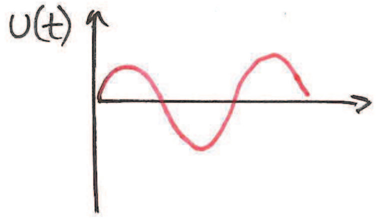
Växelström

Torsdag LV1

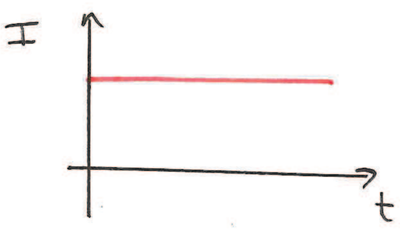
1. Intro AC
2. AC $j\omega$
3. Halvledare + tillämpningar

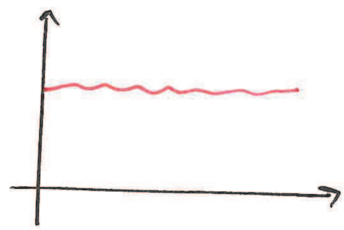
{ AC - alternating current
DC - direkt current }

AC - riktningen av laddningsbärarens flöde kastas om regelbundet



DC: riktning ändras inte



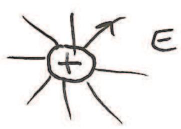


{ varierande likspänning }

Hur skapas AC-spänning

1. Magnetiskt fält B (B-fält) [T] Tesla

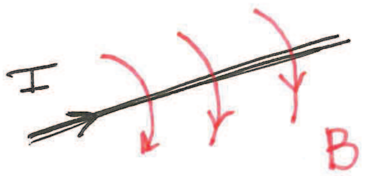
Laddningar i vila.



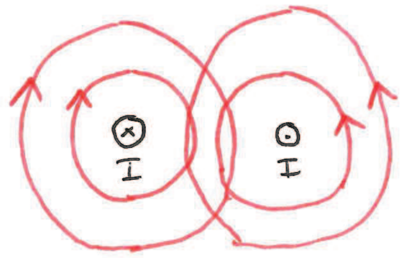
i rörelse: E- och B-fält

När en laddning rör sig börjar den alstra ett elektriskt och ett magnetiskt fält!

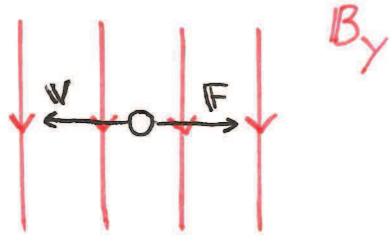
ström $\equiv$ laddningar i rörelse $\quad \dfrac{dq}{dt}$



ström i en ledare alstrar ett magnetisk fält

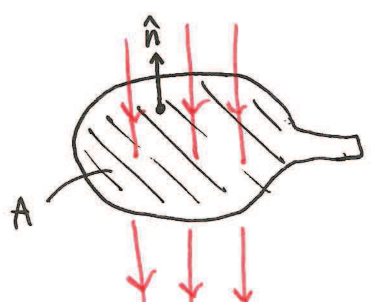


2. Inducerad ström



ledare i $\mathbb{B}$-fält inducerar spänning

3. Induktion (Faraday)



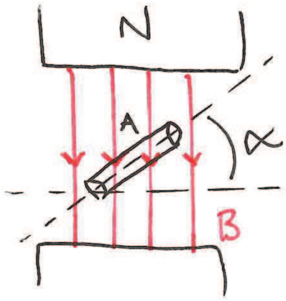
$$\phi = \mathbb{B} \cdot \mathbb{A} = BA \cdot \hat{n}$$

$$\text{emk} = -\frac{d\phi}{dt} \quad \Big\{ \text{Faradays induktionslag}$$

$$e = -N\frac{d\phi}{dt} = -N\frac{\partial \phi}{\partial t}$$

$$e = -N\frac{\Delta\phi}{\Delta t}$$

Hur produceras AC?

