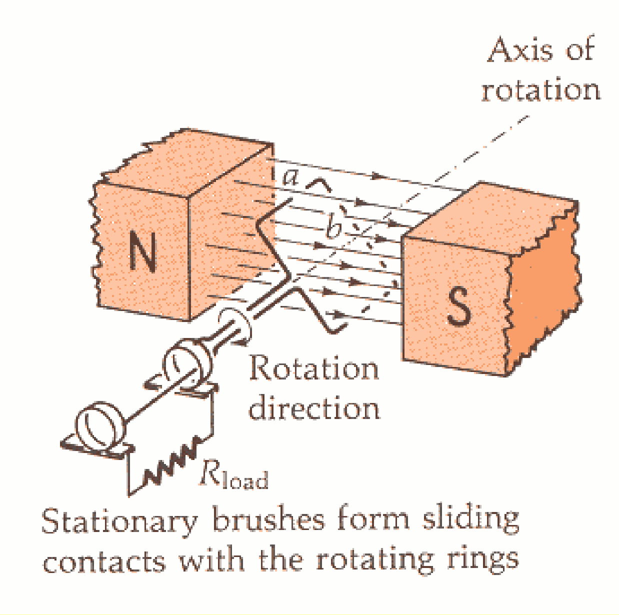
VÁLTAKOZÓ ÁRAMÚ ÁRAMKÖRÖK


Axis of
rotation
a
b
N
S
Rotation
direction
R_{load}
Stationary brushes form sliding
contacts with the rotating rings

