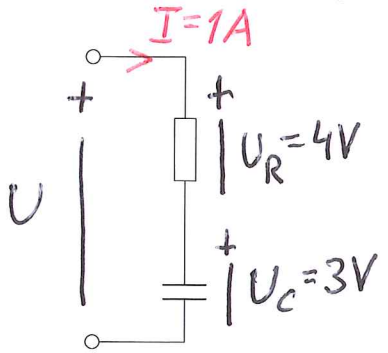
Elektroteknik MF1016 & MF1017 Föreläsning 3. Växelström

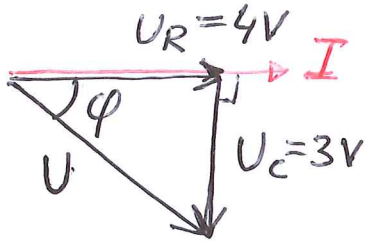
Växelströmsexempel på spänningslag och strömlag



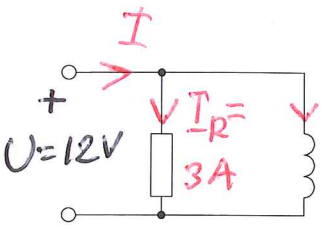
U-lag:

$\underline{U} - \underline{U}_R - \underline{U}_C = 0$

$\Rightarrow \underline{U} = \underline{U}_R + \underline{U}_C$

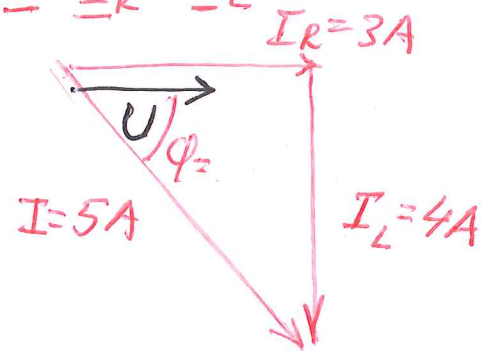


$U = \sqrt{4^2+3^2} = 5V \quad \varphi = 37°$

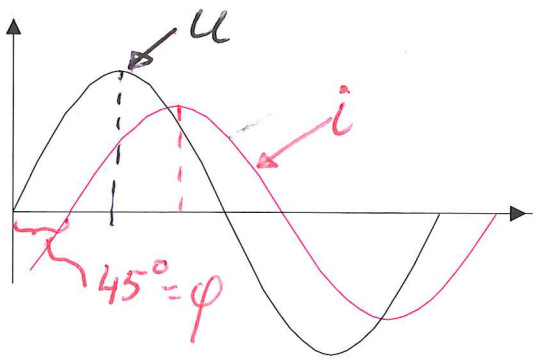


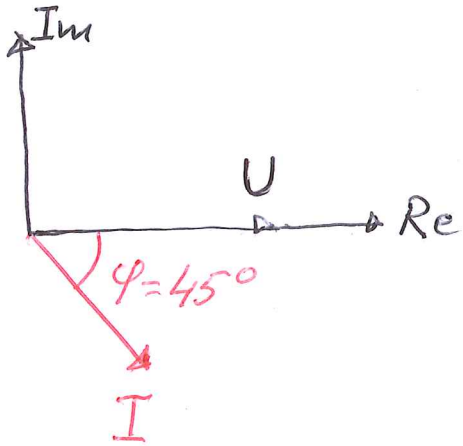
I-lag:

$\underline{I} = \underline{I}_R + \underline{I}_L$



Sinusformade tidsstorheter som visare

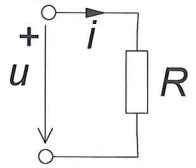


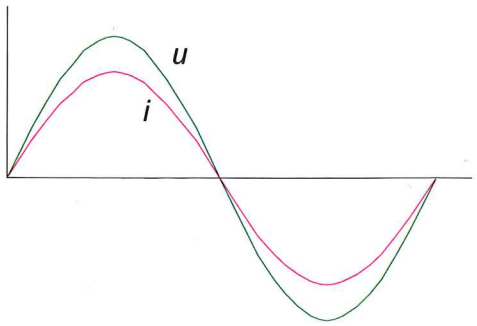


Sinusformade tidsförlopp översätts till visare i ett komplext talplan. j används istället för $i = \sqrt{-1}$.

