Superposición

calculo la Natural pasivando todo
y las Rta f haciendo
facil c-ro dejando activa 1 fuente a la vez, después sumo las f.

$V_L = L \frac{dI_L(t)}{dt}$ $I_C = C \cdot \frac{dV_C(t)}{dt}$

Capítulo 3: Circuito de Tiempo

Respuesta natural: régimen transitorio
encuentra la rta p/ cualquier valor inicial

Respuesta forzada: régimen permanente
∃ si hay una f. forzante, ∄ si hay una excitación

α = coef de amortiguamiento (determina la rapidez con la q1 decienden las oscilaciones)
W_0 = frec. resonante
$S_{1,2}$ = frec. naturales
τ = cte de tiempo (determina la veloc de crec. de la rta de un sist. de 1er Orden)

Rta f Pasivo

Orden	Sin fuente	Con fuente cte	Con fuente no cte.
1	Rta N $Ae^{-t/\tau}$	RtaN + Rta f $Ae^{-t/\tau}$ + $\underbrace{\text{Rta f}}$ (pasivo el comp y lo obtengo) $x(t) = x(\infty) + [x(0) - x(\infty)]e^{-t/\tau}$	RtaN + Rta f $Ae^{-t/\tau}$ + $\underbrace{\text{Rta f}}$ lo calculo por lagrange o coef indeterminados (va a ser parecida a la señal de entrada)
2	Rta N Se encuentra Ec. caract RRI, RRD, RCC Armo sol. Particularizo	Rta N + Rta f Encuentro Ec. caract RRI, RRD, RCC P/ Rta f uso coef. indet. Calculo las incog. de CoInd. Particularizo	

Rta Nat de 2do Orden

$RRI = A_1 e^{st} + A_2 . t . e^{st}$ (critic amort. $\alpha^2 = \omega_0^2$)

$RRD = A_1 e^{s_1 t} + A_2 e^{s_2 t}$ (sobre " $\alpha^2 > \omega_0^2$)

$RRC = e^{-\alpha t} (A_1 \cos(\omega t) + A_2 \sin(\omega t))$ (sub amort $\alpha^2 < \omega_0^2$)

Coef indeterminados

Exc.	Rep
V(cte)	A
kt	At+B
kt²	At^2+Bt+C
Ae^{nt}	Ce^{nt}
$A\cos(\omega t)$	$D\cos(\omega t) + \mathcal{E}\sin(\omega t)$
$A\sin(\omega t)$	

Derivo la rta propuesta y la meto en la EDO calculada, después hago t=0, t=∞ p/ calcular D, E

$I_{total}(t) = Ae^{-t/\tau} + \sum I(t)_{forzada}$ → Sol. completa usando superposición (1er orden) $\begin{cases} f_{fmax} = corto \\ f_{cont} = circ\ abi \end{cases}$

τ = calculo pasivando las fuentes

tco Cond Inic. $\left\{ C = \frac{q}{V} \right.$

Resistencia criticamente Amortiguada $\left\{ P^2 = 4q \right.$

Energía Almacenada ← $\mathcal{E} = \frac{1}{2} \cdot L \cdot (I_L)^2$

P/circ con bobinas inducidas

$V_{L1} = L_1 \frac{dI_1}{dt} - m \frac{dI_2}{dt}$

$V_{L2} = +L_2 \frac{dI_2}{dt} + m \frac{dI_1}{dt}$

$m = k\sqrt{L_1 L_2}$

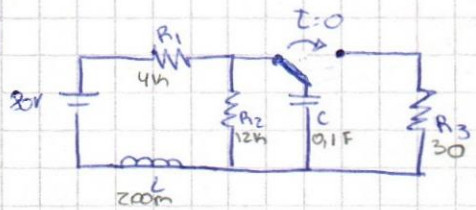
NOTA

homogenea (sin fuente)
Rta natural
1er orden

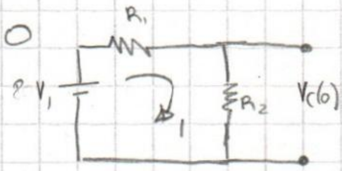
HOJA N°

FECHA

1) $V_C(t) = ?$



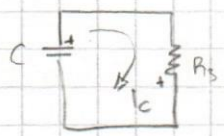
$t<0$



$V_1 - V_{R_1} - V_{R_2} = 0 \rightarrow V_1 - I R_1 - I R_2 = 0 \rightarrow I = \frac{V_1}{R_1+R_2} = 5mA$

$V_C(0) = V_{R_2} = I \cdot R_2 = 60 \rightarrow \boxed{V_C(0) = 60V}$

$t>0$



$V_C + V_{R_3} = 0 \rightarrow V_C + I_C R_3 = 0 \rightarrow V_C + \frac{dV_C}{dt} C R_3 = 0$

$\frac{dV_C}{dt} + \frac{V_C}{C \cdot R_3} = 0$ EDO homogenea $\tau = C \cdot R_3 = 3$

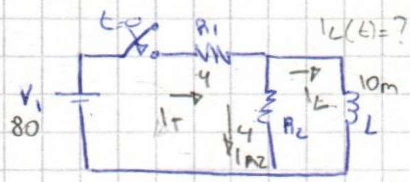
Sol natural

$V_C(t) = A e^{-t/\tau} = A e^{-\frac{t}{3}}$

Sol particular

$V_C(0) = A = 60 \rightarrow \therefore \boxed{V_C(t) = 60 e^{-\frac{t}{3}}}$

5) No homogenea (con fuente cte)
Rta N + Rta F
1er orden



$I_L(0) = 3$

$t>0$

$I_T - I_{R_2} - I_L = 0$
$V_1 - V_{R_1} - V_{R_2} = 0$
$V_{R_2} = V_L$
$I_{R_2} \cdot R_2 = L \cdot dI_L/dt$

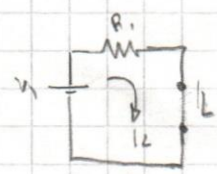
$V_1 - I_T R_1 - L \frac{dI_L}{dt} = 0 \rightarrow V_1 - I_{R_2} R_1 - I_L R_1 - L \frac{dI_L}{dt} = 0$

$V_1 - \frac{L}{R_2} \frac{dI_L}{dt} - I_L R_1 - \frac{dI_L}{dt} L = 0 \rightarrow \left(L + \frac{L}{R_2}\right) \frac{dI_L}{dt} + I_L R_1 = V_1$

Sol general $I_L(t) = X(\infty) + [X(0) - X(\infty)] e^{-t/\tau}$

$\frac{dI_L}{dt} + \frac{I_L}{(L + L/R_2)/R_1} = \frac{V_1}{(L + L/R_2)/R_1}$

$t \rightarrow \infty$



$I_L(\infty) = \frac{V_1}{R_1} = 20$

EDO no homogenea

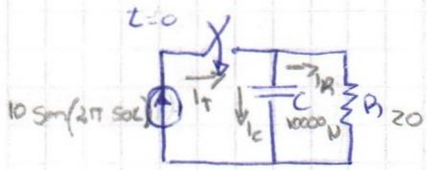
$\boxed{I_L(t) = 20 - 17 e^{-320t}}$

$\tau = \left(L + \frac{L}{R_2}\right) / R_1 = \frac{1}{320}$

NOTA

16) No homogénea (por fuente no cte)
Rta N + Rta F
1er Orden

$V_C(t) = ?$ $V_C(0) = 0$



t>0

$I_T - I_C - I_R = 0$
$V_C = V_R$

$V_C = I_R . R \to V_C = I_T R - I_C . R \to V_C = I_T . R - \frac{dV_C}{dt} . C . R$

$\frac{dV_C}{dt} + \frac{V_C}{RC} = \frac{I_T \cancel{R}}{\cancel{R}C}$ EDO no homogénea
$\tau = RC = \frac{1}{5}$

Sol general!
$V_C(t) = Ae^{-t/\tau} + RF$

Rta. forzada → coef indet → $V_C(t) = D\cos\omega t + E\sin\omega t = D\cos(100\pi t) + E\sin(100\pi t)$

$V_C(t)' = -100\pi . D\sin(100\pi t) + 100\pi . E\cos(100\pi t)$

$100\pi(-D\sin 100\pi t + E\cos 100\pi t) + 5(D\cos(100\pi t) + E\sin(100\pi t)) = \frac{10\sin(2\pi 50t)}{C}$

P/ t=0 $100\pi . E + 5D = 0 \to E = \frac{-5D}{100\pi} = 0,05 \to \boxed{E = 0,05}$

P/ t=90 $-100\pi . D + 5 . E = \frac{10}{C} \to -100\pi . D - \frac{5 . 5D}{100\pi} = \frac{10}{C} \to D\left(-100\pi - \frac{25}{100\pi}\right) = \frac{10}{C}$

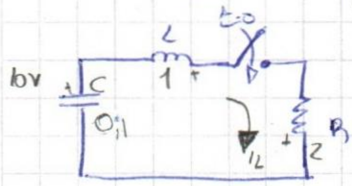
$-100\pi D = \frac{10}{C} \to D = \frac{10}{-100 . \pi . C} = -3,18 \to \boxed{D = -3,18}$

Sol general $V_C(t) = Ae^{-5t} - 3,18\cos(100\pi t) + 0,05\sin(100\pi t)$

$V_C(0) = A + 3,18 = 0 \to A = 3,184$

Sol particular $\boxed{V_C(t) = 3,18\, e^{-5t} - 3,181\cos(100\pi t) + 0,05\sin(100\pi t)}$

23) homogenea (sin fuente)
RLC N
2do Orden



$V_C(t) = ?$
$I_L(t) = ?$

$t<0 \quad V_C(0) = 10V$

$$I_L = I_C = \frac{dV_C}{dt} \cdot C$$

$t>0$

$$V_C + V_L + V_R = 0 \rightarrow V_C + L \cdot \frac{dI_L}{dt} + I_L \cdot R = 0 \rightarrow \frac{V_C}{LC} + \cancel{LC}\frac{d^2V_C}{dt} + \frac{\cancel{C}R}{L\cancel{C}}\frac{dV_C}{dt} = 0$$

$$\frac{d^2V_C}{dt} + \frac{dV_C}{dt} \cdot \frac{\cancel{C}R}{L\cancel{C}} + \frac{V_C}{LC} = 0$$