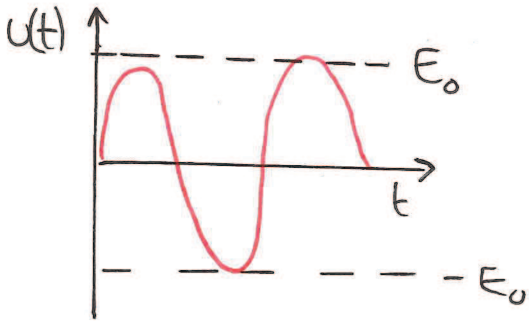


rotation: $\omega \left(\frac{rad}{s}\right)$

arean: $A \cos\alpha = A \cos \omega t$

flöde: $\phi = B \cdot A \cos \omega t$

$$e = -\frac{d\phi}{dt} = -NBA \sin \omega t = E_0 \sin \omega t$$

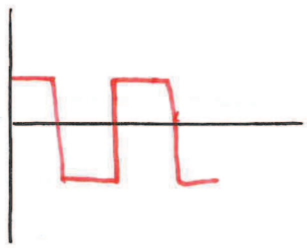
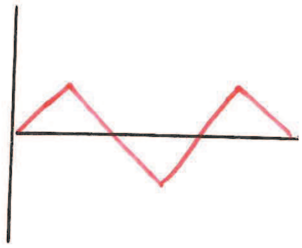
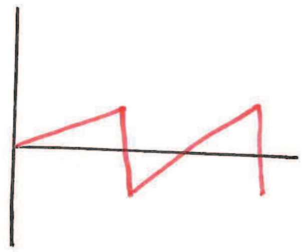


E_0 - amplitud, toppvärde

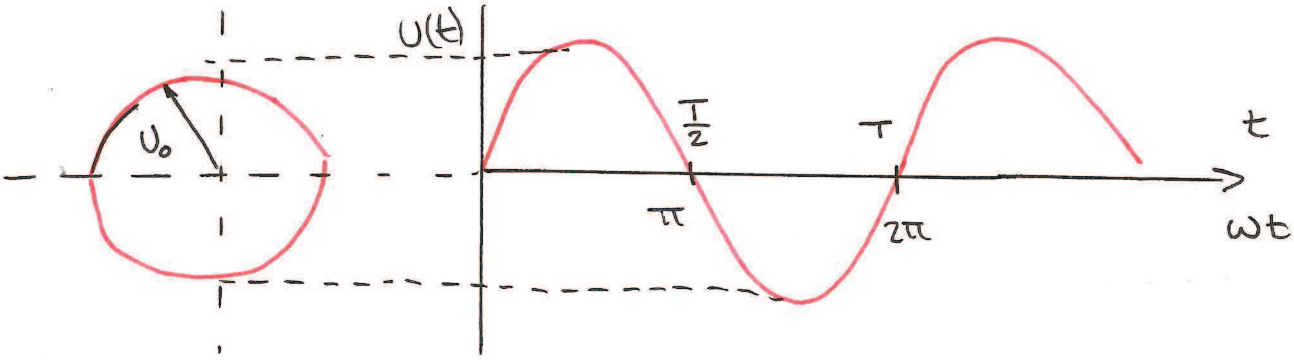
$u(t)$ - momentanvärde

$u(t) = U_0 \sin \omega t$ stationär sinusformad spänning

$$\left.\begin{array}{l} \omega = 2\pi f \\ E_0 \end{array}\right\} \begin{array}{l} \text{konstant i tid} \\ \text{tid elimineras!} \end{array}$$

Visardiagram



$$\begin{cases} u(t) = U_0 \sin \omega t \\ i(t) = I_0 \sin(\omega t + \alpha) \end{cases}$$