Kretselement

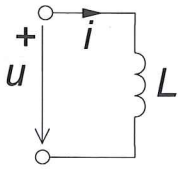
Resistans (motstånd)

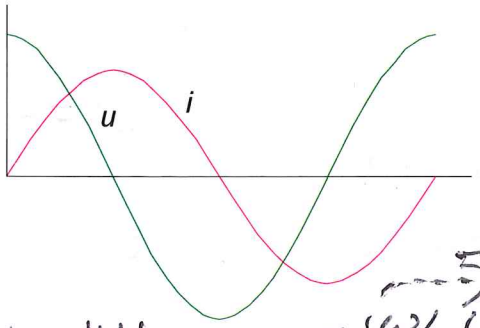




$$\underline{U} = R \cdot \underline{I}$$

Induktans (spole)





$$\underline{U} = j\omega L \, \underline{I}$$

$$u = L\frac{di}{dt} = L\frac{d}{dt}(\hat{i}\sin\omega t)$$

$$= \omega L \hat{i} \cos(\omega t) =$$

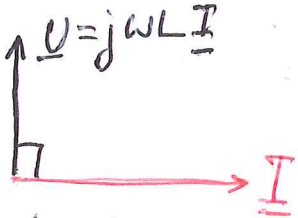
$$= (\omega L \hat{i}) \sin(\omega t + 90°)$$

$\hat{U}$

Effektivvärde = belopp $|\underline{U}|$

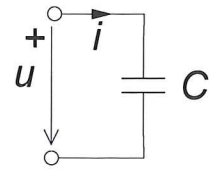
Storleken: $U = \omega L I$

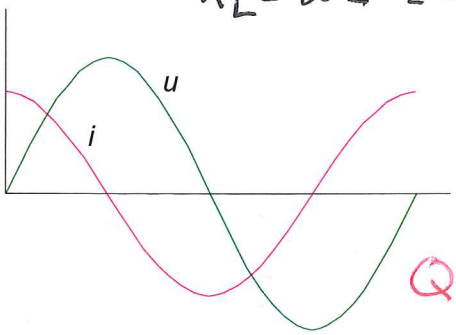
Vinkel $+90°$ motsvarar mult med j



$X_L = \omega L \; [\Omega]$ kallas reaktans

Kapacitans (kondensator)





$$\underline{U} = \frac{1}{j\omega C} \, \underline{I}$$

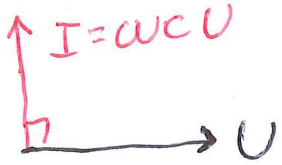
$$Q = CU \Rightarrow i = C\frac{du}{dt}$$

$$= C\frac{d}{dt}(\hat{u}\sin\omega t) = \omega C \hat{u} \cos\omega t = \underbrace{\omega C \hat{u}}_{\hat{i}} \sin(\omega t + 90°)$$

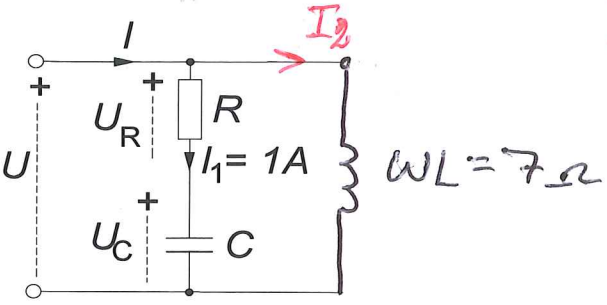
$\Rightarrow \; I = \omega C U$ effektivvärden

derivering $\rightarrow +90° \rightarrow$ mult med $j \Rightarrow \; \underline{I} = j\omega C \underline{U}$

