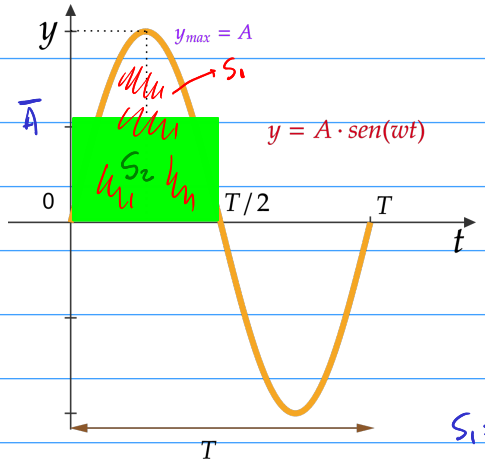
Corriente Alterna

Problema 1



Se demuestra de la siguiente forma:

El valor medio en el semiperíodo $\bar{A}$ es el que define un área $S_2 = \bar{A} \cdot T/2$ que debe ser igual al área de la función $y = A \cdot sen(\omega t)$ en el semiperíodo $T/2$.

El área de la función $S_1 = \int_0^{T/2} A \cdot sen(\omega t)$

$$S_1 = \int_0^{T/2} A\,sen(\omega t) = A/\omega \cdot -\cos(\omega t)\Big|_0^{T/2} =$$

$$= \frac{A}{2\pi} \cdot T \cdot \left[-\cos\left(\frac{2\pi}{T} \cdot T/2\right) + \cos\left(\frac{2\pi}{T} \cdot 0\right)\right] =$$

$$= \frac{A}{2\pi} \cdot T \left[-\cos\pi + \cos 0\right] = \frac{A}{\pi} T$$

($-\cos\pi + \cos 0 = 2$)

$S_2 = \bar{A} \cdot T/2$

Luego $S_1 = S_2 \quad \bar{A} \cdot T/2 = \frac{A \cdot T}{\pi} \Rightarrow \bar{A} = \frac{2 \cdot A}{\pi}$

Problema 2

$V = 220\,V$ y $f = 50\,Hz \Rightarrow V_{ef} = 220\,V$, $T = 1/f = 1/50Hz = 0{,}02\,s = 20\,ms$

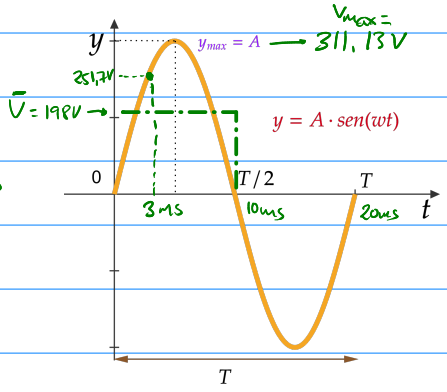
Luego $V_{ef} = \frac{V}{\sqrt{2}} \Rightarrow V_{max} = V_{ef} \cdot \sqrt{2} = 311{,}13\,V$

$$\bar{V} = \frac{2}{\pi} V_{max} = \frac{2 \cdot 311.13\,V}{\pi} = 198\,V$$

$V = V_{max} \cdot sen(\omega t)$

¡ojo! En radianes.

$V(3ms) = 311{,}13\,V \cdot sen(2 \cdot \pi \cdot 50Hz \cdot 3ms) = 251{,}7\,V$



Problema 3

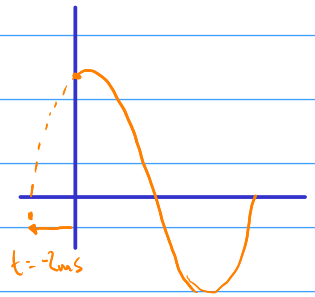
$V_{ef} = 127\,V$ $\quad f = 50\,Hz$ $\quad V_m = \sqrt{2}\cdot V_{ef} \simeq 180\,V$

$V = V_m \cdot \operatorname{sen}(\omega t + \varphi) \Rightarrow$ $\quad \operatorname{sen}(\omega t + \varphi) = 0$ en $t = -2ms$

$\omega t + \varphi = 0$ si $t = 2ms$

$\varphi = -\omega t = -2\cdot\pi\cdot f\cdot(-2ms)$

$= 0{,}628\,rad$



$V = 180\cdot \operatorname{sen}(50\pi t + 0.628)$

Onda adelantada.

Ejemplo: Suma de tensiones desfasadas. $f = 50Hz \rightarrow \omega = 2\pi f = 100\pi\,rad/s$

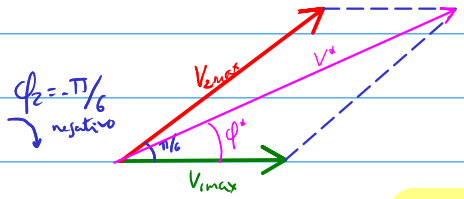
$V_1 = V_{1max}\cdot \operatorname{sen}(\omega t) = 180\cdot \operatorname{sen}(100\pi t)\,V$

$V_{1max} = \sqrt{2}\cdot V_{ef} = \sqrt{2}\cdot 127\,V = 180V$ y $V_2 = \sqrt{2}\cdot V_{ef} = \sqrt{2}\cdot 220\,V = 311{,}13\,V$

$V_2 = 311\cdot \operatorname{sen}(100\pi t + \pi/6)\,V$ $\quad \pi/6 \equiv 30°$

Tomarlo negativo. Adelantada.