Csak ellenállást tartalmazó áramkörök

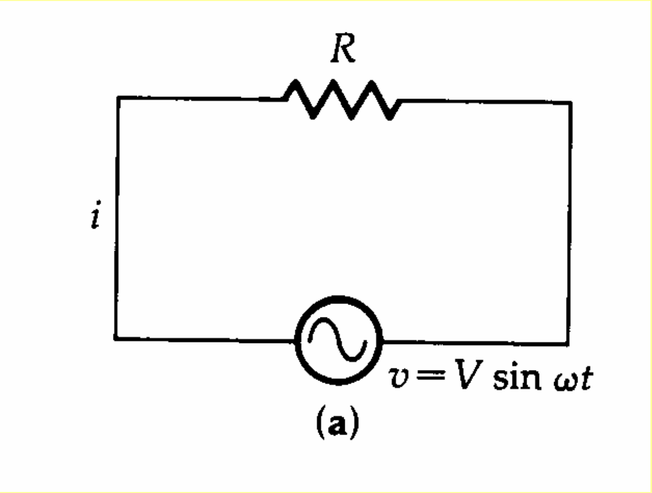
$$\sum v = 0$$

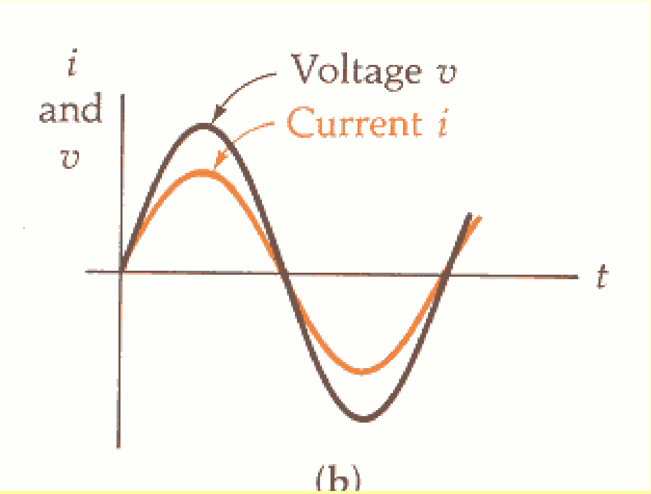
$$v - iR = 0$$

$$V \sin \omega t = iR$$

$$i = \frac{V}{R} \sin \omega t$$

Az áram és feszültség fázisban van





Csak kapacitást tartalmazó áramkör

$$\sum v = 0$$

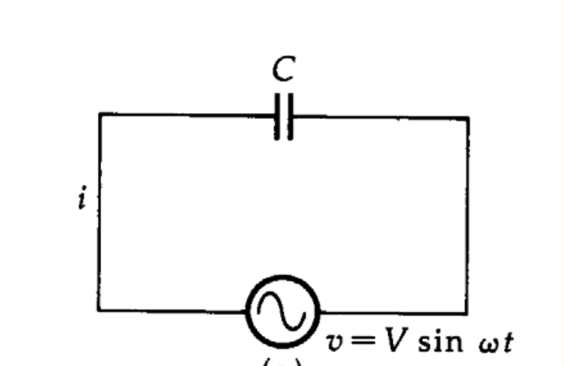
$$V \sin \omega t - \frac{q}{C} = 0$$

$$i = \frac{dq}{dt} = V\omega C \cos \omega t$$

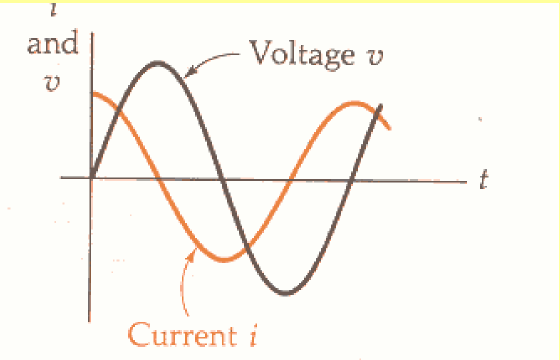
$$i = V\omega C \cos \omega t = \frac{V}{X_C} \cos \omega t$$

$$X_C = \frac{1}{\omega C}$$

kapacitív ellenállás (reaktancia)



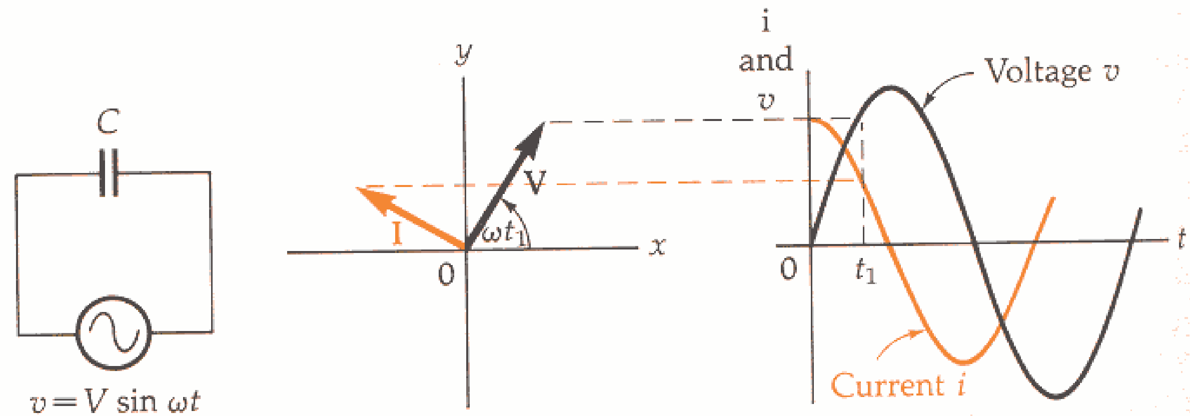
(a)



(b)

Az áram π/2 – vel megelőzi a feszültséget

Vektordiagramok (fazorok)



(a) A purely capacitive AC circuit.

(b) A phasor diagram. The phasors rotate counterclockwise with an angular frequency ω, maintaining the 90° angle between **V** and **I**.

(c) As the phasors in (b) rotate, their projections on a vertical axis generate graphs of the instantaneous voltage v and current i as a function of time t.