$S_1 = -1 + 3i$
$S_2 = -1 - 3i$

Sol general: $V_C(t) = e^{-\alpha t}\left(A_1 \cos\omega t + A_2 \operatorname{sen}\omega t\right) = e^{-1t}\left(A_1 \cos(3t) + A_2 \operatorname{sen}(3t)\right)$

Sol particular

$$V_C(0) = A_1 = 10$$

$$V_C(0)' = e^t\left(A_1 \cos(3t) + \cancel{A_2 \operatorname{sen}(3t)}\right) + e^t\left(-3A_1 \cancel{\operatorname{sen}(3t)} + 3A_2 \cos(3t)\right) = 0$$

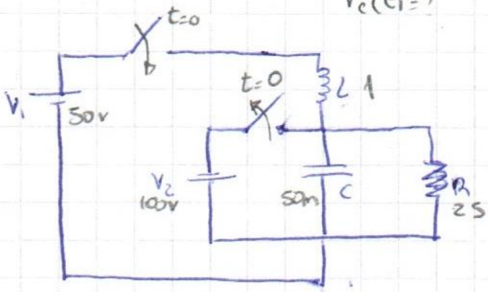
$$\therefore A_1 + 3A_2 = 0 \rightarrow 10 + 3A_2 = 0 \rightarrow A_2 = \frac{-10}{3}$$

$\therefore$ Sol particular $\boxed{V_C(t) = e^{+t}\left(10\cos(3t) - \frac{10}{3}\operatorname{sen}(3t)\right)}$

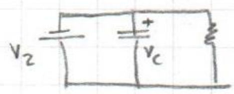
NOTA

28) No homogenea (con fuente cte)
Rta N + Rta f
2do Orden

$V_c(t) = ?$



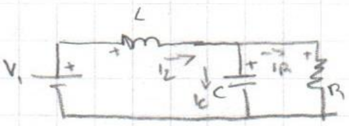
t<0



$V_c(0) = V_2 = -100V$

$i_c = C\frac{dV_c}{dt}$

t>0



$i_L - i_C - i_R = 0$

$V_1 - V_L - V_C = 0$

$V_C = V_R = I_R \cdot R \to I_R = \frac{V_C}{R}$

$V_1 - L\frac{di_L}{dt} - V_c = 0 \to V_1 - L\frac{di_c}{dt} - L\frac{di_R}{dt} - V_c = 0 \to V_1 - LC\frac{d^2V_c}{dt^2} - \frac{dV_c}{dt}\frac{L}{R} - V_c = 0$

$\frac{d^2V_c}{dt^2} + \frac{dV_c}{dt}\frac{\cancel{L}}{R}\frac{1}{\cancel{L}C} + \frac{V_c}{LC} = \frac{V_1}{LC} \to \frac{d^2V_c}{dt^2} + \frac{4}{5}\frac{dV_c}{dt} + 20V_c = 1000$

$S_1 = -0,4 + j\,4,45$
$S_2 = -0,4 - j\,4,45$ } RC
$(\alpha + j\omega)$

Sol general: $e^{-\alpha t}(A_1\cos\omega t + A_2\sin\omega t)$ + Rta f

Rta forza

$V_c(t) = A = 50$
$V_c(t)' = 0$
$V_c(t)'' = 0$

$0 + 0 + \frac{A}{LC} = \frac{V_1}{LC} \to A = V_1 = 50$

Sol general → $V_c(t) = e^{0,4t}\left(A_1\cos(4,45t) + A_2\sin(4,45t)\right) + 50$

$V_c(0) = A_1 + 50 = -100 \to A_1 = -150$

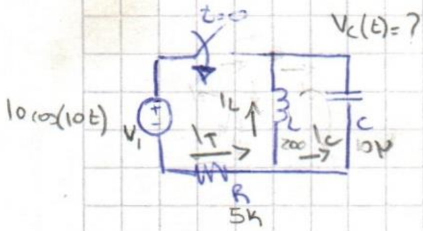
$V_c(0)' = 0,4e^{0,4t}\left(A_1\cos(4,45t) + A_2\sin(4,45t)\right) + e^{0,4t}\left(-4,45A_1\sin(4,45t) + 4,45A_2\cos(4,45t)\right)$

$= 0,41A_1 + 4,45A_2 = 0 \to \frac{-[0,41\cdot(-150)]}{4,45} = A_2 \to A_2 = 13,82$

$\boxed{\text{Sol particular } V_c(t) = e^{0,4t}\left(-150\cos(4,45t) + 13,82\sin(4,45t)\right) + 50}$

NOTA

29) No homogenea (con fuente no cte)
Rta N + Rta f
2do Orden



$V_C(t) = ?$

$t<0 \Rightarrow V_C(0) = 0V$

$t>0$

$i_T - i_L - i_C = 0$

$V_1 - V_L - V_R = 0$

$V_L = V_C$ $\qquad V_C = L\,\frac{di_L}{dt} \to \int \frac{V_C}{L} = i_L$

$V_1 - L\frac{di_L}{dt} - i_T \cdot R = 0 \to V_1 - V_C - i_L \cdot R - i_C R = 0 \to V_1 - V_C - \int \frac{V_C}{L} \cdot R - \frac{dV_C}{dt} C R = 0$

$\frac{d^2V_C}{dt} + \frac{dV_C}{dt}\frac{1}{RC} + \frac{V_C}{LRC} = \frac{V_1}{RC} \to \frac{d^2V_C}{dt} + 20\frac{dV_C}{dt} + 500\,V_C = \frac{d[200\cos(10t)]}{dt}$

$S_1 = -10 + j20$
$S_2 = -10 - j20$ } RCC

Sol general $V_C(t) = e^{+10t}\left(A_1\cos(20t) + A_2\,\text{sen}(20t)\right) + Rf$

Rta forzada $V_C(t) = [D\cos(10t) + E\,\text{sen}(10t)]$

$V_C(t)' = -10D\,\text{sen}(10t) + 10E\cos(10t)$

$V_C(t)'' = -100D\cos(10t) - 100E\,\text{sen}(10t)$

$[-100D\cos(10t) - 100E\,\text{sen}(10t)] + 200[-D\,\text{sen}(10t) + E\cos(10t)] + 500[D\cos(10t) + E\,\text{sen}(10t)] = -200.10\,\text{sen}(10t)$

$t=0$

$-100D + 200E + 500D = 0 \to D = \frac{-200}{400}E = -\frac{1}{2}E$

$t=90$

$-100E - 200D + 500E = -2000 \to +400E - 200\left(-\frac{1}{2}E\right) = -2000 \to 400E + 100E = 2000$

$E = \frac{2000}{500} = 4 \to$ $E = 4$, $D = -2$

Sol general $V_C(t) = e^{10t}\left(A_1\cos(20t) + A_2\,\text{sen}(20t)\right) - 2\cos(10t) + 4\,\text{sen}(10t)$

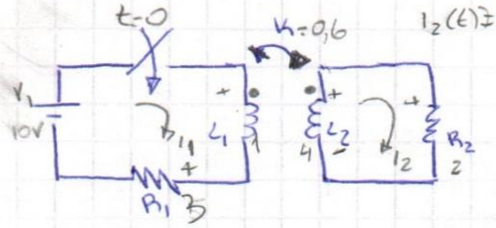
$V_C(0) = A_1 - 2 = 0 \to A_1 = 2$

$V_C(0)' = 10e^{10t}\left(A_1\cos(20t) + A_2\,\text{sen}(20t)\right) + e^{10t}\left(-20A_1\,\text{sen}(20t) + 20A_2\cos(20t)\right) + 20\,\text{sen}(10t) + 40\cos(10t)$

$= 10 \cdot A_1 + 20A_2 + 40 = 0 \to 20 + 20A_2 + 40 = 0 \to A_2 = \frac{-60}{20} = -3$

$\boxed{\text{Sol particular } V_C(t) = e^{10t}\left(2\cos(20t) - 3\,\text{sen}(20t)\right) - 2\cos(10t) + 4\,\text{sen}(10t)}$

35)



$I_2(t) = ?$

$t<0$ $\qquad I_2(0)=0$

$t>0$

$$V_1-(V_{L_1}-V_{m_1})-V_{R_1}=0 \qquad m=k\sqrt{L_1L_2}=1,2$$

$$+(V_{L_2}-V_m)-V_{R_2}=0$$

$$V_{L_2}-V_{R_2}=0$$
$$-L_2\, dI_2$$

$$L_1\frac{dI_1}{dt}+m\frac{dI_2}{dt}+I_1R_1=V_1$$

$$+L_2\frac{dI_2}{dt}-m\frac{dI_1}{dt}-I_2R_2=0 \rightarrow \frac{dI_1}{dt}=\frac{L_2\,dI_2}{m\,dt}-\frac{R_2}{m}I_2$$

$$\therefore \frac{d}{dt}\left(\frac{L_1L_2}{m}\frac{dI_2}{dt}-\frac{L_1R_2}{m}I_2-m\frac{dI_2}{dt}+I_1R_1\right)=\frac{dV_1}{dt}$$

$$\frac{L_1L_2}{m}\frac{d^2I_2}{dt}-\frac{L_1R_2}{m}\frac{dI_2}{dt}-m\frac{d^2I_2}{dt}+\frac{dI_1}{dt}\cdot R_1=\frac{dV_1}{dt}$$

$$\left(\frac{L_1L_2}{m}-m\right)\frac{d^2I_2}{dt}-\frac{L_1R_2}{m}\frac{dI_2}{dt}+\frac{R_1L_2}{m}\frac{dI_2}{dt}-\frac{R_1R_2}{m}I_2=\cancelto{0}{\frac{dV_1}{dt}}$$

$$\left(\frac{L_1L_2}{m}-m\right)\frac{d^2I_2}{dt}+\left(-\frac{L_1R_2}{m}+\frac{R_1L_2}{m}\right)\frac{dI_2}{dt}-\left(\frac{R_1R_2}{m}\right)I_2=0$$

$$\left(m-\frac{L_1L_2}{m}\right)\frac{d^2I_2}{dt}+\left(\frac{L_1R_2}{m}-\frac{L_2R_1}{m}\right)\frac{dI_2}{dt}+\left(\frac{R_1R_2}{m}\right)I_2=0$$

$$\frac{d^2I_2}{dt}+\frac{\left(\frac{L_1R_2}{m}-\frac{L_2R_1}{m}\right)}{m-\frac{L_1L_2}{m}}\frac{dI_2}{dt}+\frac{\frac{R_1R_2}{m}}{m-\frac{L_1L_2}{m}}I_2=0 \rightarrow \frac{d^2I_2}{dt}+3,9\frac{dI_2}{dt}-2,34I_2=0$$