$\varphi_2 = -\pi/6$ negativo



$\vec{V}^* = \vec{V}_{1max} + \vec{V}_{2max} = V_{1max}\,\vec{\imath} + V_{2max}\cdot\cos\pi/6\,\vec{\imath} + V_{2max}\cdot\operatorname{sen}\pi/6\,\vec{\jmath}$

$V^* = \left(180 + 311\cdot\cos\pi/6\right)\vec{\imath} + 311\cdot\operatorname{sen}\pi/6\,\vec{\jmath} = \left(449\,\vec{\imath} + 155{,}5\,\vec{\jmath}\right)V$

$|V^*| = \sqrt{449^2 + 155{,}5^2} = 475\,V$ y $\varphi^* = \operatorname{atan}\frac{155{,}5}{449} = 0{,}33\,rad$

$\varphi^* = 19{,}1°$

$V = 475\cdot \operatorname{sen}(100\pi t + 0{,}33)\,V$

$\varphi^* = -0.33\,rad = -19.1°$ } adelantada.

Problema 4

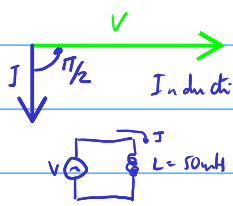
$V = 220V$, $50\,Hz$ $\quad V_0 = \sqrt{2}\cdot 220V = 311V$ $\quad \omega = 2\pi f = 100\pi\,rad/s$

$I = \frac{V}{R} = \frac{\sqrt{2}\cdot 220V}{50\Omega}\operatorname{sen}(100\pi t) = 6{,}22\cdot\operatorname{sen}(100\pi t)\,A$

Problema 5

A) $L = 50mH$ $\quad V_{ef} = 100V$ $\quad f = 50Hz$ $\quad V = V_0\operatorname{sen}(\omega t) = \sqrt{2}\cdot 100V\cdot\operatorname{sen}(100\pi t)$

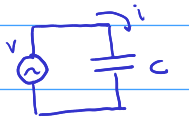
$\omega = 2\pi f = 100\pi\,rad/s$



$X_L = 2\pi f\cdot L = 5000\cdot\pi\,rad/s\,mH = 5\cdot\pi\,\Omega$

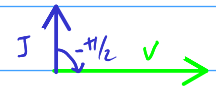
$I = \frac{V}{R} = \frac{V_0\operatorname{sen}(\omega t - \pi/2)}{2\pi f\cdot L} = \frac{\sqrt{2}\cdot 100}{5\cdot\pi}\frac{V}{\Omega}\operatorname{sen}(100\pi t - \pi/2) = 9\cdot\operatorname{sen}(100\pi t - \pi/2)\,A$

Problema 5 B $C = 100\,\mu F$ $V = 220V$, $50Hz$ $v = \sqrt{2}\cdot 220V \cdot \operatorname{sen}(100\pi t)$ $\omega = 2\pi f = 100\pi\ rad/s$



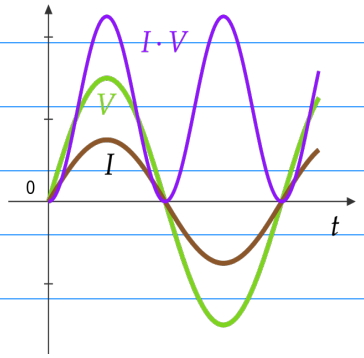
$I = C\frac{dV}{dt} = I_0 \cdot \operatorname{sen}(\omega t + \pi/2)$ adelantada.

$X_C = \frac{1}{2\pi f \cdot C} = \frac{V_0}{I_0} = \frac{1}{100\pi \cdot 100\mu F} = \frac{100}{\pi}\Omega \Rightarrow I_0 = \frac{V_0}{100/\pi\,\Omega}$



$I = \frac{\sqrt{2}\cdot 220V}{100/\pi\,\Omega}\operatorname{sen}(100\pi t + \pi/2) = 9{,}77 \cdot \operatorname{sen}(100\pi t + \pi/2)\ A$

Problema 6 La potencia media es la integral de los valores en un semiperiodo dividido entre el tiempo considerado. $(T/2)$



$P_m = \frac{\int_0^{T/2} I\cdot V\,dt}{T/2} = \frac{I_0\cdot V_0\cdot T/4}{T/2} = \frac{I_0\cdot V_0}{2}$

$\int_0^{T/2} I\cdot V\,dt = \int_0^{T/2} I_0\cdot V_0\cdot \operatorname{sen}^2(\omega t)\,dt = \int_0^{T/2} I_0\cdot V_0\,\frac{1-\cos(2\omega t)}{2}\,dt =$

$= I_0\cdot V_0\left[\int_0^{T/2}\frac{1}{2}\,dt - \frac{1}{2}\int_0^{T/2}\cos(2\omega t)\,dt\right] =$

$= I_0\cdot V_0\left[\frac{1}{2}\frac{T}{2} - \frac{1}{2}\cdot 0\right] = I_0\cdot V_0\cdot T/4$

$\int_0^{T/2}\cos(2\omega t)\,dt = \frac{1}{2\omega}\operatorname{sen}(2\omega t)\Big]_0^{T/2} = \frac{1}{2\omega}\cdot\left[\operatorname{sen}\left(2\omega\frac{T}{2}\right) - \operatorname{sen}(2\omega\cdot 0)\right] = 0$

