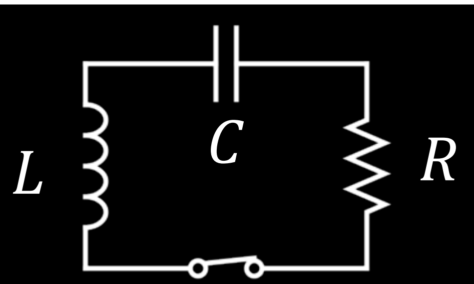


$$V_L + V_R + V_C = 0$$

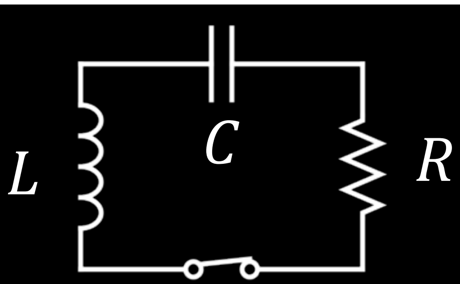
$$\frac{dV_L}{dt} + \frac{dV_R}{dt} + \frac{dV_C}{dt} = 0$$

$$L\frac{d^2I}{dt^2} + R\,\frac{dI}{dt} + \frac{I}{C} = 0$$

$$V_L = L\frac{dI}{dt}$$

$$I = C\frac{dV_C}{dt}$$

$$V_R = I\,R$$

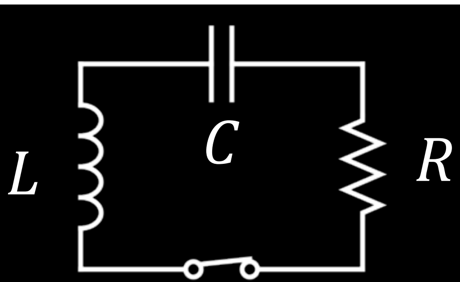


$$V_R = I\,R$$

$$\mathbb{V}_R(t) = \mathbb{V}_{0R}\, e^{j\omega t}$$

$$\mathbb{I}_R(t) = \mathbb{I}_0\, e^{j\omega t}$$

$$\mathbb{V}_{0R} = \mathbb{I}_0 R$$



$$\mathbb{V}_R(t) = \mathbb{V}_{0R}\, e^{j\omega t}$$

$$\mathbb{I}(t) = \mathbb{I}_0\, e^{j\omega t}$$

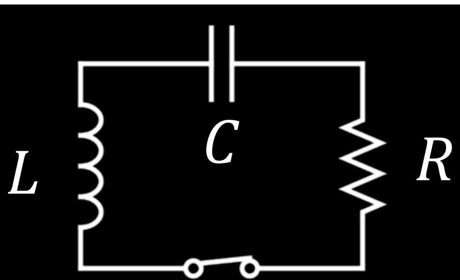
$$V(t) = Re[\mathbb{V}(t)]$$
$$I(t) = Re[\mathbb{I}(t)]$$

$$I = C\,\frac{dV_C}{dt}$$

$$\mathbb{I}_0\, e^{j\omega t} = C\,\frac{d\mathbb{V}_C}{dt}$$

$$\mathbb{V}_C(t) = \mathbb{I}_0 \int_0^t \frac{1}{C}\, e^{j\omega t'} dt'$$

$$\mathbb{V}_C(t) = \frac{1}{j\omega C}\,\mathbb{I}_0 e^{j\omega t}$$



$$\mathbb{V}_R(t) = \mathbb{V}_{0R}\, e^{j\omega t}$$

$$\mathbb{I}(t) = \mathbb{I}_0\, e^{j\omega t}$$

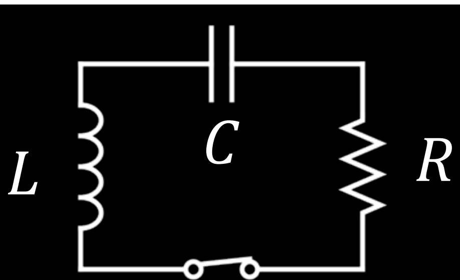
$$V(t) = Re[\mathbb{V}(t)]$$
$$I(t) = Re[\mathbb{I}(t)]$$

