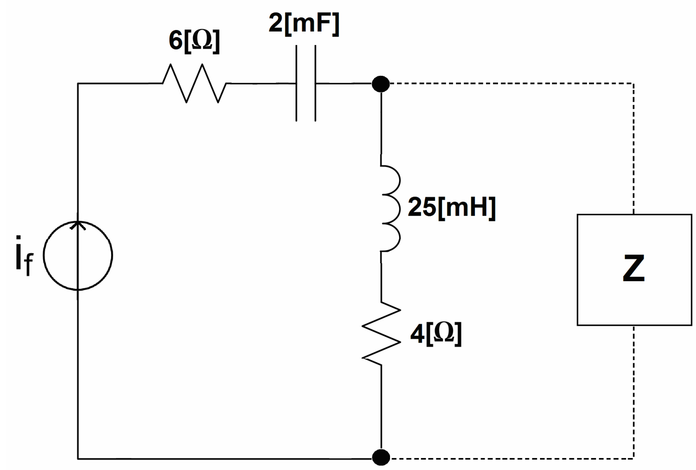
CONTROL N°3

EL 31-A ANALISIS DE REDES I

Prof : Santiago Bradford V. **11 de noviembre de 2008**
Prof. Aux : Heinz Gerdin H.

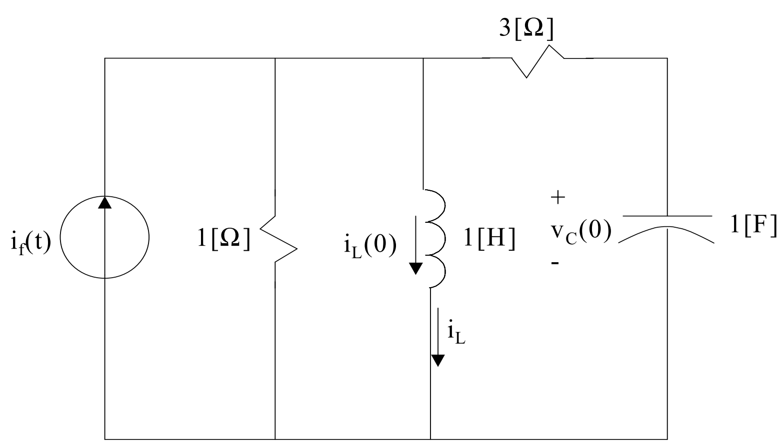
1.- Determine la carga Z que debe conectarse a los terminales del circuito (como se indica en la figura), de manera que el módulo de la potencia compleja del conjunto de elementos pasivos del circuito se mantenga constante, pero su factor de potencia resultante sea unitario.



$i_f = 220\text{sen}(200t+2\pi/3)$

2.- Para la red lineal e invariante de la figura usando transformada de Laplace, determine para $i_L(t)$:

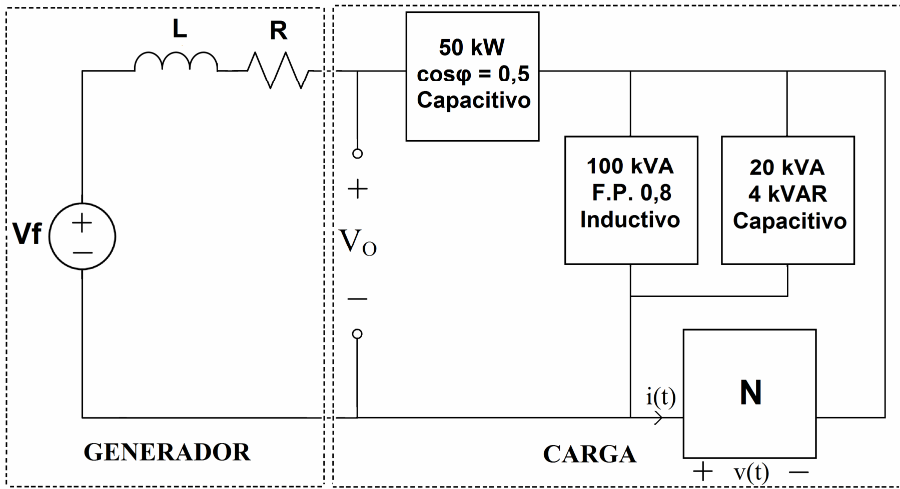
a) La respuesta de entrada cero $\forall t \geq 0$.
b) La respuesta de estado cero $\forall t \geq 0$.