$S_1=0,52$

$S_2=-4,42$

$\frac{N}{0} = \infty \quad \frac{N}{\infty} = 0 \quad \frac{\infty}{N} = \infty \quad \frac{0}{\infty} = 0 \quad N\infty = \infty$

HOJA N°

FECHA

Capitulo 4: Laplace

TVI: $\lim_{s \to \infty} sF(s) = f(0)$ encuentro CI

TVF: $\lim_{s \to 0} sF(s) = f(\infty)$ encuentro regimen permanente

Tiempo	Laplace
$\delta(t)$	1
$u(t)$	$1/s$
t	$1/s^2$
e^{-at}	$1/(s+a)$
$sen(\omega t)$	$\omega/(s^2+\omega^2)$
$cos(\omega t)$	$s/(s^2+\omega^2)$
te^{-at}	$1/(s+a)^2$
$e^{-at} sen(\omega t)$	$\omega/[(s+a)^2+\omega^2]$
$e^{-at} cos(\omega t$	$(s+a)/[(s+a)^2+\omega^2]$

} Rta natural

$$sen(\omega t+\varphi) \xrightarrow{\mathcal{L}} \frac{\omega\cos\varphi}{s^2+\omega^2} + s\cdot\frac{sen\varphi}{s^2+\omega^2}$$

Inductor

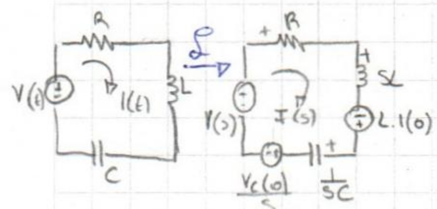
$$V_L = L\frac{di_L(t)}{dt}$$

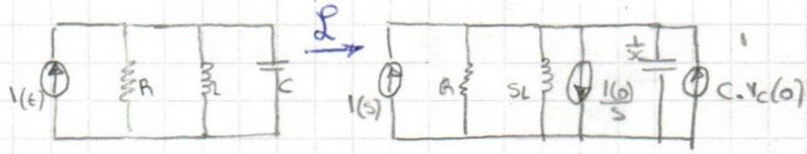
$$\begin{cases} V_L(s) = sL\, I_L(s) - L\, I_L(0) \\ I_L(s) = \frac{1}{sL} V_L(s) + \frac{1}{s} I_L(0) \end{cases}$$

Capacitor

$$i_C = C\frac{dV_C}{dt}(t)$$

$$\begin{cases} I_C(s) = Cs\, V_C(s) - C\, V_C(0) \\ V_C(s) = \frac{1}{sC} I_C(s) + \frac{1}{s} V_C(0) \end{cases}$$





p/ sist 1er Orden hago expanciones simple
2do " " matrices y si es necesario hago expanciones simples

NOTA

$q = C.V$

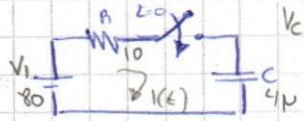
HOJA N°

FECHA

6) No homogenea (con fuente dc)

$R_t = N + R_f$

1^er Orden

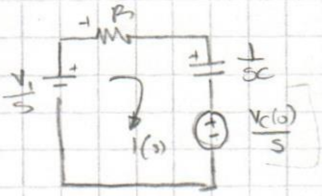


$V_c(t) = ?$

$t<0$

$$V = \frac{q}{C} = \frac{800\,\mu}{4\mu} = 200 \rightarrow \boxed{V_c(0) = 200\,v}$$

$t>0$



$$V_1 - V_{R_1} - V_c = 0 \rightarrow V_1 - iR - V_c = 0 \rightarrow V_1 - \frac{dV_c}{dt}CR - V_c = 0$$

$$\frac{V_1}{s} - V_c(s).sCR + V_c(0)CR - V_c(s) = 0$$

$$V_c(s)(sCR+1) = +V_c(0)CR + V_1/s$$

$$V_c(s) = \frac{V_c(0)CR + V_1/s}{(sCR+1)} = \frac{V_c(0)CR}{sCR+1} + \frac{V_1}{s(sCR+1)} = \frac{200}{s+25000} + \frac{2.10^6}{s(s+25000)}$$

$$V_c(s) = \frac{200}{s+25000} + \frac{A}{s} + \frac{B}{s+25000}$$

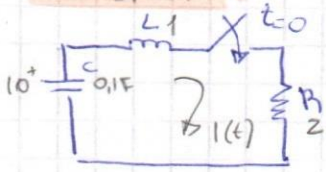
$$A \rightarrow \lim_{s\to 0} \cancel{s}\,\frac{2.10^6}{\cancel{s}(s+25000)} = 80$$

$$B \rightarrow \lim_{s\to -25000} \cancel{(s+25000)}\,\frac{2.10^6}{s\,\cancel{(s+25000)}} = -80$$

$$V_c(s) = \frac{200}{s+25000} + \frac{80}{s} - \frac{80}{s+25000} \xrightarrow{\mathcal{L}^{-1}} \boxed{V_c(t) = 200e^{-25000t} + 80u(t) - 80e^{-25000t}}$$

NOTA

11) homogenea (sin fuente)
Rta. natural
2do orden



$V_c(t) = ?$
$I_L(t) = ?$

$t<0$

$V_c(0) = 10$
$I_L(0) = 0$

$V_{V_c} \int \frac{I_L}{C}$

$I_L = \frac{dV_c}{dt} \cdot C = V_c(s)C - V_c(0) \cdot C$
$- V_c(s) Cs + I_L(s) = -V_c(0) \cdot C$

$t>0$

$V_c - V_L - V_R = 0 \rightarrow V_c - L \cdot \frac{dI_L}{dt} - I_L R = 0$

$V_c(s) - L\, I_L(s) \cdot s + L\, I_L(0) - I_L(s) \cdot R \rightarrow V_c(s) - I_L(s)(Ls+R) + I_L(0)(L) = 0$

$V_c(s) = I_L(s)(Ls+R) + I_L(0) L$

$$\begin{cases} I_L(s)\,(Ls+R) - V_c(s) = I_L(0) L \\ I_L(s) - V_c(s)(Cs) = -V_c(0) \cdot C \end{cases}$$

$$\begin{bmatrix} Ls+R & -1 \\ 1 & -Cs \end{bmatrix} \begin{bmatrix} I_L(s) \\ V_c(s) \end{bmatrix} = \begin{bmatrix} \overset{=0}{\cancel{I_L(0) \cdot L}} \\ -V_c(0) \cdot C \end{bmatrix} \rightarrow \begin{bmatrix} s+2 & -1 \\ 1 & -0{,}1s \end{bmatrix} \begin{bmatrix} I_L(s) \\ V_c(s) \end{bmatrix} = \begin{bmatrix} 0 \\ -1 \end{bmatrix}$$

$$I_L(s) = \frac{\Delta s}{\Delta z} = \frac{\begin{vmatrix} 0 & -1 \\ -1 & -0{,}1s \end{vmatrix}}{(s+2)(-0{,}1s) - (-1)} = \frac{-(1)}{-0{,}1s^2 - 0{,}2s + 1} = \frac{1}{s^2 + 2s - 10} = \frac{A}{s-2{,}31} + \frac{B}{s+4{,}31}$$

$s_1 = 2{,}31$
$s_2 = -4{,}31$

$$A \rightarrow \lim_{s \to 2{,}31} \cancel{(s-2{,}31)} \frac{1}{\cancel{(s-2{,}31)}(s+4{,}31)} = 0{,}15$$

$$B \rightarrow \lim_{s \to -4{,}31} \cancel{(s+4{,}31)} \frac{1}{(s-2{,}31)\cancel{(s+4{,}31)}} = -0{,}15$$

$$I_L(s) = \frac{+0{,}15}{(s-2{,}31)} - \frac{0{,}15}{(s+4{,}31)} \xrightarrow{\mathcal{L}^{-1}} \boxed{I_L(t)\ +0{,}15\, e^{+2{,}31t} - 0{,}15\, e^{-4{,}31t}}$$

$\boxed{\text{RRD} \rightarrow \text{sobre amortiguado}}$

$$V_c(s) = \frac{\Delta s_2}{\Delta z} = \frac{\begin{bmatrix} s+2 & 0 \\ 1 & -1 \end{bmatrix}}{s^2+2s-10} = \frac{-s-2}{s^2+2s-10} = \frac{A}{s-2{,}31} + \frac{B}{s+4{,}31}$$

$$A \rightarrow \lim_{s \to 2{,}31} \cancel{(s-2{,}31)} \frac{(-s-2)}{\cancel{(s-2{,}31)}(s+4{,}31)} = -0{,}65$$

$$B \rightarrow \lim_{s \to -4{,}31} \cancel{(s+4{,}31)} \frac{(-s-2)}{(s-2{,}31)\cancel{(s+4{,}31)}} = -0{,}34$$

$$V_c(s) = \frac{-0{,}65}{s-2{,}31} - \frac{0{,}34}{s+4{,}31} \xrightarrow{\mathcal{L}^{-1}} \boxed{V_c(t) = -0{,}65\, e^{+2{,}31t} - 0{,}34\, e^{-4{,}31t}}$$

