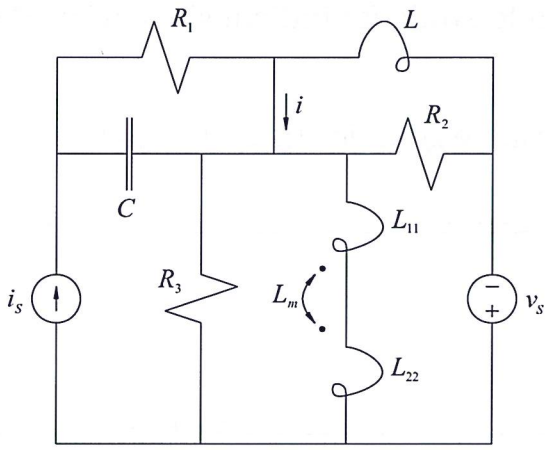
Domanda 1 (10 punti)

Si consideri il circuito in regime alternato sinusoidale alla frequenza $f = 400\,\text{Hz}$ mostrato nella figura seguente, in cui: $v_S = -\sqrt{2}\cdot 10\cos(2\pi ft)\,\text{V}$, $i_S = \sqrt{2}\cdot 3\cos(2\pi ft)\,\text{A}$, $R_1 = 10\,\Omega$, $R_2 = 13\,\Omega$, $R_3 = 15\,\Omega$, $L = 0.4\,\text{mH}$, $L_{11} = 0.8\,\text{mH}$, $L_{22} = 2.4\,\text{mH}$, $L_\text{m} = 0.4\,\text{mH}$, $C = 80\,\mu\text{F}$.



Si calcolino:

(a) Il fasore della corrente i;

(b) La potenza complessa erogata dal generatore di tensione.

$\bar{V}_S = -10\,V \quad \bar{I}_S = 3A \quad \omega = 800\pi \frac{rad}{s}$ MUTUO INDUTTORE IN SERIE CONTROVERSA

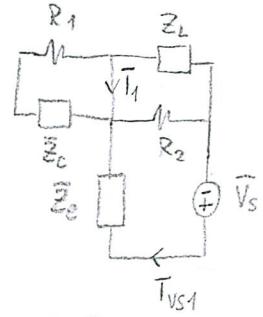
$L_{eq} = L_{11} + L_{22} - 2L_m = 2,4\,mH \quad \bar{Z}_C = \frac{-j}{\omega C} = -j4,974\,\Omega \quad \bar{Z}_L = j\omega L = j1,005\,\Omega \quad \bar{Z}_M = j\omega L_{eq} = j6,032\,\Omega$

$\bar{Z}_e = \frac{\bar{Z}_M R_3}{\bar{Z}_M + R_3} = (2,088 + j5,192)\,\Omega$

SOVRAPPOSIZIONE DEGLI EFFETTI, PER TROVARE $\bar{I}$ e $\bar{I}_{VS}$

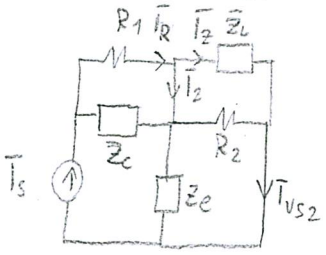
$\bar{I}_S = 0$

R_1 e $\bar{Z}_C$ CORTOCIRCUITATE →



$\bar{I}_{VS1} = \frac{\bar{V}_S}{\bar{Z}_e + \frac{R_2\bar{Z}_L}{R_2+\bar{Z}_L}} = (-0,5033 + j1,439)\,A \quad \bar{I}_1 = -\bar{I}_{VS1}\frac{R_2}{R_2+\bar{Z}_L} = (0,3896 - j1,469)\,A$

$\bar{V}_S = 0$



$\bar{I}_{VS2} = \frac{\frac{1}{R_2}+\frac{1}{\bar{Z}_L}}{\frac{1}{\bar{Z}_e}+\frac{1}{R_2}+\frac{1}{\bar{Z}_L}}\bar{I}_S = (2,557 - j0,1175)\,A$

