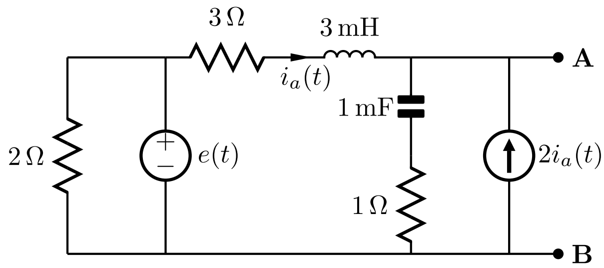
1. ARIKETA DENBORA: 45 min (10 PUNTU)

Irudiko zirkuituan sorgailua $e(t) = 2\cos(10^3 t)$ V da.



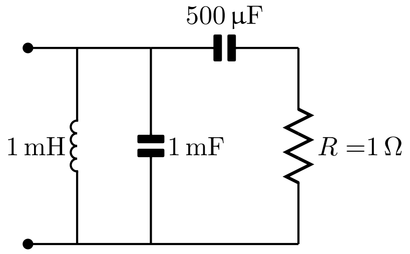
a Kalkulatu A eta B arteko Norton korrontea. **(1 puntu)**

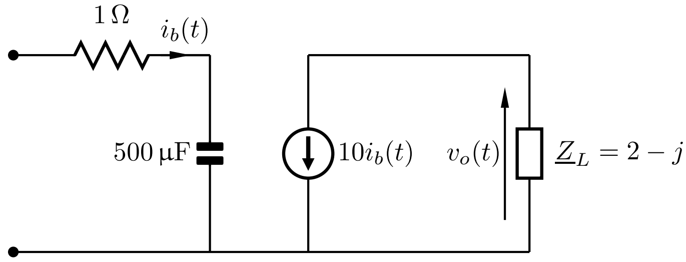
b Kalkulatu A eta B arteko Thevenin tentsioa. **(2 puntu)**

c Kalkulatu A eta B arteko Thevenin inpedantzia. Konprobatu aurreko hiru balioak bat datozela. **(2 puntu)**

OHARRA: hurrengo ataletan erabili $\underline{V}_{TH} = \sqrt{2}_{\underline{|-\frac{\pi}{4}}}$ (balio max) eta $Z_{TH} = 1$, (a)-(c) ataletan lortutako emaitzak beste batzuk izanda ere.

Irudiko bi zirkuituak ditugu. Zirkuituak (a)-(c) ataleko zirkuituko A eta B terminaleen artean konektatuko dira.





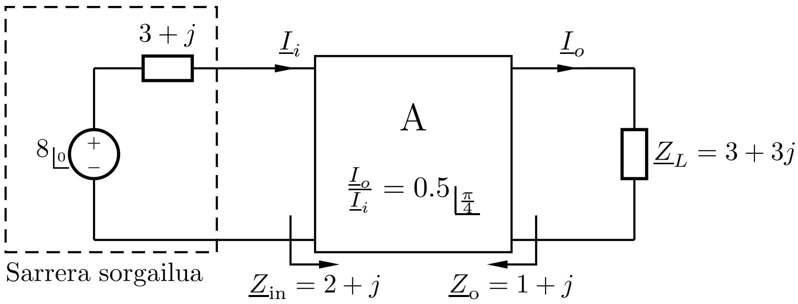
d Ezkerreko zirkuitua konektatzen badugu, kalkulatu R erresistentzian erretako potentzia. **(1.5 puntu)**

e Eskumako zirkuitua konektatzen badugu, kalkulatu $v_o(t)$ tentsioa, eta $\underline{Z}_L$-n erretako potentzia. **(2 puntu)**

f $\underline{Z}_L$ lortzeko diseinatu zirkuitu fisikoa, bi osagai paralelo erabiliz. **(1.5 puntu)**

2. ARIKETA **DENBORA: 45 min (10 PUNTU)**

Irudiko zirkuituan fasoreak balio maximotan daude, eta lan maiztasuna $\omega = 10^6$ rad/s da.



a Kalkulatu A zirkuituaren insertzio eta transmisio galerak dB-etan. **(3 puntu)**

LC egokitzapen zirkuitu bat sartuko dugu sorgailuak potentzia erabilgarria eman dezan.