$$V_L = L\frac{dI}{dt}$$

$$\mathbb{V}_L(t) = L\frac{d\left(\mathbb{I}_0\, e^{j\omega t}\right)}{dt}$$

$$\mathbb{V}_L(t) = L\mathbb{I}(j\omega)e^{j\omega t}$$

$$\mathbb{V}_L(t) = j\omega L\mathbb{I}_0\, e^{j\omega t}$$



$$\mathbb{V}_R(t) = \mathbb{V}_{0R}\, e^{j\omega t}$$

$$\mathbb{I}(t) = \mathbb{I}_0\, e^{j\omega t}$$

$$V(t) = Re[\mathbb{V}(t)]$$
$$I(t) = Re[\mathbb{I}(t)]$$

resistencia

$$\mathbb{V}_R(t) = R\,\mathbb{I}_0 e^{j\omega t}$$

$$\mathbb{V}_R(t) = R\mathbb{I}(t)$$

capacitor

$$\mathbb{V}_C(t) = \frac{1}{j\omega C}\mathbb{I}_0 e^{j\omega t}$$

$$\mathbb{V}_C(t) = \frac{1}{j\omega C}\mathbb{I}(t)$$

inductor

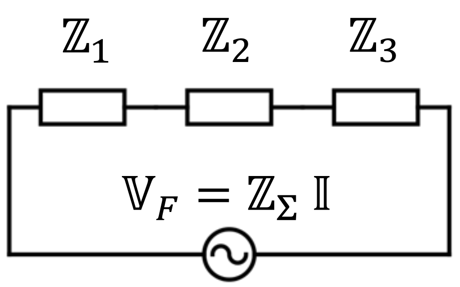
$$\mathbb{V}_L(t) = j\omega L\mathbb{I}_0\, e^{j\omega t}$$

$$\mathbb{V}_L(t) = j\omega L\mathbb{I}(t)$$

		Impedancia compleja
resistencia	$V_R(t) = R\, I_0 e^{j\omega t}$ $V_R(t) = R\, I(t)$	$\mathbb{Z}_R = R$
capacitor	$V_C(t) = \frac{1}{j\omega C} I_0 e^{j\omega t}$ $V_C(t) = \frac{1}{j\omega C} I(t)$	$\mathbb{Z}_C = \frac{1}{j\omega C}$
inductor	$V_L(t) = j\omega L\, I_0\, e^{j\omega t}$ $V_L(t) = j\omega L\, I(t)$	$\mathbb{Z}_L = j\omega L$

Circuitos de Corriente Alterna (CA)

Impedancias en Serie



$$\mathbb{V}_1 = \mathbb{Z}_1\, \mathbb{I} \qquad \mathbb{V}_2 = \mathbb{Z}_2\, \mathbb{I}$$

$$\mathbb{V}_3 = \mathbb{Z}_3\, \mathbb{I}$$

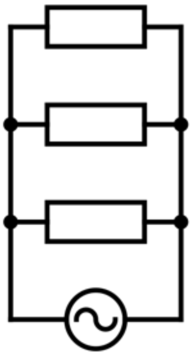
$$\mathbb{V}_F = \mathbb{V}_1 + \mathbb{V}_1 + \mathbb{V}_3$$

$$= (\mathbb{Z}_1 + \mathbb{Z}_2 + \mathbb{Z}_3)\, \mathbb{I}$$

$$\mathbb{Z}_\Sigma = \sum_n \mathbb{Z}_n$$

Circuitos de Corriente Alterna (CA)

Impedancias en Paralelo



$\mathbb{Z}_1$

$\mathbb{Z}_2$

$\mathbb{Z}_3$

$\mathbb{V}_F = \mathbb{Z}_{\parallel}\, \mathbb{I}$

$$\mathbb{V}_1 = \mathbb{Z}_1\, \mathbb{I}_1$$

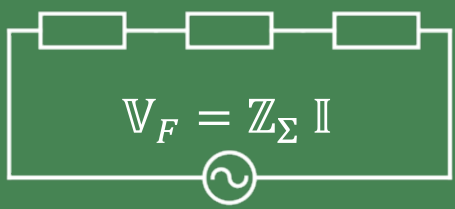
$$\mathbb{V}_2 = \mathbb{Z}_2\, \mathbb{I}_2$$

$$\mathbb{V}_3 = \mathbb{Z}_3\, \mathbb{I}_3$$

$$\mathbb{Z}_{\parallel}^{-1} = \sum_n \mathbb{Z}_n^{-1}$$

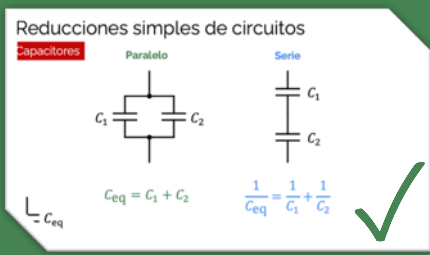
$$\mathbb{Z}_\Sigma = \sum_n \mathbb{Z}_n$$