$2\omega\cdot T/2 = 2\frac{2\pi}{T}\cdot\frac{T}{2} = 2\pi \qquad \operatorname{sen}(2\pi) = 0$

$P_m = \frac{I_0\cdot V_0}{2} = \frac{I_0}{\sqrt{2}}\cdot\frac{V_0}{\sqrt{2}} = I_{ef}\cdot V_{ef}$

$R = 2\Omega$ $V = 70\cdot\operatorname{sen}(100\pi t)\ V$ $V_0 = 70\ V$

$I_0 = \frac{V_0}{R} = \frac{70V}{2\Omega} = 35A.$

$P_{máx} = I_0\cdot V_0 = 70V\cdot 35A = 2450\ W$

$P_m = \frac{I_0\cdot V_0}{2} = 1225\ W$

$P = 2450\cdot\frac{1-\cos(200\pi t)}{2}\ W$ ← ¡Frecuencia doble!

También $\Rightarrow I_{ef} = \frac{I_0}{\sqrt{2}} = \frac{35A}{\sqrt{2}} = 24{,}75\ A$, $V_{ef} = \frac{V_0}{\sqrt{2}} = \frac{70V}{\sqrt{2}} = 49{,}5\ V$ $P_m = V_{ef}\cdot I_{ef} = 24{,}75A\cdot 49{,}5V = 1225\ W$

Problema 7

A) $L = 10\,mH$ $\quad V_0 = 90\,V$ y $f = 60\,Hz \Rightarrow \omega = 2\pi f = 120\pi\ rad/s$

$V = 90 \cdot \operatorname{sen}(120\pi \cdot t)\ V$ $\qquad V_{ef} = V_0/\sqrt{2} = 63{,}64\,V$

$I_{ef} = I_0/\sqrt{2}$ $\qquad I_{ef} = \dfrac{V_{ef}}{X_L} = \dfrac{63{,}64\,V}{2\pi f \cdot L} = \dfrac{63{,}64\,V}{120\pi\ rad/s \cdot 10\cdot10^{-3}\,H} = 16{,}88\,A \Rightarrow I_0 = \sqrt{2}\,I_{ef} = 23{,}87\,A$

$X_L = 3{,}77\,\Omega$

$P_m = 0$ $\qquad Q = \begin{cases} I_{ef} \cdot V_{ef} = 16{,}88\,A \cdot 63{,}64\,V = 1074{,}3\ VAr \\ I_{ef}^2\, X_L = (16{,}88\,A)^2 \cdot 3{,}77\,\Omega = 1074{,}3\ VAr \\ V_{ef}^2 / X_L = (63{,}64\,V)^2 / 3{,}77\,\Omega = 1074{,}3\ VAr \end{cases}$

$I = 23{,}87\,A \cdot \operatorname{sen}(120\pi t - \pi/2)$

B) $C = 30\,\mu F$ $\quad V = 150\,\operatorname{sen}(100\pi t)$ $\quad f = 50\,Hz$ $\quad \omega = 2\pi f$

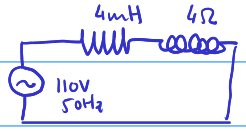
$X_C = \dfrac{1}{2\pi f \cdot C} = \dfrac{1}{100\pi\ rad/s \cdot 30\cdot10^{-6}\,F} = 106{,}1\,\Omega$

$I_0 = \dfrac{V_0}{X_C} = \dfrac{150\,V}{106{,}1\,\Omega} = 1{,}414\,A$

$I = I_0\,\operatorname{sen}(100\pi t + \pi/2) = 1{,}414 \cdot \operatorname{sen}(100\pi t + \pi/2)\ A$

$I_{ef} = \dfrac{I_0}{\sqrt{2}} = \dfrac{1{,}414\,A}{\sqrt{2}} = 1\,A$ $\qquad V_{ef} = \dfrac{150\,V}{\sqrt{2}} = 106{,}06\,V$ $\qquad Q = I_{ef} \cdot V_{ef} = 106{,}06\,VAr$

Problema 8



$V_{ef} = 110\,V$ $\qquad Z = R + jwL$

$w = 2\pi f = 100\pi\ rad/s$

$R = 4\,\Omega$ $\qquad w \cdot L = 2\pi f \cdot L = 100\pi\ rad/s \cdot 4\cdot10^{-3}\,H = 1{,}26\,\Omega$

$|Z| = \sqrt{R^2 + (wL)^2} = \sqrt{(4\Omega)^2 + (1{,}26\Omega)^2} = 4{,}19\,\Omega$

$\varphi = \operatorname{atan}\left(\dfrac{wL}{R}\right) = 0{,}305\ rad$

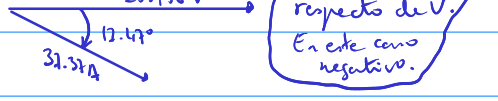
$V_0 = \sqrt{2} \cdot V_{ef} = 155{,}56\,V$

$I_0 = \dfrac{V_0}{|Z|} = \dfrac{155{,}56\,V}{4{,}19\,\Omega} = 37{,}13\,A$

$I = I_0 \angle -0.305 = 37{,}13\,A \angle \underline{-0.305} \Rightarrow$ $\qquad -17.47°$

$I = 37{,}37\,A\ \operatorname{sen}(110\pi t - 0.305\,rad)$

$I_{ef} = \dfrac{I_0}{\sqrt{2}} = 26{,}42\,A$

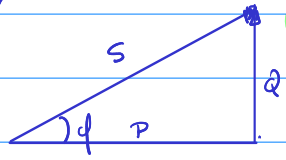


Le toma la fase de la intensidad respecto de V. En este caso negativo.