$i_L(0)= 2$ [A] $v_C(0)= 1$ [V] $i_f(t)= e^{-t}u(t)$

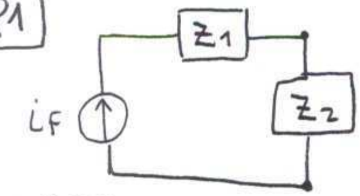
3.- Para la red lineal e invariante de la figura en régimen permanente sinusoidal, se mide $V_O=2200\angle 0° V_{RMS}$. Si N representa una red lineal e invariante con dos entradas, y sabiendo que $i(t)=10\cos(4t+\pi/6)$ y $v(t)=5000\cos(4t-\pi/3)$:

i) Determine la potencia compleja de la Carga del circuito.
ii) Calcule el valor de la inductancia L y de la resistencia R en el generador, de manera que exista una máxima transferencia de potencia activa entre el Generador y la Carga del circuito.



Señal	***Forma de onda***	***Transformada***
Impulso	$\delta(t)$	1
Escalón	$u(t)$	$\frac{1}{S}$
Rampa	$t \cdot u(t)$	$\frac{1}{S^2}$
Exponencial	$\left(e^{-\alpha \cdot t}\right) \cdot u(t)$	$\frac{1}{S+\alpha}$
Rampa Amortiguada	$\left(te^{-\alpha \cdot t}\right) \cdot u(t)$	$\frac{1}{(S+\alpha)^2}$
Seno	$[sen(\beta \cdot t)] \cdot u(t)$	$\frac{\beta}{S^2+\beta^2}$
Coseno	$[\cos(\beta \cdot t)] \cdot u(t)$	$\frac{S}{S^2+\beta^2}$
Seno Amortiguado	$[e^{-\alpha \cdot t} sen(\beta \cdot t)] \cdot u(t)$	$\frac{\beta}{(S+\alpha)^2+\beta^2}$
Coseno Amortiguado	$[e^{-\alpha \cdot t} \cos(\beta \cdot t)] \cdot u(t)$	$\frac{(S+\alpha)}{(S+\alpha)^2+\beta^2}$
Polos complejos simples	$2 \cdot \lvert K \rvert \cdot e^{\alpha \cdot t} \cdot \cos(\beta \cdot t + \angle K) \cdot u(t)$	$\frac{K}{(S+\alpha-j\beta)} + \frac{\overline{K}}{(S+\alpha+j\beta)}$
Polos complejos dobles	$2 \cdot \lvert K \rvert \cdot t \cdot e^{\alpha \cdot t} \cdot \cos(\beta \cdot t + \angle K) \cdot u(t)$	$\frac{K}{(S+\alpha-j\beta)^2} + \frac{\overline{K}}{(S+\alpha+j\beta)^2}$

P1



$w=200$

$$Z_1 = 6 - \frac{j}{200\cdot 2\cdot 10^{-3}} \Rightarrow \boxed{Z_1 = 6 - \frac{5j}{2}}$$

$$Z_2 = 4 + j\cdot 200\cdot 25\cdot 10^{-3} \Rightarrow \boxed{Z_2 = 4+5j}$$

$$\Rightarrow \boxed{Z_1 + Z_2 = Z_{Total} = 10 + \frac{5j}{2}}$$

$$\Rightarrow \dot{S} = \frac{1}{2} Z_T \cdot |\dot{I}|^2$$

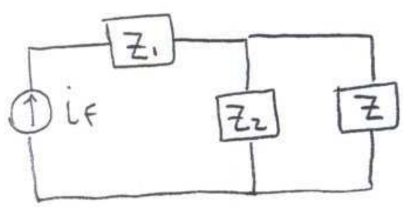
$$= \frac{1}{2}\left(10 + \frac{5j}{2}\right)\cdot (220)^2$$

$$\Rightarrow \boxed{\dot{S} = 242.000 + j60.500 = 249.448 \measuredangle 14{,}036°}$$

