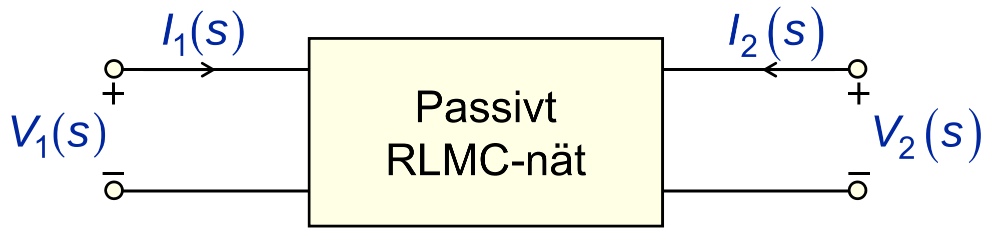
FILTER: Tvåportar (kap 6.9)



$\Rightarrow$ Kausalt LTI-system

- Uttryck två av storheterna V_1, V_2, I_1 och I_2 som funktion av de andra två.

T.ex

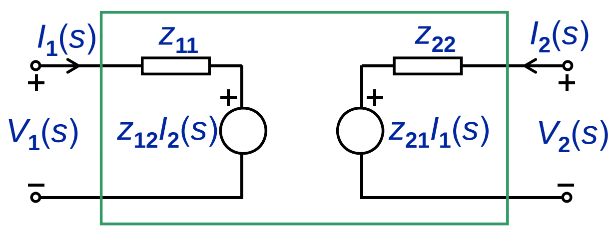
$$\begin{cases} V_1 = f_1(I_1, I_2) = \\ V_2 = f_2(I_1, I_2) = \end{cases} \Big/ \text{Linjärt system} \Rightarrow \text{superpos.} \Big/ \begin{matrix} = z_{11} \cdot I_1 + z_{12} \cdot I_2 \\ = z_{21} \cdot I_1 + z_{22} \cdot I_2 \end{matrix}$$

Tvåportar, parameterbeskrivning

Impedansparametrar

$$\begin{bmatrix} V_1(s) \\ V_2(s) \end{bmatrix} = \underbrace{\begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix}}_{z\text{-parametrar}} \cdot \begin{bmatrix} I_1(s) \\ I_2(s) \end{bmatrix}$$

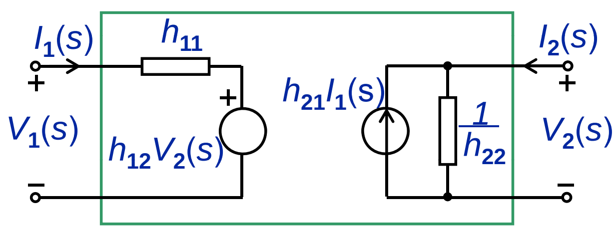
Allmän tvåportekvivalent:



Hybridparametrar

$$\begin{bmatrix} V_1(s) \\ I_2(s) \end{bmatrix} = \underbrace{\begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix}}_{h\text{-parametrar}} \cdot \begin{bmatrix} I_1(s) \\ V_2(s) \end{bmatrix}$$

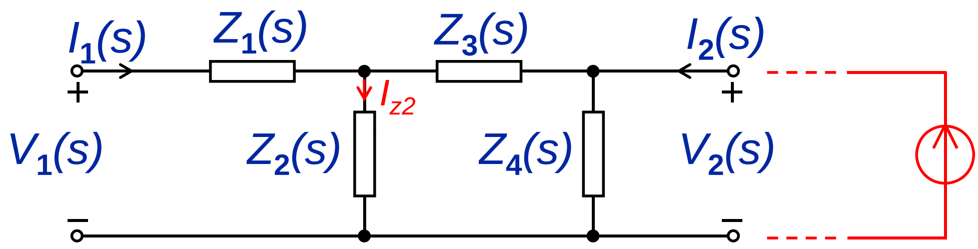
Allmän tvåportekvivalent:



Ex: linjär modell av bipolartransistorn

Tvåportar, beräkning av parametrar

Exempel:



$z_{12} = ?$

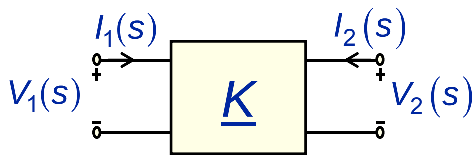
$$V_1(s) = z_{11} \cdot I_1(s) + z_{12} \cdot I_2(s) \quad \Rightarrow \quad z_{12} = \left.\frac{V_1(s)}{I_2(s)}\right|_{I_1(s)=0}$$

$$I_{z2}(s) = \frac{V_1}{Z_2} = \Bigg/ \begin{array}{c}\text{Strömdelning}\\ (\text{av } I_2 \to I_{z2})\end{array} \Bigg/ = I_2 \cdot \frac{Z_4}{Z_2 + Z_3 + Z_4}$$

$$\Rightarrow \quad z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0} = \frac{Z_2 Z_4}{Z_2 + Z_3 + Z_4}$$

Tvåportar, *K*-parametrar

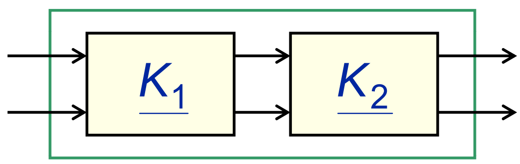
$$\begin{bmatrix} V_1(s) \\ I_1(s) \end{bmatrix} = \underbrace{\begin{bmatrix} A & B \\ C & D \end{bmatrix}}_{} \cdot \begin{bmatrix} V_2(s) \\ -I_2(s) \end{bmatrix}$$



K-parametermatrisen $\underline{K}$

K-parametrar är speciellt lämpliga vid <u>k</u>askadkoppling:

$$\underline{K}_{tot} = \underline{K}_1 \cdot \underline{K}_2$$



Ofta: $v_1(t)$ insignal, $v_2(t)$ utsignal

(Obelastad utgång ⇔ $i_2(t) = 0$)

$$\Rightarrow \quad H(s) = \left.\frac{V_2(s)}{V_1(s)}\right|_{I_2(s)=0} = \frac{1}{A}$$

PASSIVA FILTER

Bortfiltrering av signalkomponenter:

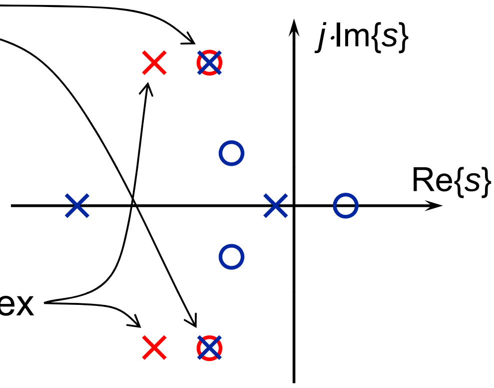
$$Y(s) = X(s) \cdot H(s)$$

$$= \frac{T_X(s)}{(s-p_1)\cancel{(s-p_2)}\cancel{(s-p_3)}(s-p_4)} \cdot \frac{\cancel{(s-p_2)}\cancel{(s-p_3)}}{N_H(s)}$$

”Signalselektiv” filtrering:

De komplexkonjugerade polerna p_2 och p_3 hos $X(s)$ motsvarar en signalkomponent i $x(t)$ som skall <u>helt</u> filtreras bort !

