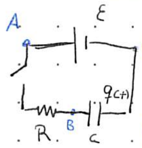
Corrent Altern

El sentit del Corrent (I) NO és constant.

Els condensadors sí que permeten el pas de corrent (Depenent del sentit)

Bobines d'auto-inducció # Nou element i tots anteriors

Transitori del Circuit RC



$t=0 \to$ Tancat ; $q(t) = q(0) = 0C$; $I(t)$ # Arribarà un punt on $I(t) = 0\,A$

$q(t) \begin{cases} t=0 \to q(0) = 0C \\ t=\infty \to q_{max} = C \cdot \mathcal{E} \end{cases}$; $I=0 \leftarrow$ Pq Condensador no deixarà passar més elec.

$0 = V_A - V_A = \underline{V_A - V_B} + \underline{V_B - V_C} + \underline{V_C - V_A}$

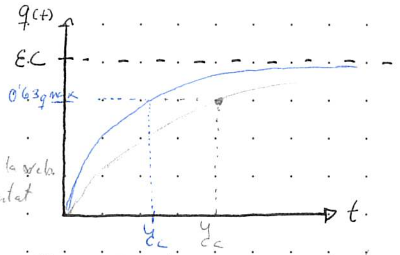
$0 = I(t) \cdot R + \frac{q(t)}{C}① + (-\mathcal{E})$ ① $q = C(V_+ - V_-) \to V_+ - V_- = \frac{q}{C}$

$\mathcal{E} = I(t) \cdot R + \frac{q(t)}{C}$ ② $I(t) = \frac{d\,q(t)}{d\,t}$

$$\boxed{\begin{aligned} \mathcal{E} &= \frac{d\,q(t)②}{d\,t} \cdot R + \frac{q(t)}{C} \\ q(t) &= \mathcal{E}C\left(1-e^{\frac{-t}{RC}}\right) \end{aligned}}$$

$\tau_c = RC \to$ Constant de temps

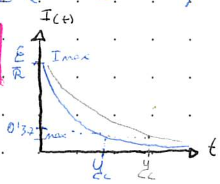
$q(t) = \mathcal{E}C\left(1-e^{\frac{-t}{\tau_c}}\right)$ ↳ Idea de la vela per arribar al estat estacionari



Quan ↑↑ $\tau_c \to$ Càrrega Lenta
Quan ↓↓ $\tau_c \to$ Càrrega Ràpida

$q(t=\tau_c) = \mathcal{E}C\left(1-e^{-\frac{\tau_c}{\tau_c}}\right) = \mathcal{E}C(1-e^{-1}) = 0'63 \cdot q_{max}$

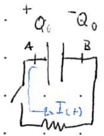
$\boxed{I(t) = \underbrace{\frac{\mathcal{E}}{R}}_{I_{max}} \cdot e^{\frac{-t}{\tau_c}}}$



$I(t=\tau_c) = I_{max}\,e^{-1} = 0'37\,I_{max}$

Quan ↑↑ $\tau_c \to I$ decreix lent
Quan ↓↓ $\tau_c \to I$ decreix ràpid

Pq $e^{-\infty} = 0$



$0 = V_A - V_A = \underline{V_A - V_B} + V_B - V_A$

$\frac{q(t)}{C} + (-I(t)R)$

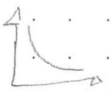
$\to q(t)$ decreix

$\frac{d\,q(t)}{dt} < 0$

$I(t)R = \frac{q(t)}{C}$

$I(t) = -\frac{d\,q(t)}{d\,t}$

$q(t) \Rightarrow t=0 \to q(t=0) = Q_0$
$I(t) \quad t=\infty \to q(t=\infty) = 0$
$I(t=\infty) = 0$



Totes dues decreixen en temps

$-\frac{d\,q(t)}{d\,t} \cdot R = \frac{q(t)}{C}$

$\boxed{I(t) = \frac{Q_0}{RC}\,e^{\frac{-t}{\tau_c}}}$

$q(t=\tau_c) = Q_0\,e^{-1} = 0'37\,Q_0$; $I(0) = \frac{Q_0}{RC} = \frac{\frac{Q_0}{C}}{R} = \frac{(V_A - V_B)_0}{R}$

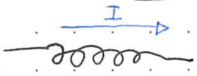
$I(t=\tau_c) = \underbrace{\frac{Q_0}{RC}}_{I_{max}} \cdot e^{-1} = 0'37\,I_{max}$

$$\left.\boxed{\begin{aligned} I(t) &= \frac{\mathcal{E}}{R} \cdot e^{\frac{-t}{\tau_c}} \\ q(t) &= \mathcal{E}C \cdot \left(1-e^{\frac{-t}{\tau_c}}\right) \end{aligned}}\right\}$$ Càrrega C.

Energia Condensador $\boxed{E = \frac{1}{2} \cdot \frac{Q^2}{C}}$

$$\left.\boxed{\begin{aligned} q(t) &= Q_0\,e^{\frac{-t}{\tau_c}} \\ I(t) &= \frac{Q_0}{RC} \cdot e^{\frac{-t}{\tau_c}} \end{aligned}}\right\}$$ Descàrrega C.

Autoinducció o Bobina



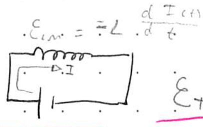
$\mathcal{E}_{in}$

Això ho fa amb Força electromotriu induïda

Si $I = const \rightarrow$ No fa res $\rightarrow \mathcal{E}_{in} = 0$

Si $I \neq const \rightarrow$ Reacciona $\begin{cases} \text{Si } I \text{ decreix} \rightarrow \text{Intenta augmentar } I \\ \text{Si } I \text{ augmenta} \rightarrow \text{Intenta disminuir } I \end{cases}$

$$\boxed{\mathcal{E}_{in} = -L \cdot \frac{d I_{(t)}}{dt}}$$ $L \Rightarrow$ Autoinducció, Henries (H)

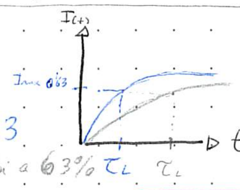


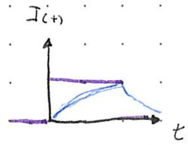
$\mathcal{E}_T = \mathcal{E} + \mathcal{E}_{in}$

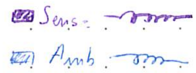
$$I_{(t)} = \frac{\mathcal{E} + \mathcal{E}_{in}}{R} \rightarrow I_{(t)} \cdot R = \mathcal{E} + \mathcal{E}_{in} \rightarrow \boxed{I_{(t)} \cdot R = \mathcal{E} + \left(-L \cdot \frac{d I_{(t)}}{dt}\right)} \rightarrow \boxed{I_{(t)} = \frac{\mathcal{E}}{R}\left(1 - e^{\frac{-tR}{L}}\right)}$$

$$\tau_L = \frac{L}{R} \rightarrow \boxed{I_{(t)} = \underbrace{\frac{\mathcal{E}}{R}}_{I_{final}}\left(1 - e^{\frac{-t}{\tau_L}}\right)}$$

Són la "mateixa"

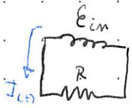






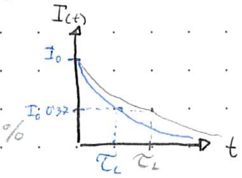
$$I_{(t=\tau_L)} = I_{max} \cdot (1 - e^{-1}) = I_{max} \cdot 0'63$$

Temps per que arribi a 63% τ_L



$$\mathcal{E}_{in} = I_{(t)} \cdot R \rightarrow \left(-L \frac{d I_{(t)}}{dt}\right) = I_{(t)} \cdot R$$

$$\boxed{I_{(t)} = I_0 \cdot e^{\frac{-t}{\tau_L}}}$$



$$I_{(t=\tau_L)} = I_0 \cdot e^{-1} = 0'37 \, I_0$$

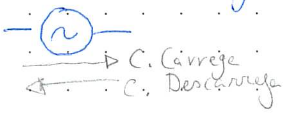
Temps pq arribi a 37%

Com les TV antigues que no s'encenien de cop.

