = \frac{10^3}{2j} + \frac{10^3}{1+2j} = 10^3\left(-\frac{j}{2} + \frac{1-j2}{5}\right) = 100(2-j9)\ \Omega$$

$\bar{E}_{TH}$



$$\bar{E}_{TH} = \bar{V}_{AC} - \bar{V}_{BC}$$

$$\bar{V}_{AC} = \frac{\bar{A}}{j\omega C_1} = \frac{4}{2j} = -2j\ V$$

P.T. $$\bar{V}_{BC} = \bar{E}\,\frac{R}{R + \frac{1}{j\omega C_2}} = \frac{2+j}{1+\frac{1}{j2}} = \frac{2(2+j)}{2-j} = \frac{2}{5}(2+j)^2 = \frac{2}{5}(3+4j)\ V$$

$$\bar{E}_{TH} = \bar{V}_{AC} - \bar{V}_{BC} = -2j - \frac{2}{5}(3+4j) = -\frac{6}{5}(1+3j)\ V$$

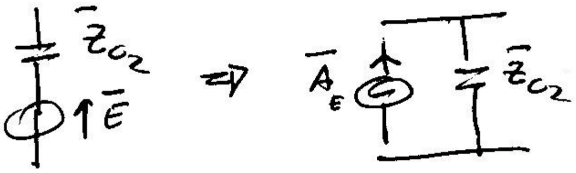
P.T. $$\bar{V}_L = \bar{E}_{TH} \cdot \frac{\bar{Z}_L}{\bar{Z}_{TH} + \bar{Z}_L} \qquad (\bar{Z}_L = j\omega L = j100\,\Omega)$$

$$= -\frac{6}{5}(1+3j) \cdot \frac{j100}{100(2-9j)+j100} = \frac{-j3(1+3j)}{5(1-j4)} \cdot \frac{(1+j4)}{(1+j4)} = \frac{21+j33}{85} = 0{,}2471 + j\,0{,}3882\ V$$

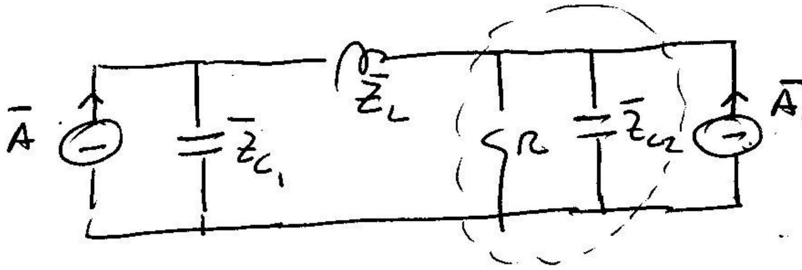
$R = 1000\,\Omega$

$\bar{Z}_{C_1} = \bar{Z}_{C2} = \frac{1}{j\omega C} = -j\,500\,\Omega$

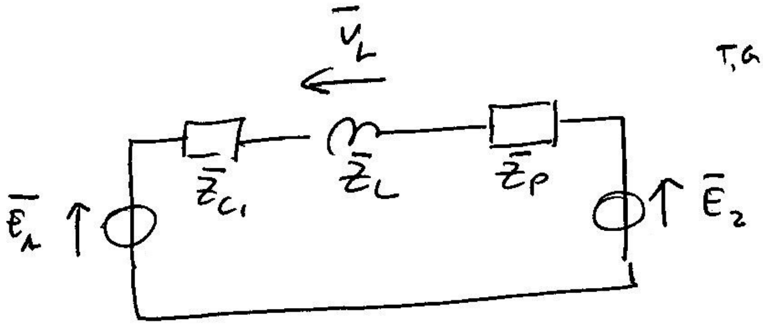
$\bar{Z}_L = j\omega L = j\,100\,\Omega$



T.G. $\bar{A}_E = \frac{\bar{E}}{\bar{Z}_{C2}} = \frac{2+j}{-j500} = -0{,}002+j0{,}004\,A$



$\bar{Z}_p = \frac{R\cdot\bar{Z}_{C2}}{R+\bar{Z}_{C2}} = 200-j\,400\,\Omega$



T.G. $\bar{E}_2 = \bar{A}_E\cdot\bar{Z}_p = 1{,}2+j\,1{,}6\,V$

$\bar{E}_A = \bar{A}\cdot\bar{Z}_{C_1} = 0{,}004\cdot(-j500) = -j2\,V$

P.T. $$\bar{V}_L = \frac{(\bar{E}_A-\bar{E}_2)\cdot\bar{Z}_L}{\bar{Z}_{C_1}+\bar{Z}_L+\bar{Z}_p} = \frac{[-j2-(1{,}2+j\,1{,}6)]\,j100}{-j500+j100+200-j400} = \frac{(-1{,}2-j3{,}6)\,j100}{200-j800} = 0{,}2471+j\,0{,}3882\,V$$