Csak induktivitást tartalmazó áramkörök

$$\sum v = 0 \qquad v - L\frac{di}{dt} = 0$$

$$L\frac{di}{dt} = V \sin \omega t \qquad \int di = \frac{V}{L}\int \sin \omega t \, dt$$

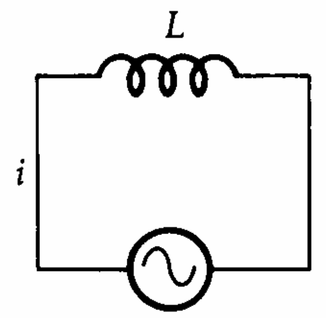
$$i = -\frac{V}{\omega L}\cos \omega t + c \qquad c=0$$

$$-\cos \omega t = \sin(\omega t - \pi / 2)$$

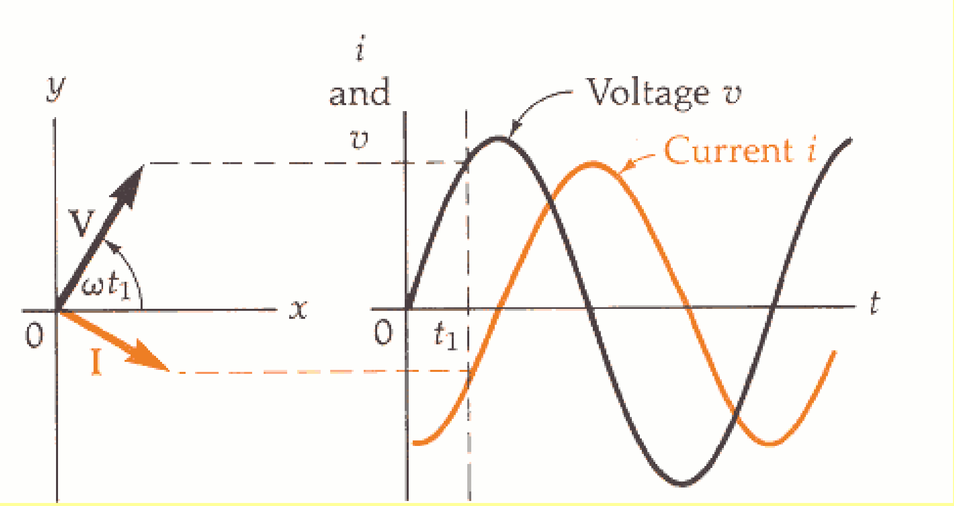
$$i = \frac{V}{X_L}\sin\left(\omega t - \frac{\pi}{2}\right)$$

$X_L = \omega L$ induktív ellenállás (reaktancia)

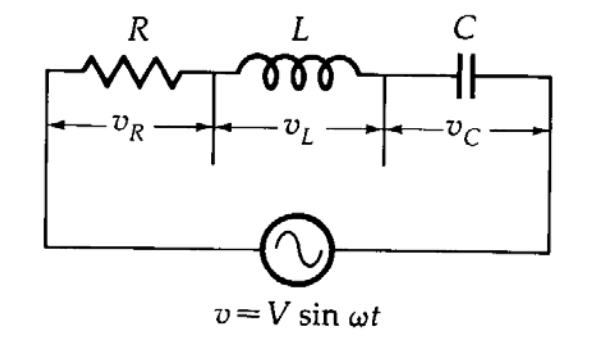
Az áram π/2-vel késik



(a) A purely inductive AC circuit.