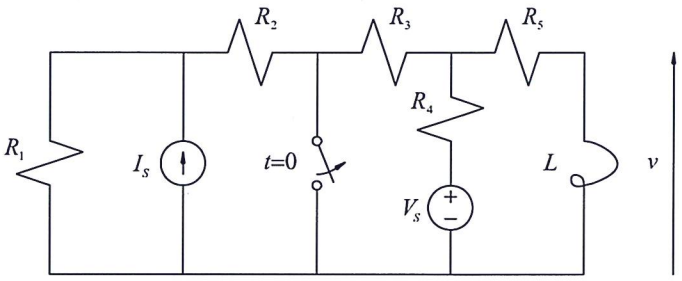
$\bar{I}_2 = \bar{I}_R - \bar{I}_2 = \bar{I}_S\frac{\bar{Z}_C}{R_1+\bar{Z}_C} - \bar{I}_S\frac{\frac{1}{\bar{Z}_L}}{\frac{1}{\bar{Z}_e}+\frac{1}{R_2}+\frac{1}{\bar{Z}_L}} = (-1,938 - j0,893)\,A$

$\bar{I} = \bar{I}_1 + \bar{I}_2 = (-1{,}548 - j\,2{,}352)\ A$ $\qquad \bar{I}_{VS} = \bar{I}_{VS1} + \bar{I}_{VS2} = (2{,}054 + j\,1{,}322)\ A$

$\bar{S} = \bar{V}_S \underline{I_{VS}} = -20{,}54\ W + j\,13{,}22\ VAr$

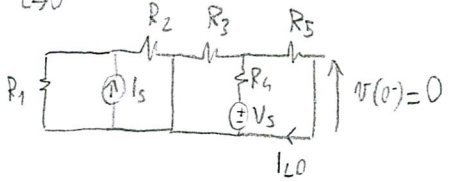
Domanda 2 (6 punti)

Sia dato il circuito mostrato nella figura seguente, in cui: $V_S = 200\,\text{V}$, $I_S = 10\,\text{A}$, $R_1 = 40\,\Omega$, $R_2 = 10\,\Omega$, $R_3 = 20\,\Omega$, $R_4 = 4\,\Omega$, $R_5 = 14\,\Omega$, $L = 0.1\,\text{H}$. Si consideri il circuito inizialmente in regime stazionario e con l'interruttore chiuso per $t < 0$, mentre in $t = 0$ si verifica la commutazione.



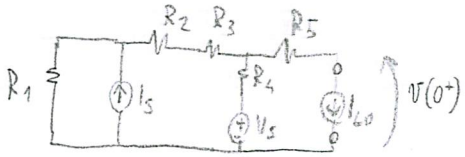
Si determini l'espressione analitica della tensione $v(t)$ a partire da $t < 0$ e se ne rappresenti graficamente l'andamento.

$t \to 0^-$ CALCOLO IL VALORE DELLA VARIABILE DI STATO IN $t=0$

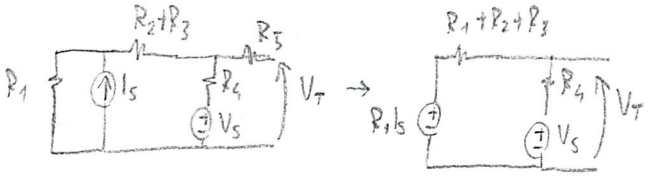


$$i_{L0} = \frac{V_S}{R_4 + \frac{R_2 R_5}{R_2 + R_5}} \cdot \frac{R_2}{R_2 + R_5} = 9{,}615\,\text{A}$$

$t \to 0^+$ IMPONGO CONTINUITA' DELLA V.D.S.

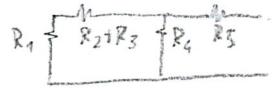


EQ. THEVENIN AI MORSETTI DELL'INDUTTORE



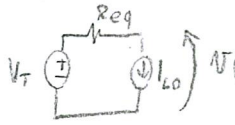
$$V_T = V_S + R_4 \frac{R_1 I_S - V_S}{R_1 + R_2 + R_3 + R_4} = 210{,}8\,\text{V}$$