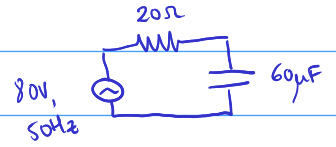
$S = V \cdot I = 110\,V \cdot 26{,}42\,A = 2906{,}2\,VA$

$P = S \cdot \cos(\varphi) = 2772{,}07\,W$

$Q = S \cdot \operatorname{sen}(\varphi) = 872{,}71\,VAr$



Problema 9



a) $V = V_0 \angle 0°$ $\quad V_0 = \sqrt{2} \cdot 80V = 113,13\,V$

b) $Z = R - \frac{j}{\omega C} = 20\Omega - \frac{j}{2\pi f \cdot 60\mu F} =$

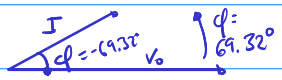
$= 20\Omega - \frac{j}{100 \cdot \pi\ rad/s \cdot 60 \cdot 10^{-6} F} = 20\Omega - \frac{j}{0,019\Omega^{-1}} = 20\Omega - 53,05j\,\Omega$

$|Z| = \sqrt{(20\Omega)^2 + (53,05\Omega)^2} = 56,69\Omega$

$\varphi = \arctg\left(\frac{-1}{\omega \cdot C \cdot R}\right) = -\arctg\left(\frac{1}{\omega C R}\right) = -1,21\,rad = -69,32°$

$Z = 56,69 \angle -69,32°\ \Omega$

El circuito es capacitivo. La intensidad está adelantada



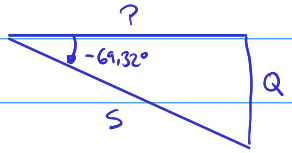
Ángulo de la int. respecto a V.

$I_0 = \frac{V_0}{|Z|} = \frac{113,13\,V}{56,69\Omega} = 2\,A$ $\quad I = I_0 \angle 69,32°$

$I = 2 \cdot \sin(100\pi t + 69,32°)\,A$

$I_{ef} = I_0/\sqrt{2} = \sqrt{2}\,A$

Potencias



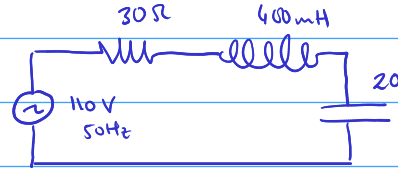
$S = U_{ef} \cdot I_{ef} = 80V \cdot \sqrt{2}\,A = 113,13\,VA$

$P = I_{ef}^2 \cdot R = (\sqrt{2}\,A)^2\,20\Omega = 40\,W$

$Q = S \cdot \sin(\varphi) = 113,13\,VA \cdot \sin(-69,32°) = -105,85\,VAr$ ($-1,21\,rad$)

Problema 1o

https://www.translatorscafe.com/unit-converter/es-ES/calculator/series-rlc-impedance/



$V_o = \sqrt{2} \cdot 110V = 155,56\,V \qquad w = 2\pi f = 100\pi\ rad/s$

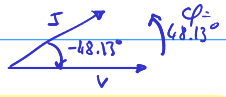
$Z = R + jwL - \frac{j}{wC} = 30\Omega + j(100\pi\ rad/s \cdot 400mH) - \frac{j}{100\pi\ rad/s \cdot 20\cdot10^{-6}F} = 30\Omega + 125,66j\,\Omega - 159,15j =$

$Z = 30\Omega - 33,49j\,\Omega$

$|Z| = \sqrt{(30\Omega)^2 + (33,49\Omega)^2} = 44,96\Omega$

$\varphi = \arctg\left(\frac{-33,49\Omega}{30\Omega}\right) = -0,84\,rad = -48,13°$

$Z = 44,96\ \angle -48,13°\ \Omega$



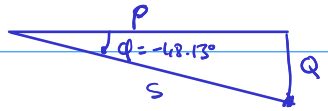
$I_{ef} = \frac{V_{ef}}{Z} = \frac{110V}{44,96\Omega} = 2,45\,A \qquad I_o = \sqrt{2} \cdot 2,45A = 3,46A$

$I = I_o\ \angle 48,13°$

$I = 3,46\ sen(100\pi t + 48,13°)\ A$

Capacitivo. Adelantada

Potencias



$S = V_{ef} \cdot I_{ef} = 110V \cdot 2,45A = 269,5\,VA$

$P = I_{ef}^2 \cdot R = (2,45A)^2 \cdot 30\Omega = 180\,W$

$Q = S \cdot sin(\varphi) = 269,5VA \cdot sen(-48,13°) = -200,68\,VAr$ (−0,84 rad)

$V_L = I \cdot X_L = 3,46A\ \angle 48,13° \cdot wL\ \angle 90° =$

$= 3,46A \cdot 100\pi\ rad/s \cdot 400\cdot10^{-3}H\ \angle 138,13° = 434,8\ \angle 138,13°\ V$

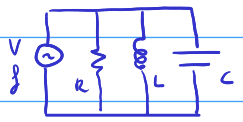
La frecuencia de resonancia cumple que

$X_L = X_C \qquad wL = \frac{1}{wC} \Rightarrow w^2 = \frac{1}{LC} \qquad w = \frac{1}{\sqrt{LC}}$