$\mathbb{Z}_1$ $\mathbb{Z}_2$ $\mathbb{Z}_3$

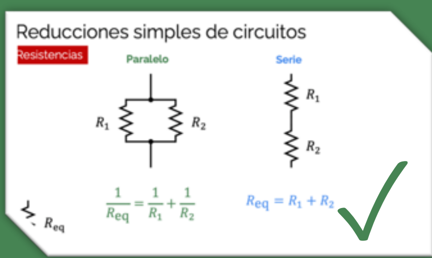


$\mathbb{V}_F = \mathbb{Z}_\Sigma\, \mathbb{I}$

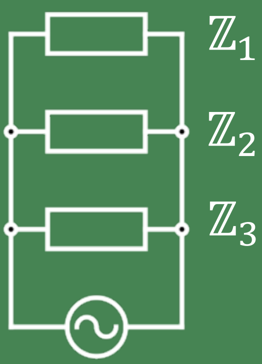
$$\mathbb{Z}_R = R$$



$$\mathbb{Z}_C = \frac{1}{j\omega C}$$



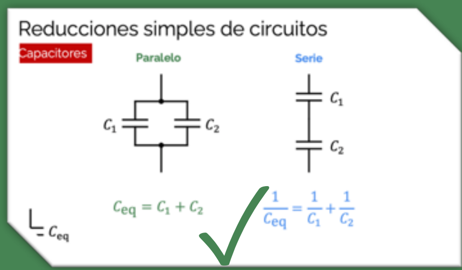
$$\mathbb{Z}_{\parallel}^{-1} = \sum_n \mathbb{Z}_n^{-1}$$

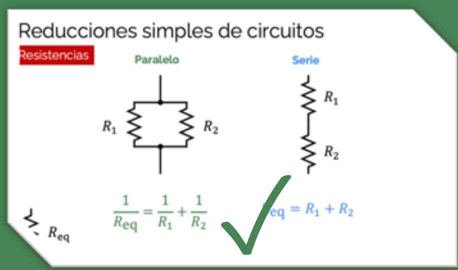


$$\mathbb{V}_F = \mathbb{Z}_{\parallel}\, \mathbb{I}$$

$$\mathbb{Z}_R = R$$

$$\mathbb{Z}_C = \frac{1}{j\omega C}$$





Leyes de Kirchhoff CA

En cada nodo

Todas las corrientes salen o entrar.
Como con el alcohol, no mezclar.

$$\sum_{k=1}^{N} \mathbb{I}_k = 0$$

La carga se conserva y no se acumula en los nodos.

$$I_k(t) = Re[\mathbb{I}_k(t)]$$

En cada malla

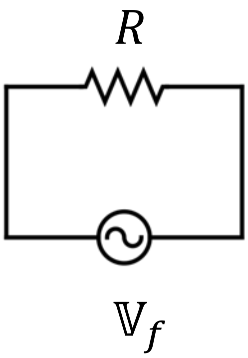
Todas las caídas de potencial en el mismo sentido.
Como con el alcohol, no mezclar.

$$\sum_{k=1}^{N} \mathbb{V}_k = 0$$

El campo eléctrico es conservativo

$$V_k(t) = Re[\mathbb{V}_k(t)]$$

Circuitos R # CA

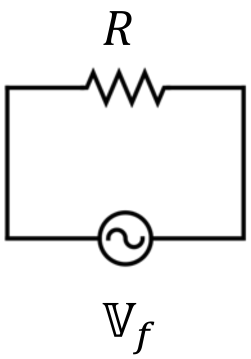


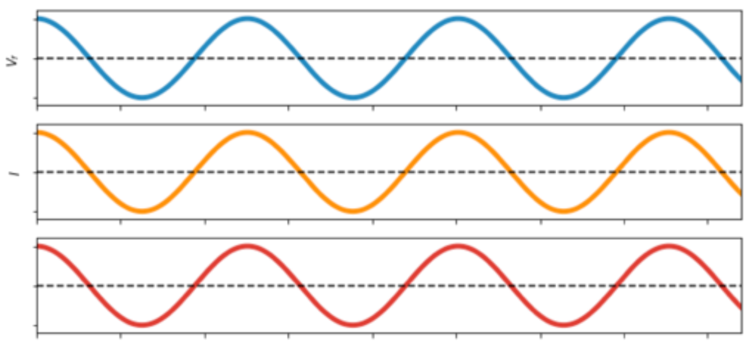
$$\mathbb{V}_f = \mathbb{Z}_R \mathbb{I} = R\ \mathbb{I}$$

