IV Exámen Parcial

Circuitos Eléctricos I

2 - 2 - 2015

1) (6pts) El generador $V_g(t) = 100\sqrt{2}\cos(2\pi 60t)$ alimenta las siguientes tres cargas:

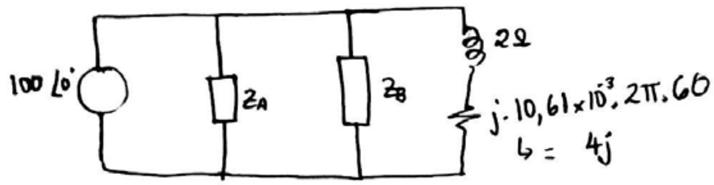
a) Z_A consume 3000VA con $fp = 0{,}707$ en adelanto

b) Z_b consume 4200 VAR con $fP = 0{,}8$ en atraso

c) $Z_c = Z_{RL}$ en serie con $R = 2\Omega$ y $L = 10{,}61\,mH$

Determine:

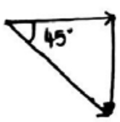
a) Elementos en serie y paralelo que componen Z_A y Z_B

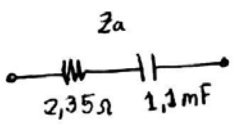


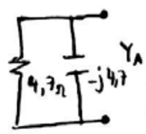
Triángulo de potencia de cada carga:

$S_A = 1500\sqrt{2} - j1500\sqrt{2}$ → Elementos en Serie:

$Z_A = \dfrac{|V|^2}{S_A^*} = \dfrac{(100)^2}{1500\sqrt{2} + j1500\sqrt{2}} = 2{,}35 - j2{,}35\ (\Omega)$

Z_A ⇒ 

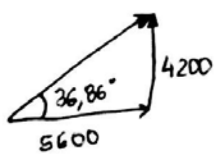




$\dfrac{1}{2\pi.60.C} = 2{,}35 \therefore C = 1{,}1\,mF$

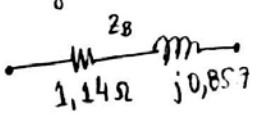
→ Elementos en Paralelo: $Y_A = \dfrac{1}{Z_A}$

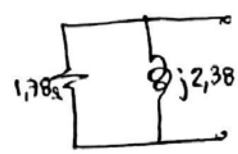
$Y_A = 0{,}212 + 0{,}212j\ (S)$

Z_B ⇒ 

$S_B = 5600 + j4200$

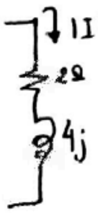
Siguiendo el mismo procedimiento





$L_p = \dfrac{2{,}38}{2\pi 60} = 6{,}3\,mH$

$L_s = \dfrac{0{,}857}{2\pi 60} = 2{,}3\,mH$

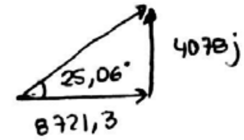
Z_c ⇒ 

$|I| = \dfrac{100}{\sqrt{2^2 + 4^2}} = 22{,}36\ A$ ∴ $S_c = |I|^2\,(2 + 4j)$

$S_c = 1000 + j2000\ \ (VA)$

c) Potencia compleja en Z_c

b) Factor de Potencia en que trabaja el generador.



$S_g = S_A + S_B + S_C = 8721,3 + 4078,7j$ (VA)

$\therefore \; F_p = \cos(25,06°) = 0,9058$

d) Corriente eficáz del generador. Indique su expresión temporal de $i_g(t)$

$|I_g| = \dfrac{|S_g|}{|V|} \Rightarrow |I_g| = \dfrac{9627,9}{100} = 96,27$ A

$i_g(t) = 96,27\sqrt{2} \cdot \cos(2\pi 60 t - 25,06)$ (A) → Tomando como referencia el voltaje de la fuente.

e) Carga que debe agregarse (elementos en serie) para corregir el fp del generador a 0,98 en atraso manteniendo:

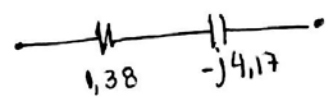
a) La potencia aparente constante   b) La potencia activa constante.

$S_{AD} = -S_g + S_{Nueva}$

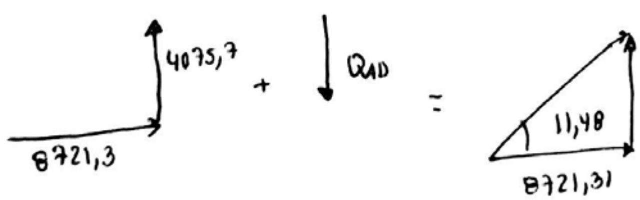
a)

$S_{AD} = -8721,3 - j\,4078,7 + 9435,4 + j\,1915,9 \quad \therefore \quad S_{AD} = 714,1 - j\,2156,8$

$Z_{AD} = \dfrac{(100)^2}{(714,1 + j2156,8)} \qquad Z_{AD} = 1,38 - j\,4,17$



b)



