Kap 31: Vekselstrømskretser

31.1 Visere og kompleks notasjon

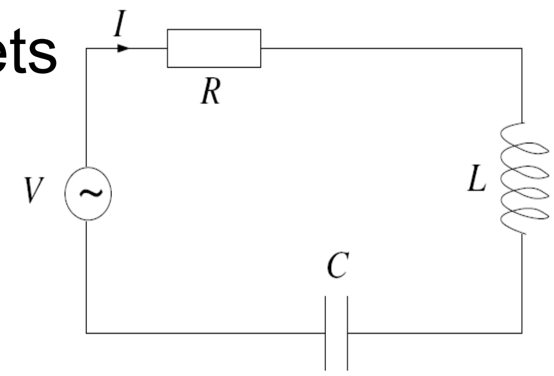
31.2 (Kompleks) reaktans

31.3 *RLC*-krets

31.5 Resonans (i *RLC*-krets)

Kretslover for AC-signal

med eksempel i *RLC*-seriekrets

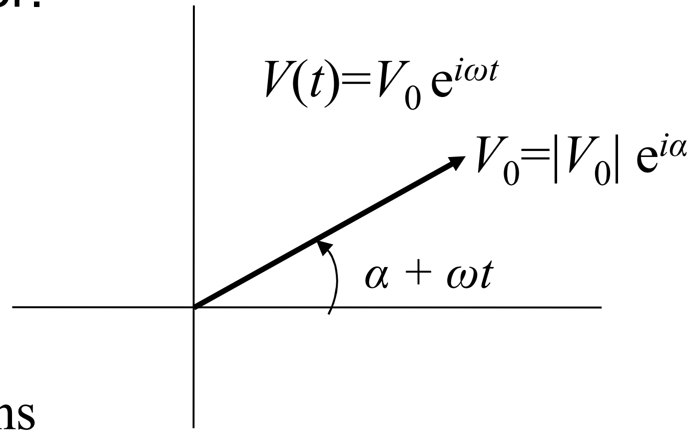


Regler:

1. $V(t) = V_0 \cdot e^{i\omega t}$ (1)

   $I(t) = I_0 \cdot e^{i\omega t}$ (2) osv. $V_R(t), V_L(t), V_C(t)$

   med lik frekvens ω og komplekse amplituder.



2. Resistans: $V_R = Z_R I = R \cdot I$ (6)

   $Z_R = R$ = resistans = resistiv impedans

3. Induktans: $V_L = Z_L I = i\omega L \cdot I$ (7)

   $Z_L = i\omega L$ = induktiv impedans, L = induktans

4. Kapasitans: $V_C = Z_C I = 1/i\omega C \cdot I$ (8)

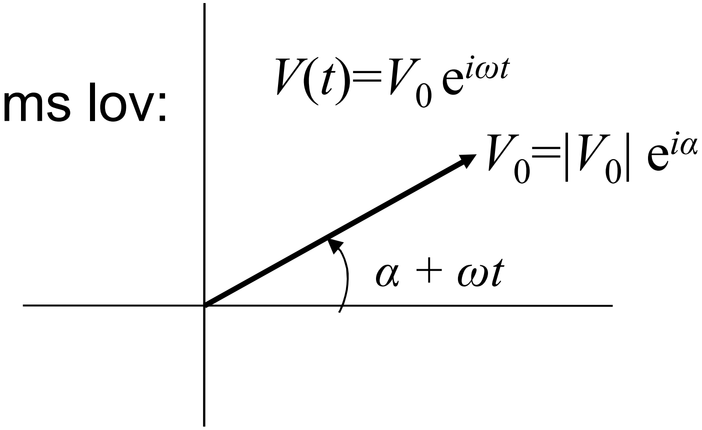
   $Z_C = 1/i\omega C$ = kapasitiv impedans, C=kapasitans

OBS:
$d/dt\,(e^{i\omega t}) = i\omega\, e^{i\omega t}$

5. Kirchhoffs lover som vanlig.

Kompleks impedans med AC-signal

1. $V(t) = V_0 \cdot e^{i\omega t}$ og $I(t) = I_0 \cdot e^{i\omega t}$
   med lik frekvens ω og komplekse amplituder V_0 og I_0 gir en utvidet Ohms lov:
2. Resistans: $V_R = Z_R I = R \cdot I$
3. Induktans: $V_L = Z_L I = i\omega L \cdot I$
4. Kapasitans: $V_C = Z_C I = 1/i\omega C \cdot I$