TVI $\lim_{s \to \infty} s \cdot F(s) = f(0) \quad \therefore \quad \lim_{s \to \infty} s \cdot I_L(s) = s \cdot \frac{0{,}15}{s-2{,}31} - \frac{0{,}15}{s+4{,}31} = \text{indefinido}$

TVF $\lim_{s \to 0} s\, F(s) = f(\infty) \qquad \lim_{s \to 0} s\, I_L(s) = 0$

Si en f_p dice adelanto
el φ es (-) x eso
a' al calcularlo da (+)

$Z_L = j\omega L$

$Z_C = \frac{-j}{\omega C}$

HOJA N°

FECHA

Capítulo 5: Método fasorial

$v = V_m \cdot \text{sen}(\omega t + \alpha) \rightarrow V = \frac{V_m}{\sqrt{2}} \angle \alpha$

Permite obtener en forma directa la rta forzada cuando la exc. una seno

$I_T = \frac{V_T}{Z} = \frac{\angle\theta}{\angle\varphi} = \theta - \varphi$

$\begin{cases} \varphi > 0 & I \text{ atrasa} \\ \varphi < 0 & I \text{ adelanta} \end{cases}$

$V_f = V_m \text{ sen } \omega t$

$V_m \cdot \text{sen}(\omega t + 30) = V_m \cos(\omega t - 60)$

Superposición: si en las fuentes frec = en todas $\rightarrow$ se puede usar superposición
frec ≠ " " (distintas) " debe " "

(calculo rta fasorial a c/ fuente y despues lo paso a tiempo y Σ)

Impedancia y admitancia

$Z \begin{cases} Z = |Z| \angle\theta & \text{polar} \\ Z = Z e^{j\theta} & \text{exponencial} \\ Z = R + jX & \text{rectangular} \end{cases}$

X ↳ reactiva

R ↳ Resistiva

$X > 0$ $\begin{cases} \text{reactancia inductiva} \\ \text{impedancia "} \end{cases}$

$X < 0$ $\begin{cases} \text{Reactancia capacitiva} \\ \text{Impedancia "} \end{cases}$

$Y \begin{cases} Y = \frac{1}{Z} \text{ [siemens]} \\ Y = \frac{1}{|Z| \angle\theta} = |Y| \angle -\theta \\ Y = \frac{1}{R + jX} = \frac{1}{R + jX} \cdot \frac{R - jX}{R - jX} = \frac{R - jX}{R^2 + X^2} = \frac{R}{R^2 + X^2} - \frac{jX}{R^2 + X^2} = G + jB \end{cases}$

G ↳ conductancia

B ↳ susceptancia

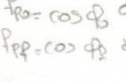
$B > 0$ susceptancia capacitiva

$B < 0$ susceptancia inductiva

Potencia

$P_{(t)} = V.I . \cos\varphi - VI \cos(2\omega t - \varphi)$ [valor eficaz]

Circuito Resistivo Puro	Circ. inductivo Puro	Circ. capacitivo puro
$Z = R$	$Z = j\omega L$	$Z = -j/\omega C$
$\varphi = 0$	$\varphi = 90$	$\varphi = -90$
$P(t) = V.I - V.I \cos(2\omega t)$	$P(t) = -V.I \cos(2\omega t - 90)$	$P(t) = -V.I \cos(2\omega t + 90)$
	$= -V.I \text{ sen}(2\omega t)$	$= V.I \text{ sen}(2\omega t)$
$P_m(t) = V.I$	$P_m(t) = 0$	$P_m(t) = 0$



Pot Activa $\rightarrow$ $P = (I_R)^2 |Z| . \cos\varphi = |V| |I| \cos\varphi$ [W] elemento resistivo

Pot Reactiva $\rightarrow$ $Q = (I_X)^2 |Z| \text{ sen}\varphi = |V| |I| \text{ sen}\varphi$ [VAR] " inductivo o capacitivo

Pot Aparente $\rightarrow$ $S = |V| . |I| = \sqrt{P^2 + Q^2}$ [VA]

Factor de Potencia $f_p = \frac{P}{S} = \cos\varphi$

Pot. compleja $S = \bar{V} . I^*$

$f_{p_0} = \cos\varphi_0$ actual

$f_{pf} = \cos\varphi_f$ deseada

Corrección del factor de potencia $\uparrow f_p$ $\downarrow$ Perdidas $\uparrow$ Rendimiento ($P \rightarrow$ Pot activa = cte)

carga capacitiva $\rightarrow$ $Q_c = Q_0 - Q_f \rightarrow V . I_0 \text{ sen}(\varphi_0) - V . I_f \text{ sen}(\varphi_f) = V . I_0 \cos(\varphi_0) Tg(\varphi_0) - V I_f \cos(\varphi_f) tg(\varphi_f)$

$Q_c = P(Tg\varphi_0 - Tg\varphi_f)$ $\qquad Q_c = C . \omega V^2$

NOTA

Valor del capacitor p/ la corrección $\rightarrow$ $C = \frac{P(Tg\varphi_0 - Tg\varphi_f)}{V^2 . \omega}$

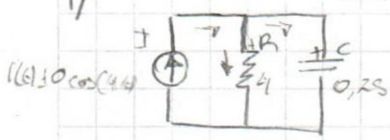
NOTA

HOJA Nº

FECHA

$\omega = 4$

1) $V_C(t) = ?$

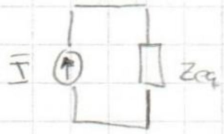


$Z_R = 4$

$Z_C = \frac{-j}{\omega C} = -j$

$\bar{I} = \frac{10}{\sqrt{2}} \angle 0$

$Z_{eq} = 0{,}23 - 0{,}94j = 0{,}97 \angle -75{,}9$

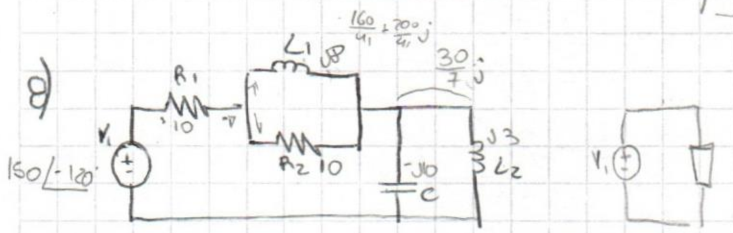


$V_{Z_{eq}} = \bar{I} \cdot Z_{eq} = \frac{10}{\sqrt{2}} \angle 0 \, (0{,}23 - 0{,}94j) = 1{,}66 - 6{,}65j$

$\boxed{\bar{V}_C = 6{,}85 \angle -75{,}96}$

$\boxed{V_C(t) = \sqrt{2} \cdot 6{,}85 \cos(4t - 75{,}96)}$

2)



$Z_{eq} = \frac{570}{41} + \frac{2630}{287} j$

$= 16{,}65 \angle 33{,}39$

$\bar{I} = \frac{\bar{V}_1}{Z_{eq}} = \frac{150 \angle -120}{16{,}65 \angle 33{,}39} = 9 \angle -153{,}39$

$\boxed{\bar{I}_{R_1} = \bar{I} = 9 \angle -153{,}39}$

$\boxed{\bar{V}_{R_1} = 90 \angle -153{,}39}$

$(V_{R_2} = V_{L_1})$

$\bar{V}_{R_2} = \bar{I} \cdot Z_{//} = 9 \angle -153{,}39 \cdot \left(\frac{160}{41} + \frac{200}{41} j\right) = 55{,}75 \angle -101{,}37 \rightarrow \boxed{\bar{V}_{R_2} = \bar{V}_{L_1} = 55{,}75 \angle -101{,}37}$

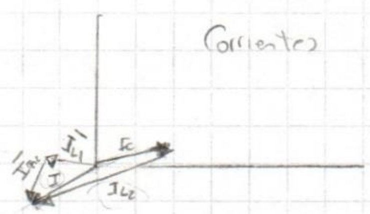
$\bar{V}_C = \bar{I} \, Z_{//} = 9 \angle -153{,}39 \cdot \left(\frac{30}{7} j\right) = 38{,}57 \angle -63{,}39 \rightarrow \boxed{\bar{V}_C = \bar{V}_{L_2} = 38{,}57 \angle -63{,}39}$

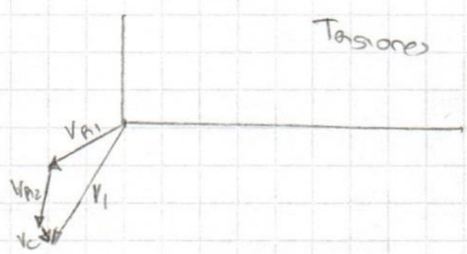
$\bar{I}_{L_1} = \frac{V_{L_1}}{Z_{L_1}} = \frac{55{,}75 \angle -101{,}37}{j8} = 6{,}96 \angle 168{,}7 \rightarrow \boxed{\bar{I}_{L_1} = 6{,}96 \angle 168{,}7}$

$\bar{I}_{R_2} = \frac{\bar{V}_{R_2}}{Z_{R_2}} = \frac{55{,}75 \angle -101{,}37}{10} = 5{,}57 \angle -101{,}37 \rightarrow \boxed{\bar{I}_{R_2} = 5{,}57 \angle -101{,}37}$

$\bar{I}_C = \frac{\bar{V}_C}{Z_C} = \frac{38{,}57 \angle -63{,}39}{-j10} = 3{,}85 \angle 26{,}61 \rightarrow \boxed{\bar{I}_C = 3{,}85 \angle 26{,}61}$

$\bar{I}_{L_2} = \frac{\bar{V}_L}{Z_L} = \frac{38{,}57 \angle -63{,}39}{j3} = 12{,}85 \angle -153{,}39 \rightarrow \boxed{\bar{I}_{L_2} = 12{,}85 \angle -153{,}39}$

