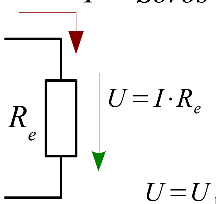
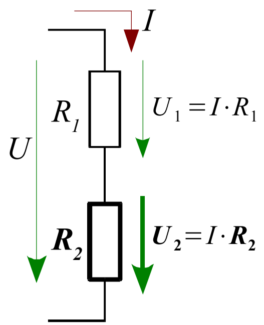
Soros eredő





$$U=U_1+U_2$$

$$I\cdot R_e=I\cdot R_1+I\cdot R_2$$

$$R_e=R_1+R_2$$

Feszültségosztó

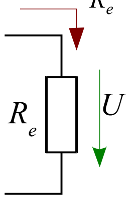
$$U_2=I\cdot R_2$$

$$I=\frac{U}{R_1+R_2}$$

$$U_2=\frac{U}{R_1+R_2}\cdot R_2$$

$$\boldsymbol{U_2}=U\cdot\frac{\boldsymbol{R_2}}{R_1+\boldsymbol{R_2}}$$

Párhuzamos eredő



$$I=\frac{U}{R_e}$$

$$I=I_1+I_2$$

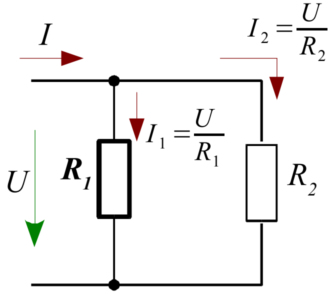
$$\frac{U}{R_e}=\frac{U}{R_1}+\frac{U}{R_2}$$

$$\frac{1}{R_e}=\frac{1}{R_1}+\frac{1}{R_2}$$

$$R_e=\frac{1}{\frac{1}{R_1}+\frac{1}{R_2}}$$

$$R_e=\frac{R_1\cdot R_2}{R_1+R_2}=R_1\times R_2$$

Áramosztó

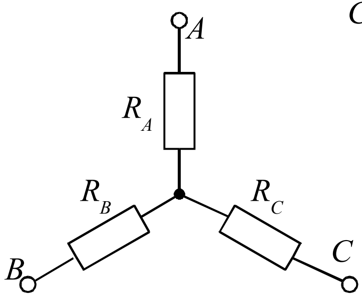


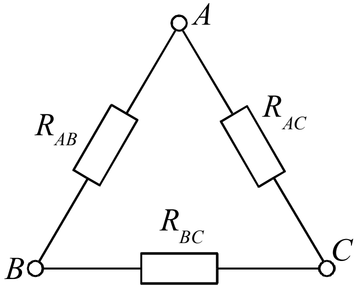
$$U=I\cdot R_e=I\cdot\frac{R_1\cdot R_2}{R_1+R_2}$$

$$I_1=\frac{1}{R_1}\cdot I\cdot\frac{R_1\cdot R_2}{R_1+R_2}$$

$$\boldsymbol{I_1}=I\cdot\frac{R_2}{\boldsymbol{R_1}+R_2}$$

Csillag - Delta





$$R_A=\frac{R_{AB}\cdot R_{AC}}{R_{AB}+R_{AC}+R_{BC}}$$

$$R_B=\frac{R_{AB}\cdot R_{BC}}{R_{AB}+R_{AC}+R_{BC}}$$

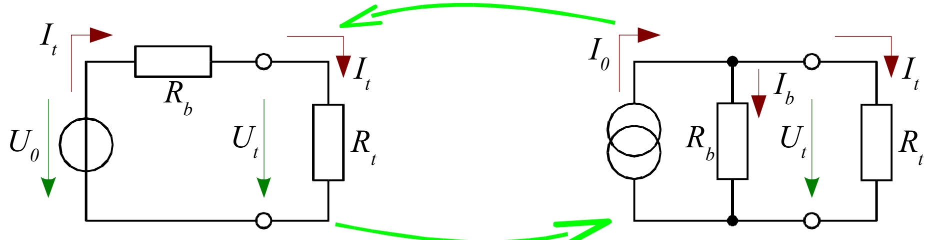
$$R_C=\frac{R_{AC}\cdot R_{BC}}{R_{AB}+R_{AC}+R_{BC}}$$