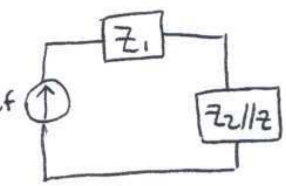
Se desea que $|\dot{S}| = 249.448$ [VA] se mantenga al conectar "Z", pero que su factor de potencia sea 1 $\Rightarrow \cos\varphi = 1 \Rightarrow \varphi = 0°$

$\Rightarrow$ Se desea que al conectar "Z", la potencia compleja de los elementos pasivos sea: $|\dot{S}| \measuredangle 0° = 249.448 \measuredangle 0° \Rightarrow \boxed{249.448 = \dot{S}}$

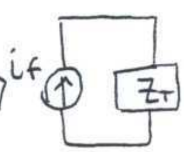
$\Rightarrow$ encontremos "Z" tal que ello ocurra.



$\Rightarrow$



$\Rightarrow$



$(Z_T = Z_1 + Z_2 // Z.)$

$(|\dot{I}| = 220)$

e impongo $\dot{S} = 249.448$

$$\Rightarrow \dot{S} = \frac{1}{2} Z_T \cdot |\dot{I}|^2 \qquad \text{y} \quad Z_T = Z_1 + \left(\frac{1}{Z_2} + \frac{1}{Z}\right)^{-1}$$

$$\Rightarrow \frac{2\dot{S}}{|\dot{I}|^2} = Z_1 + \left(\frac{1}{Z_2} + \frac{1}{Z}\right)^{-1} \Rightarrow \frac{2\dot{S} - Z_1|\dot{I}|^2}{|\dot{I}|^2} = \left(\frac{1}{Z_2} + \frac{1}{Z}\right)^{-1}$$

y despejando...

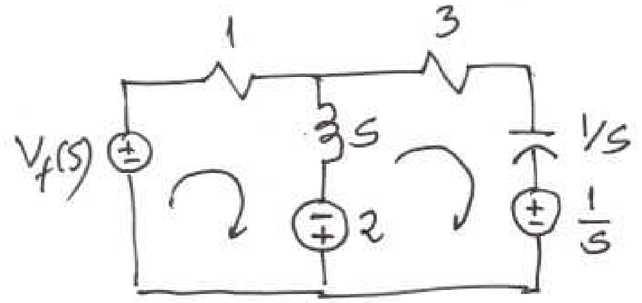
$$\Rightarrow Z = \left(\frac{|\dot{I}|^2}{2\cdot\dot{S} - Z_1|\dot{I}|^2} - \frac{1}{Z_2}\right)^{-1} = \left(\frac{220^2}{2\cdot 249448 - \left(6 - \frac{5j}{2}\right)\cdot 220^2} - \frac{1}{(4+5j)}\right)^{-1}$$

$\Rightarrow \boxed{Z = 12{,}197 - j\,3{,}394}$

$\Rightarrow Z = R - j/\omega C \longrightarrow \boxed{R = 12{,}197\ [\Omega]}$

$\dfrac{1}{\omega C} = 3{,}394 \Rightarrow C = \dfrac{1}{200 \cdot 3{,}394} \Rightarrow \boxed{C = 1{,}473\ [mF]}$

P2)



$$\begin{bmatrix} S+1 & -S \\ -S & S+3+\frac{1}{S} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_f + 2 \\ -2-\frac{1}{S} \end{bmatrix}$$