Energia Bobina $\boxed{E = \frac{1}{2} \cdot L \cdot I^2}$

Corrent Altern

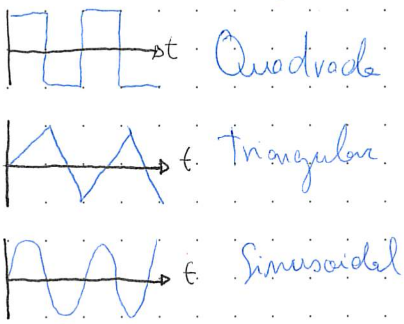
Volem que canvii el valor de ΔV pq I canvii de sentit i funcioni condensador.

Necessitem "Generador de Corrent Altern" 

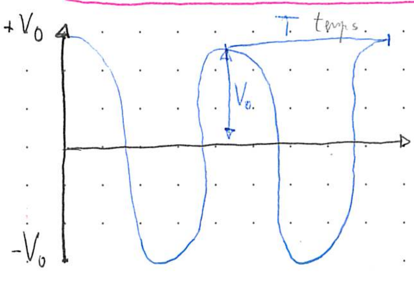
NO serà estacionària ni contínua.

Corrent Periòdica

Fluxe de Càrregues que tenen una serie de valors diferents que es repeteixen en temps.



$$\boxed{V_{(t)} = V_0 \cos(\omega t + \theta)}$$ Corrent Altern Sinusoidal



$$\boxed{\omega = \frac{2\pi}{T}}$$ Pulsació Senyal

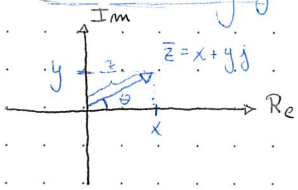
$$\boxed{V_0 \cos(\omega t + \theta + \omega T)}$$ # θ = fase inicial

$$\boxed{f = \frac{1}{T}}$$ (Hz) Freqüència

Intro Números Complexes $\mathbb{C}$

Números Imaginaris + $\mathbb{R}$; $j \Rightarrow j^2 = -1 \rightarrow j = \pm 1$ (Els típics "i")

$\bar{z} \equiv x + yj$ on $x, y \in \mathbb{R}$, $\bar{z} \in \mathbb{C}$



$x = Re(\bar{z}) \Rightarrow$ Part Real ; $y = Im(\bar{z}) \Rightarrow$ Part Imaginaria

$Re(\bar{z}) = 0$ $\bar{z}$ imaginari par ; $Im(\bar{z}) = 0 \Rightarrow$ Real Par

Mòdul del Vector $z = \|\bar{z}\| = \sqrt[2]{x^2+y^2}$ Reescriure: $x = z\cos(\theta)$; $y = z\sin(\theta)$; $\bar{z} = z\cos(\theta) + z\sin(\theta) = z\underbrace{(\cos + j\sin(\theta))}_{}$

Rad o Graus   # euler $e^{j\theta}$

Argument θ: $\sin(\theta) = \frac{y}{z}$ o $tg\,\frac{y}{x}$ θ: $\arcsin\left(\frac{y}{z}\right)$ o $\arctan\left(\frac{y}{z}\right) = \arctan\left(\frac{Im(\bar{z})}{Re(\bar{z})}\right)$

Fòrmula Euler: $\theta \in \mathbb{R}$ $e^{j\theta} = \cos(\theta) + j\,sen(\theta)$ → θ és un angle NOMÉS radians

Reescriure 2: $\bar{z} = z\angle\theta \equiv z e^{j\theta}$

↳ Rad o Graus

Suma $\bar{z}_1, \bar{z}_2$ i Resta

Fàcil si ho fas forma cartesiana. $\bar{z}_1 + \bar{z}_2 = (x_1 + y_1 j) + (x_2 + y_2 j) = (x_1 + x_2) + (y_1 + y_2)j$

Cartesià

Multiplicació $\bar{z}_1 \cdot \bar{z}_2$

Cartesià

$$\bar{z}_1 \cdot \bar{z}_2 = (x_1 + y_1 j)\cdot(x_2 + y_2 j) = x_1 x_2 + x_1 y_2 j + x_2 y_1 j + \underbrace{y_1 y_2 \overbrace{j^2}^{-1}}_{\in \mathbb{R}} =$$
$$= (x_1 x_2 - y_1 y_2) + (x_1 y_2 + x_2 y_1) j$$

$\bar{z}_1 = z_1 e^{j\theta_1}$; $z_2 = z_2 e^{j\theta_2}$ ‖ $\bar{z}_1 \cdot \bar{z}_2 = z_1 e^{j\theta_1} \cdot z_2 e^{j\theta_2} = e^{j(\theta_1+\theta_2)} \, \overbrace{z_1 \cdot z_2}^{\text{Prod. del mòdul}}$

↳ Suma arguments

$$z_1 \angle\theta_1 \cdot z_2 \angle\theta_2 = z_1 z_2 \angle\theta_1 + \theta_2$$

Divisió $\bar{z}_1 \div \bar{z}_2$

$$\frac{\bar{z}_1}{\bar{z}_2} = \frac{z_1 e^{j\theta_1}}{z_2 e^{j\theta_2}} = \frac{z_1}{z_2} e^{j\theta_1} \cdot e^{-j\theta_2} = \frac{z_1}{z_2} e^{j(\theta_1 - \theta_2)}$$

$$\frac{z_1 \angle\theta_1}{z_2 \angle\theta_2} = \frac{z_1}{z_2} \angle\theta_1 - \theta_2$$

Complexe Conjugat

$$\frac{1}{\bar{z}} \cdot \frac{\bar{z}^*}{\bar{z}^*} = \frac{x - yj}{z^2} = \frac{1}{x + yj} = \frac{x}{x^2+y^2} - \frac{y}{x^2+y^2} j$$

$\bar{z} = x + yj$

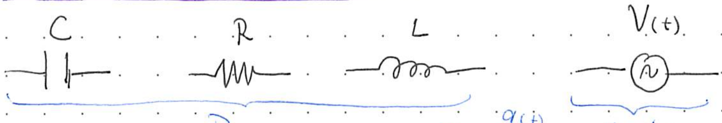
Complexe Conjugat $\bar{z}^* = x - yj$

No theta

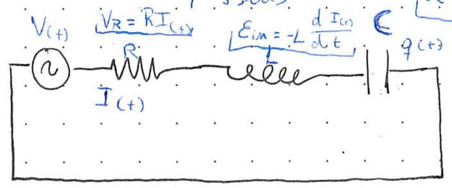
$\bar{z} \cdot \bar{z}^* \in \mathbb{R} = x^2 + y^2 + 0j = z^2$

$z = \sqrt{x^2+y^2} \rightarrow z^2 = x^2 + y^2$

Corrent Altern (2ª Part)



$V_C = \frac{q(t)}{C}$



$$V_{(t)} + \mathcal{E}_{in} = R I_{(t)} + \frac{q(t)}{C}$$

$$I_{(t)} = \frac{d\, q(t)}{d\, t}$$

$$V_{(t)} = R I_{(t)} + \frac{q(t)}{C} + L \frac{d I_{(t)}}{d\, t}$$

$$V_{(t)} = V_0 \cos(\omega t + \theta)$$

$$\boxed{I_{(t)} = I_0 \cos(\omega t + \alpha)}$$

$$\boxed{\frac{d V_{(t)}}{d\, t} = L \frac{d^2 I_{(t)}}{d\, t} + R \frac{d I_{(t)}}{d t} + \frac{1}{C} I_{(t)}}$$

$$\underbrace{I_{(t)} = I_{\text{periòdica}}(t)}_{\text{Núm. } \mathbb{C}} + \overbrace{I_{\text{transitòria}}(t)}^{0 \text{ ràpidament}}$$

$$\bar{z} = x + y j = \underbrace{z\cos(\theta)}_{Re} + \underbrace{z\sin(\theta)}_{Im} j$$