Soros RLC áramkör



$$v = V \sin \omega t \qquad v_R = iR$$

$$v_L = L\frac{di}{dt} \qquad v_C = \frac{q}{C}$$

$$\sum v = 0$$

$$V \sin \omega t - L\frac{di}{dt} - iR - \frac{q}{C} = 0$$

$$L\frac{di}{dt} + iR + \frac{q}{C} = V \sin \omega t$$

$$L\frac{di}{dt} + iR + \frac{q}{C} = V\sin\omega t$$

$$L\frac{d^2q}{dt^2} + R\frac{dq}{dt} + \frac{q}{C} = V\sin\omega t$$

$$m\frac{d^2x}{dt^2} + b\frac{dx}{dt} + kx = F_0\sin\omega t$$

$$i(t) = \frac{V}{\sqrt{R^2 + (X_L - X_C)}} \sin(\omega t - \phi) + i_0(t)$$

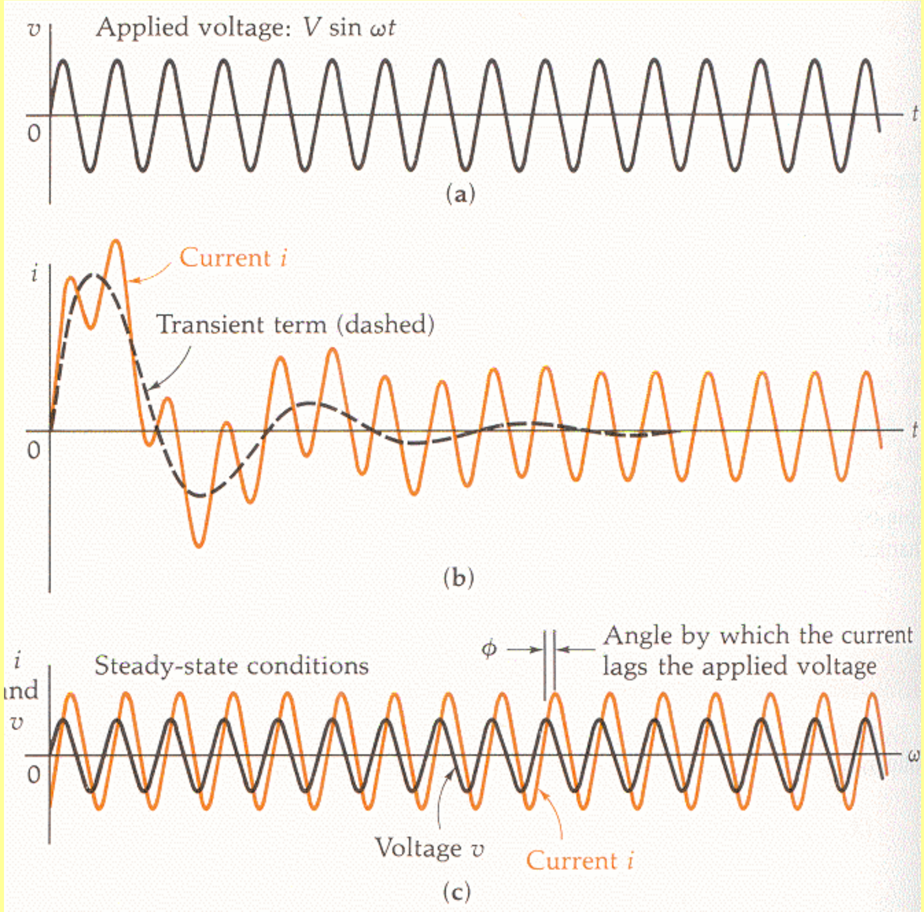
$$X_L = \omega L \qquad X_C = \frac{1}{\omega C}$$