c Kalkulatu potentzia kargan $\underline{Z}_L$, LC zirkuitua sartu ondoren. **(3 puntu)**

d Kalkulatu A eta LC zirkuituek osatzen duten multzoaren insertzio galerak dB-tan. **(1 puntu)**

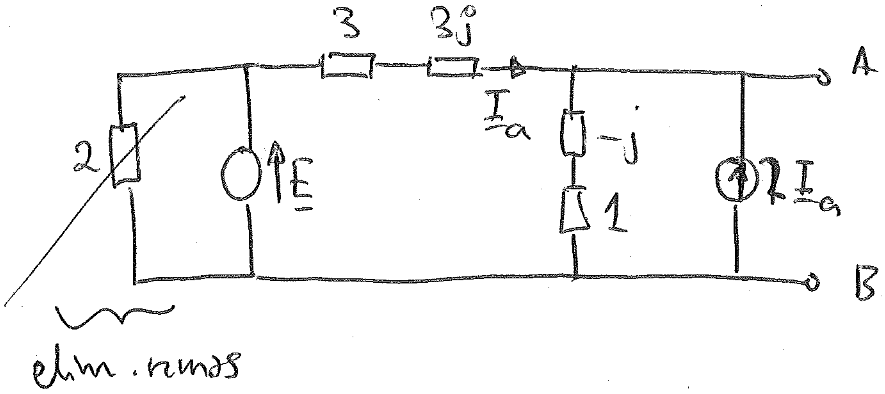
e Diseinatu LC zirkuitua osagai kopuru minimioa erabiliz, eta maiztasun altuetan $\underline{Z}_L$ kargan potentzia 0 izan dadin. **(3 puntu)**

$e(t) = 2\cos(10^3 t)\ V$ Calculemos cto complejo:

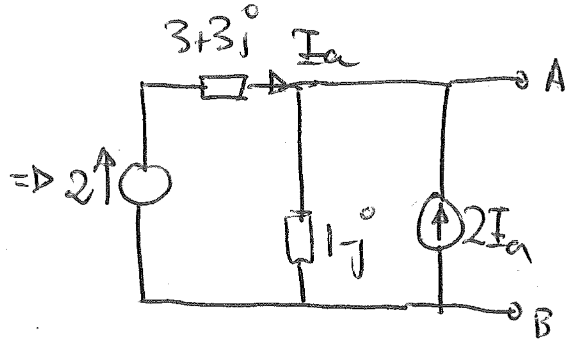
$\underline{Z}_L = j\omega L = j\,10^3 L = 3j$