Tensió Complexe

$$\bar{V}_{(t)} = V_0 e^{j(\omega t + \theta)} = \underbrace{V_0 \cos(\omega t + \theta)}_{Re(\bar{V}_{(t)}) \equiv V_{(t)}} + V_0 \sin(\omega t + \theta) \cdot j$$

Voltatge Real Circuit

Intensitat Complexe

$$\bar{I}_{(t)} = I_0 e^{j(\omega t + \alpha)} = \underbrace{I_0 \cos(\omega t + \alpha)}_{Re(I_{(t)}) \equiv I_{(t)}} + I_0 \sin(\omega t + \alpha) j$$

Intensitat Real Circuit

FASORS

$$\bar{V}_{(t)} = V_0 e^{j\omega t} e^{j\theta} = V_0 e^{j\theta} e^{j\omega t} \; ; \; \boxed{V_0 e^{j\theta} \equiv \bar{V} \rightarrow \text{Fasor de la tensió}}$$

$$\boxed{\bar{V}_{(t)} = \bar{V} e^{j\omega t}}$$

$$\bar{I}_{(t)} = I_0 e^{j\alpha} \cdot e^{j\omega t} \; ; \; \boxed{\bar{I} \equiv I_0 e^{j\alpha} \rightarrow \text{Fasor d'Intensitat}}$$

$$\boxed{\bar{I}_{(t)} = \bar{I} e^{j\omega t}}$$

$$\boxed{\bar{I} = \frac{\bar{V}}{R + j\left(L\omega - \frac{1}{C\omega}\right)}}$$

Llei d'Ohm en Corrent Altern

$$\boxed{\bar{Z} = \underbrace{R}_{Re(\bar{z})} + \overbrace{\left(L\omega - \frac{1}{C\omega}\right)}^{Im(\bar{z}) \equiv X \rightarrow \text{Reactància}} j}$$

Impedància complexa

Reactància

$$L\omega - \frac{1}{C\omega} = Im(\bar{z}) \equiv X \rightarrow \text{Impedància}$$

$$X_L = L\omega \rightarrow \text{Reactància inductiva}$$

$$X_C = \frac{1}{C\omega} \rightarrow \text{Reactància capacitiva}$$

$$X = X_L - X_C$$

$$z = \sqrt{R^2 + X^2} = \sqrt{R + \left(L\omega - \frac{1}{C\omega}\right)^2}$$

Argument de $\bar{z}$ $\rightarrow \varphi = \operatorname{arctg}\left(\frac{X}{R}\right) = \operatorname{arctg}\left(\frac{L\omega - \frac{1}{C\omega}}{R}\right)$

$$\bar{Z} = z \cdot e^{j\varphi} \equiv z \angle \varphi$$

$$\bar{I} = \frac{\bar{V}}{\bar{z}}$$

$$I_0 e^{j\alpha} = \frac{V_0 e^{j\theta}}{z e^{j\varphi}} = \frac{V_0}{z} \cdot e^{(\theta - \varphi) j}$$

$$I_0 = \frac{V_0}{z} \rightarrow \text{Mòdul}$$

$$\alpha = \theta - \varphi \rightarrow \text{Fase Inicial}$$

$$I = \frac{V_0}{z} \cos(\omega t + \theta - \varphi)$$

Màxim tensió i Intensitat no coincidiran

Estan desfasades (Donat per $-\varphi$)

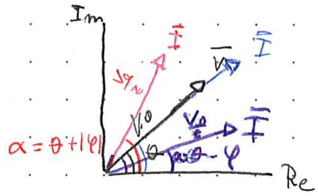


Diagrama fasorial

$$\bar{V} = V_0 e^{j\theta}$$

$$\bar{I} = \frac{V_0}{z} e^{(\theta - \varphi) j}$$

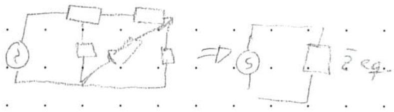
a) $X > 0$, $X_L > X_C$, $\varphi > 0 \Rightarrow \theta - \varphi < \theta$ — I dessfassada de V (Dessfassada)
$\left(L\omega > \frac{1}{C\omega}\right)$

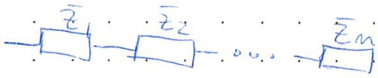
b) $X < 0$, $X_L < X_C$, $\varphi < 0 \Rightarrow \theta - \varphi > \theta + |\varphi| > \theta$ — I desfessada de V (Avançada)

c) $X = 0$, $X_L = X_C$, $\varphi = 0 \Rightarrow \alpha = \theta$ — En fase

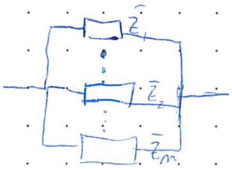
Circuits de Corrent Altern

Única Font de Tensió —Ⓢ— . Tipus → Circuit en Sèrie / → Circuits no Sèrie



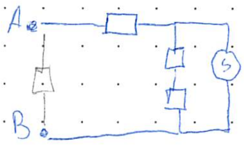


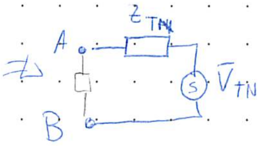
$\Rightarrow \bar{Z}_{eq} = \sum_i \bar{Z}_i$ (Sèrie)



$\Rightarrow \frac{1}{\bar{Z}_{eq}} = \sum_i \frac{1}{\bar{Z}_i}$ (Paral·lel)

Eq. Thevenin en C.A





$\bar{Z}_{TN} \equiv \bar{Z}_{eq}$ entre A i B

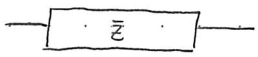
$\bar{V}_{TN} \equiv$ Fasor Tensió entre A i B

Potència del C.A.

Potència Instantània

$\# \cos(A) \cdot \cos(B) = \frac{\cos(A-B)}{2} + \frac{\cos(A+B)}{2}$

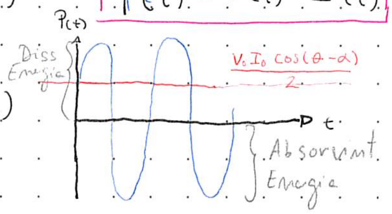
$V(t) = V_0 \cos(\omega t + \theta)$



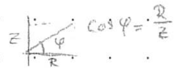
$I(t) = I_0 \cos(\omega t + \alpha)$

$$\boxed{P(t) = V(t) \cdot I(t)} = V_0 I_0 \cos(\overbrace{\omega t + \theta}^{A}) \cos(\overbrace{\omega t + \alpha}^{B}) =$$

$$= \underbrace{\frac{V_0 I_0 \cos(\theta - \alpha)}{2}}_{\text{Indep de } t} + \underbrace{\frac{V_0 I_0 \cos(2\omega t + \theta + \alpha)}{2}}_{\text{Depen de } t}$$



Potència Mitjana



$$P = \frac{1}{T} \int_0^T P(t')\, dt' = \boxed{\frac{1}{2} I_0 V_0 \cos(\theta - \alpha)}$$

$$P = \frac{1}{2} I_0 V_0 \cos(\varphi) = \frac{1}{2} I_0 V_0 \frac{R}{Z} = \boxed{\frac{1}{2} I_0^2 \cdot R = P}$$

$$\boxed{V_{ef} = \frac{V_0}{\sqrt{2}}} \qquad \boxed{I_{ef} = \frac{I_0}{\sqrt{2}}}$$

$$P = \frac{1}{2} I_0 V_0 \cos(\varphi) = \frac{1}{2} \cdot (\sqrt{2} I_0) \cdot (\sqrt{2} V_0) \cdot \cos(\varphi) =$$

$$\boxed{P = I_{ef} \cdot V_{ef} \cdot \cos(\varphi)}$$

$\boxed{P = I_{ef}^2 R}$ Llei de Joule en C.A.

$$\boxed{\cos(\varphi) = \frac{R_{eq}}{Z_{eq}} \equiv \text{Factor de Potència}}$$

$\left.\begin{array}{l}\bar{Z} = R \\ Z = R\end{array}\right\}$ $\cos\varphi = 1 \Rightarrow P = I_{ef} V_{ef}$

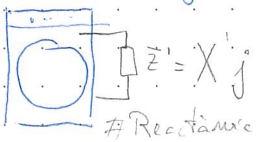
$\left.\begin{array}{l}\bar{Z} = Xj \\ Z = X\end{array}\right\}$ $\cos\varphi = 0 \Rightarrow P = 0$

$P = I_{ef} \cdot V_{ef} \cdot \cos(\varphi)$ $\cos(\varphi)$ petit $\Rightarrow I_{ef}$ gran

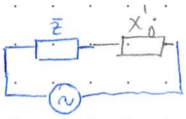
Volem que factor de potència $[\cos(\varphi)]$ sigui el màxim

$\cos(\varphi)\uparrow$ gran $\Rightarrow I_{ef}$ petit.