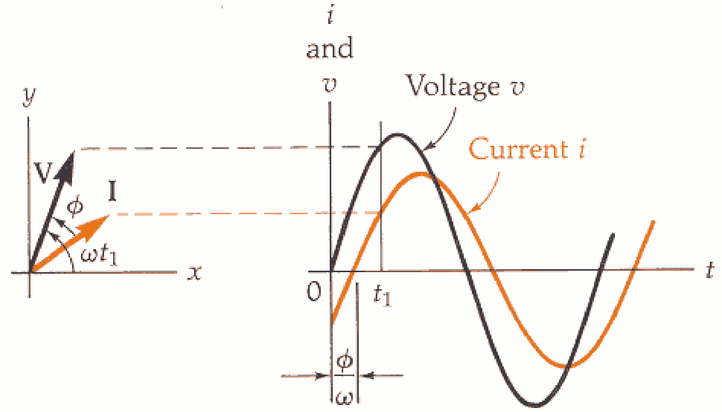
tranziens tag $\quad i_0(t)$

Stacionárius váltakozó áram

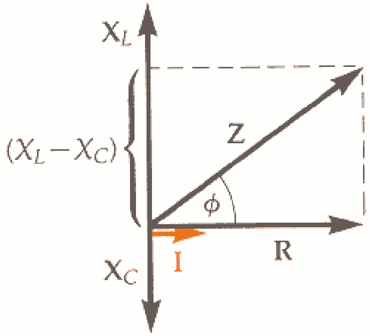
$$i(t) = I \sin(\omega t - \phi)$$

$$\phi = \text{arctg}\left(\frac{X_L - X_C}{R}\right)$$

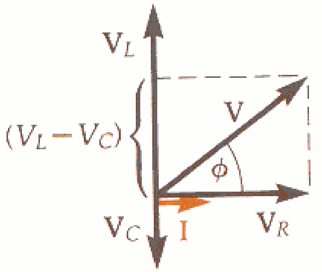




(a) The projections of the rotating phasors on a vertical axis generate graphs of the instantaneous voltage v and current i vs. the time t.

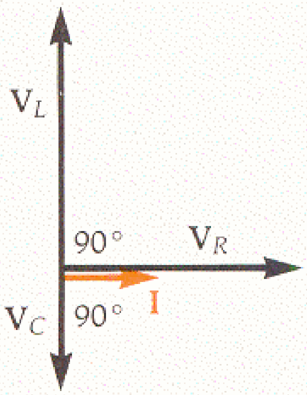


(b) An impedance diagram.

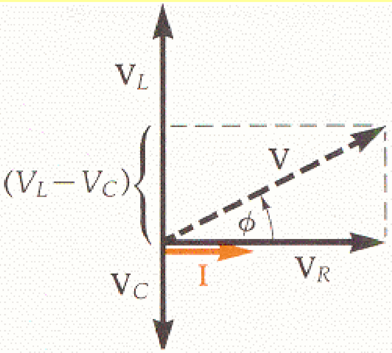


(c) A voltage phasor diagram. The current I is in phase with V_R.

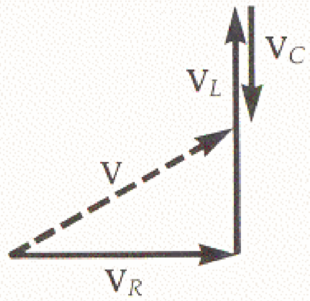
A fázisvektort az *I* áramerősség vektorához viszonyítjuk



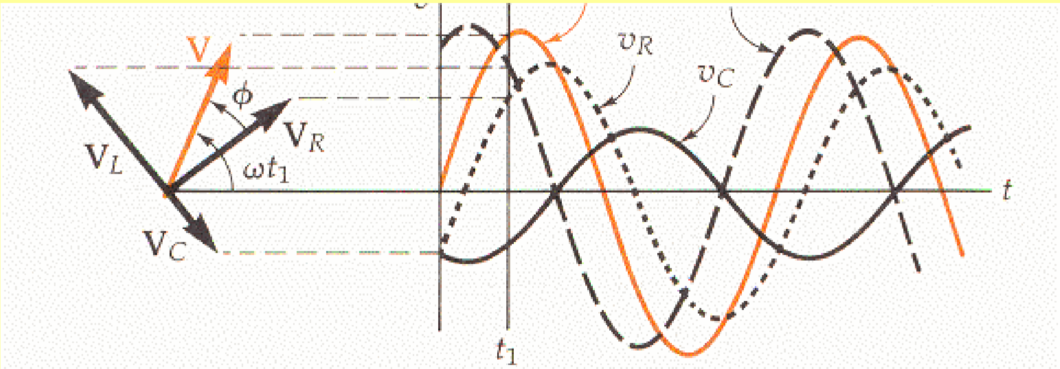
(a) A voltage phasor diagram with the current I as a reference.



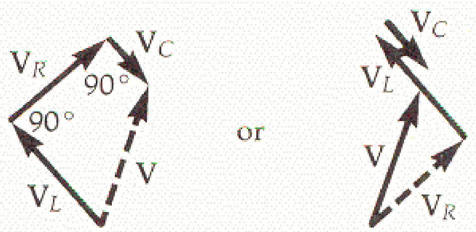
(b) The applied voltage phasor V is the vector sum of the voltage phasors for individual circuit elements: $\mathbf{V} = \mathbf{V}_R + \mathbf{V}_L + \mathbf{V}_C$.