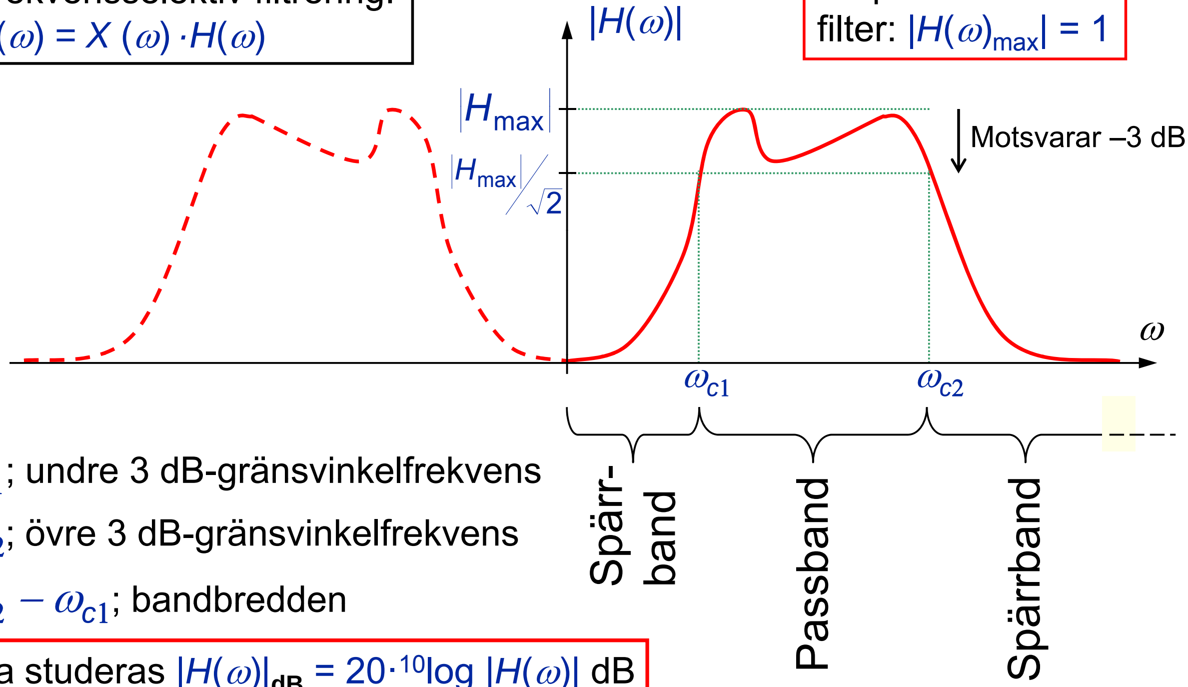
Stabilt system: # poler $\geq$ # nollställen $\Rightarrow$ t.ex



Frekvensselektiva Passiva Filter

Frekvensselektiv filtrering:
$Y(\omega) = X(\omega) \cdot H(\omega)$

Amplitudnormerat filter: $|H(\omega)_{max}| = 1$



ω_{c1}; undre 3 dB-gränsvinkelfrekvens

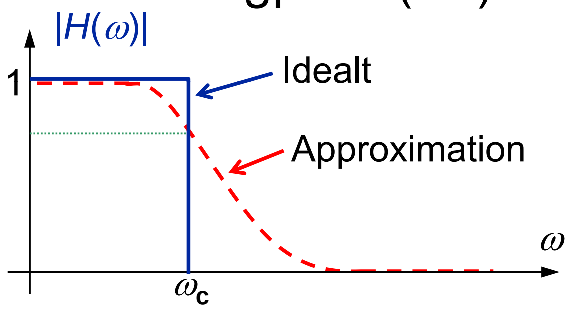
ω_{c2}; övre 3 dB-gränsvinkelfrekvens

$\omega_{c2} - \omega_{c1}$; bandbredden

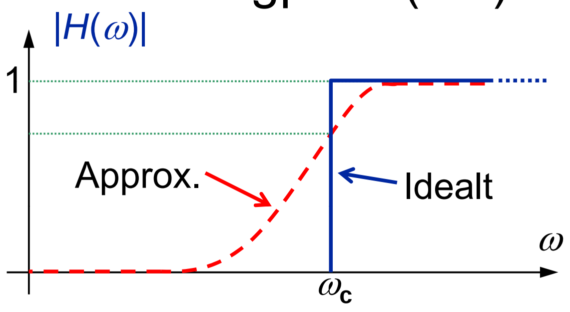
Ofta studeras $|H(\omega)|_{dB} = 20 \cdot {}^{10}\log |H(\omega)|$ dB