Si ens arriba un $\cos(\varphi)$ petit, hem de corretgir el factor de potència el més gran possible $[\cos(\varphi) = 1]$



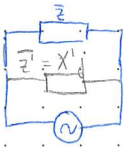
Reactància pura



$\bar{Z}_{eq} = \bar{Z} + X'j = R + \boxed{(X + X')j}$ sigui 0 donat que $\cos(\varphi) = \frac{R}{Z} = 1$

$R = Z$

Part Im sigui 0.



$$\bar{Z}_{eq} = \frac{1}{\bar{Z}} + \frac{1}{\bar{Z}'} = \frac{1}{R + Xj} \cdot \frac{R - Xj}{R - Xj} + \frac{1}{X'j} \cdot \frac{-Xj}{-Xj} =$$

$$= \frac{RX' - (X \cdot X' + R^2 + X^2)j}{X'(R^2 + X^2)}$$

$$\boxed{X' = \frac{-Z^2}{X}}$$

$P = \frac{1}{2} I_0 V_0 \cos(\varphi) = I_{ef} V_{ef} \cos(\varphi) \Rightarrow$ Potència Dissipada / Potència Activa $[Watts]$

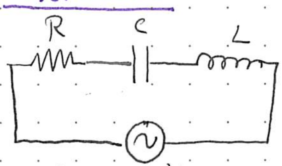
$S = \frac{1}{2} V_0 I_0 = I_{ef} V_{ef} \Rightarrow$ Potència Aparent $\left(\begin{matrix}\text{Màxima Pot} \\ \text{Si } \cos(\varphi) = 1\end{matrix}\right)$ $[V \cdot A]$

$$\bar{S} = \frac{1}{2} \bar{I}^* \bar{V} = \frac{1}{2} V_0 e^{j\theta} I_0 e^{-j\alpha} = \frac{1}{2} I_0 V_0 e^{(\theta - \alpha)j} = \frac{1}{2} I_0 V_0 e^{\varphi j} = I_{ef} V_{ef} e^{\varphi j} =$$

$= I_{ef} V_{ef} \cos(\varphi) + (I_{ef} V_{ef} \sin(\varphi))j \Rightarrow$ Potència Complexa

- Mòdul $\bar{S} \equiv I_{ef} V_{ef} =$ Pot. Aparent
- $Re(\bar{S}) = I_{ef} V_{ef} \cos(\varphi) =$ Pot. Activa
- $Im(\bar{S}) = V_{ef} I_{ef} \sin(\varphi) =$ Pot. Reactiva

Resonància



ω no fixe

$$\boxed{P = I_{ef} V_{ef} \cos(\varphi) = \frac{V_{ef}^2 \cdot R}{Z^2} = \frac{1}{2} \cdot \frac{V_0^2 \cdot R}{Z^2} = \frac{1}{2} \cdot \frac{V_0^2 \cdot R}{R^2 + \underbrace{(X_L - X_C)^2}_{\text{Això depèn de } \omega}}}$$

Freq. de resonància f_0 / Pulsació de resonància ω_0 $\Big\}$ P sigui màxima $\Rightarrow R^2 + (X_L - X_C)^2$ mínim

$(X_L - X_C)^2$ mínim

$$\boxed{f_0 = \frac{\omega_0}{2\pi} = \frac{1}{2\pi} \cdot \frac{1}{\sqrt{LC}}}$$

Condició de Resonància: $\boxed{X_L = X_C}$ Circuit en resonància

per $\omega = \omega_0$ $\underline{X_L - X_C = 0}$

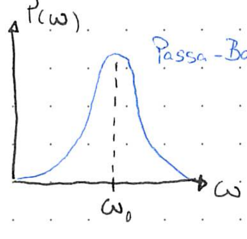
$$\boxed{P(\omega) = \frac{1}{2} \cdot \frac{V_0^2 \cdot R}{R^2 + (X_L + X_C)^2} = \frac{1}{2} \cdot \frac{V_0^2 R \omega^2}{\omega^2 R^2 + L^2(\omega^2 - \omega_0^2)^2}}$$

$\rightarrow$ Pot màxima

$\rightarrow X = 0 \Rightarrow \bar{Z} = R + 0j \Rightarrow \varphi = 0°$

$\Rightarrow I_{(t)}$ i $V_{(t)}$ en fase.

$\rightarrow \omega_0 L = \frac{1}{\omega_0 C} \Rightarrow \boxed{\omega_0 = \frac{1}{\sqrt{LC}}}$

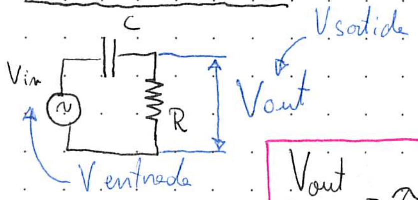


Filtres

Detectar ω grans o f grans $\Rightarrow$ Filtre Passa-Alts

ω petites o ω petits $\Rightarrow$ Filtre Passa-baixos

Filtre Passa-Alts



$$\boxed{\frac{V_{out}}{V_{in}} = \tau = \text{funció de transferència}}$$

$$\boxed{\overline{V_{out}} = \overline{I} \cdot \overline{Z}_R \Rightarrow V_{out} = I_0 R}$$

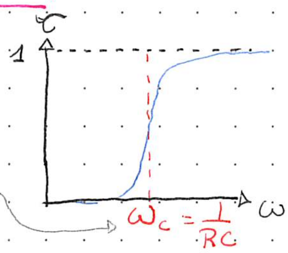
$$\boxed{\overline{I} = \frac{\overline{V_{in}}}{\overline{Z}} \Rightarrow I_0 = \frac{V_{in}}{\sqrt{R + X_c^2}}}$$

$$\boxed{V_{out} = \frac{V_{in} \cdot R}{\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}}}$$

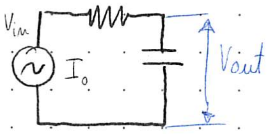
$$\boxed{\tau = \frac{V_{out}}{V_{in}} = \frac{RC\omega}{\sqrt{R^2C^2\omega^2 + 1}}}$$

$$\boxed{\frac{V_{out}}{V_{in}} = \frac{R}{Z}}$$ Només en aquest context

$R^2C^2\omega^2 \simeq 1$ $\rightarrow$ $\omega_c = \frac{1}{RC}$

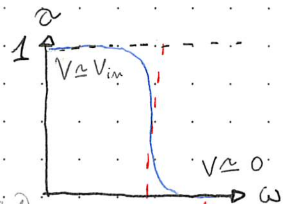


Filtre Passa-Baixos



$$\boxed{V_{out} = \frac{V_{in}}{\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}} \cdot \frac{1}{\omega C}}$$

$$\boxed{\tau = \frac{1}{\sqrt{R^2C^2\omega^2 + 1}}}$$



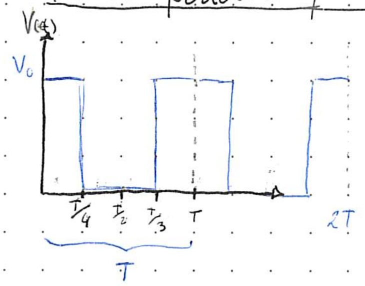
$R^2C^2\omega^2 \simeq 1$ $\rightarrow$ $\omega_c = \frac{1}{RC}$

Per saber si és passa $\rightarrow$ Baixos / $\rightarrow$ Alts s'ha de dibuixar i veure que passa amb div. valors

Superposició de Senyals i Ample de Banda

$V(t) = V_0 \cos(\omega t)$ període de T.