$$\mathbb{V}_f = \mathbb{V}_0 e^{j\omega t}$$

$$\mathbb{I} = \frac{\mathbb{V}_0}{R} e^{j\omega t}$$

Circuitos R # CA





$$\mathbb{V}_f = \mathbb{V}_0 e^{j\omega t}$$

$$\mathbb{I}_f = \frac{\mathbb{V}_0}{R} e^{j\omega t}$$

$$\mathbb{V}_R = \mathbb{V}_0 e^{j\omega t}$$

Potencia CA

Instantánea

$$P(t) = V(t)I(t) = Re[\mathbb{V}(t)]\, Re[\mathbb{I}(t)]$$

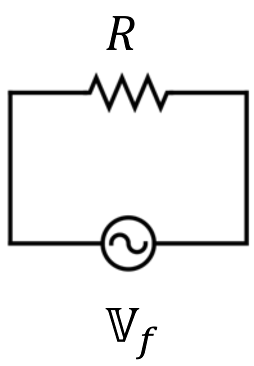
Media
(en un período)

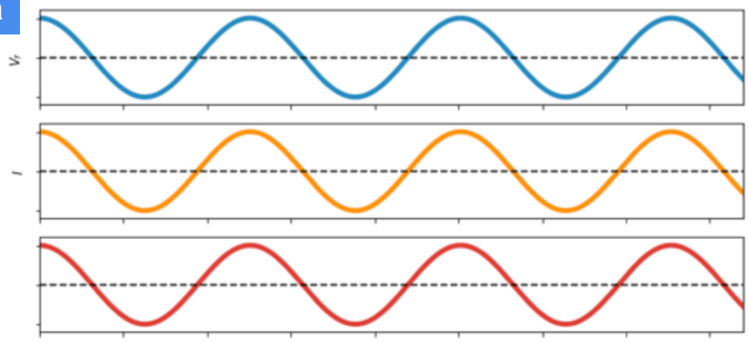
$$T = \frac{2\pi}{\omega}$$

$$P_{med} = \frac{1}{T}\int_0^T P(t)\, dt$$

Circuitos R # CA

Potencia disipada



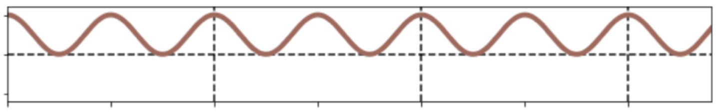


$$\mathbb{V}_f = \mathbb{V}_0 e^{j\omega t}$$

$$\mathbb{I}_f = \frac{\mathbb{V}_0}{R} e^{j\omega t}$$

$$\mathbb{V}_R = \mathbb{V}_0 e^{j\omega t}$$

$$P(t) = \frac{{V_0}^2}{R}\cos^2 \omega t \qquad P_{med} = \frac{1}{2}\frac{{V_0}^2}{R}$$



$P_R(t)$

Potencia CA

Instantánea

$$P(t) = V(t)I(t)$$
$$= Re[\mathbb{V}(t)]\; Re[\mathbb{I}(t)]$$
$$= Re\left[\mathbb{V}_0 e^{j\alpha}\right]\; Re\left[\mathbb{I}_0 e^{j\beta}\right]$$

Media

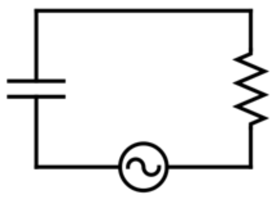
(en un período)

$$T = \frac{2\pi}{\omega}$$

$$P_{med} = \frac{1}{T}\int_0^T P(t)\, dt$$
$$= \frac{V_0 I_0}{2}\cos(\alpha - \beta) = \frac{V_0}{\sqrt{2}}\frac{I_0}{\sqrt{2}}\cos(\varphi)$$

Circuitos RC # CA

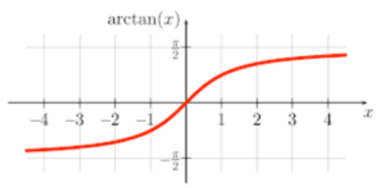
$$\mathbb{V}_f = (\mathbb{Z}_R + \mathbb{Z}_C)\,\mathbb{I} = \left(R + \frac{1}{j\omega C}\right)\mathbb{I}$$



$$\mathbb{I} = \frac{\mathbb{V}_0}{\left(R + \frac{1}{j\omega C}\right)} e^{j\omega t}$$