(c) Another way of sketching the vector sum of the individual voltage phasors to obtain the applied voltage phasor $\mathbf{V} = \mathbf{V}_R + \mathbf{V}_L + \mathbf{V}_C$.

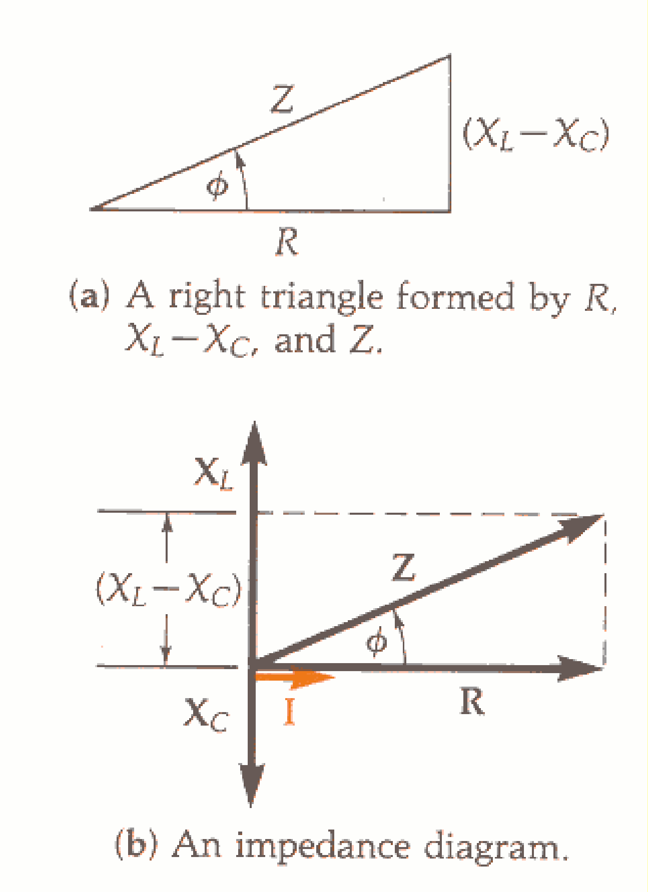


(a) A voltage phasor diagram. The projections of the rotating phasors on a vertical axis generate graphs of the instantaneous voltages vs. time for the voltage across each circuit element.



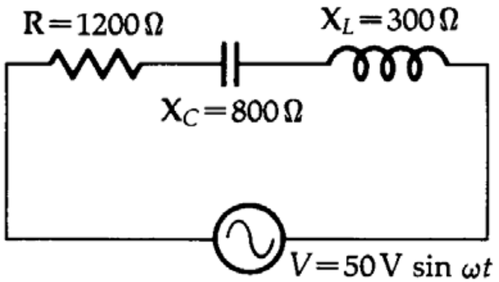
(b) The voltage phasors for each circuit element add together as vectors to give the applied voltage phasor $\mathbf{V} = \mathbf{V}_R + \mathbf{V}_L + \mathbf{V}_C$. (Two different ways of drawing the vector addition are shown.)

Soros RLC kör impedanciája

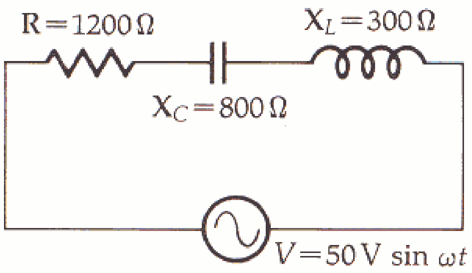


(a) A right triangle formed by R, $X_L - X_C$, and Z.