$Q_{nueva} = 8721,3 \cdot \text{tag}(11,48)$

$Q_{nueva} = 1770,9$ VAR

$Q_{AD} = 4075,3 - 1770,9$

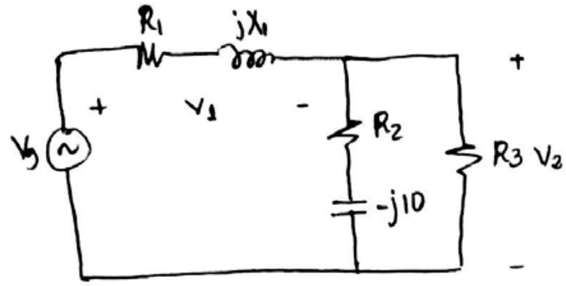
$Q_{AD} = 2304,8$ VAR

$\dfrac{V^2}{X_c} = 2304,8$

$\underline{X_c = 4,33}$

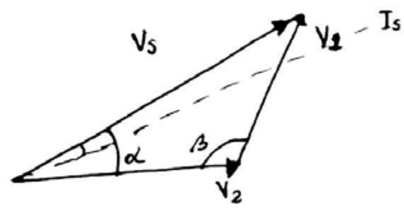
② (5pts) Se conoce que el generador V_g suministrando una corriente de módulo 10A, entrega una potencia de $800+j600$, determine, R_1, X_1, R_2 y R_3

si $|V1| = 71V$ y $|V2| = 64V$



Observe que $|S_g| = |V_g||I_g| = 800+j600 \Rightarrow |V_g| = \dfrac{\sqrt{800^2+600^2}}{10} = 100V$

tomando como referencia V2



Aplicando el Teorema del coseno:

$$\cos\alpha = \frac{|V_1|^2 - |V_s|^2 - |V_2|^2}{-2|V_s||V_2|} \qquad \alpha = 45°$$

$$\cos\beta = \frac{|V_s|^2 - |V_1|^2 - |V_2|^2}{-2|V_1||V_2|} \qquad \beta = 95{,}45°$$

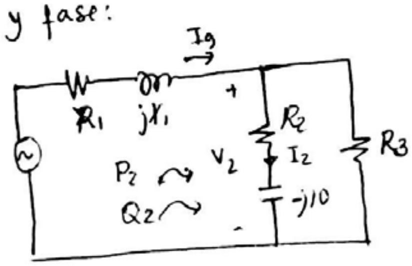
Luego los voltajes en módulo y fase:

$V_2 = 64\angle 0°\ V$

$V_1 = 71\angle 84{,}55°\ V$

$V_g = 100\angle 45°$

$I_g = 10\angle 8{,}13°\ A$

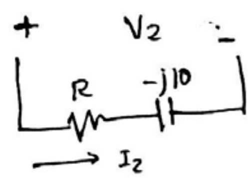


$S_2 = P_2 + jQ_2 = V_2 \cdot I_g^*$

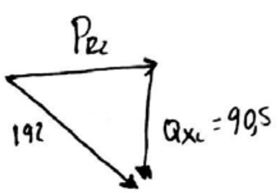
$S_2 = 633{,}57 - 90{,}5j$

$S_2 = 640\angle{-8{,}13}$

Observe que $Q_2 = |I_2|^2 \cdot [10]$ $\quad I_2 = \sqrt{\dfrac{90{,}5}{10}} = 3{,}0A$



El triangulo de potencia de la impedancia



$P_{R2} = \sqrt{192^2 - 90{,}5^2} = 169{,}33$

$P_{R2} = |I_2|^2 \cdot R_2$

$R_2 = \dfrac{169{,}33}{9} = 18{,}814\Omega$

$P_2 = P_{R2} + P_{R3} \Rightarrow 633,57 = 169,33 + P_{R3}$

$P_{R3} = 464,2367 = \dfrac{V^2}{R_3}$ $\quad R_3 = \dfrac{64^2}{464,2367}$ $\quad R_3 = 8,82\ \Omega$

$Z_1 = R_1 + jX_1$

Dos métodos:

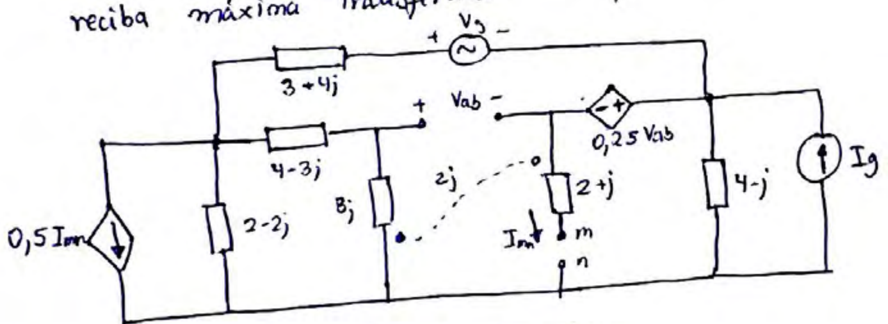
$Z_1 = \dfrac{V_1}{I_g} = \dfrac{71\angle 84,55}{10\angle 8,13} = \underline{1,66 + 6,90j}\ (\Omega)$

