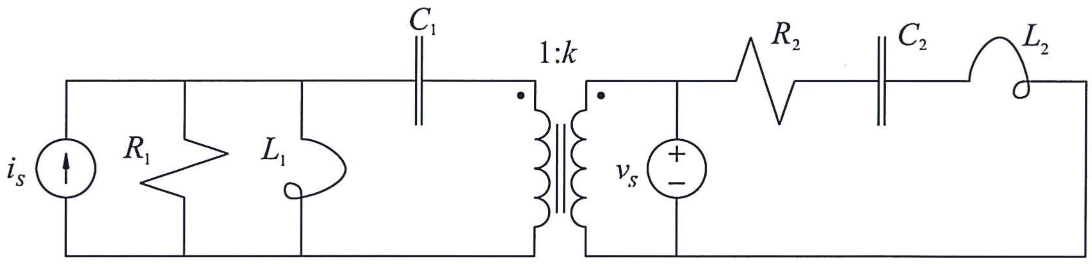
Domanda 1 (9 punti)

Si consideri il circuito in regime alternato sinusoidale alla frequenza $f = 60\,\text{Hz}$ della figura seguente, in cui: $v_S = \sqrt{2}\cdot 300\sin(2\pi f t)$ V, $i_S = \sqrt{2}\cdot 8\cos(2\pi f t)$ A, $R_1 = 10\,\Omega$, $R_2 = 100\,\Omega$, $L_1 = 30\,\text{mH}$, $L_2 = 200\,\text{mH}$, $C_1 = 800\,\mu\text{F}$, $C_2 = 10\,\mu\text{F}$, k=5.



(a) Si calcoli l'equivalente di Thevenin della rete vista dal generatore di tensione v_S;

(b) Si determini la potenza attiva e reattiva erogata dal generatore di corrente i_S.

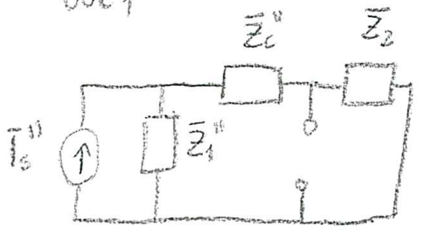
$\omega = 120\pi\ [\text{rad/s}]$

$$\bar{Z}_1 = \frac{j\omega L_1 R_1}{R_1 + j\omega L_1} = (5{,}612 + j4{,}962)\,\Omega \qquad \bar{I}_s = 8\,A \quad \bar{V}_s = -j300\,V$$

$$\bar{Z}_2 = R_2 + j\omega L_2 - \frac{j}{\omega C_2} = (100 - j189{,}9)\,\Omega$$

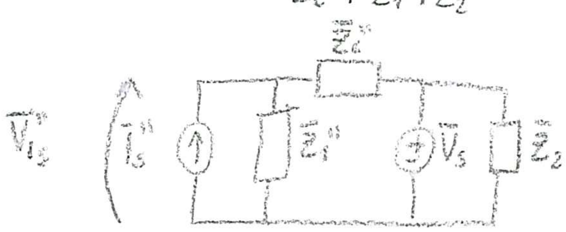
$$\bar{Z}_1'' = K^2 \bar{Z}_1 = (140{,}3 + j124{,}1)\,\Omega \qquad \bar{I}_s'' = \frac{\bar{I}_s}{K} = 1{,}6\,A$$

$$\bar{Z}_c'' = -j\frac{K^2}{\omega C_1} = -j82{,}89\,\Omega$$



$$\bar{Z}_T = \frac{(\bar{Z}_c'' + \bar{Z}_1'')\bar{Z}_2}{\bar{Z}_c'' + \bar{Z}_1'' + \bar{Z}_2} = (107{,}7 - j27{,}10)\,\Omega$$

$$\bar{V}_T = \bar{I}_s'' \frac{\bar{Z}_2 \bar{Z}_1''}{\bar{Z}_c'' + \bar{Z}_1'' + \bar{Z}_2} = (223{,}4 + j63{,}44)\,V$$