Funció periòdica quadrada simètrica



Tmb cap endarrere

Teorema de Fourier

Els parell són 0

$V(t)$ periòdica $V(t+T) = V(t)$, $f = \frac{1}{T}$

$$\boxed{V(t) = \frac{A_0}{2} + \sum_{n=1}^{\infty} A_n \cos(2\pi n f_0 t) + \sum_{n=1}^{\infty} B_n \sin(2\pi n f_0 t)}$$

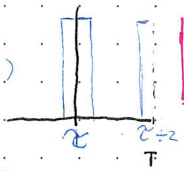
Harmònics ordre n:

$$\left.\begin{array}{l} A_n \cos(\omega_n t) \\ B_n \sin(\omega_n t) \end{array}\right\} \begin{array}{l} A_n \text{ amplades} \\ \omega_n = n\,\omega_0; \end{array}$$

$$\boxed{V(t) = \frac{V_0}{2} + \sum_{n=1}^{\infty} \frac{2V_0}{n\pi} \sin\left(\frac{n\pi}{2}\right) \cos(2\pi f_0 n t)}$$

Pols d'Amplada τ # qualsevol amplada

$$V(t) \begin{cases} V_0 = 0 < t < \tau \div 2 \\ 0 = \tau \div 2 < t < T - (\tau \div 2) \\ V_0 = T - (\tau \div 2) < t < T \end{cases}$$



$$\boxed{V(\omega) = \frac{2V\tau}{T} \cdot \frac{\sin(n\omega_0 \tau \div 2)}{n\omega_0 \tau \div 2}}$$

$$\boxed{A(\omega) = E_0 \frac{\sin(\omega\tau \div 2)}{\omega\tau \div 2}}$$ Pols aïllat.

Pols aïllat: Senyal aïllada; Superposició: 2 senyals succeixen al mateix temps i convinen

Veloitat de transmissió Ample de Banda

La veloitat s'expresa en bits/segon (bauds) $\frac{1 \text{ bit}}{\text{segon}}$

$$\boxed{V = \frac{1}{2\tau} = \frac{BW}{2}}$$

$$\boxed{BW = \frac{1}{\tau} = 2V}$$

→ veloitat de transmissió

→ Band With

vel ↑↑ $\begin{cases} \text{Amplada pols } \tau \text{ petita} \\ \text{BW gran} \end{cases}$

1. Quants cops ha de transcórrer τ_c sigui 99%

$t \to \infty \quad q_{max} = \mathcal{E}C$

$$q(t) = \mathcal{E}C(1-e^{\frac{-t}{\tau_c}}) = q_{max}(1-e^{\frac{-t}{\tau_c}})$$

$$t^* \to q(t^*) = 0'99 \cdot q_{max} = q_{max} \cdot (1-e^{\frac{-t^*}{\tau_c}}) \to q(t^*) = 0'99 = 1-e^{\frac{-t^*}{\tau_c}}$$

$$e^{\frac{-t^*}{\tau_c}} = 1-0'99 = 0'01 \to \ln(e^{\frac{-t^*}{\tau_c}}) = \ln(0'01) \to \frac{-t^*}{\tau_c} = \ln(0'01) \to t^* = -\tau_c \ln(0'01)$$

$\ln(x)$ on $x<1$ = negatiu $\quad t^* = -(-4'61) \to \boxed{t^* = 4'61\tau_c}$

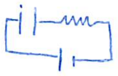
$$I(t) = I_{max} \cdot e^{\frac{-t}{\tau_c}}$$

$$I(t^*) = I_{max} \cdot e^{-\frac{t^*}{\tau_c}} = I_{max} \cdot e^{\frac{-4'61\tau_c}{\tau_c}} = I_{max} \cdot e^{-4'61} = I_{max} \cdot 0'01$$

2. $C = 40\mu F$

$R = 2k\Omega$

$\mathcal{E} = 200\,V$



a) Intensitat Inicial I_0

$$I_{(0)} = \frac{Q_0}{RC} = \frac{\frac{Q_0}{C}}{R} = \frac{(V_A - V_B)_0}{R} = \frac{200}{2000} = \frac{1}{10} = \boxed{0'1\,A = I_{(0)}}$$

$40 \times 10^{-6} \cdot 2000 = 0'08$

b) Eq. corrent en funció temps.

$$I(t) = \frac{\mathcal{E}}{R} \cdot e^{\frac{-t}{\tau_c}} = 0'1 \cdot e^{\frac{-t}{\tau_c}} = [\tau_c = RC] = 0'1 \cdot e^{\frac{-t}{40\mu F \cdot 2000}} = \boxed{0'1 \cdot e^{\frac{-t}{0'08}}}$$

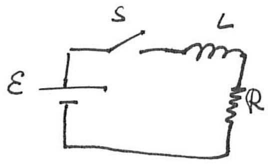
c) Eq. càrrega condensador funció temps.

$$q(t) = \mathcal{E}C \cdot (1-e^{\frac{-t}{\tau_c}}) = 200 \cdot 40 \times 10^{-6} \cdot (1-e^{\frac{-t}{40 \times 10^{-6} \cdot 2000}}) = 0'008 \cdot (1-e^{\frac{-t}{0'08}}) = \boxed{0'008(1-e^{\frac{-t}{0'08}})}$$

4. $R = 175\,\Omega$

$I = 36\,mA$

#No pot augmentar més de 4'9 mA els primers 58 μs $\quad I(58) \leq 4'9\,mA$



a) Quant val $\mathcal{E}$?

En estacionari (Estat) L no fa res.

$$I_S = \frac{\mathcal{E}}{R} \Rightarrow \mathcal{E} = I_S \cdot R \to \mathcal{E} = 36 \times 10^{-3} \cdot 175 = 6'3V$$

b) Quant ha de valer autoinducció L?

$$I(t) = \frac{\mathcal{E}}{R}(1-e^{\frac{-tR}{L}}) \to I(t) = I_S(1-e^{\frac{-t}{\tau_L}}); \; I(t_x) = I_c = I_S(1-e^{\frac{-t_x}{\tau_L}})$$

(t_x: 58 μs; I_c: 4'9 mA; I_S: 36 mA)

$$\frac{I_c}{I_S} = (1-e^{\frac{-t_x}{\tau_L}}) \to e^{\frac{-t_x}{\tau_L}} = 1-\frac{I_c}{I_S} \to \frac{-t_x}{\tau_L} = \ln(1-\frac{I_c}{I_S}) \to \tau_L = \frac{-t_x}{\ln(1-\frac{I_c}{I_S})} = 396'42\,ms$$

$$\tau_L = 396'42\,ms = \frac{L}{R} \to L = 396'42 \times 10^{-6} \cdot 175 = 0'0694\,H = \boxed{69'4\,mH = L}$$

c) Quant valdrà la constant de temps del circuit?

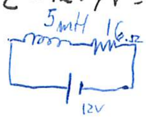
$$\tau_L = \frac{L}{R} = \frac{69'4 \times 10^{-3}}{175} = 396'5 \times 10^{-6}\,seg = \boxed{396'5\,\mu s = \tau_L}$$

3.

$L = 5\,mH = 5 \times 10^{-3}\,H$

$R = 15\,\Omega$

$\mathcal{E} = 12V, \; r = 1\,\Omega$



a) Calc I després de 100 μs

$$I(t) = \frac{\mathcal{E}}{R} \cdot (1-e^{\frac{-t}{\tau_L}}) \to I_{(100\mu s)} = \frac{12}{16} \cdot \left(1-e^{\frac{-100 \times 10^{-6}}{\frac{5 \times 10^{-3}}{16}}}\right) = \boxed{0'2054\,A = I_{(100\mu s)}}$$

b) Traiem la pila, quina serà I 20 μs després d'assolir règim estacionari?