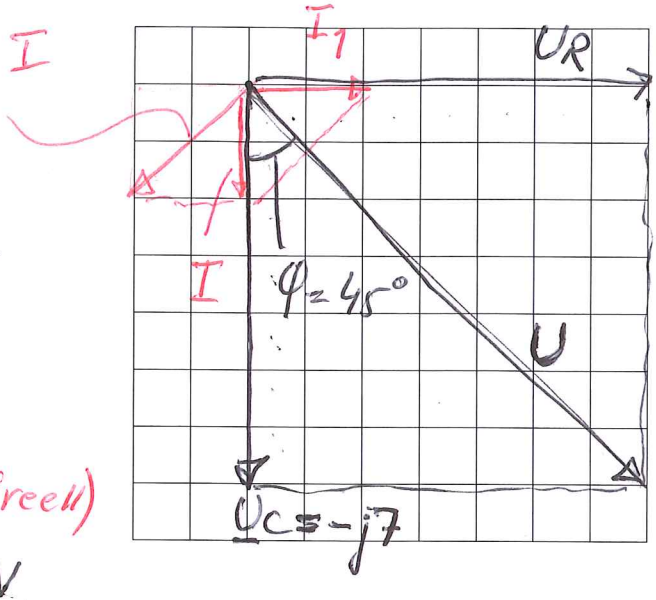
$$\Rightarrow \underline{U} = \frac{1}{j\omega C}\underline{I} = j\frac{-1}{\omega C}\underline{I}$$



X_C kallas reaktans $[\Omega]$



$$\frac{1}{\omega C} = R = 7\Omega$$



Vi väljer I_1 som riktfas (reell)

$\underline{I}_1 = 1A \quad \underline{U}_R = R\underline{I}_1 = 7 \cdot 1 = 7V$

$\underline{U}_C = \frac{1}{j\omega C}\underline{I}_1 = \frac{7}{j} \cdot 1 = -j7V \Rightarrow U_C = 7V$ (storleken)

$\underline{U} = \underline{U}_R + \underline{U}_C = 7V - j7V \qquad U = \sqrt{7^2 + 7^2} = \underline{10V}$

$\underline{I}_2 = \frac{\underline{U}}{j\omega L} = \frac{7V - j7V}{j7\Omega} = \left(\frac{1}{j} - 1\right)A = (-1 - j)A$

$I_2 = \sqrt{1^2 + 1^2} = \underline{\sqrt{2}A}$

$\underline{I} = \underline{I}_1 + \underline{I}_2 = 7 - 1 - j = -jA \Rightarrow \underline{I = 1A}$

Kretsens impedans $Z = \frac{U}{I} = \frac{10}{1} = \underline{10\Omega}$

Tillförd effekt:

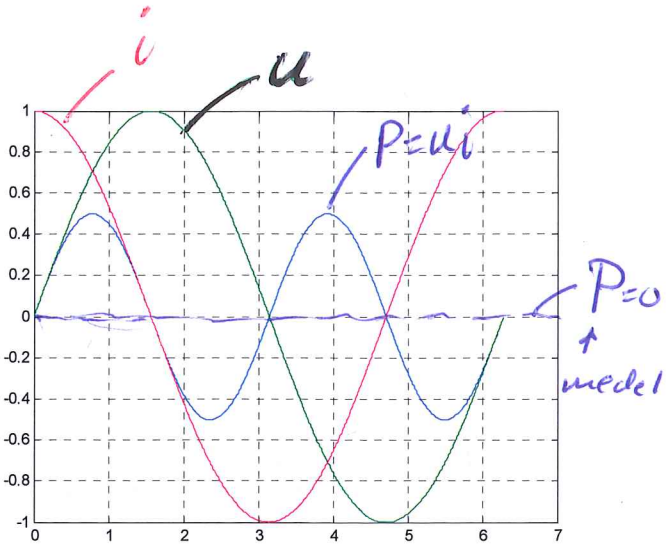
$P = UI\cos\varphi = 10 \cdot 1 \cdot \cos 45° = 7W$