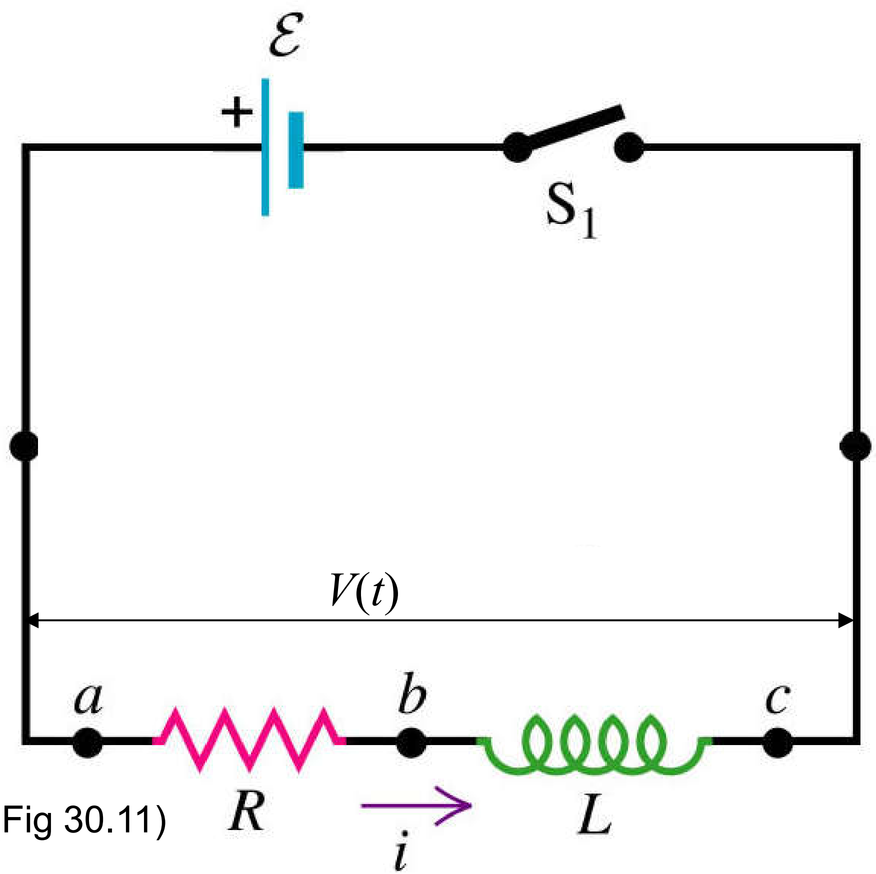


- Seriekopling: $Z = Z_1 + Z_2$
- Parallellkopling: $1/Z = 1/Z_1 + 1/Z_2$

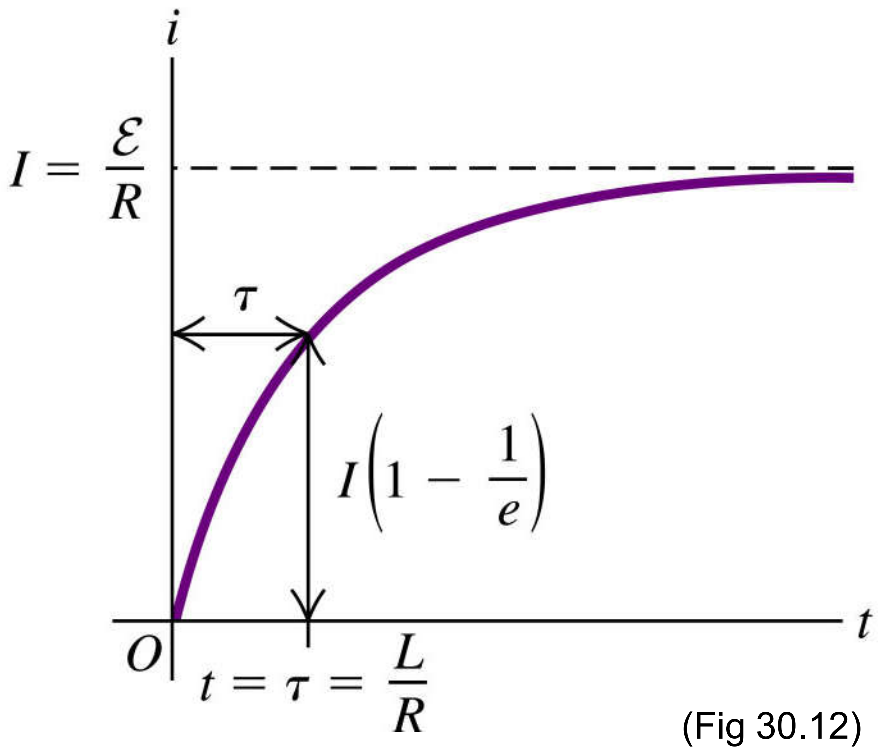
- Alle kretslover gjelder for AC når Z brukes:
  Kirchoff 1 (strømlov)
  Kirchoff 2 (spenningslov)
  Ohms lov