Olika frekvensselektiva filtertyper

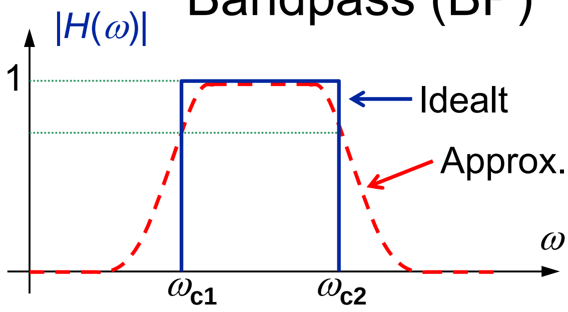
Lågpass (LP)



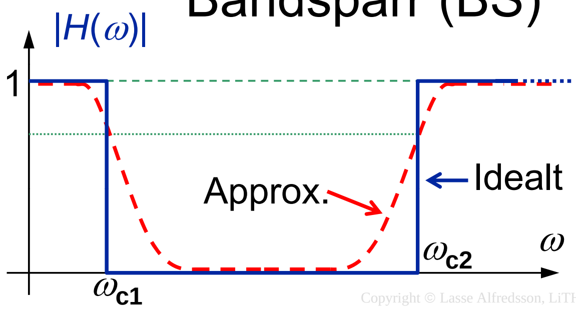
Högpass (HP)



Bandpass (BP)

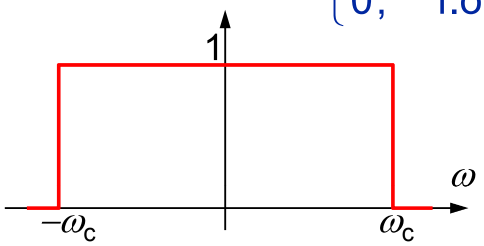


Bandspärr (BS)

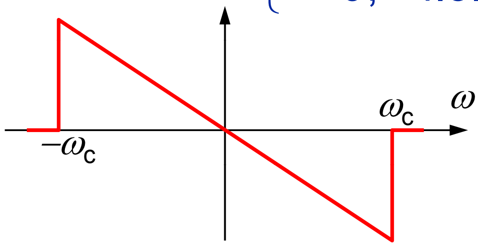


Ideala Filter (Exempel - LP):

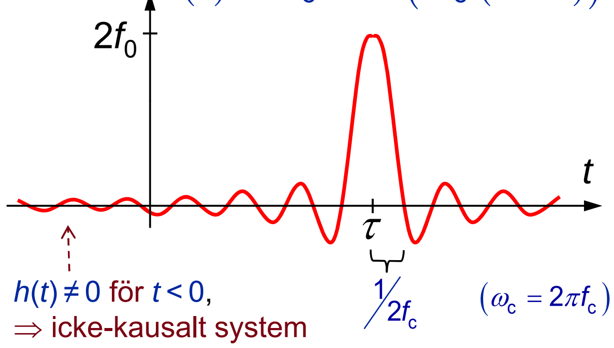
$$|H(\omega)| = \begin{cases} 1; & |\omega| \le \omega_c \\ 0; & \text{f.ö.} \end{cases}$$



$$\arg H(\omega) = \begin{cases} -\omega\tau; & |\omega| \le \omega_c \\ 0; & \text{f.ö.} \end{cases}$$



$$h(t) = 2f_c \operatorname{sinc}\left(2f_c\,(t-\tau)\right)$$



$h(t) \neq 0$ för $t < 0$,

$\Rightarrow$ icke-kausalt system

$\Rightarrow$ **ej realiserbart!**

Grupplöptiden:

$$\boxed{t_g = -\frac{d}{d\omega}(\arg H(\omega))}$$

Idealt filter $\Rightarrow$

t_g konstant i passbandet (= τ)