$$R_{AB}=\frac{R_A\cdot R_B}{R_C}+R_A+R_B$$

$$R_{BC}=\frac{R_B\cdot R_C}{R_A}+R_B+R_C$$

$$R_{AC}=\frac{R_A\cdot R_C}{R_C}+R_A+R_C$$

Thevennin — Norton



Üresjárásban $I_t=0$: $U_t=U_0=I_0\cdot R_b$

Rövidzárlatban $U_t=0$: $I_t=I_0=\frac{U_0}{R_b}$

$$U_t=U_0\cdot\frac{R_t}{R_b+R_t}$$

$$I_t=\frac{U_0}{R_b+R_t}$$

$$I_t=I_0\cdot\frac{R_b}{R_b+R_t}$$

$$U_t=I_0\cdot\frac{R_b\cdot R_t}{R_b+R_t}$$

$$P_t=U_t\cdot I_t=U_0^2\cdot\frac{R_t}{(R_b+R_t)^2}$$

$$P_t=U_t\cdot I_t=I_0^2\cdot\frac{R_b^2\cdot R_t}{(R_b+R_t)^2}$$

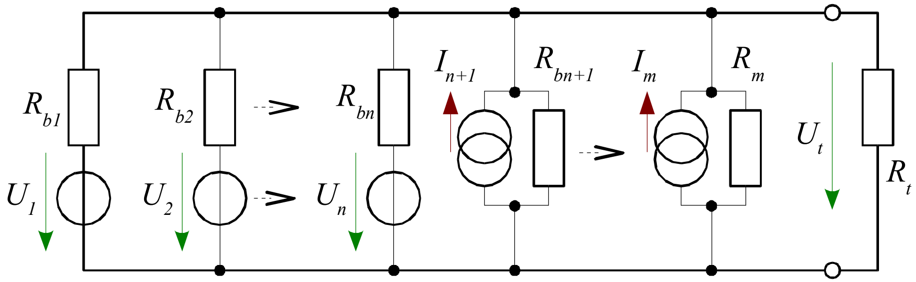
Illesztés: P_t=max ha $R_t=R_b$

$$P_b=(U_0-U_t)\cdot I_t=I_t^2\cdot R_b$$

$$P_b=(I_0-I_t)\cdot U_t=\frac{U_t^2}{R_b}$$

$$P_G=-U_0\cdot I_0=-\frac{U_0^2}{R_b+R_t}=-I_0^2\cdot\frac{R_b\cdot R_t}{R_b+R_t}$$

Millmann tétel



$$U_t=\frac{\frac{U_1}{R_{b1}}+\frac{U_2}{R_{b2}}+\ldots+\frac{U_n}{R_{bn}}+I_{n+1}+\ldots+I_m}{\frac{1}{R_{b1}}+\frac{1}{R_{b2}}+\ldots+\frac{1}{R_{bn}}+\frac{1}{R_{bn+1}}+\ldots+\frac{1}{R_m}+\frac{1}{R_t}}$$

$$\varepsilon_0=\frac{1}{4\pi\cdot 9\cdot 10^9}\approx 8{,}85\cdot 10^{-12}\frac{As}{Vm}$$

$$\mu_0=4\pi\cdot 10^{-7}\approx 1{,}256\cdot 10^{-6}\frac{Vs}{Am}$$

$$c=\frac{1}{\sqrt{\varepsilon_0\cdot\mu_0}}$$

BHM 2006.04.28

Effektív-érték: teljesítmény-átlag egyenérték, (az a mennyiség, amely, ha egyen mennyiség lenne, egységnyi idő alatt a váltakozóval azonos nagyságú villamos munkát végezne). pl feszültségre:

$I=\frac{U}{R}\longleftrightarrow U=I\cdot R$

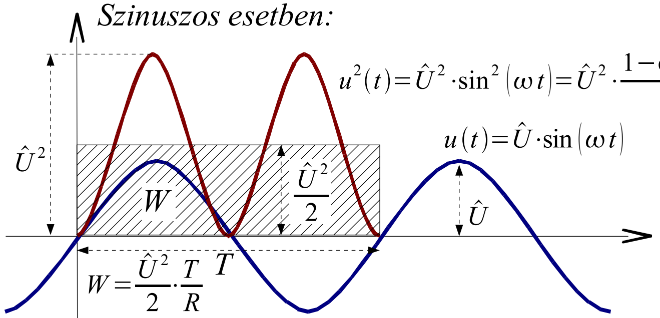
$W=U\cdot I\cdot \Delta t$

$P=\frac{W}{\Delta t}=U\cdot I=\frac{U^2}{R}=I^2\cdot R$

a teljesítmény a feszültség/ áram négyzetével arányos, így a teljesítmény átlag:

$U=\sqrt{\frac{1}{T}\int_0^T u^2(t)\,dt}\quad I=\sqrt{\frac{1}{T}\int_0^T i^2(t)\,dt}$

Szinuszos esetben:

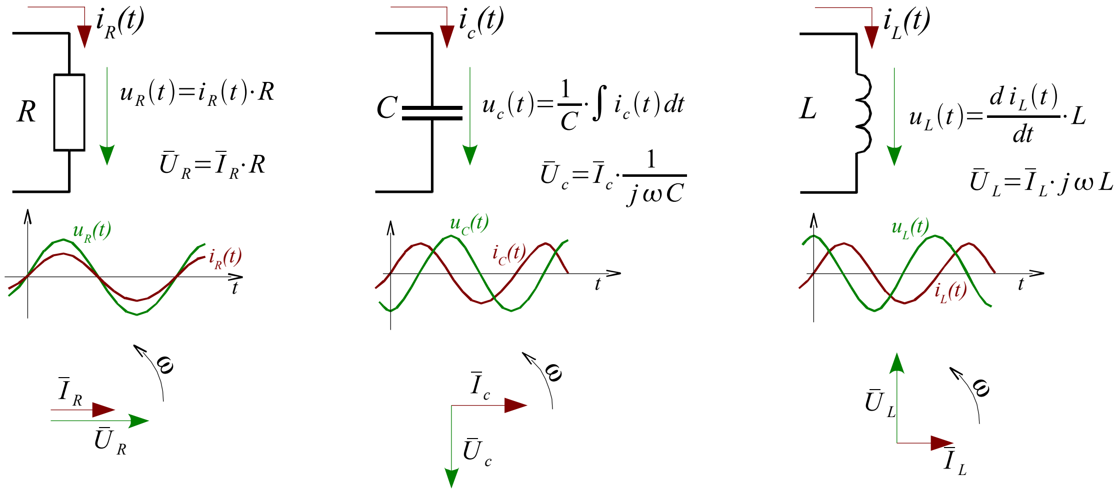


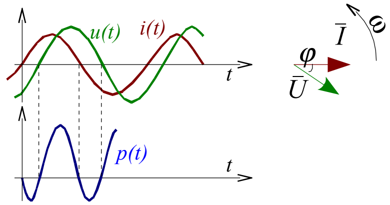
$u^2(t)=\hat{U}^2\cdot\sin^2(\omega t)=\hat{U}^2\cdot\frac{1-\cos(2\omega t)}{2}$

$u(t)=\hat{U}\cdot\sin(\omega t)$

$W=\frac{\hat{U}^2}{2}\cdot\frac{T}{R}$

$P=\frac{W}{T}=\frac{\hat{U}^2}{2\,R}=\frac{U_{eff}^2}{R}\rightarrow U_{eff}=U=\frac{\hat{U}}{\sqrt{2}}$