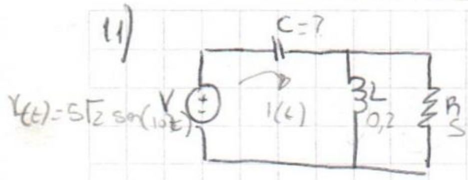




NOTA

I con atraso 30

11)



$\bar{I} = \frac{\hat{I}}{\sqrt{2}} \angle 30$

$\bar{V} = 5 \angle 0$

$\omega = 10$

$Z_R = 5$

$Z_C = \frac{-j}{\omega C}$

$Z_L = j\omega L = 2j$

$Z_p = 1,85 \angle 68,19 = 0,689 + j1,72$

$Z_{eq} = 0,689 + j1,72 - \left(\frac{j}{10C}\right)$

$Z_{eq} = 0,689 + j\left(1,72 - \frac{1}{10C}\right)$

$\bar{V} = \bar{I}\, Z_{eq} \rightarrow \bar{Z}_{eq} = \frac{\bar{V} \angle 0}{\bar{I} \angle -30} = Z_{eq} \angle 30 \rightarrow \varphi = 30$

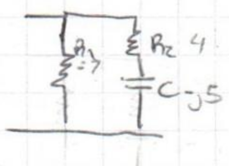
$\varphi = tg^{-1} \frac{1,72 - 1/10C}{0,687} \rightarrow tg\,\varphi \cdot 0,687 - 1,72 = -\frac{1}{10C}$

$C = \frac{-1}{10\left[(tg(30)\ 0,687) - 1,72\right]} = 0,0754 \rightarrow \boxed{C = 75,4\ mF} \quad \therefore\ Z_{eq} = 0,79 \angle 29,74$

$\bar{I} = \frac{5 \angle 0}{0,79 \angle 29,74} = 6,30 \angle -30 \rightarrow \boxed{\bar{I} = 6,3 \angle -30}$

V

15) FActor de Potencia Adelanto



$f_p = 0,891$

$f_p = \frac{P}{S} = \cos(\varphi)$

$P = |V|\,|I| \cos\varphi$

$S = |V|\,|I|$

$Z = \hat{Z} \angle -27$

$I = \hat{I} \angle -27$

$V = \hat{V} \angle 0$

$-51,3 + 27 = -2$

$\varphi = \cos^{-1}(0,891) = 27$

$Z_{eq} = \frac{R_1 (4 - j5)}{(R_1 + 4) - j5} = \frac{\hat{R}_1 \angle 0 \cdot 6,4 \angle -51,3}{\sqrt{(R_1+4)^2 + (-5)^2}\ tg^{-1}\left(\frac{-5}{R_1+4}\right)}$

$(-24) = tg^{-1}\left(\frac{-5}{R_1+4}\right) \rightarrow Tg(-24) = \frac{-5}{R_1+4} \rightarrow (R_1+4) = \frac{-5}{Tg(-24)} \rightarrow R_1 = \frac{-5}{tg(-24)} - 4 = 7,0$

$\boxed{R_1 = 7,05}$

$-51 - x = (-27)$

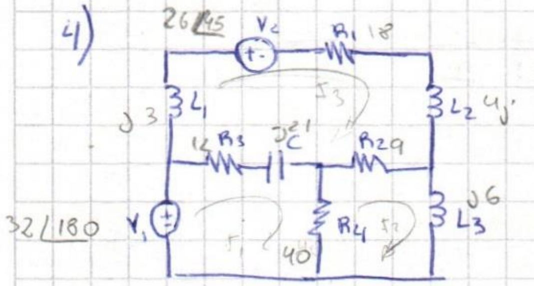
HOJA N°

FECHA

Capítulo 6: Resolución sistemática de circuitos (nudos / mallas)

Método de las I en las mallas [Z]

4)



$$\begin{cases} Z_{11} = Z_{R3} + Z_{C1} + Z_{R4} \\ Z_{22} = Z_{R4} + Z_{R2} + Z_{L3} \\ Z_{33} = Z_{L1} + Z_{R1} + Z_{L2} + Z_{R2} + Z_C + Z_{R3} \end{cases}$$

$Z_{12} = -Z_{R4}$

$Z_{13} = -(Z_{R3} + Z_C)$

$Z_{23} = -(Z_{R2})$

$$\begin{bmatrix} 52 - j21 & -40 & -12 + j21 \\ -40 & 49 + j6 & -9 \\ -12 + j21 & -9 & 39 - 14j \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 32\angle 180 \\ 0 \\ -26\angle 45 \end{bmatrix}$$

$$\Delta S = \begin{matrix} 52 - j21 & -40 & -12 + j21 \\ -40 & 49 + j6 & -9 \\ -12 + j21 & -9 & 39 - 14j \\ 52 - j21 & -40 & -12 + j21 \\ -40 & 49 + j6 & -9 \end{matrix}$$

$= [(94298 - 65399j) + (-4320 + j7560) + (-4320 + 7560j)]$

$- [(-11529 - 26478j) + (4212 - 1701j) + (62400 - 22400j)]$

$= 30525 + 300j$

$$\Delta S_1 = \begin{matrix} -32 & -40 & -12 + j21 \\ 0 & 49 + j6 & -9 \\ -18,38 - 18,38j & -9 & 39 - 14j \\ -32 & -40 & -12 + j21 \\ 0 & +49 + j6 & -9 \end{matrix}$$

$= [(-63840 + 14464j) + (0) + (-6616,8 - 6616,8j)]$

$- [(30712,98 - 4466,34j) + (-2592) + 0 =$

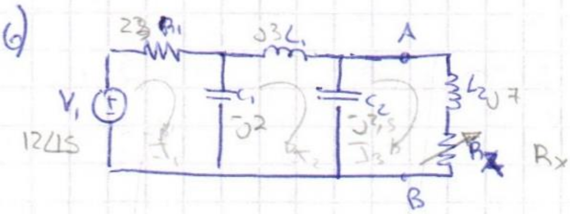
$= -98577,78 + 12313,54j$

$$\boxed{I_1 = -3,23 + j0431 = 3,25 \angle 172,32}$$

NOTA

Impedancia de entrada

6)



$$\frac{|V_1| \angle 15}{|1| \angle 15} = |21|\angle 0$$

$$\begin{cases} Z_{11} = Z_{R_1} + Z_{C_1} = \\ Z_{22} = Z_{C_1} + Z_{L_1} + Z_{C_2} = \\ Z_{33} = Z_{C_2} + Z_{L_2} + Z_{R_X} = \end{cases} \qquad \begin{cases} Z_{12} = -Z_{C_1} \\ Z_{13} = 0 \\ Z_{23} = -Z_{C_2} \end{cases}$$

$$\begin{bmatrix} 23 - j2 & +j2 & 0 \\ +j2 & -1{,}5j & j2{,}5 \\ 0 & -j2{,}5 & R_x + 4{,}5j \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 11{,}59 + 3{,}1j \\ 0 \\ 0 \end{bmatrix}$$

$$\Delta S = \begin{vmatrix} 23 - j2 & +j2 & 0 \\ j2 & -1{,}5j & +2{,}5j \\ 0 & 2{,}5j & R_x + 4{,}5j \\ 23 - j2 & j2 & 0 \\ j2 & -1{,}5j & 2{,}5j \end{vmatrix} = \left[(-3 - 34{,}5j)(R_x + 4{,}5j) + 0 + 0\right] - \left[0 + (-143{,}75 + 12{,}5j) + (-4)(R_x + 4{,}5j)\right]$$

$$= -3R_x - 13{,}5j - 34{,}5jR_x + 155{,}25 + 143{,}75 - 12{,}5j - (-4R_x - 18j)$$

$$= -3R_x - 26j - 34{,}5R_xj + 299 + 4R_x + 18j =$$

$$= 299 + R_x - 8j - 34{,}5R_xj = (299 + R_x) - j(8 + 34{,}5R_x)$$

$\Delta_{11} \rightarrow$

$$\begin{vmatrix} V_1 & j2 & 0 \\ 0 & -1{,}5j & 2{,}5j \\ 0 & 2{,}5j & R_x + 4{,}5j \end{vmatrix} = \boxed{I_1 = \frac{V_1 \cdot \Delta_{11}}{\Delta z}}$$

$$\Delta_{11} = -1{,}5jR_x + 6{,}75 - (-6{,}25)$$

$$= -1{,}5jR_x + 13$$

$$Z_{ent} = \frac{\Delta_{11}}{\Delta z} = \frac{13 - 1{,}5jR_x}{(299 + R_x) - j(8 + 34{,}5R_x)} =$$

$$\cancel{Ij}\left(\frac{-1{,}5R_x}{13}\right) = \cancel{Ij}\left(\frac{-8 - 34{,}5R_x}{299 + R_x}\right) \rightarrow (-1{,}5R_x)(299 + R_x) = 13(-8 - 34{,}5R_x)$$

$$-\cancel{448{,}5}R_x - 1{,}5R_x^2 = -108 - \cancel{448{,}5}R_x \rightarrow 1{,}5R_x^2 - 108 = 0$$

$S_1 = 8{,}48$
$S_2 = -8{,}48$

$$\boxed{\therefore R_x = 8{,}48}$$

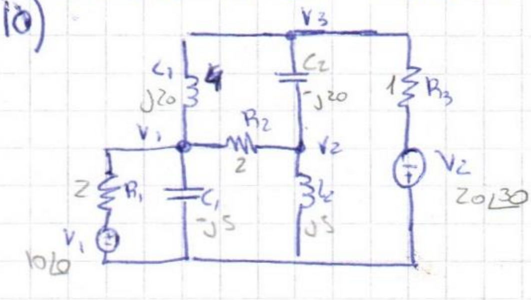
NOTA:

Impedancia de transferencia

$$Z_{Trasf} = \frac{V_1}{I_3} = \frac{\Delta Z}{\Delta_{13}}$$

Metodo de las Tensiones en los nudos

10)