Règim estacionari és aquell punt on I no varia en funció del temps. $\quad I_{max} = \frac{12}{16} = 0'75\,A$

$$I(t) = I_{max} \cdot e^{\frac{-t}{\tau_L}} \to I_{(20\mu s)} = 0'75 \cdot e^{\frac{-20 \times 10^{-6}}{\frac{5 \times 10^{-3}}{\cancel{16}\;15}}} = \boxed{0'706\,A = I_{(20\mu s)}}$$

! Pq ara hem tret la bateria i llavors desapareix r

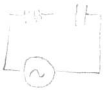
⑤. Det. Fassor d'Intensitat que circula.

$R = 80\,\Omega$

$C = 40\,\mu F$

$V(t) = (500\,V)\cos(\underbrace{2500t}_{\omega t} - \underbrace{\tfrac{\pi}{9}}_{\theta})$

Voltatge Real



$Z = R + jX$ on $X = \frac{-1}{\omega C}$

$\theta = \frac{-\pi}{9}$ rad/s $\left[\begin{matrix} 2\pi - 360 \\ \frac{\pi}{9} - x \end{matrix}\right] = -20^\circ$

$Z = 80 + \frac{-1}{2500 \cdot 40 \times 10^{-6}} j = 80 - 10j$

$V = 500 \angle -\frac{\pi}{9}$ ← 2 maneres

$V = 500\, e^{-\frac{\pi}{9} j}$

$I = \frac{V}{Z}$ = [Com que denom. té Im. s'ha de multipl. pel conjugat] $= \frac{V \cdot (Z^*)}{Z \cdot (Z^*)}$; $Z^* = 80 + 10j$

$I = \frac{500 \angle -20^\circ}{80 - 10j} \cdot \frac{80 + 10j}{80 + 10j} = \frac{80 \cdot 80 + 80 \cdot 10j - 10j \cdot 80 - 10j \cdot 10j}{80^2 - (10j)^2} = \frac{40000 + 5000j}{6500}$

$80^2 - (10j)^2 = 6400 + 100 = 6500$

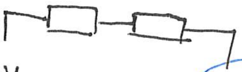
$|I| = \sqrt{a^2 + b^2} = \sqrt{\left(\frac{40000}{6500}\right)^2 + \left(\frac{5000}{6500}\right)^2} = 6'2\,A = |I|$

$\varphi = \operatorname{arctg}\left(\frac{X}{R}\right) = \operatorname{arctg}\left(\frac{-10}{80}\right) = -0'124$ rad

$6'2\,A \angle -12'9^\circ$

El angle és α: $\theta - \varphi = \frac{-\pi}{9} - (-0'124) = -0'22$ rad $= 12'9^\circ$

⑦. R, L, C ← Trobar això.



$V(t) = 300\,V\, \boxed{\text{sin}}(100\,t + \frac{\pi}{3})$! Això ho de ser cos

$I(t) = 4A \cdot \cos(1000\,t + \frac{\pi}{6})$

$V_0 = 300\,V$ | $I_0 = 4A$

$\omega = 1000$ rad/s | $\alpha = \frac{\pi}{6}$

$\theta = \frac{-\pi}{6}$

$\boxed{R = 37'5\,\Omega}$

$\boxed{C = 15'4\,\mu F}$

$\bar{I} = \frac{\bar{V}}{\bar{Z}} \Rightarrow \bar{Z} = \frac{\bar{V}}{\bar{I}} = R + (L\omega - \frac{1}{C\omega})$

$\bar{V} = V_0 \cos(\omega t + \theta)$

$\cos(x) = \sin(x + \frac{\pi}{2})$

$300\,V \cdot \cos(100t + \frac{\pi}{3} - \frac{\pi}{2}) =$

$= \underbrace{300\,V \cdot \cos(100\,t - \frac{\pi}{6})}$ → Ara ja puc fer-ho.

$\bar{I} = I_0 e^{j\alpha} = (4A)\, e^{\frac{\pi}{6} j}$

$\bar{V} = (300\,V) \cdot e^{\frac{-\pi}{6} j}$

$\bar{Z} = \frac{\bar{V}}{\bar{I}} = \frac{300 \angle \frac{-\pi}{6}}{4 \angle \frac{\pi}{6}} = 75\,\Omega \angle \frac{-\pi}{6} - \frac{\pi}{6} = \frac{-\pi}{3} = 75 \angle \frac{-\pi}{3}$

$\cos(x) = \cos(-x)$

$\sin(-x) = -\sin(x)$

$\bar{Z} = (75\,\Omega) \cdot e^{-\frac{\pi}{3} j} = 75 \cos(\frac{-\pi}{3}) + (75 \sin(\frac{-\pi}{3}))j =$

$= 75 \cos(\frac{\pi}{3}) - (75 \sin(\frac{\pi}{3}))j =$

$= 37'5\,\Omega - (64'95\,\Omega)j$

$Re(\bar{Z}) = 37'5$ | $Im(\bar{Z}) = -64'95 = -X_c = -\frac{1}{C\omega}$

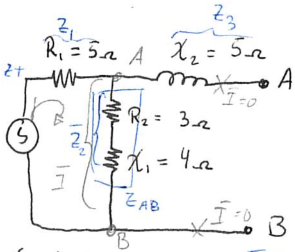
→ Com que és negatiu et diu que és Condensador, sino seria Bobina (L)

$\frac{1}{C\omega} = 64'95$

$C = \frac{1}{\omega \times 64'95}$

$C = \frac{1}{1000 \times 64'95} = 15,4\,\mu F$

(11).



$V_{(t)} = (10V)\cdot \sin(\omega t) = \left[\begin{array}{l}\sin(\alpha) = \\ = \cos(\alpha - \frac{\pi}{2})\end{array}\right]$

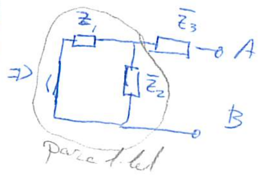
$V_0 = 10V$ No me la diuen
$\omega = ?$
$\theta = \frac{-\pi}{2} = -90°$

$V_{(t)} = (10V)\cdot(\omega t - \frac{\pi}{2})$

$Z_1 = (5\Omega) + 0j$

$\bar{Z}_2 = (+3\Omega) + (4\Omega)j$

$\bar{Z}_3 = 0\Omega + (5\Omega)j$



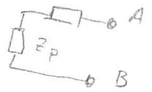
$\bar{Z}_p = \frac{1}{Z_1} + \frac{1}{\bar{Z}_2} = \frac{1}{5} + \frac{1}{3+4j} = \frac{1}{5} + \frac{1}{3+4j} \cdot \frac{3-4j}{3-4j} = \frac{1}{5} + \frac{3-4j}{3^2+4^2} =$

$= \frac{1}{5} + \frac{3-4j}{25} = \frac{5}{25} + \frac{3-4j}{25} = \frac{8-4j}{25} = Z_{TOT}$

Pq?

$\bar{Z}_p = \frac{1}{8-4j} \cdot 25 \frac{8+4j}{8+4j} = \frac{25(8+4j)}{8^2+4^2} = \frac{200}{80} + \frac{100}{80}j$

$\bar{Z}_p = (2'5) + (1'25)j$



$\bar{Z}_{eq} = \bar{Z}_p + \bar{Z}_3 = (2'5) + 1'25j + 5j = \boxed{2'5 + 6'25j = \bar{Z}_{Th}}$ Dues maneres d'escriure-ho

$Z_{Th} = \sqrt{2'5^2 + 6'25^2} = 6'73\Omega$ (Treure i saber Re)

$\varphi_{Th} = \operatorname{arctg}\left(\frac{6'25}{2'5}\right) = 68'20°$ (Saber angle)

$\boxed{\bar{Z}_{Th} = 6'73 \angle 68'20°}$

$\bar{Z}_{TOT} = R_1 + R_2 + X_1 + X_2 = 5\Omega + (3\Omega) + 4j + 0 \overset{\text{No passa } I}{=} 8\Omega + 4j = \boxed{8'89V \angle 26'57° = \bar{Z}_{TOT}}$

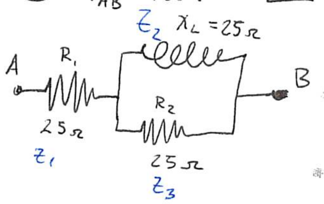
$\bar{I} = \frac{\bar{V}}{\bar{Z}_T} = \frac{10V \angle -90}{8'89 \angle 26'57} = \boxed{1'12A \angle -116'5 = \bar{I}}$

$\bar{Z}_{AB} = 3\Omega + 4j = \boxed{5\Omega \angle 53'13° = Z_{AB}}$

$\bar{V}_{AB} = \bar{I}\cdot \bar{Z}_{AB} = 1'12A \angle -116'57 \cdot 5 \angle 53'13 = \boxed{5'59V \angle -63'41 = \bar{V}_{Th}}$

$V_{Th}(t) = (5'59V)\cdot \cos(\omega t - \frac{63'41}{180}\pi)$ Pq passa a rad

(10). $\bar{V}_{AB} = 100\sqrt{2}\,V \angle 0°$



a) Impedància complexa circuit.