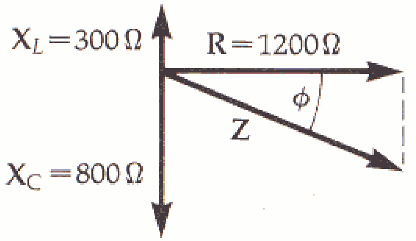
(b) An impedance diagram.



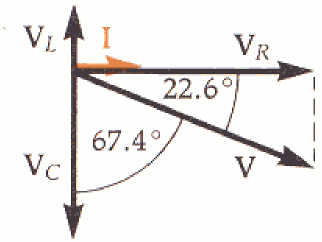
(a) A series *RLC* circuit with an applied AC voltage of 50-V amplitude.



(a) A series *RLC* circuit with an applied AC voltage of 50-V amplitude.



(b) The impedance diagram for the circuit shown in (a).



(c) The voltage phasor diagram.

IGURE 34-12

A váltakozó áramú áramkörök teljesítménye

$$v(t) = V \sin(\omega t)$$

amplitúdó = csúcsérték

$$i(t) = I \sin(\omega t - \phi)$$

$$dW = v\, dq$$

$$p = \frac{dW}{dq}$$

$$p = v\frac{dq}{dt} = v\,i$$

$$p = V\;I\,\sin(\omega t)\sin\left(\omega t - \phi\right)$$

$$P_{átl} = \frac{1}{T}\int_0^T p\,dt$$

$$P_{átl} = \frac{1}{T}\int_0^T VI\,\sin(\omega t)\sin(\omega t - \phi)\,dt$$

$$P_{átl} = \frac{1}{T}\int_0^T VI \sin(\omega t)\sin(\omega t - \phi)\, dt$$

$$\sin(\omega t - \phi) = \sin(\omega t)\cos(\phi) - \cos(\omega t)\sin(\phi)$$

$$P_{átl} = \frac{VI\cos\phi}{T}\int_0^T \sin^2(\omega t)\, dt - \frac{VI\sin\phi}{T}\int_0^T \sin(\omega t)\cos(\omega t) dt$$

$$\sin\alpha\cos\beta = \frac{1}{2}\left[\sin(\alpha-\beta) + \sin(\alpha+\beta)\right]$$

$$\sin(\omega t)\cos(\omega t) = \frac{1}{2}\sin(2\omega t)$$

$$\sin\alpha\sin\beta = \frac{1}{2}\left[\cos(\alpha-\beta) - \cos(\alpha+\beta)\right] \qquad \sin^2\omega t = \frac{1}{2}\left[1-\cos(2\omega t)\right]$$

$$T = \frac{2\pi}{\omega} \qquad \cos^2\omega t = \frac{1}{2}\left[1+\cos(2\omega t)\right]$$

$$\frac{1}{T}\int_0^T \sin^2(\omega t)\,dt = \frac{1}{T}\int_0^T \frac{1}{2}\left[1-\cos(2\omega t)\right]dt = \frac{1}{2} + \left[\frac{\sin(2\omega t)}{T2\omega}\right]_0^T = \frac{1}{2}$$

$$\frac{1}{T}\int_0^T \sin(\omega t)\cos(\omega t)dt = \frac{1}{2T}\int_0^T \sin(2\omega t)dt = \frac{1}{2T}\left[\frac{\cos(2\omega t)}{2\omega}\right]_0^T = 0$$

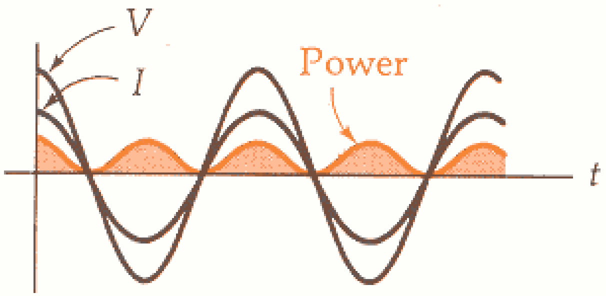
Az átlagos teljesítmény $$P_{átl} = \frac{VI}{2}\cos\phi$$