$T = \frac{1}{f}$ [s] periodtid

f [Hz, $\frac{1}{s}$] frekvens

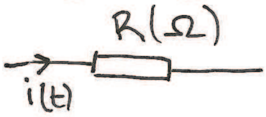
ω [$\frac{rad}{s}$] vinkelfrekvens $\boxed{\omega = 2\pi f}$

α fasvinkel [rad]

Effekt av komponenter

Kirchhoffs lagar gäller alltid

Resistans



$u(t), i(t)$	momentanvärde
U_0, I_0	amplitud, toppvärde
U, I	effektivvärde
$\overline{U}, \overline{I}$	komplexa värden

1. Effektiv- och toppvärde

sinus: $I_{eff} = \frac{I_0}{\sqrt{2}}$ $\qquad U_{eff} = \frac{U_0}{\sqrt{2}}$

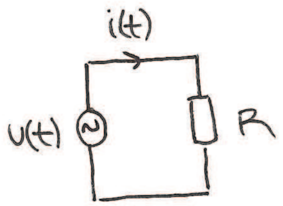
Definition: $\cancel{R} I_{eff}^2 = \frac{1}{T} \int_0^T \cancel{R} I_0^2 \sin^2(\omega t)\, dt$

$$I_{eff}^2 = \frac{I_0^2}{T} \int_0^T \sin^2(\omega t)\, dt$$

Obs! voltmeter mäter effektivvärde
oscilloskop mäter toppvärde

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

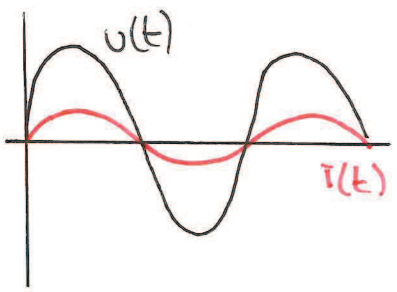
2. seriekrets

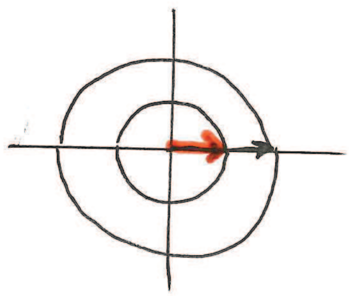


$u(t) = R \cdot i(t)$

$U_0 \sin \omega t = R I_0 \sin \omega t$

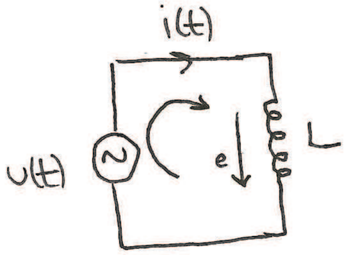
$U_0 = R I_0$ R ger ingen fasförskjutning mellan u(t) och i(t)





Induktans (en spole)   L(H)

(ideal spole: $R_L = 0$)



$$e = -L\frac{di}{dt}$$

$$u + e = 0 = u - L\frac{di}{dt} = 0$$

$$U_0 \sin(\omega t + \varphi) = L\frac{di}{dt} = L\frac{d}{dt}(I_0 \sin \omega t)$$

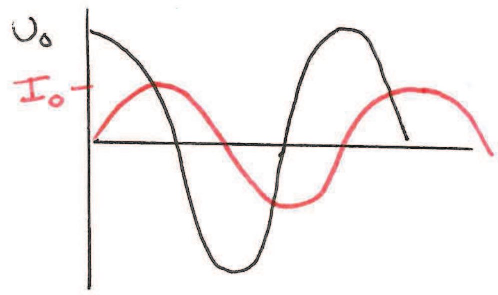
$$U_0 \sin(\omega t + \varphi) = \omega L I_0 \cos \omega t$$