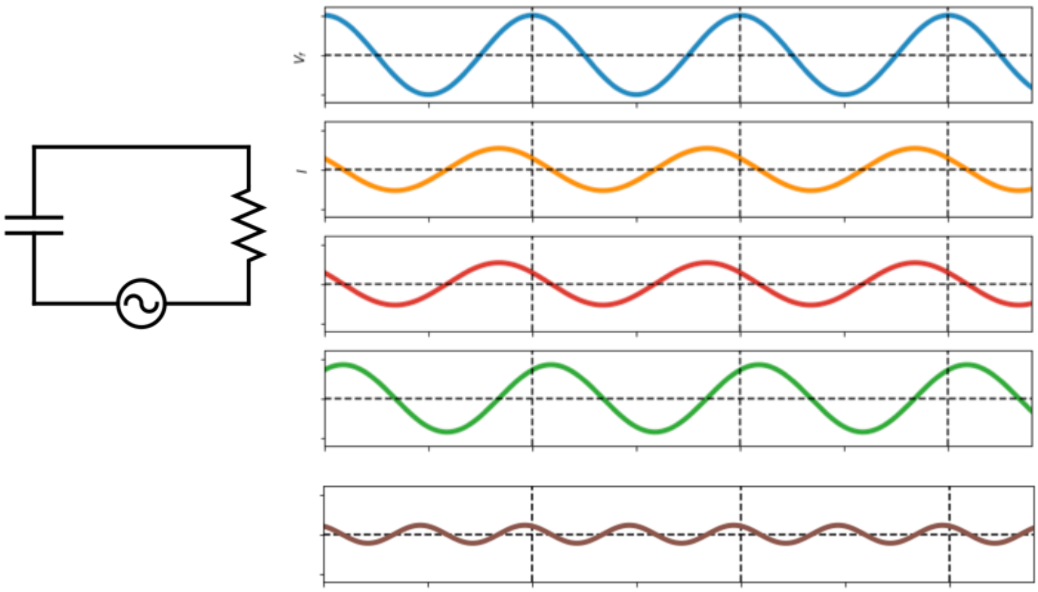
$$= \frac{e^{j\theta}}{\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}}\,\mathbb{V}_0\, e^{j\omega t}$$

$$\mathbb{V}_f = \mathbb{V}_0 e^{j\omega t}$$



$$\theta = arctan\left(-\frac{1}{\omega}\frac{1}{RC}\right)$$

Circuitos RC # CA



$\mathbb{V}_f = \mathbb{V}_0 e^{j\omega t}$

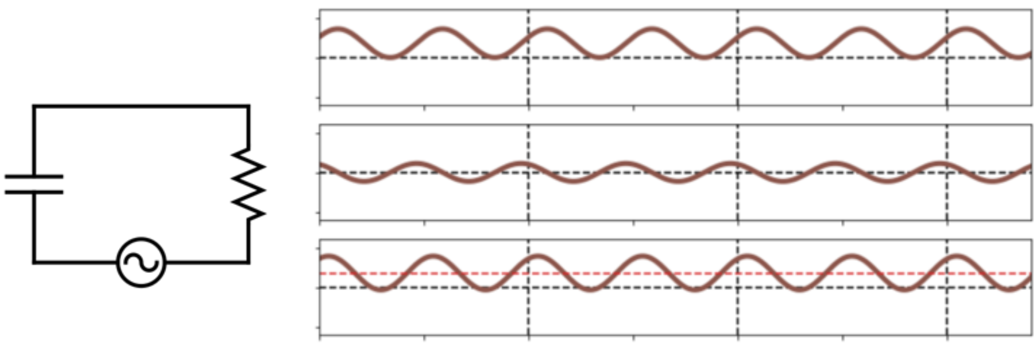
$\mathbb{I}_f = \frac{\mathbb{V}_0}{R} e^{j\omega t}$

$\mathbb{V}_R$

$\mathbb{V}_C$

P_C

Circuitos RC # CA



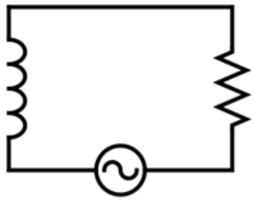
P_R

P_C

P_T

Circuitos RL # CA

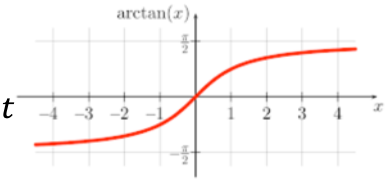
$$\mathbb{V}_f = (\mathbb{Z}_R + \mathbb{Z}_L)\,\mathbb{I} = (R + j\omega L)\mathbb{I}$$



$$\mathbb{I} = \frac{\mathbb{V}_0}{(R + j\omega L)} e^{j\omega t}$$

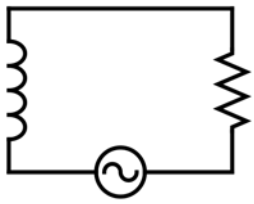
$$\mathbb{V}_f = \mathbb{V}_0 e^{j\omega t}$$