A teljesítménytényező $$\cos\phi = \frac{R}{Z}$$

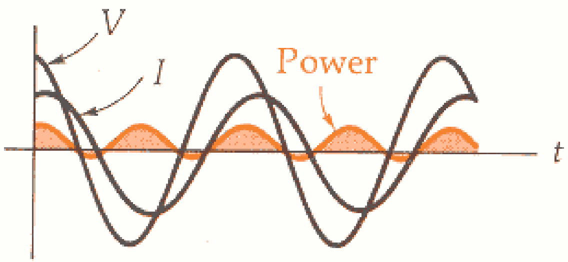
Tisztán induktív áramkörben $\phi = \pi/2$ $P_{átl} = 0$

Tisztán kapacitív áramkörben $\phi = -\pi/2$ $P_{átl} = 0$

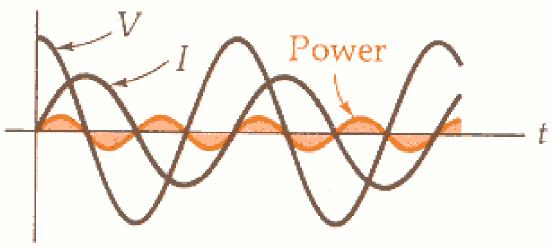
Energia-disszipáció csak az ohmos ellenálláson történik $$P_{átl} = \frac{V_R I}{2}$$



(a) A pure resistive load. Current I and voltage V are in phase: $\phi = 0°$. The power is always positive.



(b) An inductive reactance with resistance. The current I lags the applied voltage V: $\phi = 45°$. When the power is negative, energy is being returned from the inductance to the source.



(c) A pure inductive load (no resistance). The current I lags the applied voltage V: $\phi = 90°$. The power varies equally between positive and negative values, so the average power is zero.

A váltakozó feszültség vagy áram effektív értéke azzal az egyenfeszültséggel vagy egyenárammal egyezik meg, amely ugyanakkora hőt fejlesz egy ellenálláson, mint a váltakozó áram.

$$V_{eff}^2 \frac{1}{R} = \frac{1}{T}\int_0^T v^2(t)\,dt\,\frac{1}{R}$$

$$V_{eff}^2 = \frac{1}{T}\int_0^T v^2(t)\,dt$$

$$I_{eff}^2 R = \frac{1}{T}\int_0^T i^2(t)\,dt\,R$$

$$I_{eff}^2 = \frac{1}{T}\int_0^T i^2(t)\,dt$$

Szinuszosan váltakozó feszültség effektív értéke

$$V_{eff}^2 = \frac{1}{T}\int_0^T V^2 \sin^2(\omega t)\, dt = \frac{1}{2} V^2$$

$$V_{eff} = \frac{V}{\sqrt{2}}$$

Szinuszosan váltakozó áram effektív értéke

$$I_{eff}^2 = \frac{1}{T}\int_0^T I^2 \sin^2(\omega t)\, dt = \frac{1}{2} I^2$$

$$I_{eff} = \frac{I}{\sqrt{2}}$$

$$P_{átl} = V_{eff} I_{eff} \cos\phi \qquad V_R = V\cos\phi$$

$$P_{átl} = (V_R)_{eff} I_{eff}$$

Soros RLC áramkörben disszipált átlagos teljesítmény

$$P_{átl} = \frac{VI}{2}\cos\phi$$

$$P_{átl} = V_{eff} I_{eff} \cos\phi$$

$$P_{átl} = \frac{V_{eff}^2}{Z}\cos\phi$$

$$P_{átl} = (V_R)_{eff} I_{eff}$$

$$P_{átl} = I_{eff}^2 R$$

Fűrészjel effektív értékének meghatározása

$$V(t) = at \qquad 0 < t \leq T \qquad V_m = aT$$

$$V_{eff}^2 = \frac{1}{T}\int_0^T v^2(t)\,dt = \frac{1}{T}\int_0^T a^2 t^2\,dt = \frac{a^2 T^3}{3T} = \frac{V_m^2}{3}$$

$$V_{eff} = \frac{V_m}{\sqrt{3}}$$