$w = 2\pi f \Rightarrow 2\pi f = \frac{1}{\sqrt{LC}} \qquad f = \frac{1}{2\pi\sqrt{LC}}$

$f = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{400mH \cdot 20\mu F}} = \frac{1}{2\cdot\pi\sqrt{400\cdot10^{-3}H \cdot 20\cdot10^{-6}F}} = 56,269\ Hz$

Problema 11



$X_L = jwL$

$X_C = \frac{-j}{wC}$

$$\frac{1}{z} = \frac{1}{R} + \frac{1}{jwL} - \frac{wC}{j} = \frac{(jwL)j + R\cdot j - (wC)(jwL)\cdot R}{R(jwL)j} =$$

$$\frac{1}{z} = \frac{-wL + Rj - Rw^2LCj}{-RwL} = \frac{-wL + R(1-w^2LC)j}{-RwL} = \frac{1}{R} - \frac{1}{wL}(1-w^2LC)j$$

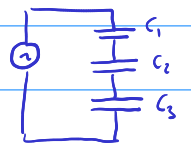
$$z = \frac{-RwL}{-wL + R(1-w^2LC)j} \cdot \frac{-wL - R(1-w^2LC)j}{-wL - R(1-w^2LC)j} = \frac{Rw^2L + R^2wL(1-w^2LC)j}{(wL)^2 + R^2(1-w^2LC)^2}$$

$$\varphi = \operatorname{atan}\left(\frac{R^2wL(1-w^2LC)}{Rw^2L}\right) = \operatorname{atan}\left(\frac{R(1-w^2LC)}{w}\right)$$

$$|z| = \sqrt{\left[\frac{Rw^2L}{(wL)^2 + R^2(1-w^2LC)^2}\right]^2 + \left[\frac{R^2wL(1-w^2LC)}{(wL)^2 + R^2(1-w^2LC)^2}\right]^2}$$

$$I = \frac{V_0}{|z|}\operatorname{sen}(wt - \varphi)$$

Problema 12



$$z_1 = \frac{-j}{wC_1}$$

$$z_2 = \frac{-j}{wC_2}$$

$$z_3 = \frac{-j}{wC_3}$$

$$z = z_1 + z_2 + z_3 = \frac{-j}{wC_1} - \frac{j}{wC_2} - \frac{j}{wC_3} = -\frac{j}{w}\left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)$$

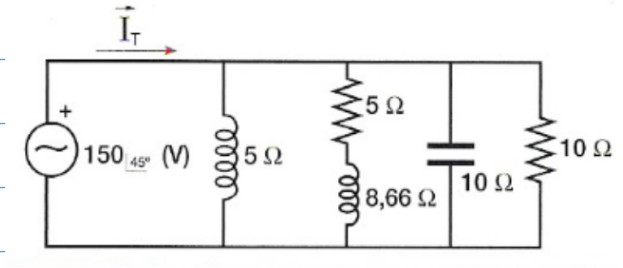
$\Rightarrow$ el circuito se puede sustituir por uno con un condensador equivalente de capacidad

$$z_{eq} = \frac{-j}{wC_{eq}} = \frac{-j}{w}\left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)$$

$$\boxed{1/C_{eq} = 1/C_1 + 1/C_2 + 1/C_3}$$

Si estuvieran en paralelo, la cap. equivalente sería $\boxed{C = C_1 + C_2 + C_3}$

Problema 13 A



$V = 150 \angle 45° \, V$ 150V de tensión máxima cuando me lo den así.

a) $Z_1 = jwL = j5\Omega$ ¡Cuidado! me dan ya su valor calculado, su impedancia.

b) $Z_2 = 5\Omega + j8.66\Omega = 10 \angle 60° \, \Omega$

c) $Z_3 = -j\,10\Omega$ d) $Z_4 = 10\Omega$

2º paso a admitancias: $Y_1 = \frac{1}{5\Omega j} = 0,2 \angle -90° \, \Omega^{-1}$ / $Y_2 = \frac{1}{10 \angle 60° \Omega} = 0,1 \angle -60° \, \Omega^{-1}$ $(0,1\cos(-60°) + 0,1\sin(-60°)j)$

$Y_3 = \frac{1}{-j10\Omega} = 0,1j \, \Omega^{-1} = 0,1 \angle 90° \, \Omega^{-1}$ / $Y_4 = \frac{1}{10\Omega} = 0,1 \, \Omega^{-1}$

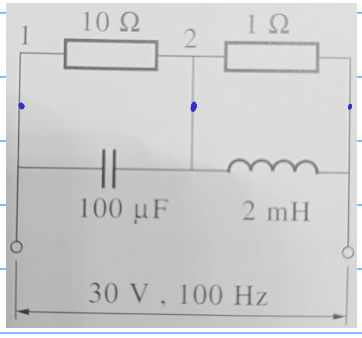
$Y = Y_1 + Y_2 + Y_3 + Y_4 = \left[-0,2j + 0,1\cdot\cos(-60°) + 0,1\cdot\sin(-60°)j + 0,1j + 0,1\right] \Omega^{-1} =$