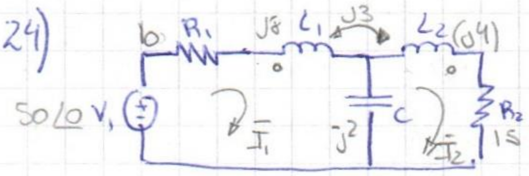
$$\begin{cases} Y_{11} = \dfrac{1}{R_1} + \dfrac{1}{C_1} + \dfrac{1}{L_1} + \dfrac{1}{R_2} \\ Y_{22} = \dfrac{1}{R_2} + \dfrac{1}{C2} + \dfrac{1}{L_2} \\ Y_{33} = \dfrac{1}{L_1} + \dfrac{1}{C_2} + \dfrac{1}{R_3} \end{cases} \qquad \begin{cases} Y_{12} = -\dfrac{1}{R_2} \\ Y_{13} = -\dfrac{1}{L_1} \\ Y_{23} = -\dfrac{1}{C_2} \end{cases}$$

$$I_1 = \frac{V_1}{R_1} = \frac{10\angle 0}{2} = 5$$

$$-I_3 = \left(\frac{V_2}{R_3}\right) = \frac{20\angle 30}{1} = -(17{,}32 + j10)$$

$$\begin{bmatrix} 1+0{,}15j & -0{,}5 & 0{,}05j \\ -0{,}5 & 0{,}5-0{,}15j & -0{,}05j \\ 0{,}05j & -0{,}05j & 1 \end{bmatrix} \begin{bmatrix} \bar V_1 \\ \bar V_2 \\ \bar V_3 \end{bmatrix} = \begin{bmatrix} 2 \\ 0 \\ -17{,}32 - j10 \end{bmatrix}$$

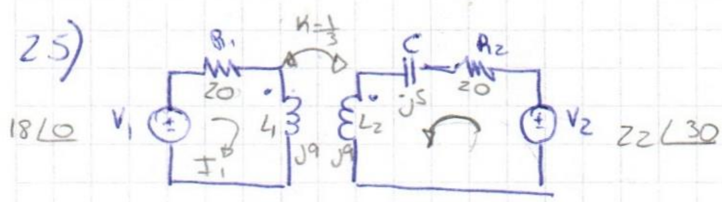
24)



$$\begin{cases} Z_{11} = Z_{R_1} + Z_{L_1} + Z_C \\ Z_{22} = Z_C + Z_{L2} + Z_{R_2} \end{cases} \qquad Z_{12} = \overbrace{-Z_C}^{\text{debido a la } I} \underbrace{- Z_m}_{}$$

xq' entra y sale por un punto homologo

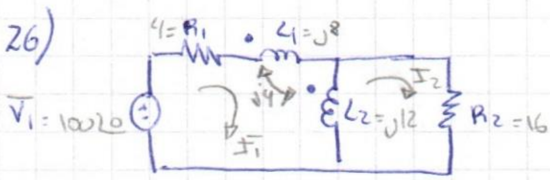
25)



$$m = K\sqrt{L_1 L_2} = 3j$$

$$\begin{cases} Z_{11} = Z_{R_1} + Z_{L_1} \\ Z_{22} = Z_{L_2} + Z_C + Z_{R_2} \end{cases} \qquad \begin{cases} Z_{12} = 3j \end{cases}$$

26)



$$\begin{cases} Z_{11} = Z_{R_1} + Z_{L_1} + Z_{L2} + 2Z_m \\ Z_{22} = Z_{L2} + Z_{R_2} \end{cases} \qquad \begin{cases} Z_{12} = (-Z_{L2}) \end{cases}$$

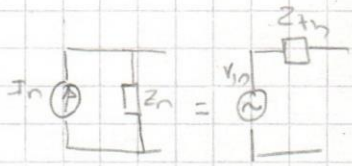
NOTA:

Capítulo 7: Teoremas circuitales

otra forma: pasivo las fuentes y calculo Z_{eq} en AB

teorema de thevenin

$$Z_{th} = \frac{V_{AB}|_{CA}}{I_{AB}|_{cc}} \qquad V_{th} = V_{AB}|_{CA}$$



teorema de norton

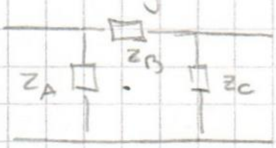
$$Z_n = Z_{th} = \frac{1}{Y_n} \qquad I_n = I_{AB}|_{cc}$$

$V_{th} = I_n \cdot Z_n$

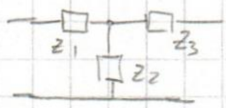
Redes triangulo y estrella

Δ Y

Triangulo



Estrella



Conversión $Y \to \Delta$

$$Z_A = \frac{Z_1 Z_2 + Z_2 Z_3 + Z_3 Z_1}{Z_3}$$
$$Z_B = \frac{''}{Z_2}$$
$$Z_C = \frac{''}{Z_1}$$

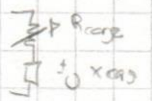
Conversión $\Delta \to Y$

$$Z_1 = \frac{Z_A Z_B}{Z_A + Z_B + Z_C}$$
$$Z_2 = \frac{Z_A Z_C}{''}$$
$$Z_3 = \frac{Z_B Z_C}{''}$$

teorema de max transferencia de potencia

R_v = Rvariable
X_f = R_{fija}

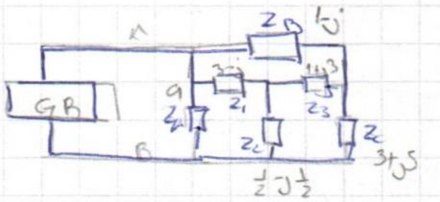
Casos	Descripción	Cálculo
Carga generica	$R_v \pm j X_v$	$Z_{carga} = Z_{th}^* \rightarrow$ Generador
Resist. variable	$R_v \pm j X_f$	$Z_{carga} = \lvert Z_{th} + j X_{carga} \rvert$ → ↳ $= Z_{th} = Z_0$
Reactancia Variable	$R_f \pm j X_v$	$jX_{carga} = -j X_{th}$
Resist. Pura	$R_v \pm j X = 0$	$Z_{carga} = \lvert Z_0 \rvert$



NOTA

Conversión $\Delta \to Y$

10) $P = 8653,8\,W$



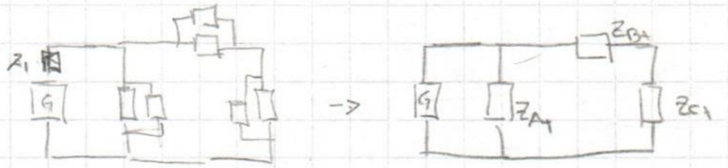
Conv $Y \to \Delta$

$$Z_A = \frac{z_1 \cdot z_2 + z_1 \cdot z_3 + z_3 \cdot z_2}{z_3} = \frac{(1-2j) + (6+8j) + (2+j)}{1+j3} = \frac{9+7j}{1+j3}$$

$$= 3-2j$$

$$Z_B = \frac{''}{z_2} = 2+16j$$

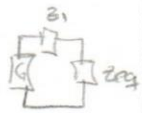
$$Z_C = \frac{''}{z_1} = 2+3j$$



$Z_{A_1} = 2{,}43 - 1{,}09j$

$Z_{B_1} = 1{,}12 - 0{,}97j$

$Z_C = 1{,}2 + 1{,}87j$



$Z_{eq} = 1{,}18 - 0{,}49j$
$= 1{,}28 \angle -22$

$Z_1 = Z_{eq}^* \Rightarrow 1{,}18 + 0{,}49j$

$\frac{V}{I} = \varphi_V - \varphi_I$

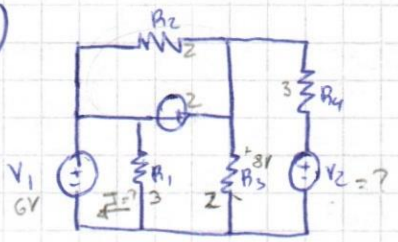
$Z\frac{V}{I} = \varphi_V - 0$

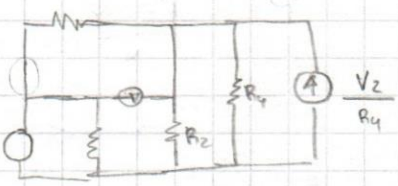
$$|I| = \sqrt{\frac{P}{Re[Z_{eq}]}} = 85{,}63\,A$$

$V_{th} = I\,(Z_1 + Z_{eq}) = 202\,V$

Norton y Thevenin

12)

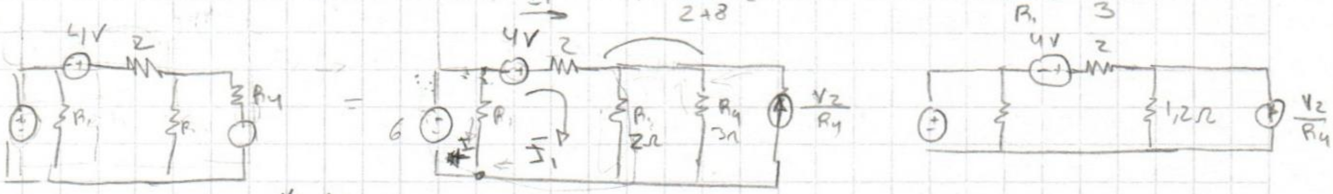




$V = I R$

$I_1 = \frac{6+4}{2+8} = 1$

$I = \frac{V_1}{R_1} = \frac{6}{3} = 2A$



$V = I\,R$

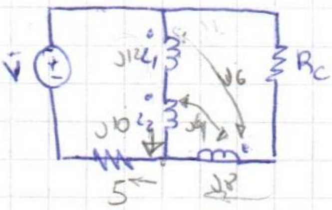
$6 + 4 - 2 - 1{,}2 - \frac{V_2}{3} \cdot 1{,}2 = 0$

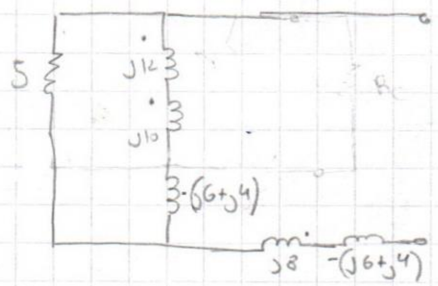
$V_2 = \frac{6{,}8 \cdot 3}{1{,}2} = 17$