PASSIVANDO LA RETE



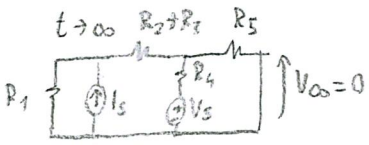
$$R_{eq} = R_5 + \frac{(R_1 + R_2 + R_3) R_4}{R_1 + R_2 + R_3 + R_4} = 17{,}78\,\Omega$$

DUNQUE:



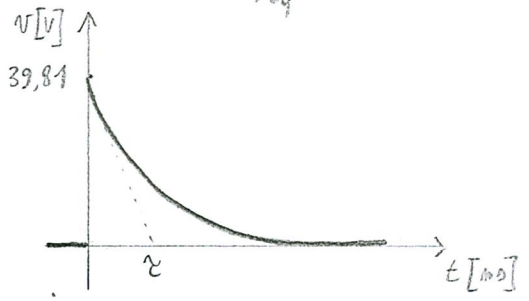
$$v(0^+) = V_T - R_{eq} I_{L0} = 39{,}81\,\text{V}$$

$t \to \infty$



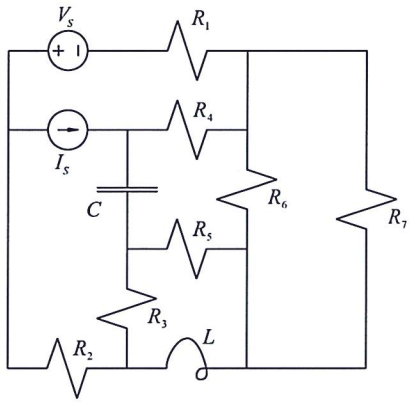
PER DEFINIZIONE: $\tau = \frac{L}{R_{eq}} = 5{,}623\,\text{m}\Delta$

$$v(t) = \begin{cases} 0\,\text{V} & t < 0 \\ 39{,}81\, e^{-\frac{t}{\tau}}\,\text{V} & t > 0 \end{cases}$$



Domanda 3 (6 punti)

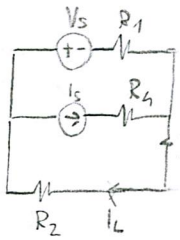
Sia dato il circuito in regime stazionario della figura seguente, in cui: $V_S = 24\,\text{V}$, $I_S = 2\,\text{A}$, $R_1 = 9\,\Omega$, $R_2 = 5\,\Omega$, $R_3 = 18\,\Omega$, $R_4 = 4\,\Omega$, $R_5 = 7\,\Omega$, $R_6 = 8\,\Omega$, $R_7 = 11\,\Omega$, $L = 10\,\text{mH}$, $C = 10\,\mu\text{F}$.



(a) Si trovi l'equivalente di Thévenin della rete vista ai morsetti del generatore di corrente I_S;

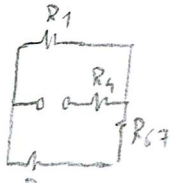
(b) Si calcoli l'energia immagazzinata nell'induttore L.

LA RETE PUÒ ESSERE SEMPLIFICATA



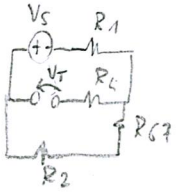
$$R_{67} = \frac{R_6 R_7}{R_6 + R_7} = 4{,}632\,\Omega$$

PASSIVANDO LA RETE:



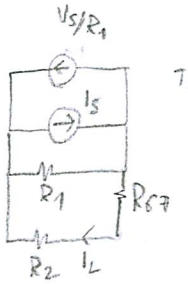
$$R_T = R_4 + \frac{R_1 (R_2 + R_{67})}{R_1 + R_2 + R_{67}} = 8{,}653\,\Omega$$

TENSIONE DI CIRCUITO APERTO:



$$V_T = V_S \frac{R_2 + R_{67}}{R_1 + R_2 + R_{67}} = 12{,}41\,\text{V}$$

PER IL CALCOLO DELLA CORRENTE I_L:



TRASCURO R_4, IN SERIE A UN GENERATORE IDEALE DI CORRENTE

$$I_L = \left(I_S - \frac{V_S}{R_1}\right) \frac{R_1}{R_1 + R_2 + R_{67}} = -0{,}3220\,\text{A}$$

$$W = \frac{1}{2} L I_L^2 = 0{,}5185\,\text{mJ}$$