Effekt i R

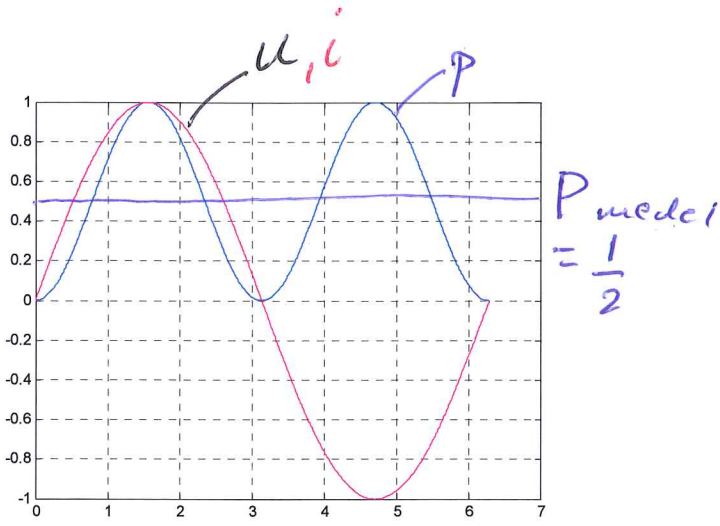
$P = RI_1^2 = 7 \cdot 1^2 = 7W$

Tillförd effekt omvandlas till värme i R.