- **OBS:**
  Z gjelder kun AC (harmonisk variasjon), ikke andre periodiske signal som f.eks. firkantpuls.

Eks: *RL*-krets



(Fig 30.11)



(Fig 30.12)

$$V(t) = R\, I(t) + L\, \mathrm{d}I(t)/\mathrm{d}t \qquad (30.12)$$

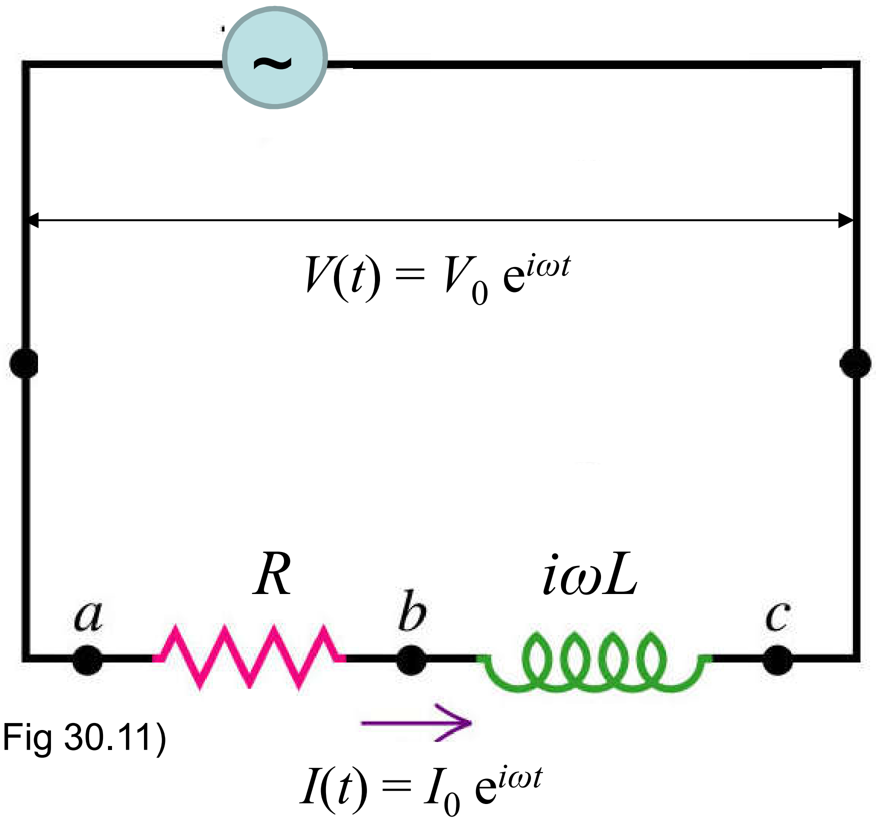
1) Lukke bryter S_1
2) Åpne bryter S_1

} Kap. 30.4

3) $\mathcal{E}$ = AC-spenning

} Nå (kap 31.2)