$\underline{Z}_C = \frac{-j}{\omega C} = \frac{-j}{10^3 \cdot 1mF} = -j$

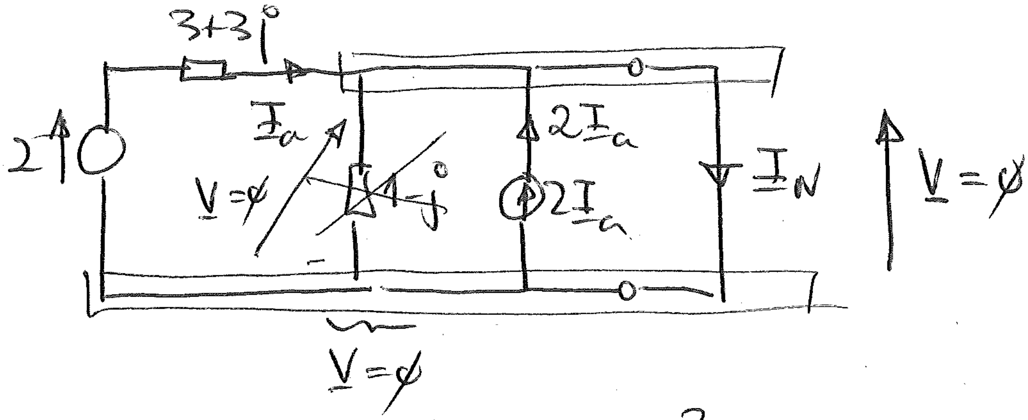
$\underline{E} = 2\angle\emptyset$



$\Rightarrow$



(a) Corriente Norton

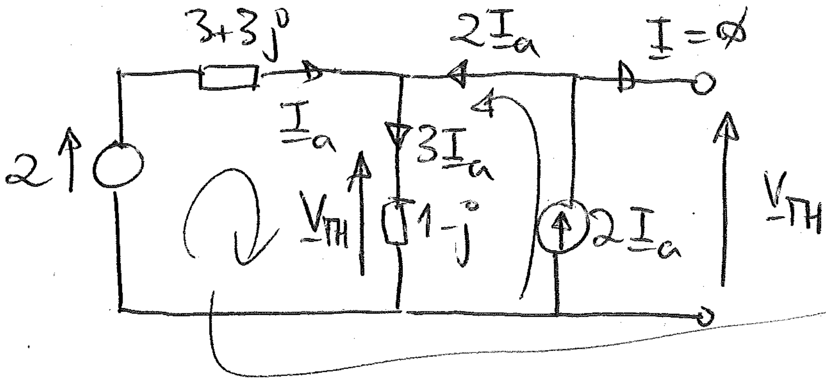


$2 - \underline{I}_a(3+3j) = \emptyset$ $\underline{I}_a = \frac{2}{3+3j}$

$(1k): -\underline{I}_N + \underline{I}_a + 2\underline{I}_a = \emptyset$ $\underline{I}_N = 3\underline{I}_a = 3\,\frac{2}{3+3j} = \frac{\cancel{2}(1-j)}{\cancel{(1+j)(1-j)}} = 1-j$

$$\boxed{\underline{I}_N = \sqrt{2}\angle{-\pi/4}}$$

(b) Tensión Thevenin.



$\underline{V}_{TH} = 3\underline{I}_a(1-j)$

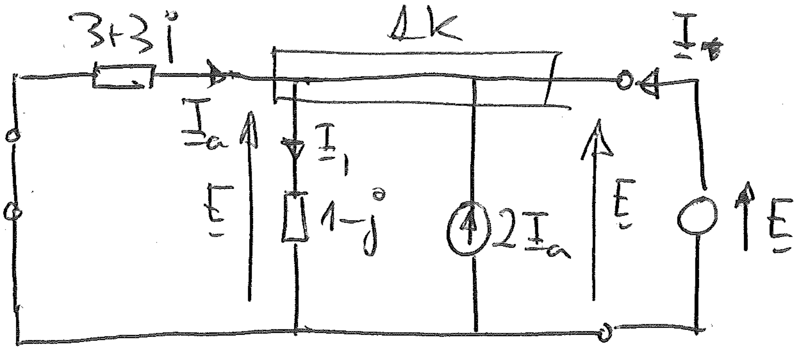
$2 - (3+3j)\underline{I}_a = \underline{V}_{TH}$

$\Downarrow$

$(3 - \cancel{3j})\underline{I}_a = 2 - (3 + \cancel{3j})\underline{I}_a$

$\Rightarrow 6I_a = 2 \qquad I_a = \frac{1}{3} \Rightarrow \underline{V}_{TH} = 3\underbrace{I_a}_{=1/3}(1-j) = 1-j = \boxed{\sqrt{2}\,\angle{-\pi/4} = \underline{V}_{TH}}$

(c) Z_{TH}, apagamos gen independientes:



$$Z_{TH} = \frac{E}{I}$$

$$E = (1-j)I_1 \rightsquigarrow I_1 = \frac{E}{1-j}$$

$$E = -(3+3j)I_a \rightsquigarrow I_a = \frac{-E}{3+3j}$$

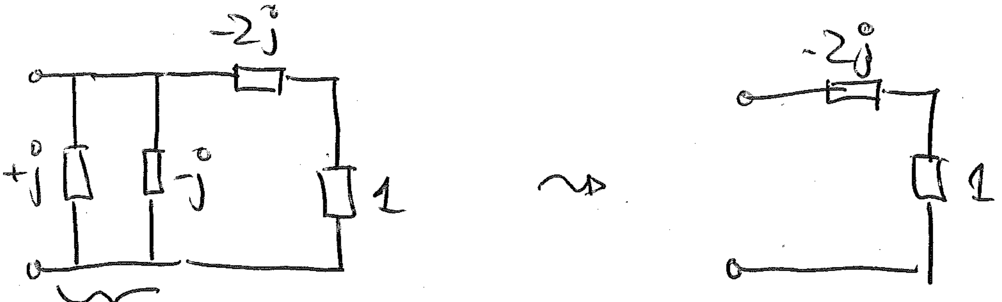
(1k) $\quad I_a - I_1 + 2I_a + I = 0$

$$I = I_1 - 3I_a = \frac{E}{1-j} + 3\frac{E}{3+3j} = \frac{E}{1-j} + \frac{E}{1+j} =$$