$R \angle 0°$; $\bar{Z}_1 = 25\Omega \angle 0°$

$X_L \angle 90°$; $\bar{Z}_2 = 25\Omega \angle 90°$

$X_C \angle -90°$; $Z_3 = 25\Omega \angle 0°$

→ Paral·lel → Total Impedància complexa circuit.

$Z_p = \frac{1}{\frac{1}{25\angle 0} + \frac{1}{25\angle 90}} = \frac{25\sqrt{2}}{2} \angle 45°$; $\bar{Z}_T = Z_p + Z_1 = \frac{25\sqrt{2}}{2} \angle 45° + 25 \angle 0° = \boxed{39'52 \angle 18'13°}$

b) Fasor Intensitat i Tensió de cada Branca.

Primer haurem de saber la Intensitat total del circuit $\bar{I} = \frac{\bar{V}_{AB}}{\bar{Z}} = 3'57 \angle -18'13°$

Aquesta tmb. serà la que passi per R_1 així que $\boxed{\bar{I}_1 = 3'57 \angle -18'13°}$

Per saber $\bar{V}_1$ apliquem ohm $\bar{V} = \bar{I}_1 \cdot \bar{Z}_1 = \boxed{89'25 \angle -18'13° = \bar{V}_1}$

Ara que sabem quem consumeix R_1, fem la Resta a $\bar{V}_{AB}$ per saber diff que passa per cada Branca.

$I_L = \frac{100\sqrt{2} \angle 0° - 89'25 \angle -18'13°}{25 \angle 90°} = \boxed{2'52 \angle -63'86 = \bar{I}_2}$ $\quad I_2 = \frac{(100\sqrt{2} \angle 0) - (89'25 \angle -18'13)}{25 \angle 0} = \boxed{2'52 \angle 26'57° = \bar{I}_2}$

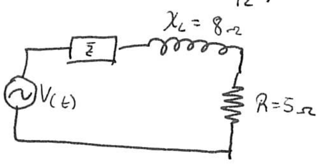
El $\bar{V}$ que passa a $\underline{100\sqrt{2} \angle 0 - 89'25 \angle -18'13}$

8. Calc $\bar{Z}$

$f = 50\ Hz$

$V(t) = (50V)\cos(\omega t + \frac{\pi}{4})$

$I(t) = (2'5A)\cos(\omega t - \frac{\pi}{12})$



$\bar{Z}_T$: Total del circuit

$\bar{V} = 50V\angle\frac{\pi}{4}$

$\bar{I} = 2'5A\angle\frac{-\pi}{12}$

$\bar{Z}_T = \frac{\bar{V}}{\bar{I}} = \frac{50V\angle\frac{\pi}{4}}{2'5\angle\frac{-\pi}{12}} = 20\angle 1'04$

$\bar{Z}_R = 5\Omega + 0j \Rightarrow 5\Omega\angle 0$

$\bar{Z}_L = 0 + 8j \Rightarrow 8\Omega\angle\frac{\pi}{2}$ $\quad \frac{90 \cdot 2\pi}{360} = \frac{\pi}{2}$

$\bar{Z}_R + \bar{Z}_L = 12'99\angle 0'96$

$\bar{Z}_T = \bar{Z} + (\bar{Z}_R + \bar{Z}_L) \rightarrow \bar{Z} = \bar{Z}_T - (\bar{Z}_R + \bar{Z}_L) = (20\angle 1'04) - (12'99\angle 0'96)$

$\boxed{\bar{Z} = 10'57\Omega\angle 1'06} \rightarrow \frac{1'06 \cdot 360}{2\pi} = 60'73^\circ$

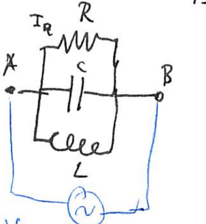
CUIDADO LA CALCULADORA

Si treballes amb rad, ficar calculadora en "Rad".

9. $I_R = 1A$, $R = 10\Omega$

$C = 10\mu F$, $L = 1H$

$\omega = 100\pi$ rad/s



$V(t) = V_0\cos(\omega t + \theta)$

Suposem que $\theta = 0$

a) Det. tensió entre A i B $\quad \bar{V} = \bar{I} \cdot \bar{Z}$

$\bar{Z}_R = 10\Omega + 0j \qquad \bar{V}_R = \bar{V} = \bar{I}_R \cdot \bar{Z}_R$

$I_R = 1A \qquad \bar{V} = 1A \cdot 10\Omega = 10V$; $\boxed{\bar{V} = 10V\angle 0^\circ}$

$\bar{I}_R = I_R \cdot e^{+j\alpha}\ (\alpha = 0) = I_R \cdot e^0 = I_R$

b) Calc I que passa per C i L

$C = \bar{Z}_C = \left(\frac{-1}{\omega C}\right)j = \left(\frac{-1}{100\pi \cdot 10 \times 10^{-6}}\right)j = -318'3j =$

$\sqrt{0^2 + (-318'3)^2} = 318'3$

Com que és C $= -90^\circ$

$\boxed{318'3\angle -90^\circ = \bar{Z}_C}$

$\bar{I}_C = \frac{\bar{V}}{\bar{Z}_C} = \frac{10V\angle 0^\circ}{318'3\Omega\angle -90^\circ} = \boxed{0'03A\angle 90^\circ = \bar{I}_C}$

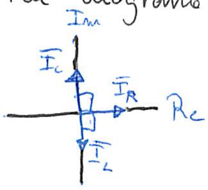
$\bar{L} = \bar{Z}_L = (\omega L)j = (100\pi \cdot 1)j = (314'16)j =$

$\sqrt{0^2 + (314'16)^2} = 314'16$

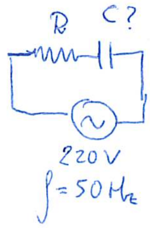
Com que és L $= 90^\circ$

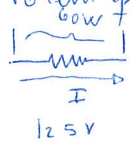
$\bar{I}_L = \frac{\bar{V}}{\bar{Z}_L} = \frac{10V\angle 0^\circ}{314'16\Omega\angle 90^\circ} = \boxed{0'03A\angle -90^\circ = \bar{I}_L} \quad \boxed{314'16\angle 90^\circ = \bar{Z}_L}$

c) Fer diagrama fasorial de les Intensitats.