<u>RENC</u>

$$\Delta = (S+1)(S+3+\tfrac{1}{S}) - S^2 = \cancel{S^2} + 3S + 1 + S + 3 + \tfrac{1}{S} - \cancel{S^2}$$

$$\Delta = 4S + 4 + \tfrac{1}{S}$$

$$\Delta_1 = \begin{vmatrix} 2 & -S \\ -2-\frac{1}{S} & S+3+\frac{1}{S} \end{vmatrix} = 2(S+3+\tfrac{1}{S}) - S(2+\tfrac{1}{S})$$

$$= \cancel{2S} + 6 + \tfrac{2}{S} - \cancel{2S} - 1 = 6 + \tfrac{2}{S} - 1$$

$$= 5 + \tfrac{2}{S}$$

$$\Delta_2 = \begin{vmatrix} S+1 & 2 \\ -S & -2-\frac{1}{S} \end{vmatrix} = -(S+1)(2+\tfrac{1}{S}) + 2S = -\cancel{2S} - 1 - 2 - \tfrac{1}{S} + \cancel{2S}$$

$$= -3 - \tfrac{1}{S}$$

$$\Delta_1 - \Delta_2 = 8 + \tfrac{3}{S}$$

$$I_L = \frac{8 + 3/S}{4S + 4 + \frac{1}{S}} \quad \begin{matrix} /\, S/4 \\ /\, S/4 \end{matrix} \quad \Rightarrow I_L = \frac{2S + 3/4}{S^2 + S + \frac{1}{4S}}$$

$$I_L(S) = \frac{2S + 3/4}{(S+1/2)^2} = \frac{A}{(S+1/2)^2} + \frac{B}{(S+1/2)}$$

$$A = -1 + 3/4 = -1/4$$

$$B = 2$$

$$i_L(t) = (-\tfrac{1}{4}t + 2)e^{-\frac{1}{2}t}$$

RESC

$$\left.\begin{array}{l}\Delta_1 = V_f(s+3+1/s)\\ \Delta_2 = sV_f\end{array}\right\} \Delta_1-\Delta_2 = V_f(3+1/s)$$

$$I_L = \frac{V_f(3+1/s)}{4s+4+1/s} \cdot \frac{/s/4}{/s/4} = \frac{V_f\left(\frac{3}{4}s+\frac{1}{4}\right)}{s^2+s+\frac{1}{4}}$$

$$I_L = \frac{\frac{1}{4}(3s+1)}{(s+1/2)^2(s+1)} = \frac{A}{(s+1/2)^2} + \frac{B}{(s+1/2)} + \frac{C}{(s+1)}$$

$$A = \frac{\frac{1}{4}(-3/2+1)}{(-1/2+1)} = \frac{1}{4}\frac{(-1/2)}{1/2} = -1/4$$

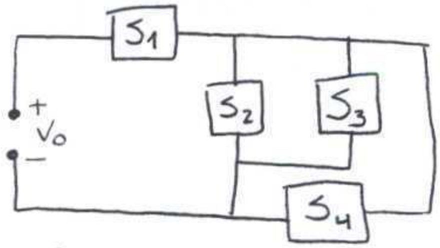
$$C = \frac{\frac{1}{4}(-3+1)}{(-1+1/2)^2} = \frac{-1/2}{(-1/2)^2} = -2$$

$$B \Rightarrow \frac{\frac{1}{4}}{1/4} = 4A+2B+C \qquad \begin{array}{l}2B = 1-4A-C\\ 2B = 1+1+2 = 4\\ B=2\end{array}$$

$$i_L(t) = \left(-\frac{1}{4}t+2\right)e^{-1/2\,t} - 2e^{-t}$$

P3 i

Sea:



$\dot{S}_{carga} = \dot{S}_1 + \dot{S}_2 + \dot{S}_3 + \dot{S}_4$

$\dot{S}_1$ | $P = 50.000\ [W]$; $\cos\varphi = 0,5$; capacitivo $\Rightarrow \varphi < 0$.