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

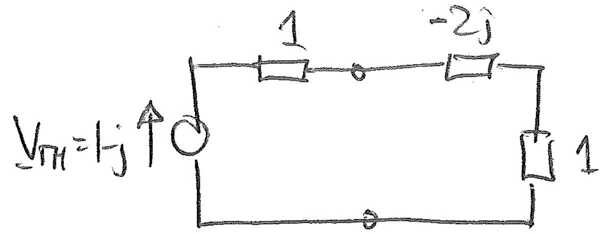
$\Rightarrow E = I \rightsquigarrow \boxed{Z_{TH} = \frac{E}{I} = 1}$ $\quad \Rightarrow V_{TH} = Z_{TH} \cdot I_N$; $1-j = 1\cdot(1-j)$ ✓

(d) Cto de la izquierda: $\quad Z_C = -j\frac{1}{\omega C} = -j\frac{1}{10^3 \cdot 500 \cdot 10^{-6}} = -2j$



$$Z_p = \frac{j(-j)}{j-j} = \infty \text{ (cto abierto)}$$

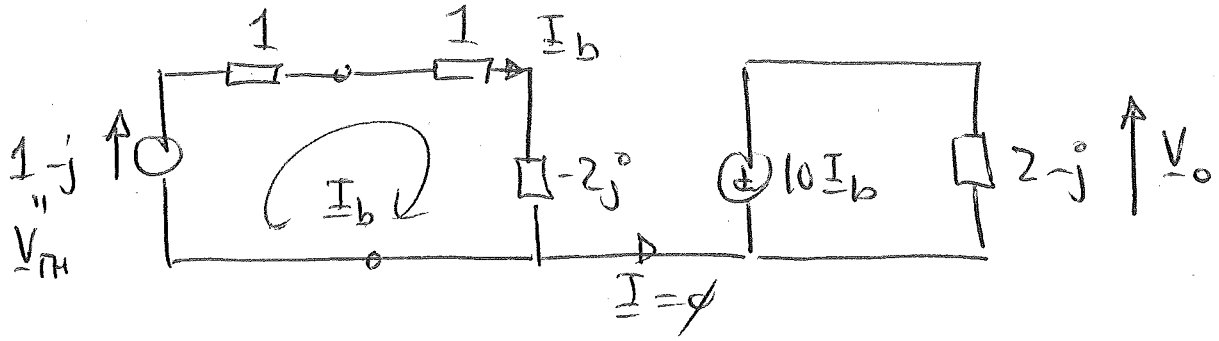
Usando el thevenin:



$$\underline{I} = \frac{1-j}{2+2j} = \frac{1}{2}$$

$$P_1 = \frac{1}{2}\cdot 1 \cdot |\underline{I}|^2 = \frac{1}{2}\left(\frac{1}{2}\right)^2 = \boxed{\frac{1}{8}\ W = P_R}$$

ⓒ En el cto de la derecha:



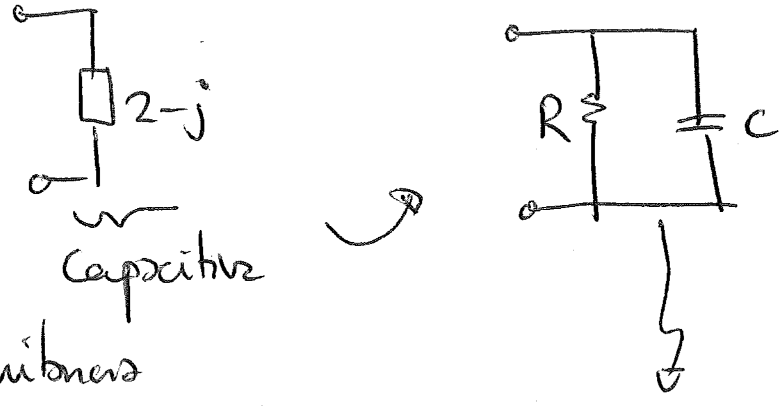
$$\underline{I}_b = \frac{1-j}{2-2j} = \frac{1}{2} \qquad \underline{V}_o = -10\,\underline{I}_b\,(2-j)$$

$$= -5\,(2-j) = 11'2 \angle 2'68$$

$$\boxed{v_o(t) = 11'2 \cdot \cos(10^3 t + 2.68)\ V}$$

$$\underline{I}_o = 10\,\underline{I}_b = 5 \rightsquigarrow P_L = \frac{1}{2}\cdot 2 \cdot |\underline{I}_o|^2 = \boxed{25\,W = P_L}$$