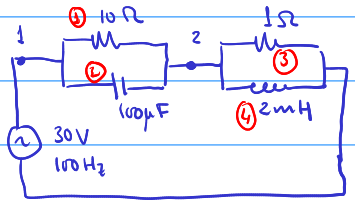
$Y_{eq} = (0.15 - 0.18j)\Omega^{-1} \Rightarrow Z_{eq} = \frac{1}{Y_{eq}} = \frac{1}{0,23} \frac{\angle 50.19}{\Omega} = 4,27 \angle 50.19° \, \Omega$

$= 0.23 \angle -50.19° \, \Omega^{-1}$

$I = \frac{V}{Z} = \frac{150 \angle 45° \, V}{4,27 \angle 50.19° \, \Omega} = 35,14 \angle -5.19° \, A$

Problema 13 B





$w = 2\pi f = 200\pi \, rad/s$

De 1 a 2

$Z_1 = 10\Omega$

$Z_2 = -\frac{j}{wC} = -\frac{j}{200\pi \, rad/s \cdot 100\mu F} = -15,92j\,\Omega$

$Y_1 = \frac{1}{10} \Omega^{-1} = 0,1 \, \Omega^{-1}$

$Y_2 = \frac{1}{-15,92j} \Omega^{-1} = 0,0628j \, \Omega^{-1}$

$Y_{12} = Y_1 + Y_2 = (0.1 + 0.0628j)\Omega^{-1} = 0.118 \angle 32.13° \, \Omega^{-1}$

$Z_{12} = \frac{1}{Y_{12}} = \frac{1}{0.118} \frac{\angle -32.13°}{\Omega} = 8.468 \angle -32.13° \, \Omega = (7.17 - 4,5j)\Omega$

De 2 a 3

$Z_3 = 1\Omega$ / $Y_3 = 1 \, \Omega^{-1}$

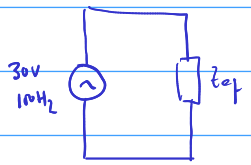
$Z_4 = wLj = 200\pi \, rad/s \cdot 2\cdot10^{-3} H \, j = 1,26j \, \Omega$ / $Y_4 = \frac{1}{1.26j} \Omega^{-1} = -0.79j \, \Omega^{-1}$

$Y_{23} = Y_3 + Y_4 = (1 - 0.79j)\Omega^{-1} \Rightarrow Z_{23} = \frac{1}{Y_{23}} = \frac{1}{1.278 \angle -38.51° \, \Omega^{-1}} = (0,61 + 0.48j)\Omega = 0,78 \angle 38.51° \, \Omega$

$= 1,278 \angle -38.51° \, \Omega^{-1}$

$Z_{eq} = Z_{12} + Z_{13} = (7.17 - 4,5j)\Omega + (0.61 + 0.48j)\Omega = (7,78 - 4,02j)\Omega = 8.75 \angle -27.32° \, \Omega$

$Z_{eq} = 8{,}75\ \angle -27.32°\ \Omega$ $\varphi = -27.32°$ atrasada, capacitivo.



$I = \frac{V_0}{Z} \operatorname{sen}(20\pi t + 27.32°) = \frac{42{,}43\,V}{8.75\,\Omega} \operatorname{sen}(20\pi t + 27.32°) = 4{,}84 \operatorname{sen}(\omega t + 27.8°)\ A.$

$I_{máx.}$

$V_0 = \sqrt{2} \cdot V_{ef} = 30V \cdot \sqrt{2} = 42{,}43V$

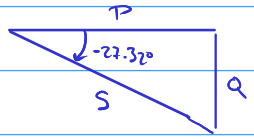
$I_{ef} = \frac{V_{ef}}{Z} = \frac{30\,V}{8.75\,\Omega} = 3{,}43\ A$

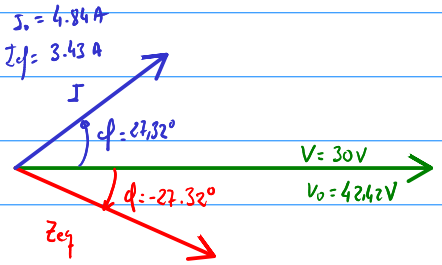
Potencia activa.

$S = V_{ef} \cdot I_{ef} = 30V \cdot 3{,}43\ A = 102.6\ VA$

$P = V_{ef} \cdot I_{ef} \cdot \cos(-27.32°) = 91.16\ W$

$Q = V_{ef} \cdot I_{ef} \cdot \operatorname{sen}(-27.32°) = -47.09\ VAr$





Como el ángulo de la intensidad en este caso se toma desde V, la intensidad tiene la expresión compleja $I = I_0 \angle \varphi = 4.84\ A \angle 27.32°$

$V_{12} = I_0 \cdot Z_{12} = (4{,}84\ A \cdot \angle 27.32°) \cdot (8.468\ \angle -32.13°\ \Omega) = 40.98\ V \angle -4.81° = (40.83 - 3.44j)\ V$

$V_{12ef} = V_{12_0} / \sqrt{2} = 28{,}97\ V$

$V_{23} = I_0 \cdot Z_{23} = (4.84\ A \angle 27.32°) \cdot (0.78\ \Omega \angle 38.51°) = 3.77 \angle 65.83°\ V = (1.545 + 3.44j)\ V$

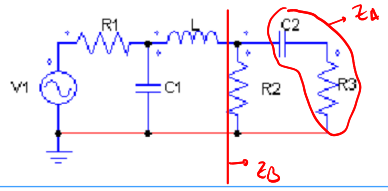
$V_T = V_{12} + V_{23} = (1.545 + 3.44j)V + (40.83 - 3.44j)V = 42.38 \angle 0.005°\ V$

↳ $V_{ef} = \frac{42.38\,V}{\sqrt{2}} = 29.96\,V \simeq 30V$

Comprobar que está bien por kirchhoff.