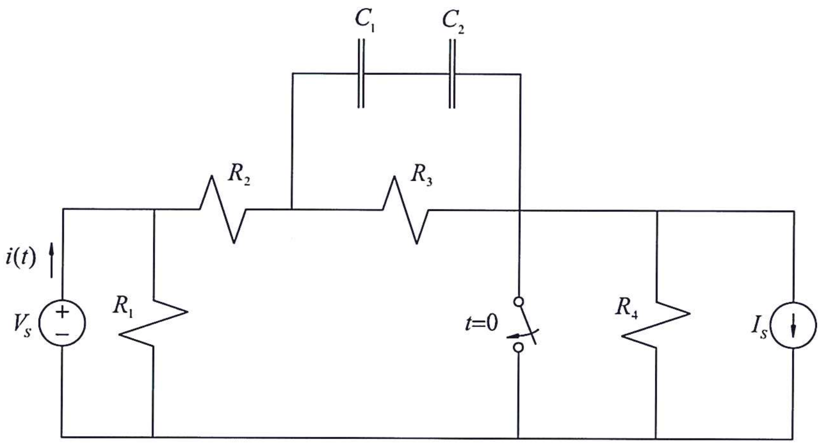


$$\bar{V}_{1s}'' = \frac{\bar{I}_s'' + \frac{\bar{V}_s}{\bar{Z}_c''}}{\frac{1}{\bar{Z}_1''} + \frac{1}{\bar{Z}_c''}} = (397{,}4 - j358{,}4)\,V$$

$$\bar{S} = \bar{V}_{1s}''\, \underset{\sim}{I_s''} = 635{,}9\,W - j573{,}4\,VAr$$

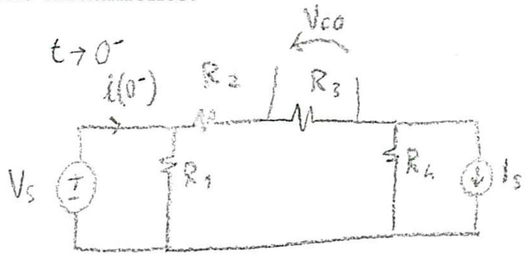
Domanda 2 (7 punti)

Sia dato il circuito mostrato nella figura seguente, in cui: $V_S = 100\,\mathrm{V}$, $I_S = 5\,\mathrm{A}$, $R_1 = 40\,\Omega$, $R_2 = 10\,\Omega$, $R_3 = 30\,\Omega$, $R_4 = 20\,\Omega$, $C_1 = 10\,\mathrm{mF}$, $C_2 = 20\,\mathrm{mF}$. Si consideri il circuito inizialmente in regime stazionario e con l'interruttore aperto per $t < 0$, mentre in $t = 0$ si verifica la commutazione.



Si determini l'espressione analitica della corrente $i(t)$ a partire da $t < 0$ e si rappresenti graficamente il suo andamento.

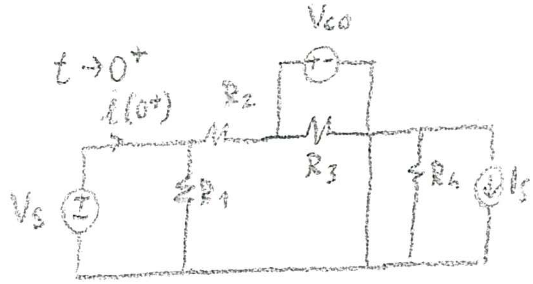
$t \to 0^-$



$$i(0^-) = \frac{V_S}{\frac{R_1(R_2+R_3+R_4)}{R_1+R_2+R_3+R_4}} + I_S \frac{R_4}{R_2+R_3+R_4} = 5{,}833\,A$$