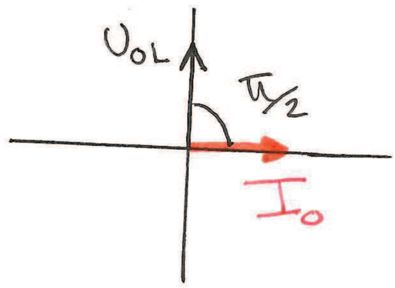
$$U_0 = \omega L I_0 \qquad \varphi = +\frac{\pi}{2}$$

$$U = \omega L I$$

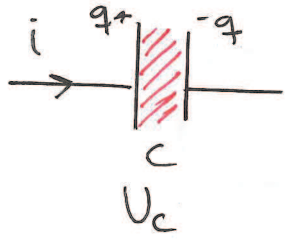
X_L - spolens reaktans $= \omega L$

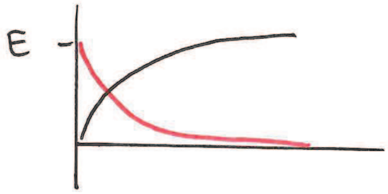
$$U_L = X_L I = \omega L I$$

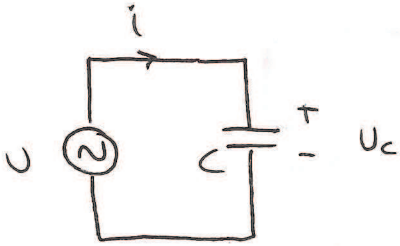




Kapacitans (kondensator)   C(F)







$$\frac{dU_c}{dt} = \frac{1}{C}\frac{dq}{dt} = \frac{1}{C} i$$

$$\frac{d}{dt}\left(U_0 \sin \omega t\right) = \frac{1}{C}\left(I_0 \sin \omega t\right)$$

$$U_0 \omega \cos \omega t = \frac{I_0}{C} \sin \omega t = \frac{I_0}{C} \cos\left(\omega t - \frac{\pi}{2}\right)$$

$$U_0 = \frac{1}{\omega C} I_0 \qquad \varphi = \frac{-\pi}{2}$$

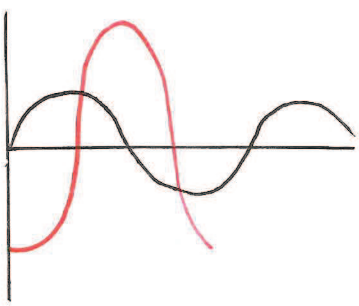
$$U = \frac{1}{\omega C} I$$

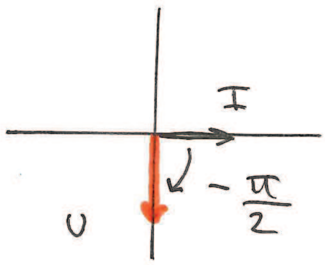
stopp för DC!

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

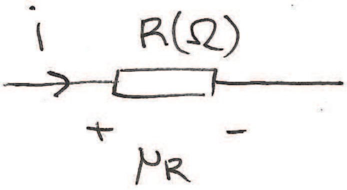
reaktans för kondensatorn

$$U_C = X_C I$$

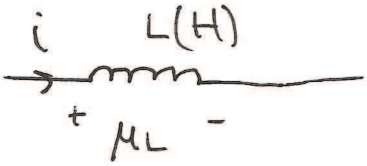




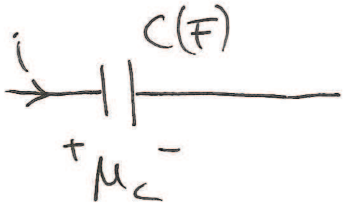
Sammanfattning



$$u_R = iR \qquad \boxed{U_R = IR} \qquad \varphi = 0$$



$$u_L = L\frac{di}{dt} \qquad \boxed{U_L = \omega L I} \qquad \varphi = \frac{\pi}{2}$$



$$u_c = \frac{1}{c}\int_0^t i(t)\,dt \qquad \boxed{U_c = \frac{1}{\omega C} I} \qquad \varphi = \frac{-\pi}{2}$$

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