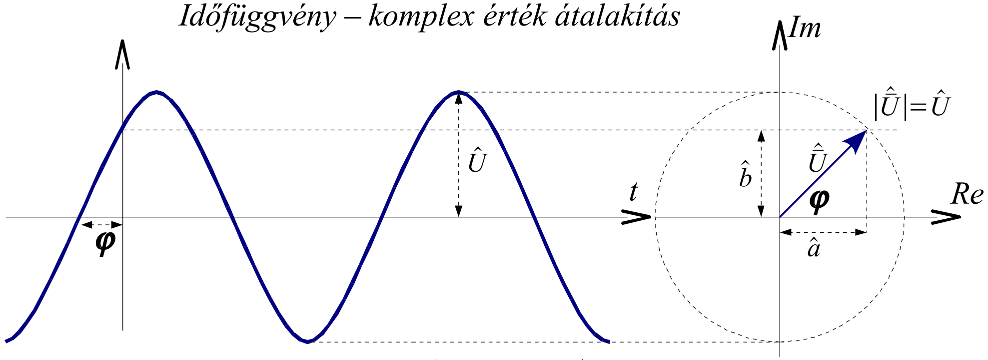
$p(t)=u(t)\cdot i(t)\quad P=\frac{1}{T}\int_0^T p(t)\,dt=\frac{\hat{U}\cdot\hat{I}}{2}\cdot\cos\varphi=U\cdot I\cdot\cos\varphi$

$\bar{S}=\bar{U}\cdot\overset{*}{I}=P+jQ$

$S=\sqrt{P^2+Q^2}$

$\cos\varphi=\frac{P}{S}$

Időfüggvény – komplex érték átalakítás



$u(t)=\hat{U}\cdot\sin(\omega t+\varphi)$

$\hat{a}=\hat{U}\cdot\cos(\varphi)$

$\hat{b}=\hat{U}\cdot\sin(\varphi)$

$\hat{U}=\hat{a}+j\cdot\hat{b}=\hat{U}\cdot\cos(\varphi)+j\cdot\hat{U}\cdot\sin(\varphi)$

$U_{eff}=U=\frac{\hat{U}}{\sqrt{2}}$

$a=U\cdot\cos(\varphi)$

$b=U\cdot\sin(\varphi)$

$\bar{U}=a+j\cdot b=U\cdot\cos(\varphi)+j\cdot U\cdot\sin(\varphi)$

Komplex érték - időfüggvény átalakítás

$\bar{U}=a+j\cdot b$

$u(t)=\hat{U}\cdot\sin(\omega t+\varphi)$

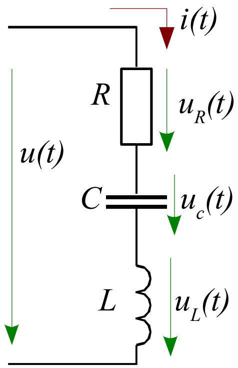
$U=\sqrt{a^2+b^2}$

$\hat{U}=U\cdot\sqrt{2}$

$\varphi=arctg\left(\frac{b}{a}\right)+\begin{Bmatrix}0 & |a>0\\ \pi & |a<0\end{Bmatrix}$

$\varphi=\frac{\pi}{2}\quad |a=0,\ b>0$

$\varphi=-\frac{\pi}{2}\quad |a=0,\ b<0$



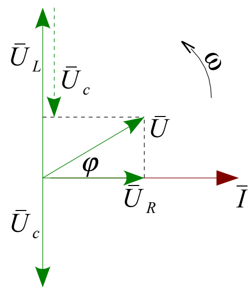
$\bar{U}=\bar{U}_R+\bar{U}_c+\bar{U}_L=\bar{I}\cdot R+\bar{I}\cdot\frac{1}{j\omega C}+\bar{I}\cdot j\omega l$

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

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

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

$\varphi=arctg\left(\frac{\omega L-\frac{1}{\omega C}}{R}\right)$



rezonancia:

$|\bar{U}_L|=|\bar{U}_c|$

$\omega_0 L=\frac{1}{\omega_0 C}$

$\omega_0=\frac{1}{\sqrt{L\cdot C}}\quad f_0=\frac{1}{2\pi\cdot\sqrt{L\cdot C}}$