(12). Cap. Cond. en sèrie amb bombeta 125V i 60W
220V i 50Hz





Volem que C treballi a P = 60W

$P = I^2 \cdot R \rightarrow P = \left(\frac{V}{R}\right)^2 \cdot R$

$V = I \cdot R \rightarrow I = \frac{V}{R}$

$$P = \frac{V^2}{R^{\cancel{2}}} \cdot \cancel{R} \rightarrow R = \frac{V^2}{P} = \frac{125^2}{60} = \boxed{260'92\,\Omega = R}$$

$$P = I_{ef} V_{ef} \cos(\varphi) \; ; \; \cos(\varphi) = \frac{R}{Z} \; ; \; P = I_{ef} V_{ef} \frac{R}{Z} \; ; \; I_{ef} = \frac{V_{ef}}{Z} \; ; \; P = \frac{(V_{ef})^2 \cdot R}{Z^2}$$

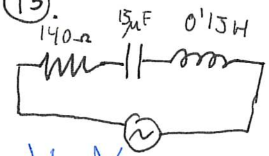
$$Z^2 = \frac{220^2 \cdot 260'92}{125} = 2100\,6944\,\Omega^2$$

[Aquí intervene Z^2 i no Z
Pq. $Z^2 = R^2 + X^2$ on $X = \frac{1}{\omega C}$]

$$X^2 = Z^2 - R^2 = 2100\,6944 - 68079'2 = 141990'44 = X^2$$

$$X = 376'81 = \frac{1}{\omega C} \; ; \; \omega = 2\pi f = 100\pi \; ; \; C = \frac{1}{\omega X} = \boxed{8'44\,\mu F = C}$$

(13).



Calc Fact. Pot.
Tensió Eficaç
Pot Mitjana.

NOMÉS R dissipa, la Resta no.

$\boxed{P_L = P_C = 0W}$

$\omega = 2\pi 50 = 100\pi$

$V_{(t)} = V_0 \cos(\omega t + \theta)$

$I_0 = 0'18A$

$f = 50\,Hz$

$$\bar{Z} = R + \left(L\omega - \frac{1}{C\omega}\right)j = 140 + \left(0'15\omega - \frac{1}{15\mu F \omega}\right)$$

$$\bar{Z} = 140 - 165'08j \; ; \; Z = \sqrt{140^2 + 165^2} = 216'4\,\Omega$$

$\boxed{\cos(\varphi) = \frac{R}{Z}}$

$$\cos(\varphi) = \frac{140}{216'4} = \boxed{0'64 = \text{Factor Potència}}$$

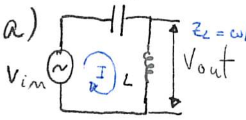
$$V_{ef} = Z \cdot I_0 = 216'4 \cdot 0'18 = \boxed{38'95V = V_{ef}}$$

$$P_R = P = I_{ef} V_{ef} \cos(\varphi) = 0'18 \cdot 38'95 \cdot 0'64 = \boxed{4'48W = P}$$ # Pot mitjana

(34). $F(\omega) = \tau$

$V_{out} = ?$

a)



$$I_0 = \frac{V_{in}}{Z} = \frac{V_{in}}{\left|L\omega - \frac{1}{\omega C}\right|} \; ; \; V_{out} = I_0 Z_L = \frac{V_{in}}{\left|L\omega - \frac{1}{\omega C}\right|} \cdot L\omega$$

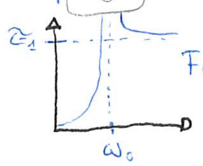
$$\bar{Z} = 0 + \left(L\omega - \frac{1}{\omega C}\right)j \rightarrow Z^2 = \left(L\omega - \frac{1}{\omega C}\right)^2 \rightarrow Z = \sqrt{\left(L\omega - \frac{1}{\omega C}\right)^2} = \left|L\omega - \frac{1}{\omega C}\right|$$

$L\omega > \frac{1}{C\omega} \Rightarrow 90°$ $L\omega < \frac{1}{C\omega} \Rightarrow -90°$

$LC = \frac{1}{\omega_0^2}$

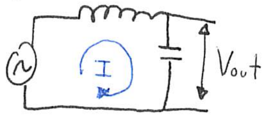
$$\tau = F = \frac{L\omega}{\left|L\omega - \frac{1}{\omega C}\right|} = \frac{L\omega}{\left|L\omega - \frac{1}{\omega C}\right|} \cdot \frac{\omega C}{\omega C} = \frac{LC\omega^2}{\left|L\omega^2 C - 1\right|} = \frac{\frac{1}{\omega_0^2} \cdot \omega_0^2}{\left|\frac{\omega^2}{\omega_0^2} - 1\right|} =$$

$$= \frac{\frac{\omega_0^2}{\omega_0^2}}{\left|\frac{\omega^2}{\omega_0^2} - 1\right|} \cdot \frac{\omega_0^2}{\omega_0^2} = \tau = \frac{\omega_0^2}{\left|\omega^2 - \omega_0^2\right|}$$



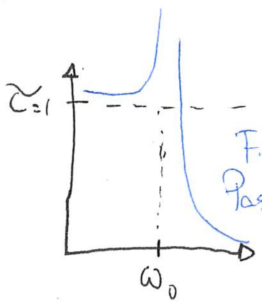
Filtre passa Alts.

b)



$I_0 = \frac{V_{in}}{Z} = \frac{V_{in}}{|L\omega - \frac{1}{\omega C}|}$;

$V_{out} = I_0 Z_c = I_0 \cdot \left(\frac{1}{\omega C}\right) = \frac{V_{in}}{|L\omega - \frac{1}{\omega C}|} \cdot \frac{1}{\omega C}$;



$\frac{V_{in}}{V_{out}} = \tau = \frac{1}{\omega C |L\omega - \frac{1}{\omega C}|} = \frac{1}{|LC\omega^2 - 1|} = \frac{1}{|\frac{\omega^2}{\omega_0^2} - 1|} = \frac{1}{|\frac{\omega^2}{\omega_0^2} - 1|} \cdot \frac{\omega_0^2}{\omega_0^2} =$

$= \frac{\omega_0^2}{|\omega^2 - \omega_0^2|}$;

$\lim_{\omega \to 0} \frac{\omega_0^2}{|\omega - \omega_0^2|} = \frac{\omega_0^2}{|-\omega_0^2|} = \frac{\omega_0^2}{\omega_0^2} = 1$

$\lim_{\omega \to \infty} \frac{\omega_0^2}{|\omega - \omega_0^2|} = 0$ pq denom més gran

(23). $T = 12\,ms = 12 \times 10^{-3}\,s \Rightarrow f_0 = \frac{1}{T} = \frac{1}{12 \times 10^{-3}}$

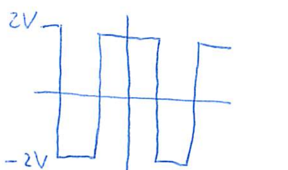
$n = 3$

$f_3 = 3 f_0 = \frac{3}{12 \times 10^{-3}} = 0'25 \times 10^3 = \boxed{250\,Hz}$

(24). $T = 2'5\,ms = 2'5 \times 10^{-3}$

$-2V$ — $2V$

Det. f, amplitud i fase en graus de 11 ~~harmò~~



$V(t) + 2V = 0\,V - 4V$

$V_0 = 4V$

$B_n = \frac{2 V_0}{\pi n} \sin\left(\frac{n\pi}{2}\right)$, $f_n = n f_0$.

$B_{11} = \frac{2 \cdot 4}{\pi \cdot 11} = \boxed{0'231 = B_{11}}$

$f_{11} = 11 \cdot \frac{1}{2'5 \times 10^{-3}} =$

$n = 1, 5, 9, 13, \dots$ negatiu

$n = 3, 7, 11, 15, \dots$ positiu

(30). 30 char/s

1 char → 8 bits

$\frac{n^o\ bits}{segon} = \frac{8 \cdot 30}{s} = 240$ bits/segon = Vel

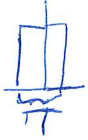
$BW = 2v = \boxed{480\,Hz = BW}$

(27). Amplada nominal = 4 kHz

Duració del pols més curt?

Quants pols per segon?

$f = \frac{1}{T} = 4000\,Hz \to \boxed{T = 250\,\mu s}$ aquesta és duració del pols



Un pols no és 1 paquet de info, sinó 2 paquets donat que Paquet + Espai per següent paquet. (Llavors x2)

$T = 500\,\mu s$ fem regla de 3 i llestos. 1 paquet — 500×10^{-6} seg $\boxed{x = 2000\ \text{paquets}}$

— 1 seg

(25). Pols 10 ms amplada. Quants Hz per enviar-lo. $f = \frac{1}{T} \to f = \frac{1}{10 \times 10^{-3}} = \boxed{10\,Hz = f}$