Detaljer for *RL*-krets



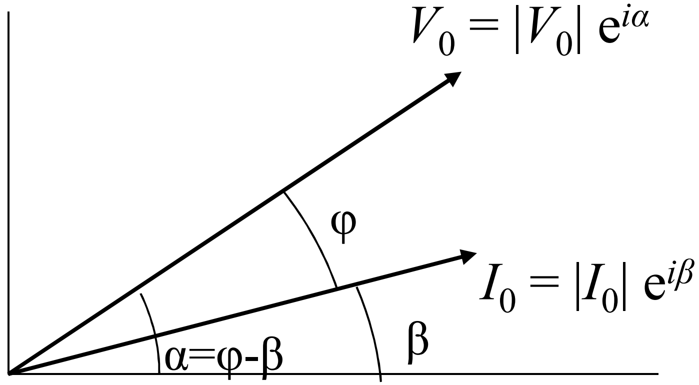
(Fig 30.11)

Ohms lov: $V(t) = Z\ I(t)$

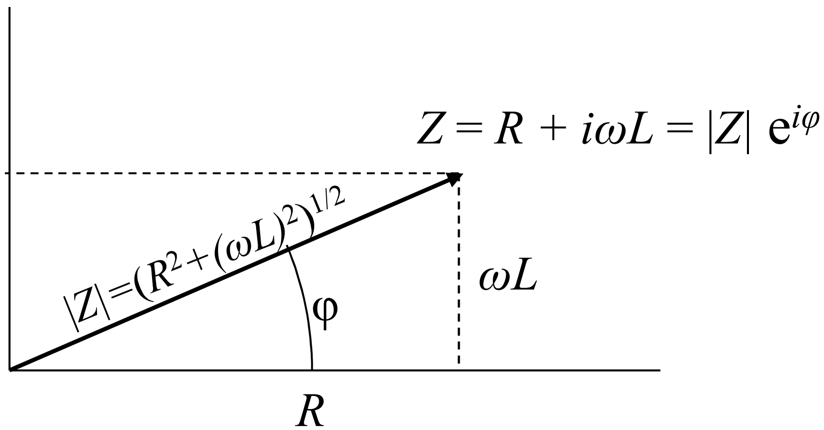
Impedans = $Z = R + i\omega L = |Z|\ e^{i\varphi}$

Med kompleks amplitityde: $V_0 = Z\ I_0$,

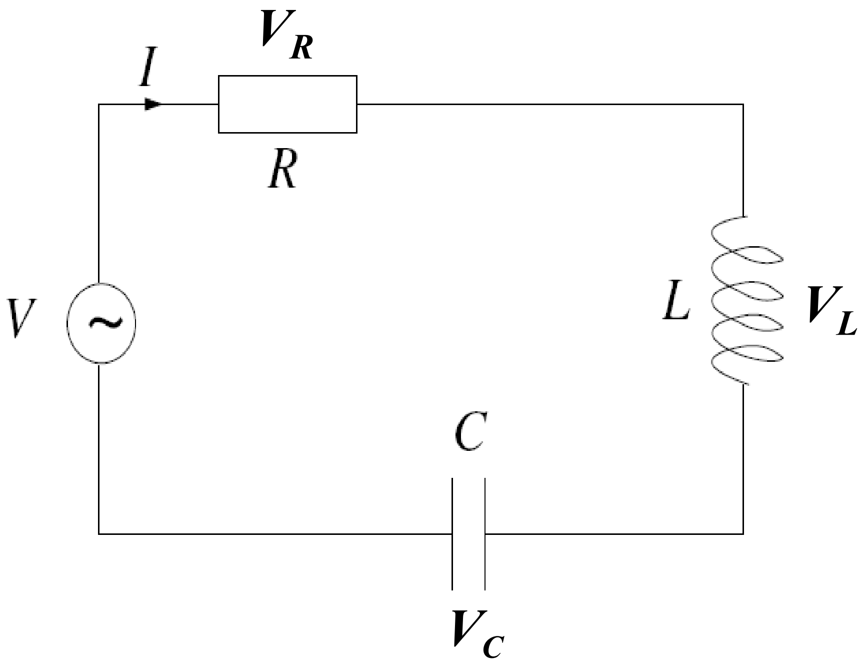
der:



Her:
velger
$\beta = 0$



AC-spenning på *RLC*-krets



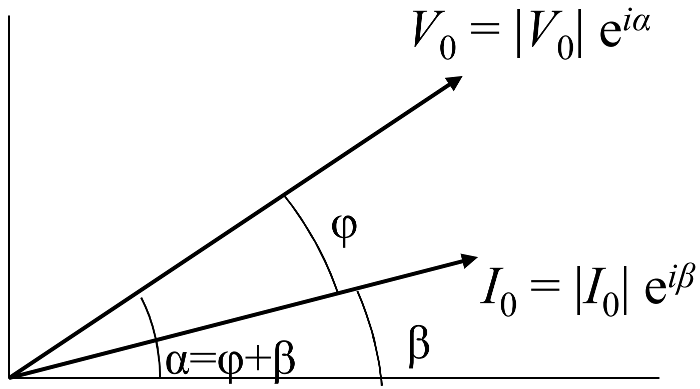
$V(t) = V_0 \cdot e^{i\omega t}$ (1)
$I(t) = I_0 \cdot e^{i\omega t}$ (2)

Kirchhoff:
$V(t) = V_R + V_L + V_C = Z\,I(t)$ (9)

$V_R = Z_R I = R \cdot I$ (6)
$V_L = Z_L I = i\omega L \cdot I$ (7)
$V_C = Z_C I = 1/i\omega C \cdot I$ (8)

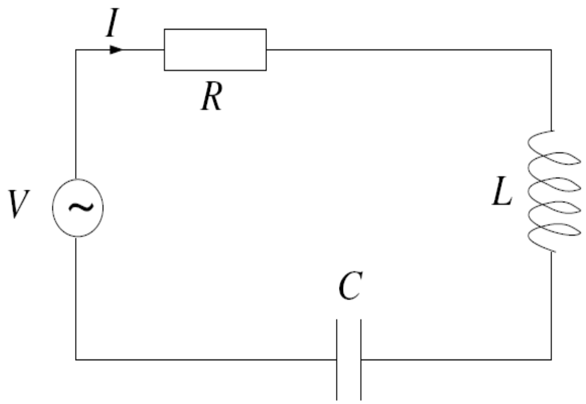
gir seriekretsens komplekse impedans:

$$Z = R + i\omega L + 1/i\omega C$$
$$= R + i(\omega L - 1/\omega C) \quad (10)$$



eller
$$Z = R + Z_L + Z_C$$
(vanlig seriekopling av impedanser)

Eks.: *RLC*-krets



Kirchhoffs spenningslov:

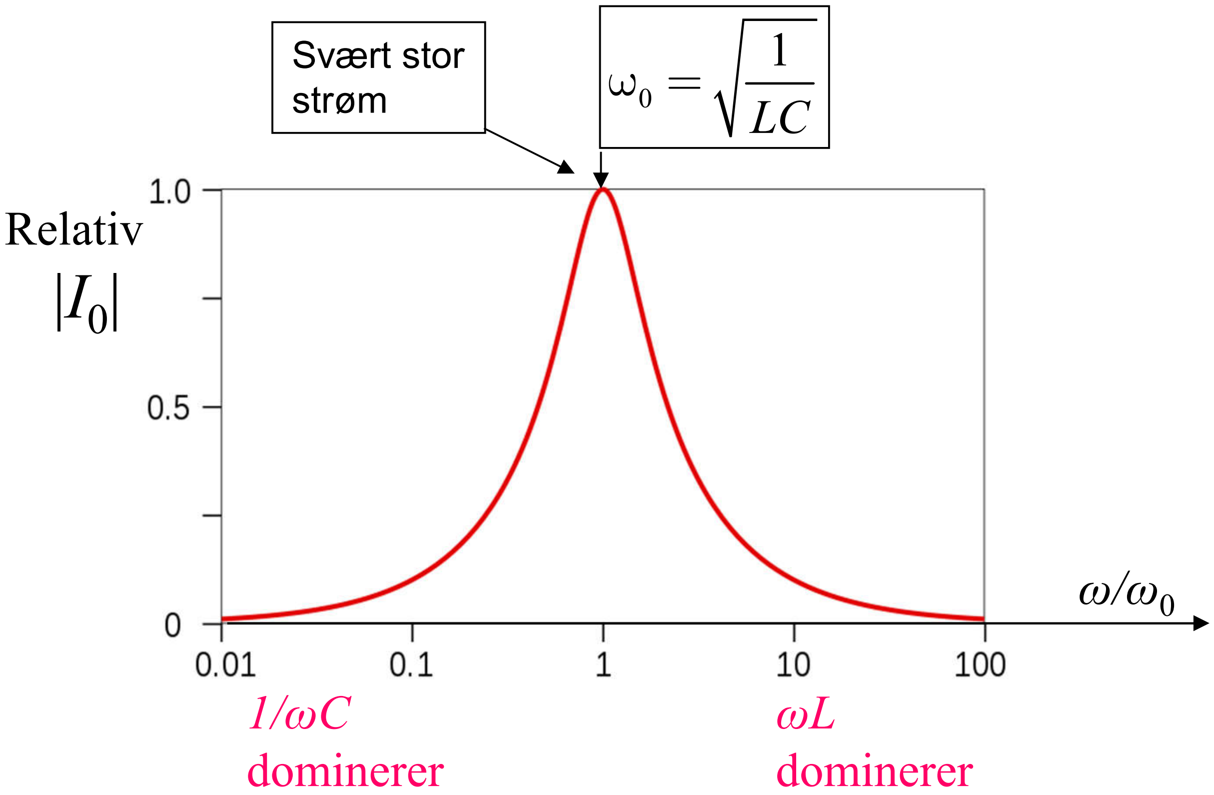
$$V(t) = V_R + V_L + V_C = Z \cdot I(t)$$