Problema 13 c

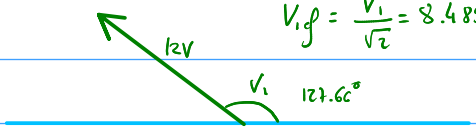
Hallad I (corriente que genera V_1) en el circuito inferior, sabiendo que $R_1 = 0{,}5\Omega$, $C_1 = 1F$, $L = 1H$, $C_2 = 0{,}5F$, $R_2 = 3\Omega$, $R_3 = 2\Omega$ y la tensión $V_1 = 12 \cdot sen(wt + 14)$.



$V_1 = 12V\angle 14rad = 12V\angle 2.28rad = 12V\angle 127.66°$

$w = 100\pi rad/s \quad f = 50Hz.$

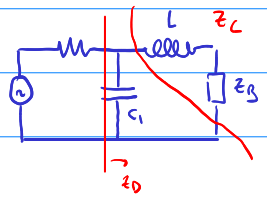
$V_{1ef} = \frac{V_1}{\sqrt{2}} = 8.485\ V$



$Z_A = X_{C_2} + R_3 = 2\Omega + \frac{-j}{wC_2} = 2\Omega - \frac{2j}{w} = 2\Omega - \frac{j}{50\pi}\Omega \cong 2\Omega.$

$Z_B^{-1} = \frac{1}{R_2} + \frac{1}{Z_A} = \frac{1}{3\Omega} + \frac{1}{2\Omega} = \frac{5}{6\Omega}$

$Z_B = 6/5\ \Omega$



$Z_C = X_L + Z_B = (100\pi rad/s \cdot 1H\,j + 6/5)\Omega = 314.16\angle 89.78°\ \Omega$

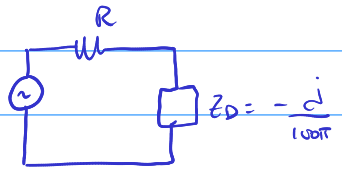
$Z_D^{-1} = \frac{1}{Z_C} + \frac{1}{X_{C_1}} = \frac{1}{314.16\angle 89.78°} + 100\pi\angle 90° \cong 100\pi\angle 90°$

$X_{C_1} = \frac{-j}{wC_1} = \frac{-j}{100\cdot\pi\cdot 1F} = \frac{1}{100\pi}\angle -90°\ \Omega$

$Z_D^{-1} = 100\pi\angle 90°\ \Omega^{-1}$

$Z_D = \frac{1}{100\pi}\angle -90°\ \Omega$

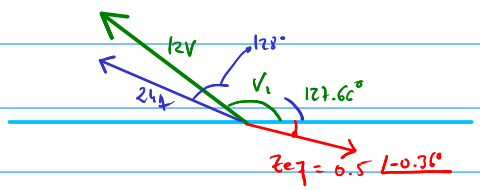
$Z_D = \frac{-j}{100\pi} \cong X_{C_1}$



$Z_{eq} = R - j/100\pi = \left(0.5 - \frac{j}{100\pi}\right)\Omega = 0.5\angle -0.36°\ \Omega$

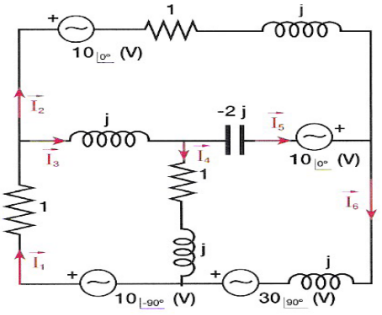
$I = \frac{V}{Z_{eq}} = \frac{12\angle 127.66°\ V}{0.5\angle -0.36°\ \Omega} = 24A\angle 128.0°$

$I_{ef} = \frac{24A}{\sqrt{2}} = 16.97\ A$

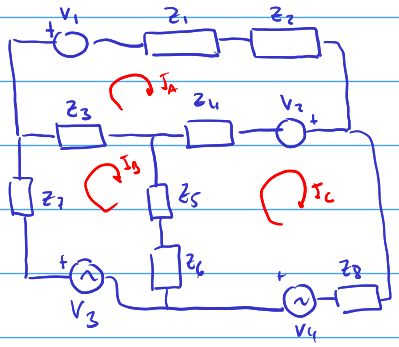


Intensidad adelantada respecto de la tensión.
Circuito Capacitivo.

Problema 13.D



C



$V_1 = 10\angle 0°$ V

$V_2 = 10\angle 0°$ V

$V_3 = 10\angle -90° V = -j\,10$ V

$V_4 = 30\angle 90°$ V $= 30j$ V

$Z_1 = 1\Omega$ $Z_2 = j\Omega$

$Z_3 = j\Omega$ $Z_4 = -2j\Omega$

$Z_5 = 1\Omega$ $Z_6 = j\Omega$

$Z_7 = 1\Omega$ $Z_8 = j\Omega$

A) $+V_1 + I_A(Z_1+Z_2) + V_2 + (I_A - I_C)Z_4 + Z_3(I_A - I_B) = 0$

$10 + I_A(1+j) + 10 - 2j\,I_A + 2j\,I_C + I_A j - I_B j = 0$

$I_A - I_B j + 2j\,I_C = -20$ V (I en A, V en V.)