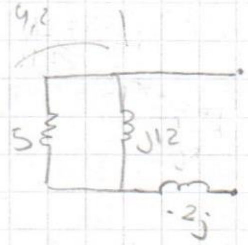
$\boxed{V_2 = 17V}$

$\boxed{I = 2A}$

15) $R_c = ?$ max Tx pot







$Z_{eq} = 4{,}26 - 0{,}224j$

$4{,}26 \angle -3{,}02$

$\boxed{R_c = |Z_{eq}| = 4{,}26}$

NOTA

Resonancia $\left\{ C, L \text{ varia} \quad Img\{1/R_{eq}\} < \frac{1}{2 R_{variable}} \right.$

Capítulo 8 Resonancia

$$\omega_0 = \frac{1}{\sqrt{LC}} = \sqrt{\omega_1 \cdot \omega_2} = 2\pi f_0 \qquad [rad/s]$$

$$AB : \frac{R}{L} = \omega_2 - \omega_1 \quad [rad/s] \qquad \omega_{1/2} = \left| \frac{-R}{2L} \pm \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}} \right|$$

$\omega_{1/2}$ → a Pot máx

Factor de sobretensión P/circ serie

$$Q_0 = \frac{\omega_0 L}{R} = \frac{1}{\omega_0 \cdot R \cdot C} = \frac{\omega_0}{AB} = \frac{Q}{P}$$

Q → Pot reactiva; P → Pot Activa

$Q_0 < 1$ no hay sobretensión

$Q_0 > 1$ si " "

$$R_C = \sqrt{2\frac{L}{C}} > R \quad \text{hay sobretensión}$$

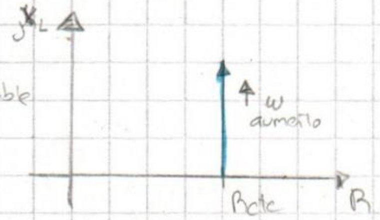
serie $\left\{ Q_0 = \frac{V_L}{V_T} \right.$ $\qquad AB = \frac{\omega_0}{Q_0}$

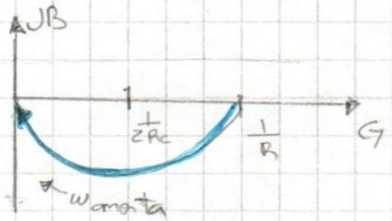
P/circ Paralelo

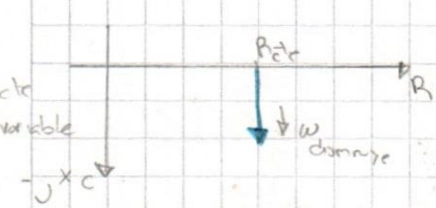
$$Q_0 = \omega_0 \cdot R \cdot C = \frac{R}{\omega_0 \cdot L}$$

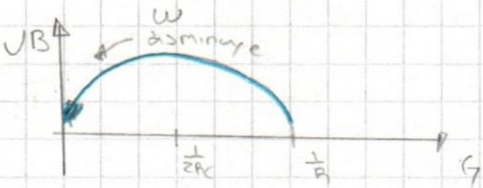
Lugar Geométrico

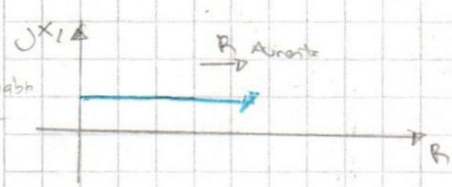
(2)

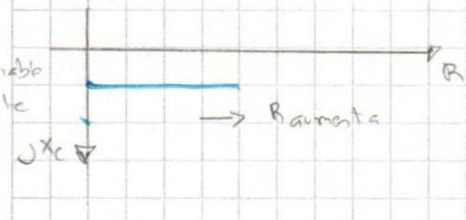


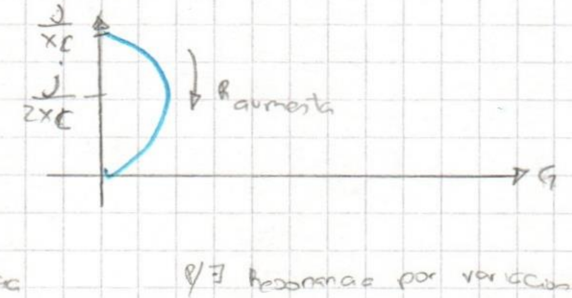










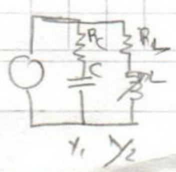


P/∃ Resonancia por variación de inductancia

$$Img\{Y_1\} \leq \frac{1}{2R_L}$$

Si es mayor no hay Reso.

$$\therefore \frac{X_C}{R_C^2 + X_C^2} \leq \frac{1}{2R_L}$$



P/∃ Resonancia por variación de resistencia R_C

$$Img\{Y_2\} < \frac{1}{X_C}$$

$$\frac{X_L}{R_L^2 + X_L^2} < \frac{1}{X_C}$$

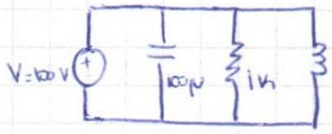
HOJA N°

FECHA

NOTA

NOTA :

2)



$\omega_0 = 1000 \ \frac{rad}{s}$

$Z_C = \frac{-j}{\omega C} = -10j$

$Z_L = j\omega L = 10j$

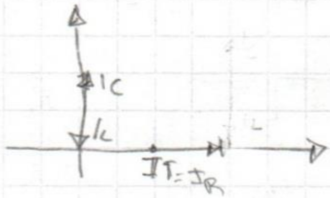
$\omega_0 = \frac{1}{\sqrt{LC}} \rightarrow L = \frac{1}{C.\omega_0^2} = 0{,}01$

$I = \frac{V}{Z_{eq}} \quad \frac{100 \angle 0}{1000 \angle 0} = 0{,}1 \angle 0$

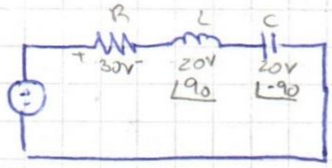
$I_C = \frac{V}{Z_C} = \frac{10j}{10 \angle 90}$

$I_L = \frac{V}{Z_L} = \frac{-10j}{10 \angle -90}$

$I_R = \frac{V}{Z_R} = 0{,}1 \angle 0$



7)



$\omega_0 = 2000 \ \frac{rad}{s}$

$I_T = 6A$

$R = \frac{V_T}{I} = 5$

$L = \frac{R V_L}{AB} = \frac{5}{3000} = 1{,}66 \ mH$

otra forma es usando $X_L = \frac{20j}{6}$ y así calculo L y C

$Q_0 = \frac{V_L}{V_T} = \frac{2}{3}$

$AB = \frac{\omega_0}{Q_0} = 3000$

$\omega_0 = \frac{1}{\sqrt{LC}} \rightarrow C = \frac{1}{\omega_0^2 L} = 0{,}15 \ mF$

$AB = \frac{R}{L} = 1{,}5$

$\omega_{1;2} = \left| \frac{-R}{2L} \pm \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}} \right| = \left| (-1506) \pm \sqrt{(1506)^2 + 1338688} \right|$

$\omega_1 = |(-1506) \pm 2500{,}31| \rightarrow \omega_1 = 1000{,}13$

$\omega_2 = 4000$

8)

$P_R = 200W$ en resonancia

$P = 100W$ en $\begin{cases} \omega_1 = 270{,}16 \\ \omega_2 = 374{,}16 \end{cases}$

$P = V.I = \frac{V^2}{R} \rightarrow V = \sqrt{P.R} = 141{,}42 \ V$

$\omega_0 = 2\pi f_0 \rightarrow f_0 = 50{,}32 \ Hz$

$\omega_0 = \sqrt{\omega_1 \omega_2} = 316{,}23$

$\frac{200}{100} (\omega_2 - \omega_1)$

$AB = \frac{R}{L} = (\omega_2 - \omega_1) 2 = 100$

$Q = \frac{\omega_0 L}{R} \rightarrow L = \frac{Q R}{\omega_0} = 0{,}1 \ H$

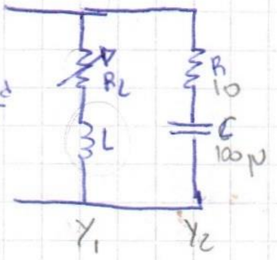
$Q_0 = \frac{\omega_0}{AB} = 3{,}16$

$\omega_0 = \frac{1}{\sqrt{LC}} \rightarrow C = \frac{1}{\omega_0^2 L} = 100 \ \mu F$

NOTA

12)

$\omega = 1000 \frac{rad}{s}$



L p/ q' no entre en resonancia , $0 < R_L < \infty$

$Imag\{Y_2\} > \frac{1}{X_L}$ $\qquad X_C = -10j \qquad \frac{1}{X_C} = \frac{1}{10}j$

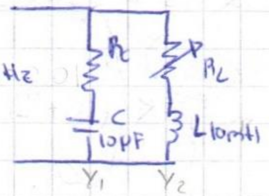
$X_L = j\omega L$

$$Imag\left\{\frac{1}{R + jX_C}\right\} > \frac{1}{X_L} \rightarrow \frac{1}{10-10j} \cdot \frac{10+10j}{10+10j} = \frac{10+10j}{10^2+10^2} = \frac{10}{200} + \frac{10j}{200}$$

$$\therefore \frac{1}{20} > \frac{1}{\omega L} \rightarrow \rightarrow L > \frac{1}{20 \cdot \omega} = 20 \text{ mH} \rightarrow \boxed{L > 20 \text{ mH}}$$

13)