$$= \frac{e^{j\theta}}{\sqrt{R^2 + (\omega L)^2}} \mathbb{V}_0\, e^{j\omega t}$$

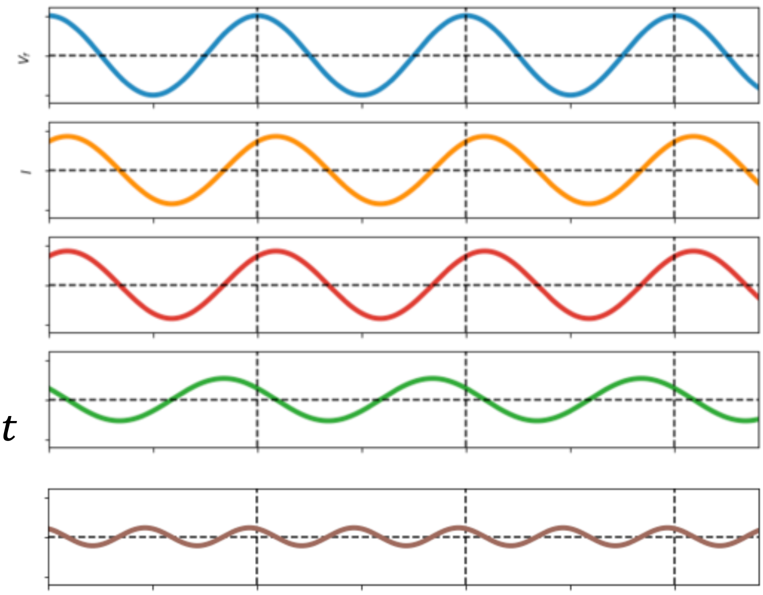


$$\theta = arctan\left(\omega \frac{L}{R}\right)$$

Circuitos RL # CA



$$\mathbb{V}_f = \mathbb{V}_0 e^{j\omega t}$$



$\mathbb{V}_f = \mathbb{V}_0 e^{j\omega t}$

$\mathbb{I}_f = \frac{\mathbb{V}_0}{R} e^{j\omega t}$

$\mathbb{V}_R$

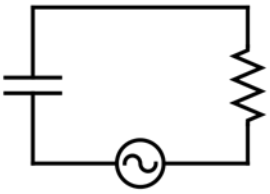
$\mathbb{V}_L$

P_L

Circuitos RC # CA

Aplicaciones: Filtro

$$\mathbb{I} = \frac{\mathbb{V}_0}{\left(R + \frac{1}{j\omega C}\right)} e^{j\omega t}$$



$$\mathbb{V}_C = \mathbb{Z}_C\, \mathbb{I}_f = \frac{1}{j\omega C} \frac{\mathbb{V}_0}{\left(R + \frac{1}{j\omega C}\right)} e^{j\omega t}$$

$$= \frac{\mathbb{V}_0}{(j\omega RC + 1)} e^{j\omega t}$$

$$\mathbb{V}_f = \mathbb{V}_0 e^{j\omega t}$$

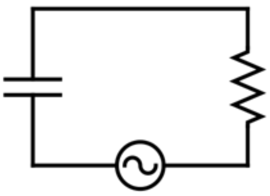
$$= \frac{e^{j\theta}}{\sqrt{(\omega RC)^2 + 1}} \mathbb{V}_0 e^{j\omega t}$$

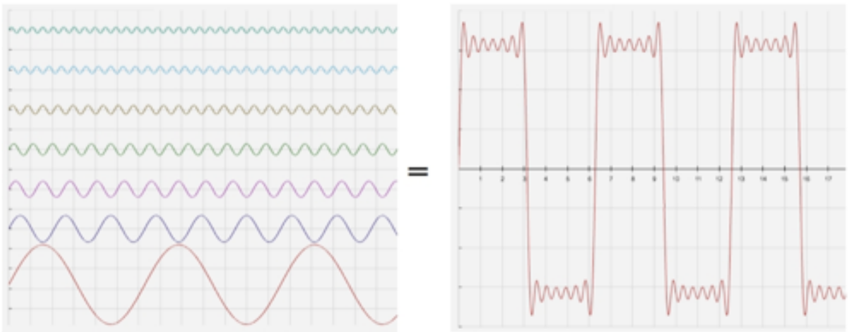
$$\theta = arctan\left(\frac{1}{\omega}\frac{1}{RC}\right)$$