AC-effekt std 1-ST härledning



i 90° före u alltså kondensator



i & u i fas

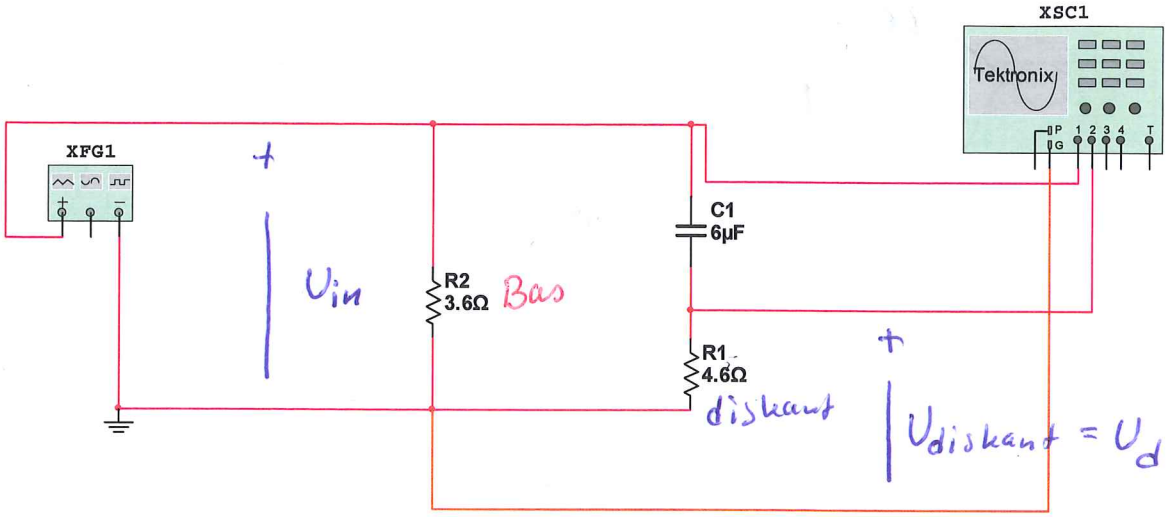
u täcks av i, syns ej. i diagrammet

Formel ger: $P = UI \cdot \underbrace{\cos\varphi}_{=0} = 0$

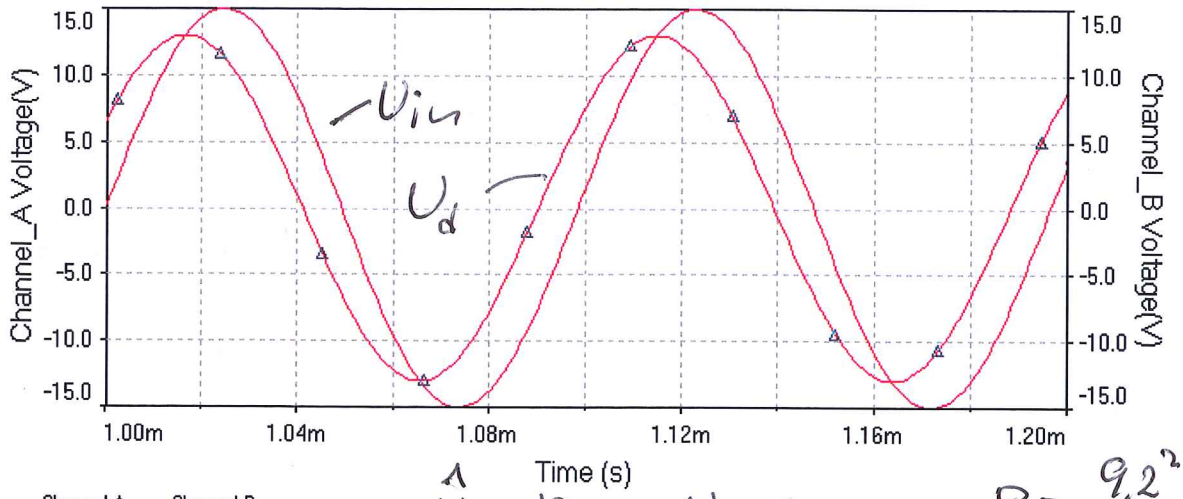
Induktans ger samma resultat.

$P = U \cdot I \cos\varphi =$

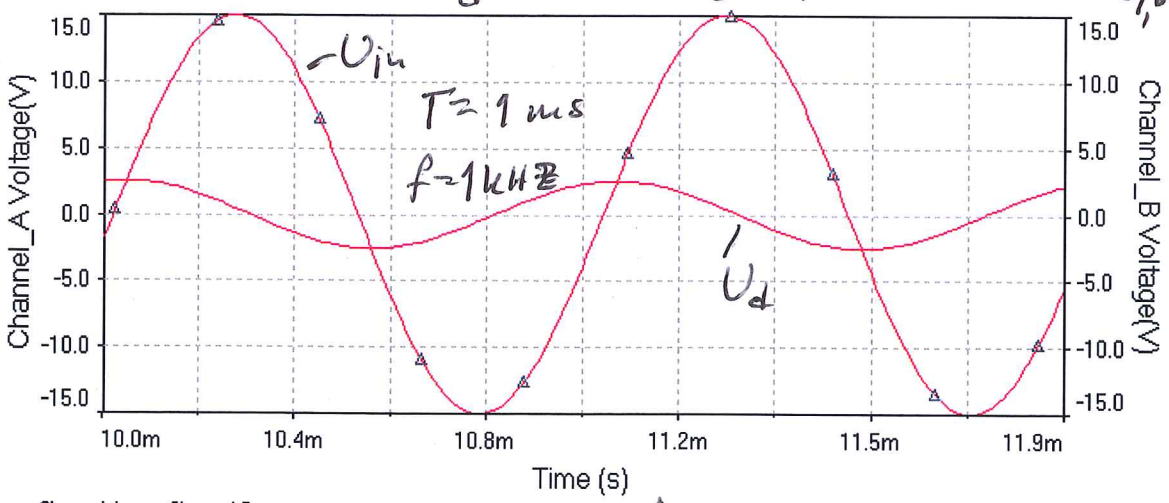
$= \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} \cdot 1 = \frac{1}{2}$



$T = 0{,}1\,ms \Rightarrow f = 10\,kHz$



$\hat{U}_d \approx 13V \Rightarrow U_d = 9{,}2V \Rightarrow P = \frac{9{,}2^2}{4{,}6} = 18{,}4W$



$\hat{U}_d \approx 2{,}5V \Rightarrow U_d = 1{,}8V$

$\Rightarrow P = \frac{1{,}8^2}{4{,}6} = 0{,}7W$