$f = 20$ kHz



R_C p/ resonancia

$\omega_0 = 2\pi f_0 = 40000 \cdot \pi$

$X_L = j\omega L = 400\pi j$

$X_C = \frac{-j}{\omega C} = -0,795j$

$Imag\{Y_1\} < \frac{1}{X_L}$

$$Imag\left\{\frac{1}{R_C + jX_C}\right\} < \frac{1}{X_L} \qquad \frac{1}{R_C - 0,795j} \cdot \frac{R_C + j0,795}{R_C + j0,795} \rightarrow \frac{R_C + j0,795}{R_C^2 + 0,795^2}$$

$$\frac{0,795}{R_C^2 + 0,795^2} < \frac{1}{400\pi} \rightarrow (0,795 \cdot 400\pi) < R_C^2 + 0,795^2$$

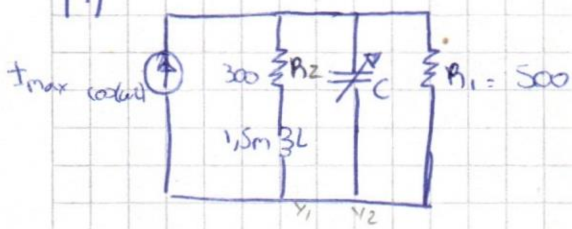
$$\sqrt{(0,795 \cdot 400\pi) - (0,795)^2} < R_C \qquad \therefore \boxed{R_C > 31,59\ \Omega}$$

14)

HOJA N°

FECHA

14)



$f = 60kHz$

$\omega_0 = 2\pi \cdot 60000 = 120.000\pi$

$X_L = 180\pi j$ $\qquad X_C = \frac{j}{\omega C}$

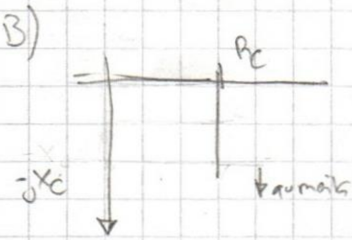
A) $Imag\{Y_1\} < \frac{1}{X_C}$ $\qquad \frac{X_L}{R^2+X_L^2} < \frac{1}{X_C}$

$\frac{180\pi}{300^2+(180\pi)^2} < \frac{1}{\frac{-1}{\omega C}} \rightarrow 180\pi \cdot \frac{(-1)}{\omega C} < 300^2+(180\pi)^2$

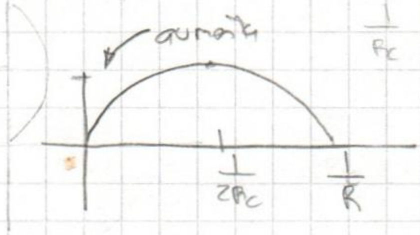
$\frac{180\pi\left(\frac{+1}{\omega}\right)}{300^2+(180\pi)^2} < C \rightarrow \boxed{3,66\ nF < C}$

B)

(Z)



(Y)



$C = \frac{1}{2R} = 1mF$

p/ max tr pot y al ser Resist pur

$\therefore |Y_{carga}| = |Y_{equivalente}|$ $\quad \frac{1}{R_1}$

$Y_{equivalente} = \frac{(R_2+L)C}{R_2+L+C}$

$Y_{carga} = \frac{1}{R_1}$

$\frac{R_2C+LC}{R_2+L+C} = \frac{1}{R_1}$

$\frac{300 \cdot \frac{j}{\omega C} + 180\pi j \frac{j}{\omega C}}{}$

NOTA

NOTA

Capitulo 9: Sistemas polifasicos

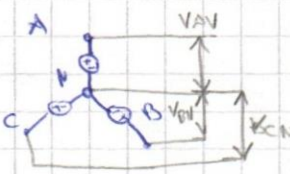
Esta formado por n tensiones sinusoidales de la misma frec conectadas a n cargas a traves de n pares conductores

Bifasico

$V_\varphi = \frac{V_{max}}{\sqrt{2}} \angle \varphi$ $\qquad$ $V_L = \sqrt{2}\, V_\varphi \angle \varphi$

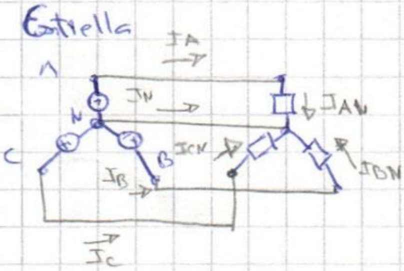
Trifasico

Sist equilibrado $\begin{cases} \sum V_\varphi = 0 \\ \sum V_L = 0 \end{cases}$

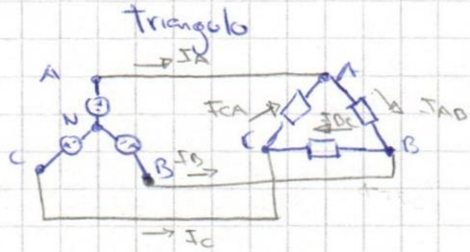


$V_{fase} \begin{cases} V_{AN} = V_\varphi \angle 90 \\ V_{BN} = V_\varphi \angle -30 \\ V_{CN} = V_\varphi \angle -150 \end{cases}$ $\qquad$ $V_{linea} \begin{cases} V_{AB} = V_L \angle 120 \\ V_{BC} = V_L \angle 0 \\ V_{CA} = V_L \angle 240 \end{cases}$

Estrella



triangulo



$V_{carga} = V_\varphi = \frac{V_L}{\sqrt{3}}$ $\qquad$ $V_{carga} = V_L$

$I_L = I_\varphi = \left(\frac{V_\varphi}{Z \angle \varphi}\right)$ $\qquad$ $I_L = \sqrt{3}\, I_\varphi = \left(\frac{V_L}{Z\angle\varphi}\right)\sqrt{3}$

φ es el argumento de la carga no la dif.

$\begin{cases} P_T = 3\,|V_\varphi|.|I_\varphi| \cos\varphi = \frac{3}{\sqrt{3}} V_L I_L \cos\varphi \\ Q_T = \sqrt{3}\,|V_L||I_L| \operatorname{sen}\varphi \\ S_T = \sqrt{3}\,|V_L|.|I_L| \end{cases}$ $\qquad$ $\begin{cases} P_T = \frac{3}{\sqrt{3}} |V_L|.|I_L| \cos\varphi \\ Q_T = \sqrt{3}\,|V_L||I_L| \operatorname{sen}\varphi \\ S_T = \sqrt{3}\,|V_L|.|I_L| \end{cases}$

Corriente de linea $\begin{cases} I_A = I_L \angle 120 - \varphi - 30 \\ I_B = I_L \angle 0 - \varphi - 30 \\ I_C = I_L \angle 240 - \varphi - 30 \end{cases}$

NOTA

2) $V_{carga} = 380\ V$
$Z = 12 + j22\ \Omega$

$V_L \begin{cases} V_{AN} = V \angle 90 \\ V_{BN} = V \angle -30 \\ V_{CN} = V \angle -150 \end{cases}$

$V_{carga} = V_L$

$I_L = \sqrt{3} \cdot I_f = \dfrac{V_L}{Z}\sqrt{3}$

$I_{AN} = \dfrac{380 \angle 90}{12+j22} \cdot \sqrt{3} = 26,26 \angle 28,61$

$I_{BN} = \dfrac{380 \angle -30}{12+j22} \sqrt{3} = 26,26 \angle -91,3$

$I_{CN} = \dfrac{380 \angle -150}{12+j22} \sqrt{3} = 26,26 \angle 148,6$

1) $V = 60V$
$(I_L, I_f, P, Q, S) = ?$

$Z = 11 \angle 30$
Estrella

$V_L \begin{cases} V_{AB} = 60 \angle 90 \\ V_{BC} = 60 \angle -30 \\ V_{CA} = 60 \angle -150 \end{cases}$ $V_f \begin{cases} V_{AN} = 20\sqrt{3} \angle 90 \\ V_{BN} = 20\sqrt{3} \angle -30 \\ V_{CN} = 20\sqrt{3} \angle -150 \end{cases}$

$V_{carga} = V_f = \dfrac{V_L}{\sqrt{3}}$

$I_L = I_f = \dfrac{V_f}{Z} = \dfrac{1}{\sqrt{3}} \dfrac{V_L}{Z}$

$I_{AB} = \dfrac{1}{\sqrt{3}} \dfrac{60 \angle 90}{11 \angle 30} = 3,15 \angle 60$

$I_{BC} = \dfrac{1}{\sqrt{3}} \dfrac{60 \angle -30}{11 \angle 30} = 3,15 \angle -60$

$\{Z\}$

$I_{CA} = \dfrac{1}{\sqrt{3}} \dfrac{60 \angle -150}{11 \angle 30} = 3,15 \angle -180$

argumento $\{Z\}$

$P = |V_f| |I_f| \cos(\varphi) = 20\sqrt{3} \cdot 3,15 \cos 30 = 94,5\ [W]$ p/ cada fase

$Q = |V_f| \cdot |I_f| \operatorname{sen}(\varphi) = 20\sqrt{3} \cdot 3,15 \operatorname{sen} 30 = 54,55\ [VAR]$ p/ cada fase

$S = |V_f| \cdot |I_f| = 20\sqrt{3} \cdot 3,15 = 109,11\ [VA]$ p/ cada fase

3) Estrella (M)
$Z_m = 36 \angle 25$

Estrella (N)
$Z_n = 106 \angle 15$

$V_L = 380 \angle \theta$ $V_f = \dfrac{380}{\sqrt{3}} \angle \varphi$

$I_{Lm} = \dfrac{380/\sqrt{3} \angle \theta}{36 \angle 25} = 6,09 \angle \theta - 25$

$I_{LN} = \dfrac{380/\sqrt{3} \angle \theta}{106 \angle 15} = 2,06 \angle \theta - 15$

$P = |V_f| \cdot |I_f| \cos(\varphi)$

$P_m = 3 \cdot \dfrac{380}{\sqrt{3}} \cdot 6,09 \cos(25) = 3632,76\ W$

$P_N = 3 \cdot \dfrac{380}{\sqrt{3}}\ 2,06 \cos(15) = 1309,67\ W$

$\boxed{P_T = P_m + P_N = 4951,1\ W}$

4)