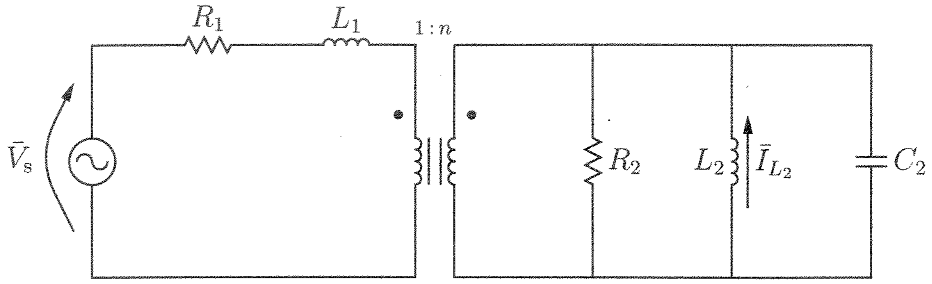
Domanda 1 (10 punti)

Si consideri il circuito nella figura seguente, funzionante in regime alternato sinusoidale alla frequenza $f = 100$ Hz; siano: $v_s = \sqrt{2} \cdot 50 \cos(2\pi f t - \pi/2)$ V, $R_1 = 5.5\,\Omega$, $L_1 = 1.8$ mH $R_2 = 5000\,\Omega$, $L_2 = 2$ H, $C_2 = 1\,\mu$F, $n = 30$.



Si calcolino:

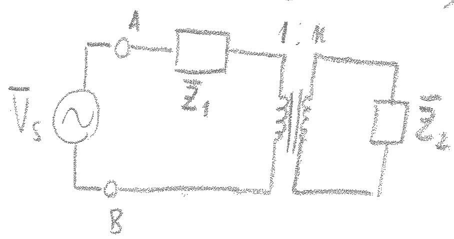
(a) L'equivalente di Thévenin della rete ai morsetti del generatore di tensione;

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

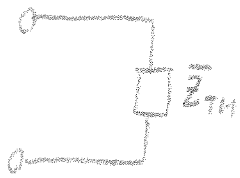
(c) Il fasore $\bar{I}_{L_2}$ e la corrispondente espressione della corrente nel dominio del tempo.

a) $\bar{V}_s = 50 e^{-j\frac{\pi}{2}} V = -j50 V$ $\bar{Z}_1 = R_1 + j\omega L_1 = 5{,}5 + j1{,}131\ \Omega$

$\bar{Z}_2 = \left(\frac{1}{R_2} + \frac{1}{j\omega L_2} + j\omega C_2\right)^{-1} = 2939 + j2461\ \Omega$



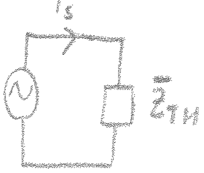
eq. Thevenin →



$\bar{V}_{TH} = 0$

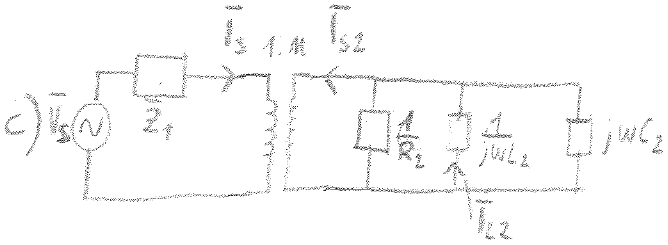
$\bar{Z}_{TH} = \bar{Z}_1 + \frac{\bar{Z}_2}{n^2} = 8{,}766 + j3{,}866\ \Omega$

b)



$\bar{I}_s = \frac{\bar{V}_s}{\bar{Z}_{TH}} = -2{,}106 - j4{,}775\ A$ $\bar{S} = \bar{V}_s \underline{I}_s = 238{,}8 + j105{,}3\ VA$

c)



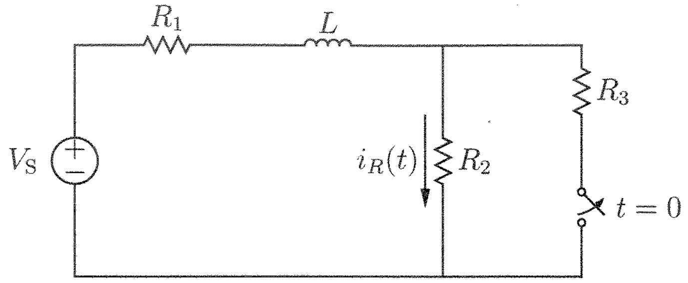
$\bar{I}_{s2} = -\frac{\bar{I}_s}{n}$ $\bar{I}_{L2} = \bar{I}_{s2} \dfrac{\frac{1}{j\omega L_2}}{\frac{1}{R_2} + \frac{1}{j\omega L_2} + j\omega C_2} =$

$= 0{,}5098 + j0{,}1476\ A = 0{,}5307\ A \angle 0{,}2817\ [rad]$

$i_{L2} = \sqrt{2} \cdot 0{,}5307 \cos(200\pi t + 0{,}2817)\ A$

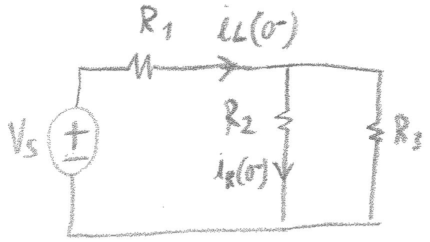
Domanda 2 (7 punti)

Sia dato il circuito in regime transitorio di figura in cui: $V_s = 30\,\text{V}$, $R_1 = 4\,\Omega$, $R_2 = 20\,\Omega$, $R_3 = 10\,\Omega$ e $L = 20\,\text{mH}$. Si consideri il circuito in regime stazionario per $t < 0$, mentre in $t = 0$ si verifica l'apertura dell'interruttore.