$$V_{C0} = \frac{(V_S + R_4 I_S) R_3}{R_2+R_3+R_4} = 100\,V$$

$t \to 0^+$

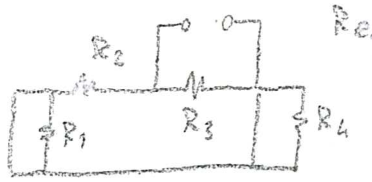


$$i(0^+) = \frac{V_S}{R_1} + \frac{V_S - V_{C0}}{R_2} = 2{,}5\,A$$

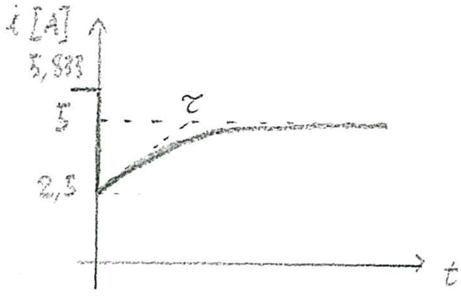
$t \to \infty$

$$i_\infty = \frac{V_S}{\frac{R_1(R_2+R_3)}{R_1+R_2+R_3}} = 5\,A$$

$$C = \frac{C_1 C_2}{C_1 + C_2} = 6{,}667\,mF$$



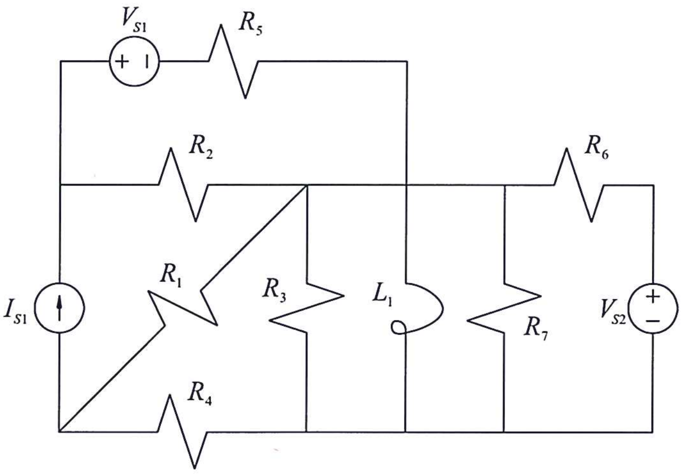
$$R_{eq} = \frac{R_2 R_3}{R_2 + R_3} = 7{,}5\,\Omega \qquad \tau = R_{eq} C = 50\,ms$$



$$i(t) = \begin{cases} 5{,}833\,A & t < 0 \\ \left(5 - 2{,}5\,e^{-\frac{t}{\tau}}\right) A & t > 0 \end{cases}$$

Domanda 3 (6 punti)

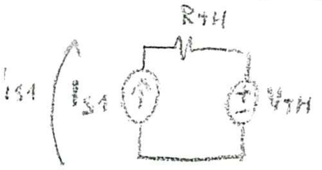
Sia dato il circuito in regime stazionario della figura seguente, in cui: $V_{S1} = 25\,\text{V}$, $V_{S2} = 20\,\text{V}$, $I_{S1} = 1\,\text{A}$, $R_1 = 20\,\Omega$, $R_2 = 15\,\Omega$, $R_3 = 50\,\Omega$, $R_4 = 10\,\Omega$, $R_5 = 5\,\Omega$, $R_6 = 25\,\Omega$, $R_7 = 8\,\Omega$, $L_1 = 20\,\text{mH}$.



Si calcolino le potenze erogate da ciascun generatore.

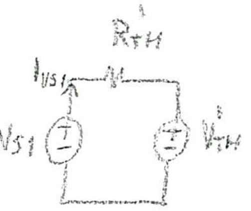
EQ. THEVENIN AI MORSETTI DI IS1:

$R_{TH} = \frac{R_2 R_5}{R_2+R_5} + \frac{R_1 R_4}{R_1+R_4} = 10,42\,\Omega$ $V_{TH} = V_{S1}\frac{R_2}{R_2+R_5} = 18,75\,V$



$V_{IS1} = V_{TH} + R_{TH} I_{S1} = 29,17\,V$ $P_{IS1} = V_{IS1} I_{S1} = 29,17\,W$

EQ. THEVENIN AI MORSETTI DI V_{S1}



$R'_{TH} = R_2 + R_5 = 20\,\Omega$ $V'_{TH} = R_2 I_{S1} = 15\,V$

$I_{VS1} = \frac{V_{S1} - V'_{TH}}{R'_{TH}} = 0,5\,A$ $P_{VS1} = V_{S1} I_{VS1} = 12,5\,W$

$P_{VS2} = \frac{V_{S2}^2}{R_6} = 16\,W$