$\Rightarrow$ Por Balance energético

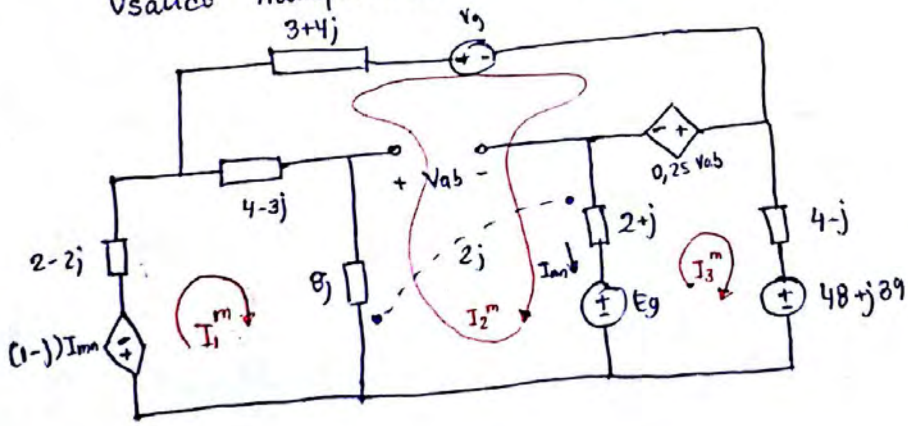
$Z_1 = \dfrac{S_g - S_2}{|I_g|^2} = \underline{1,66 + j6,9}\ (\Omega)$

③ (7pts) El circuito de la figura si $V_g = 24\angle 0$ y $I_g = 9 + 12j$

i) Encuentre la impedancia a conectar entre los nodos m y n para que reciba máxima transferencia de potencia



Usando transformación de fuentes.



$I_{mn} = (I_2^m - I_3^m)$

$$(1-j)(I_2^m - I_3^m) + (2-2j) I_1^m + (4-3j)(I_1^m - I_2^m) + 8j(I_1^m - I_2^m) + 2j(I_3^m - I_2^m) = 0$$

$$\boxed{(6+3j) I_1^m - (3+8j) I_2^m - (1-3j) I_3^m = 0} \quad (I)$$

$$-E_g + (2+j)(I_3^m - I_2^m) + 2j(I_1^m - I_2^m) - 0{,}25 V_{ab} + (4-j) I_3^m + 48 + j39 = 0$$

$$-V_{ab} + (4-3j)(I_2^m - I_1^m) + (3+4j) I_2^m + 24\angle 0 + 0{,}25 V_{ab} = 0$$

$$V_{ab} = \frac{4}{3}\left[(4-3j)(I_2^m - I_1^m) + (3+4j) I_2^m + 24\angle 0\right]$$

Sustituyendo

$$(2+j)(I_3^m - I_2^m) + 2j(I_1^m - I_2^m) - \frac{1}{3}\left[(4-3j)(I_2^m - I_1^m) + (3+4j) I_2^m + 24\angle 0\right] +$$

$$+ (4-j) I_3^m + 48 + j39 = E_g$$

$$\boxed{\left(\frac{4}{3} + j\right) I_1^m - \left(\frac{13}{3} + j\frac{10}{3}\right) I_2^m + 6 I_3^m = E_g - 48 - j39 + 8} \quad (II)$$

Malla externa.

$$(1-j) \underbrace{I_{mn}}_{(I_2^m - I_3^m)} + (2-2j) I_1^m + (3+4j) I_2^m + 24\angle 0 + (4-j) I_3^m + 48 + j39 = 0$$

$$\boxed{(2+2j) I_1^m + (4+3j) I_2^m + 3 I_3^m = -72 - j39} \quad (III)$$

Si $E_g = 0$, $I_N = I_{mn} = I_2^m - I_3^m$

$I_n = 2{,}51 + j7{,}9$

Si $Z_{th} = \dfrac{V_{th}}{I_N}$

$$Z_{th} = \frac{V_{th}}{I_N} = 6{,}19 - j0{,}05$$

Si $I_{mn} = 0 \Rightarrow E_g = V_{th}$

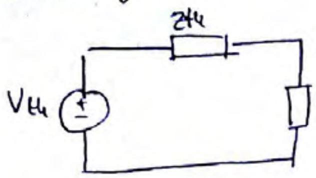
resolviendo

$I_2^m - I_3^m = 0$

$V_{th} = 15{,}94 + j48$

(i) Calcule el valor de la potencia que recibe esta impedancia.

Potencia que recibe la carga $Z_{th}^* = Z_c$



$Z_c = Z_{th}^* = 6,19 + j0,05$

$S_c = 1322,4 + j\,11,14j$

$I = \frac{V_{th}}{2R_{th}}$

$S_c = \left|\frac{V_{th}}{2R_{th}}\right|^2 \cdot [R_{th} + j0,05]$