Circuitos RC # CA

Aplicaciones: Filtro

$$\mathbb{V}_C = \frac{e^{j\theta}}{\sqrt{(\omega RC)^2 + 1}} \mathbb{V}_0 e^{j\omega t}$$

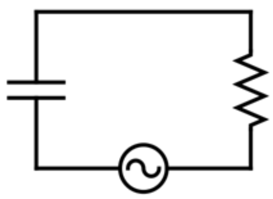


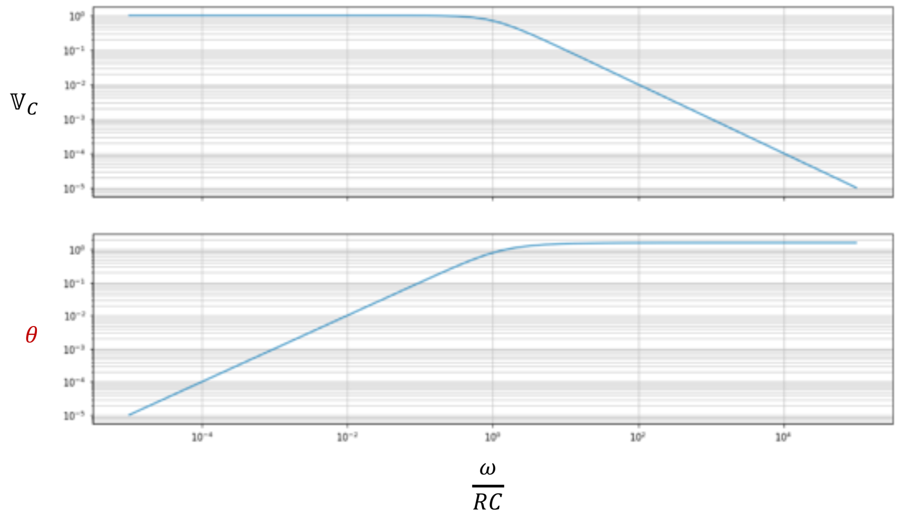


$$\mathbb{V}_f = \mathbb{V}_0 e^{j\omega t}$$

Circuitos RC # CA

Aplicaciones: Filtro

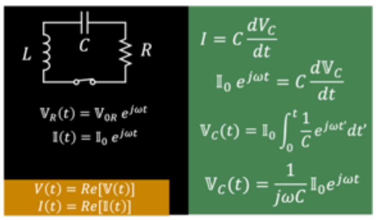




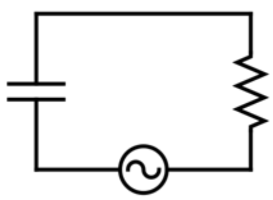
$$\mathbb{V}_f = \mathbb{V}_0 e^{j\omega t}$$

Circuitos RC # CA

Aplicaciones: Integrador



$$\mathbb{I} = \frac{\mathbb{V}_0}{\left(R + \frac{1}{j\omega C}\right)} e^{j\omega t}$$



$$V_C(t) = \frac{\mathbb{V}_0}{\left(R + \frac{1}{j\omega C}\right)} \int_0^t \frac{1}{C} e^{j\omega t'} dt'$$

$$V_C(t) = \frac{\mathbb{V}_0}{\left(RC + \frac{1}{j\omega}\right)} \int_0^t e^{j\omega t'} dt'$$

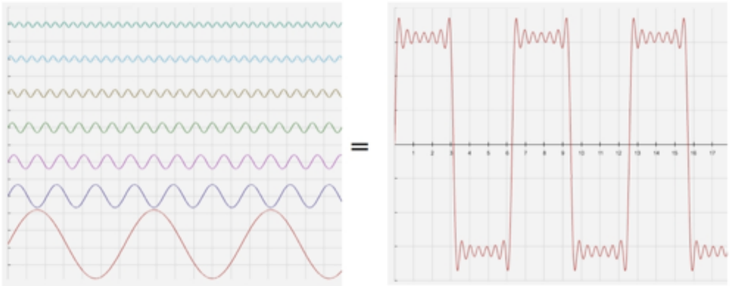
$$\mathbb{V}_f = \mathbb{V}_0 e^{j\omega t}$$