Determinare l'espressione analitica della corrente $i_R(t)$ e fornirne la rappresentazione grafica a partire da $t < 0$.

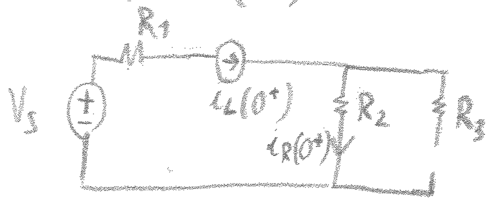
$t = 0^-$



$$i_L(0^-) = \frac{V_S}{R_1 + \frac{R_2 R_3}{R_2 + R_3}} = 2{,}813\,A$$

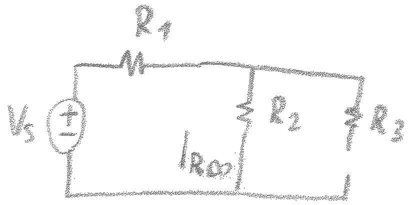
$$i_R(0^-) = i_L(0^-)\,\frac{R_3}{R_2 + R_3} = 0{,}9375\,A$$

$t = 0^+$ $\quad i_L(0^-) = i_L(0^+)$



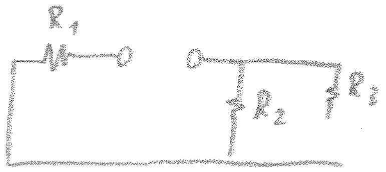
$$i_R(0^+) = i_L(0^+) = 2{,}813\,A$$

$t \to \infty$

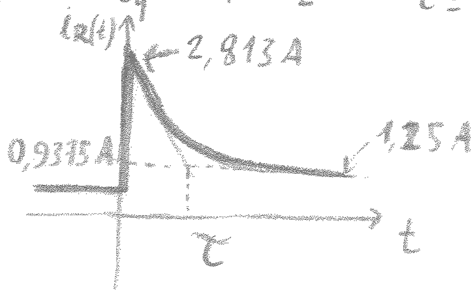


$$I_{R\infty} = \frac{V_S}{R_1 + R_2} = 1{,}25\,A$$

τ



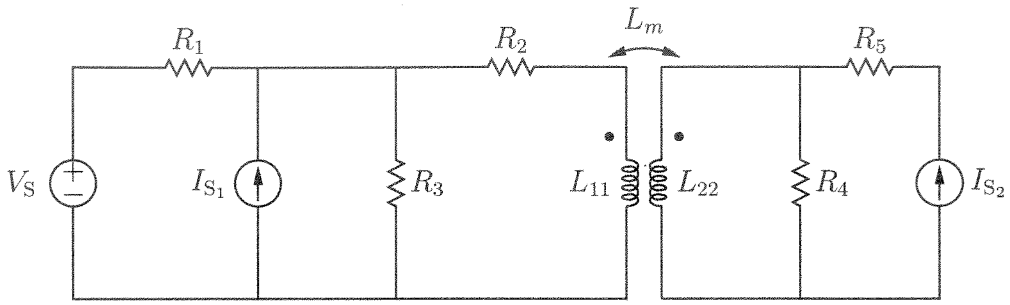
$$R_{eq} = R_1 + R_2 \qquad \tau = \frac{L}{R_{eq}} = 0{,}833\,\text{ms}$$



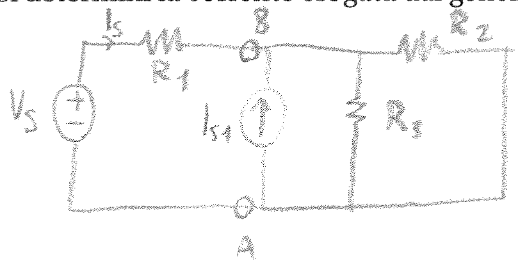
$$i_R(t) = \begin{cases} 0{,}9375 & t < 0 \\ \left(i_R(0^+) - I_{R\infty}\right) e^{-\frac{t}{\tau}} + I_{R\infty} = \left(1{,}563\,e^{-\frac{t}{\tau}} + 1{,}25\right) A \end{cases}$$

Domanda 3 (5 punti)

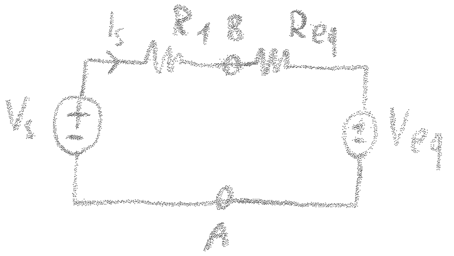
Sia dato il circuito in regime stazionario della figura seguente in cui: $R_1 = 10\,\Omega$, $R_2 = 20\,\Omega$, $R_3 = 30\,\Omega$, $R_4 = 20\,\Omega$, $R_5 = 10\,\Omega$, $L_{11} = 0.5\,\mathrm{H}$, $L_{22} = 0.3\,\mathrm{H}$, $L_m = 0.25\,\mathrm{H}$, $V_S = 100\,\mathrm{V}$, $I_{S_1} = 5\,\mathrm{A}$ e $I_{S_2} = 10\,\mathrm{A}$.



Si determini la corrente erogata dal generatore V_S.



Trasformazione parallelo → serie



$$R_{eq} = \frac{R_2 R_3}{R_2 + R_3} = 12\ \Omega \qquad V_{eq} = I_{S1} R_{eq}$$

$$I_s = \frac{V_S - V_{eq}}{R_1 + R_{eq}} = \frac{V_S - I_{S1} R_{eq}}{R_1 + R_{eq}} = 1{,}818\ \mathrm{A}$$