B) $j(I_B - I_A) + (I_B - I_C)(1+j) - V_3 + I_B \cdot 1\Omega = 0$

$I_B(2+2j) - I_A j - I_C(1+j) = V_3$ $\quad -I_A j + (2+2j)I_B - (1+j)I_C = -10j$ V

C) $I_C j - V_4 + (I_C - I_B)(1+j) + (I_C - I_A)(-2j) - V_2 = 0$

$2j\,I_A - (1+j)I_B + I_C = V_2 + V_4 = (10+30j)$ V

A) $I_A - j\,I_B + 2j\,I_C = -20$ V

B) $-I_A j + (2+2j)I_B - (1+j)I_C = -10j$ V

C) $2j\,I_A - (1+j)I_B + I_C = 10+30j$ V

$$\begin{pmatrix} 1 & -j & 2j \\ -j & (2+2j) & -(1+j) \\ 2j & -(1+j) & 1 \end{pmatrix} \begin{pmatrix} I_A \\ I_B \\ I_C \end{pmatrix} = \begin{pmatrix} -20\text{ V} \\ -10j\text{ V} \\ 10+30j\text{ V} \end{pmatrix}$$

https://matrix.reshish.com/es/cramer.php

A y B) $(3+2j)I_B - (3+j)I_C = -30j$

A y C) $-(3+j)I_B + 5I_C = 10+70j$

$-2j \cdot A + C$

$\times 5$ → $5(3+2j)I_B - 5(3+j)I_C = -150j$

$+ \times(3+j)$ $\quad -(3+j)(3+j)I_B + 5(3+j)I_C = (10+70j)(3+j)$

$(15+10j-8-6j)I_B = 30+210j+10j-70-150j$

$(7+4j)I_B = -40+70j$ $\quad I_B = \dfrac{-40+70j}{7+4j} = 10j$ A

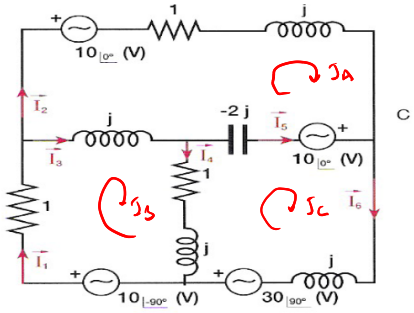
$I_C = \dfrac{(10+70j) + (3+j)10j}{5}$

$I_C = (2+14j) + (6j-2) =$

$I_C = 20j$

A) $I_A - j\,I_B + 2j\,I_C = -20$ V

$I_A = -20\text{V} + j\,I_B - 2j\,I_C = -20\text{V} - 10\text{V} + 40\text{V} = 10$ A



$I_A = 10\,A \qquad I_B = 10j\,A \qquad y \qquad I_C = 20j\,A$

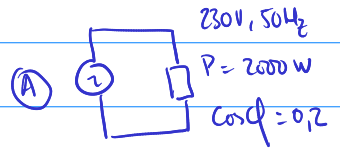
$I_1 = I_B = 10j\,A \qquad I_3 = I_B - I_A = (10j - 10)A = (-10+10j)\,A$

$I_2 = I_A = 10A \qquad I_4 = I_B - I_C = 10j - 20j\,A = -10j\,A$

$I_5 = I_C - I_A = 20j\,A - 10A = (-10+20j)A$

$I_6 = I_C = 20j\,A$

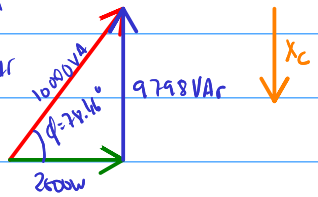
Problema 14

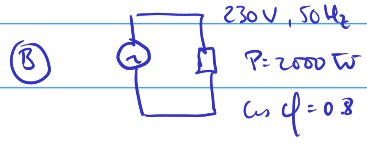


$\cos\varphi = 0.2 \Rightarrow \varphi = 78.46°$

$S = \frac{P}{\cos\varphi} = 10000\,VA$

$Q = S \cdot \operatorname{sen}(\varphi) = 9798\,VAr$

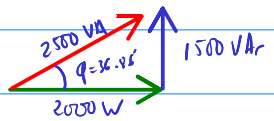




$\cos\varphi = 0.8 \Rightarrow \varphi = 36.86°$

$S = \frac{P}{\cos\varphi} = \frac{2000W}{0.8} = 2500\,VA$

$Q = S \cdot \operatorname{sen}\varphi = 1500\,VAr$



A: al A) le añado un condensador, tal que X_C compense la diferencia de Vtr.

$$Q = Q_A - Q_B = I_{ef}^2 \cdot |X_C| = \frac{V_{ef}^2}{|X_C|} \Rightarrow \qquad |X_C| = \frac{V_{ef}^2}{Q_A - Q_B} = \frac{(230V)^2}{9798\,V_{ar} - 1500\,VAr} =$$

$$\frac{1}{\omega C} = |X_C| = 6.375\,\Omega \qquad C = \frac{1}{\omega |X_C|} = \frac{1}{2\cdot\pi\cdot f\cdot |X_C|} = \frac{1}{100\pi\,rad/s \cdot 6.375\Omega} = 4.99\cdot 10^{-4}\,F$$

$= 500\,\mu F$