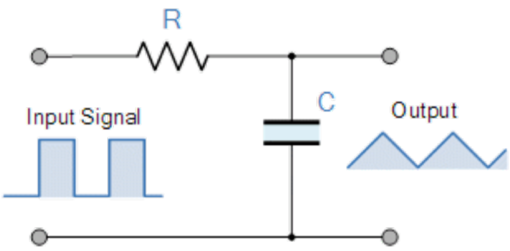
Si $RC \gg \frac{1}{\omega}$

$$V_C(t) = \frac{\mathbb{V}_0}{RC} \int_0^t e^{j\omega t'} dt'$$

Circuitos RC # CA

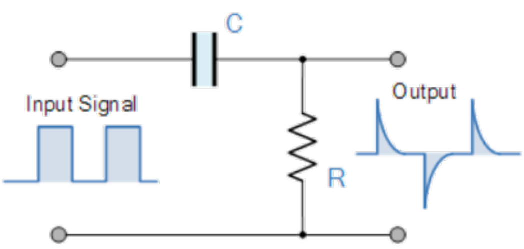
Aplicaciones: Integrador



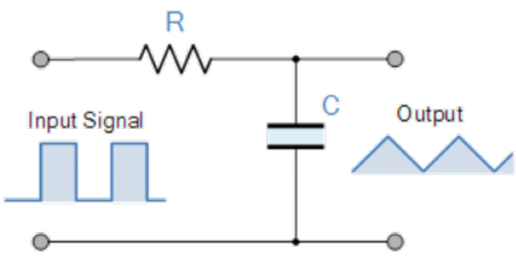


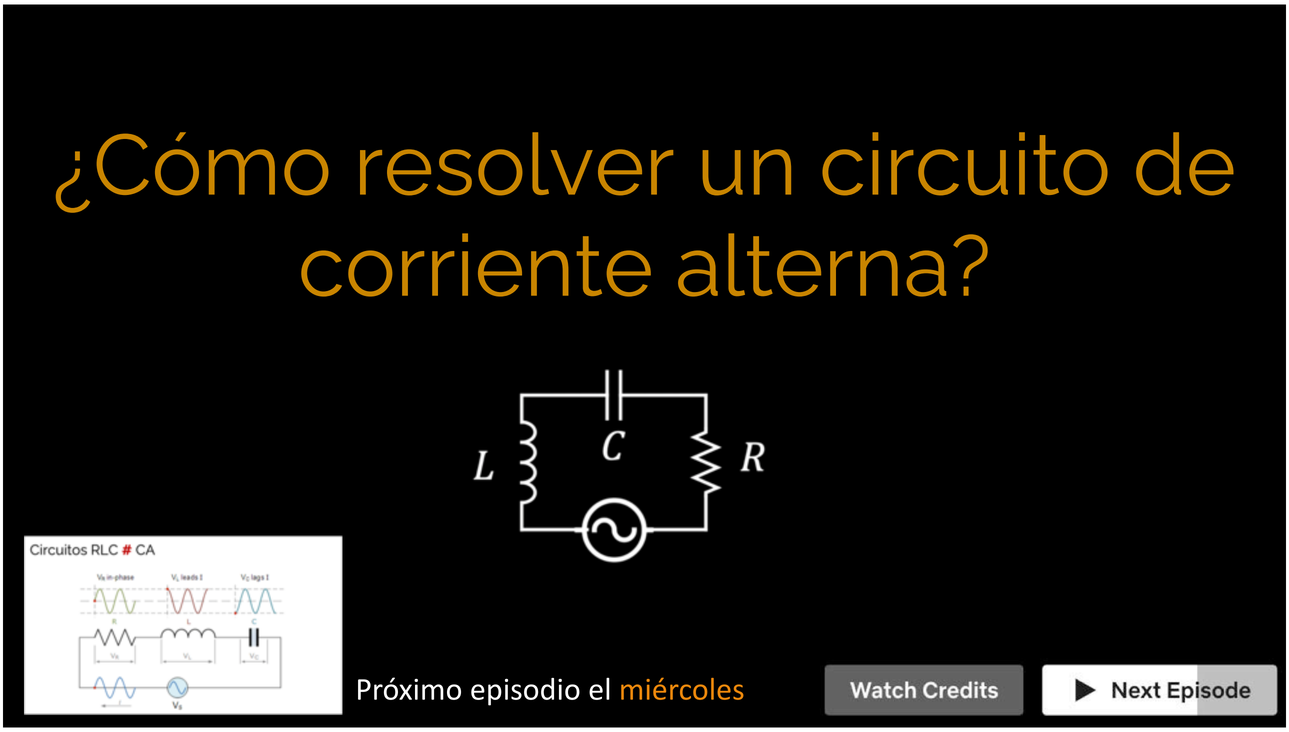
Circuitos RC # CA

Aplicaciones: Derivador



Aplicaciones: Integrador




¿Cómo resolver un circuito de corriente alterna?
L
C
R
Circuitos RLC # CA
Próximo episodio el miércoles
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Next Episode