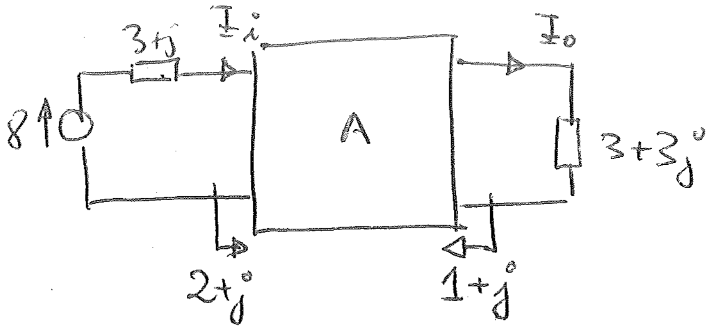
ⓓ



Admitancia

$$\underline{Y}_L = \frac{1}{(2-j)}\frac{(2+j)}{(2+j)} = \frac{2+j}{5} = \frac{1}{R} + j\omega C = \begin{cases} \frac{2}{5} = \frac{1}{R} & \boxed{R = 2'5\,\Omega} \\ \frac{1}{5} = \omega C & C = \frac{1}{5\omega} \end{cases}$$

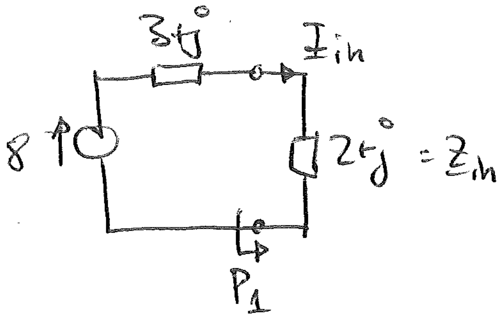
$$\boxed{C = 200\,\mu F}$$



$$G_I = \frac{I_o}{I_i} = 0'5 \angle \pi/4$$

ⓐ $\alpha_I = 10 \log \frac{P_{20}}{P_2}$ $\alpha_T = 10 \log \frac{P_1}{P_2}$

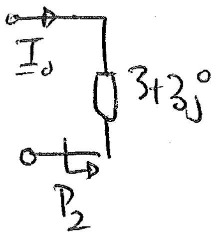
Entrada:



$$I_{in} = \frac{8}{5+2j}$$

$$P_1 = \frac{1}{2} \cdot 2 \cdot |I_{in}|^2 = \frac{64}{25+4} = \frac{64}{29} \text{ w.}$$

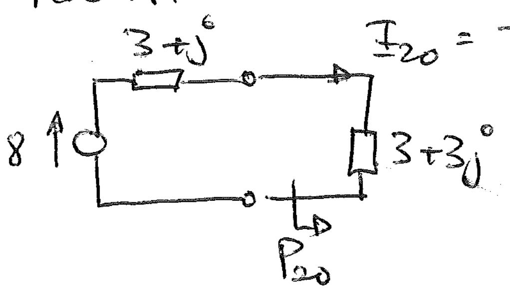
Salida: $I_o = G_I \cdot I_i = \frac{1}{2} \angle \pi/4 \cdot \frac{8}{5+2j}$



$$P_2 = \frac{1}{2} \cdot 3 \, |I_o|^2 = \frac{3}{2} \cdot \frac{1}{4} \cdot \frac{64}{25+4} = \frac{3}{8} \frac{64}{29}.$$

$$\alpha_T = 10 \log \frac{\cancel{64}}{\cancel{29}} \times \frac{8}{3} \frac{\cancel{29}}{\cancel{64}} = \boxed{4{,}26 \text{dB} = \alpha_T}$$

Sin red A:



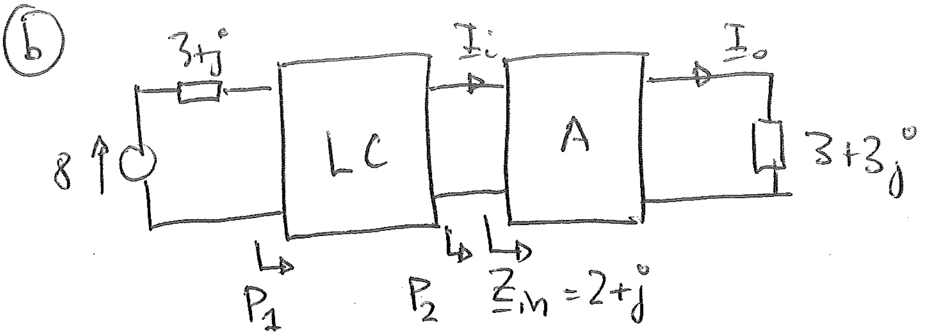
$$I_{20} = \frac{8}{6+4j}$$

$$P_{20} = \frac{1}{2} \cdot 3 \cdot |I_{20}|^2 = \frac{3}{2} \frac{64}{36+16} =$$

$$= \frac{3}{2} \frac{64}{52}$$

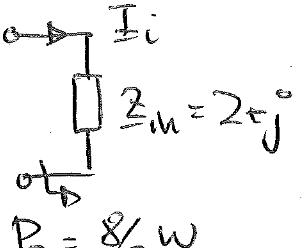
$$\alpha_I = 10 \log \frac{\cancel{3}}{2} \frac{\cancel{64}}{52} \times \frac{8}{\cancel{3}} \frac{29}{\cancel{64}} = 10 \log \frac{4 \times 29}{52} = \boxed{3{,}48 \text{dB} = \alpha_I}$$

(b)



$$G_I = \frac{I_o}{I_i}$$

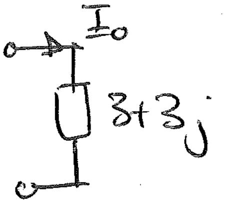
$$P_1 = P_{disp} = \frac{1}{8}\frac{|V_s|^2}{R_s} = \frac{64}{8\cdot 3} = 8/3 \text{ W.} \qquad P_2 = P_1 \quad (LC).$$



$$P_2 = \frac{1}{\cancel{2}}\cdot\cancel{2}\cdot|I_i|^2 \Rightarrow |I_i| = \sqrt{P_2} = \sqrt{\frac{8}{3}}$$

$P_2 = 8/3$ W

$$I_o = G_I \cdot I_i \quad \leadsto \quad |I_o| = |G_I|\cdot|I_i| = \frac{1}{2}\cdot\sqrt{8/3}$$



y la P_L:

$$P_L = \frac{1}{2}\cdot 3\cdot|I_o|^2 = \frac{3}{2}\cdot\left(\frac{1}{2}\sqrt{\frac{8}{3}}\right)^2 = \frac{\cancel{3}}{2}\cdot\frac{1}{4}\cdot\frac{8}{\cancel{3}} = \underline{1\text{W}}$$

$$\boxed{P_L = 1\text{W}}$$

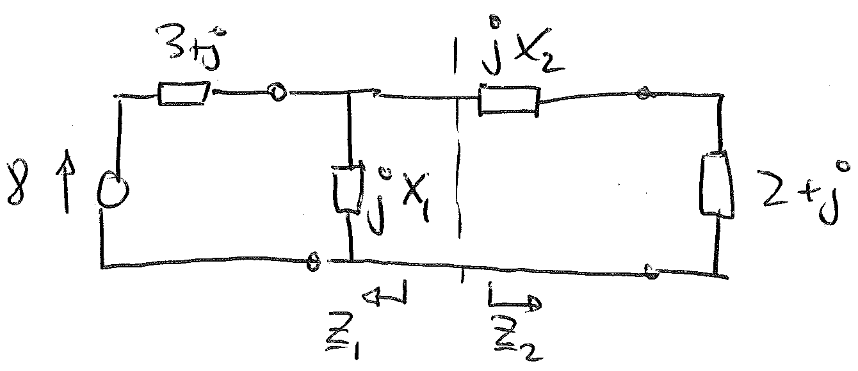
(c) Pérdidas inserción conjunto $\boxed{LC-A}$

Sin conjunto P_{20} es la del apartado (a) $\rightarrow P_{20} = \frac{3}{2}\,\frac{64}{52}$

Con el conjunto $P_2 = P_L = 1$.

$$\alpha_I = 10\log\frac{3}{2}\,\frac{64}{52}\cdot\frac{1}{1} = \boxed{2'66 \text{ dB} = \alpha_I}$$