gir $Z = R + i\omega L + 1/i\omega C$

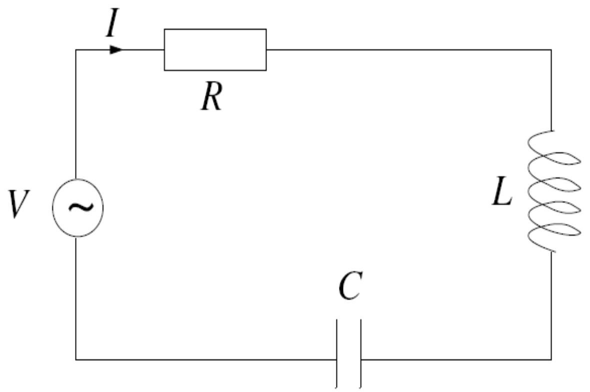
$\Rightarrow |Z| = (R^2 + (\omega L - 1/\omega C)^2)^{1/2}$

Nå praktisk å **velge** $\alpha = 0$, slik at $\beta = -\varphi$:

$$I_0 = |V_0|/|Z| \exp(-i\varphi)$$



Eks.: *RLC*-krets



Kirchhoffs spenningslov:

$$V(t) = V_R + V_L + V_C = Z \cdot I(t)$$

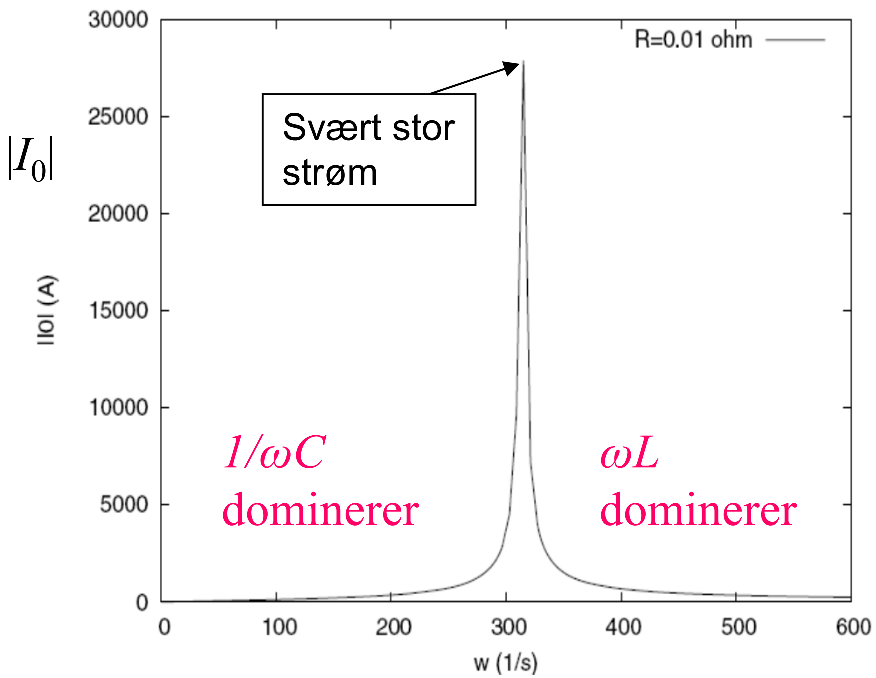
gir $Z = R + i\omega L + 1/i\omega C$

$\Rightarrow |Z| = (R^2 + (\omega L - 1/\omega C)^2)^{1/2}$

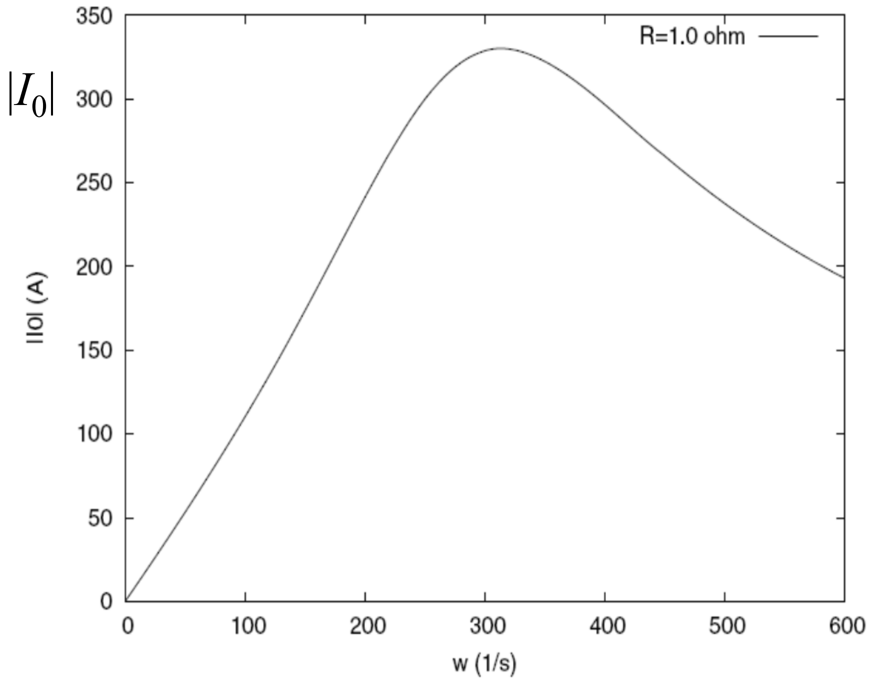
$I_0 = |V_0|/|Z| \exp(-i\varphi)$

Øving 13, oppgave 5

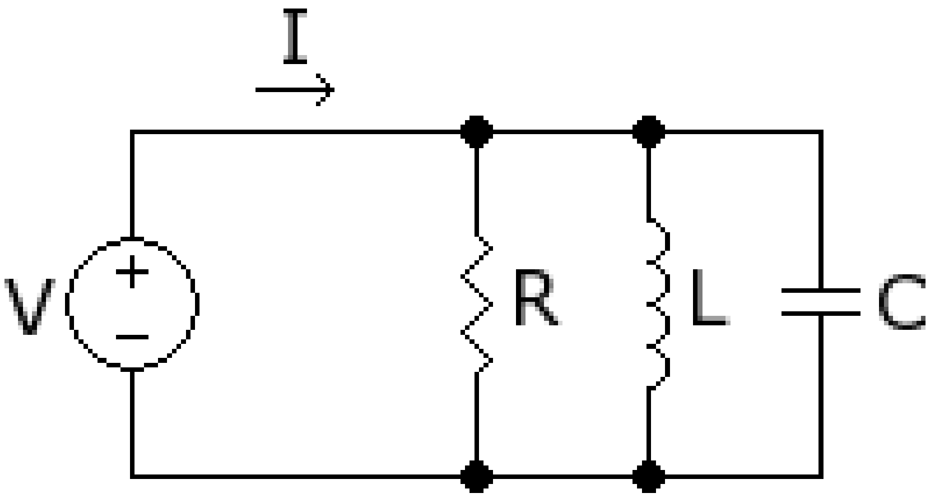
Med $R = 1/100\ \Omega$:



Med $R = 1\ \Omega$:



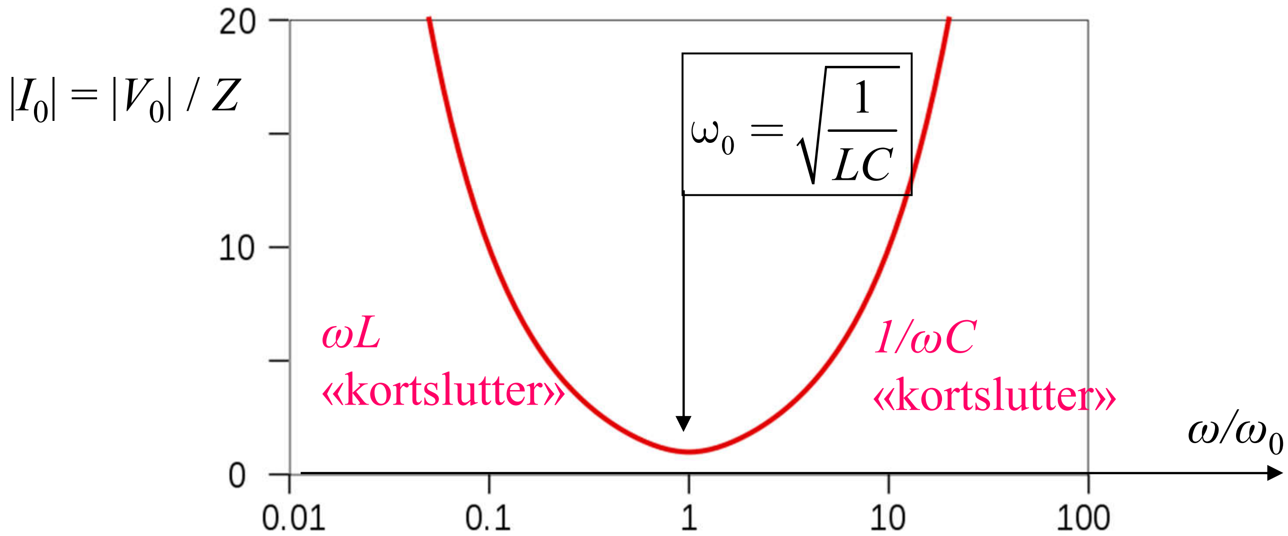
Eks: *RLC*-parallellkrets



Parallellkopling:

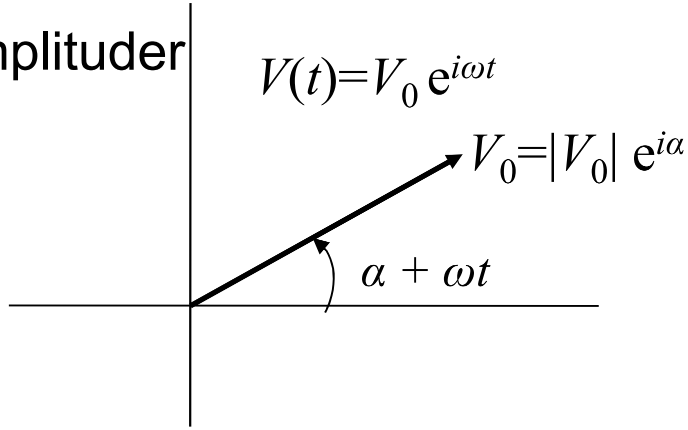
$$1/Z \;=\; 1/R \;+\; 1/i\omega L \;+\; i\omega C$$

$$Z \;=\; \frac{R}{1 \;+\; i\left(\omega RC - \dfrac{R}{\omega L}\right)}$$



Kompleks impedans med AC-signal

1. $V(t) = V_0 \cdot e^{i\omega t}$ og $I(t) = I_0 \cdot e^{i\omega t}$
   med lik frekvens ω og komplekse amplituder V_0 og I_0 gir en utvidet Ohms lov:
2. Resistans: $V_R = Z_R I = R \cdot I$
3. Induktans: $V_L = Z_L I = i\omega L \cdot I$
4. Kapasitans: $V_C = Z_C I = 1/i\omega C \cdot I$



- Seriekopling: $Z = Z_1 + Z_2$
- Parallellkopling: $1/Z = 1/Z_1 + 1/Z_2$

- Alle kretslover gjelder for AC når Z brukes:
  Kirchoff 1 (strømlov)
  Kirchoff 2 (spenningslov)
  Ohms lov

- OBS:
  Z gjelder kun AC-signal, ikke andre periodiske signal eller ikke-periodiske signal.