$|\dot{S}| = \dfrac{P}{\cos\varphi} = \dfrac{50.000}{0,5} \Rightarrow |\dot{S}| = 100.000$

$Q^2 = |\dot{S}|^2 - P^2 \Rightarrow |Q| = \sqrt{|\dot{S}|^2 - P^2} = \sqrt{100.000^2 - 50.000^2}$

$\Rightarrow |Q| = 50.000\sqrt{3}$ y es capacitivo! $\Rightarrow Q < 0$

$\Rightarrow \boxed{\dot{S}_1 = 50.000 - j\sqrt{3}\cdot 50.000}$ (86.602)

$\dot{S}_2$ | $|\dot{S}| = 100.000\ [VA]$; $\cos\varphi = 0,8$; inductivo $\Rightarrow \varphi > 0$

$P = |\dot{S}|\cos\varphi = 100.000 \cdot 0,8 \Rightarrow P = 80.000$

$|Q| = \sqrt{|\dot{S}|^2 - P^2} = \sqrt{100.000^2 - 80.000^2}$

$\Rightarrow |Q| = 60.000$ inductivo! $\Rightarrow Q > 0$

$\Rightarrow \boxed{\dot{S}_2 = 80.000 + j\,60.000}$

$\dot{S}_3$ | $|\dot{S}| = 20.000\ [VA]$; $|Q| = 4.000\ [VAR]$; capacitivo $\Rightarrow \varphi < 0$

$P = \sqrt{|\dot{S}|^2 - Q^2} = \sqrt{20.000^2 - 4000^2}$

$\Rightarrow P = \sqrt{6}\cdot 8000$ capacitivo! $\Rightarrow Q < 0$

(19.595,9)

$\Rightarrow \boxed{\dot{S}_3 = \sqrt{6}\cdot 8000 - j4000}$

$\dot{S}_4$ | $\dot{V} = 5000 \measuredangle -60°$; $\dot{I} = 10 \measuredangle 30°$

$\dot{S} = \frac{1}{2}\dot{V}\dot{I}^* = \frac{1}{2}(5000\measuredangle -60°)(10\measuredangle -30°)$

$\Rightarrow \boxed{\dot{S}_4 = -j\,25000}$

$$\Rightarrow \dot{S}_{carga} = \dot{S}_1 + \dot{S}_2 + \dot{S}_3 + \dot{S}_4$$
$$= (50.000 - j\sqrt{3}\cdot 50.000) + (80.000 + j60.000) + (\sqrt{6}\cdot 8000 - j4000) + (-j25.000)$$

$$\Rightarrow \boxed{\dot{S}_{carga} = 149.596 - j55.602,5 = 159.595 \measuredangle -20,38^\circ} \rightarrow \text{capacitivo!}$$

ii En la carga, $V_0 = 2200 \measuredangle 0^\circ \, V_{RMS} = \dfrac{V_m}{\sqrt{2}}$

$$\Rightarrow \boxed{V_m = \sqrt{2}\cdot 2200 \measuredangle 0^\circ}$$

$$\dot{S}_{carga} = \frac{1}{2}\frac{|\dot{V}|^2}{Z^*} \Rightarrow Z_c^* = \frac{|\dot{V}|^2}{2\cdot \dot{S}_{carga}} = \frac{(\sqrt{2}\cdot 2200)^2}{2\cdot(149.596 - j55602,5)}$$

$$\Rightarrow \boxed{Z_c^* = 28,427 + j10,566}$$ impedancia conjugada de la carga.

$\boxed{Z_G = R + j\omega L}$ y hay máx. transf. de potencia activa entre el generador y la carga si $Z_G = Z_c^*$

$$\Rightarrow \boxed{Z_G = 28,427 + j10,566} \quad (\omega = 4)$$

$$\Rightarrow \boxed{R = 28,427\,[\Omega]}$$

$$\omega L = 10,566 \Rightarrow L = \frac{10,566}{4} \Rightarrow \boxed{L = 2,642\,[H]}$$