(d) Diseño de la red :



$$\underline{Z}_1 = (3+j) // jX_1 = \frac{jX_1(3+j)}{(3+j+jX_1)} \cdot \frac{(3-j(1+X_1))}{(3-j(1+X_1))} = \frac{(j3X_1 - X_1)(3-j(1+X_1))}{9+(1+X_1)^2}$$

$$= \frac{j9X_1 + jX_1(1+X_1) - \cancel{3X_1} + 3X_1(\cancel{1}+X_1)}{9+(1+X_1)^2}$$

$$= \frac{j(10X_1+X_1^2)+3X_1^2}{9+(1+X_1)^2}$$

$$\underline{Z}_2 = 2+j+jX_2 = 2+j(1+X_2)$$

$$\underline{Z}_1 = \underline{Z}_2^* \equiv \begin{cases} 2 = \dfrac{3X_1^2}{9+(1+X_1)^2} \\[2ex] 1+X_2 = -\dfrac{10X_1+X_1^2}{9+(1+X_1)^2} \end{cases}$$

$$\Rightarrow 18+2+4X_1+2X_1^2 = 3X_1^2$$

$$X_1^2 - 4X_1 - 20 = 0$$

$$\downarrow$$

$$X_1 = \frac{4 \pm \sqrt{16+80}}{2} = \frac{4\pm\sqrt{96}}{2} = \frac{4\pm 4\sqrt{6}}{2} = 2 \pm 2\sqrt{6}$$

$$\downarrow$$

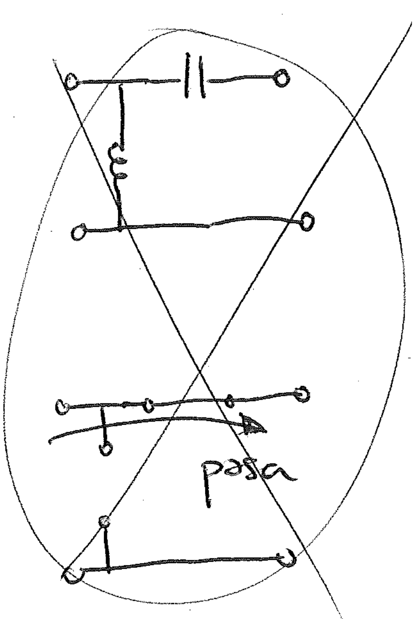
$$X_2 = -1 - \frac{10X_1+X_1^2}{9+(1+X_1)^2}$$

(a) $X_1 = 2+2\sqrt{6} = 6'899$

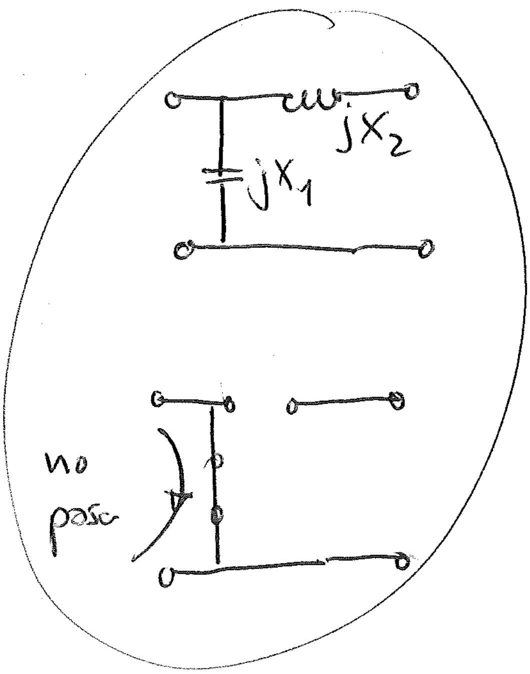
$$X_2 = -1 - \frac{68'99 + 47'596}{9+(7'899)^2} = -2'633$$

(b) $X_1 = 2-2\sqrt{6} = -2'899$

$$X_2 = 0'633$$



$f \rightarrow \infty$



El circuito físico es:

$-j2'899 = \frac{-j}{\omega C}$ $\qquad C = \frac{1}{\omega \cdot 2'899} = \frac{1}{10^6 \cdot 2'899} = \boxed{345 nF = C}$

$j0'633 = j\omega L$ $\qquad L = \frac{0'633}{\omega} = \boxed{633 nH = L}$