Lineaire Schakelingen

ET1300

Instructie, week 2.3

Slides by Marijn van dongen, et al.

Deze week

- Frequentieoverdracht
- Bode plots
- Resonantie-circuits
- Filters (passief en actief)

Frequentieoverdracht

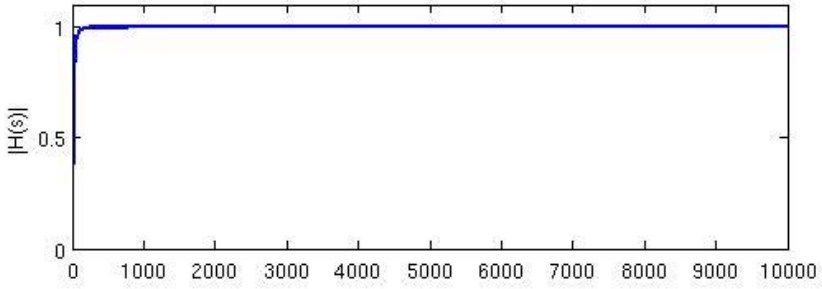
- Tot nu toe: bronnen met één enkele frequentie
- Maar hoe gedraagt het circuit zich voor verschillende frequenties?

- Daarom:
  - overdrachtsfunctie als functie van frequentie!
  - amplitude en fase zijn belangrijk

Log-schaal en decibel (dB)

Amplitude →1e orde hoogdoorlaat filter, ω_0: 20 rad/s

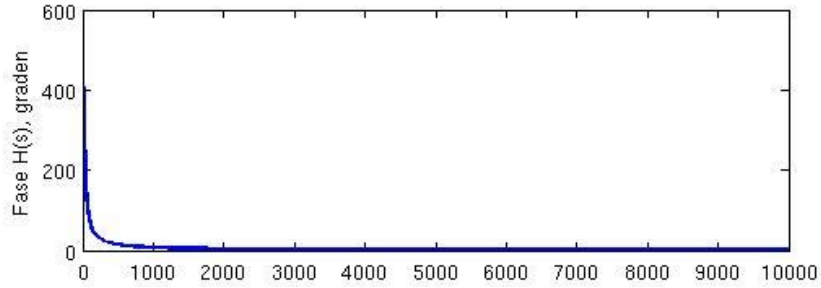
Lineaire schaal



Log-schaal en decibel (dB)

Fase →1e orde hoogdoorlaat filter, ω_0: 20 rad/s

Lineaire schaal

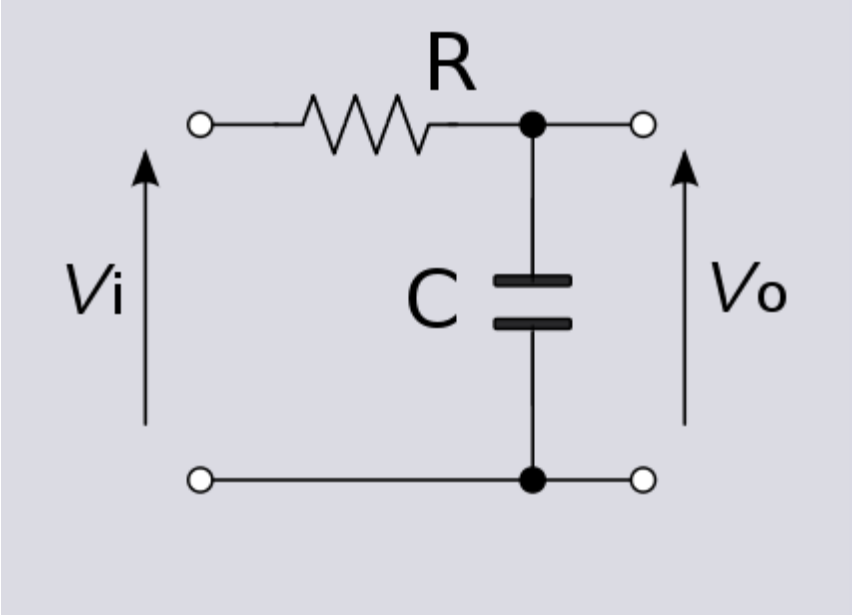


Bode-plot

Frequentieoverdracht met behulp van:

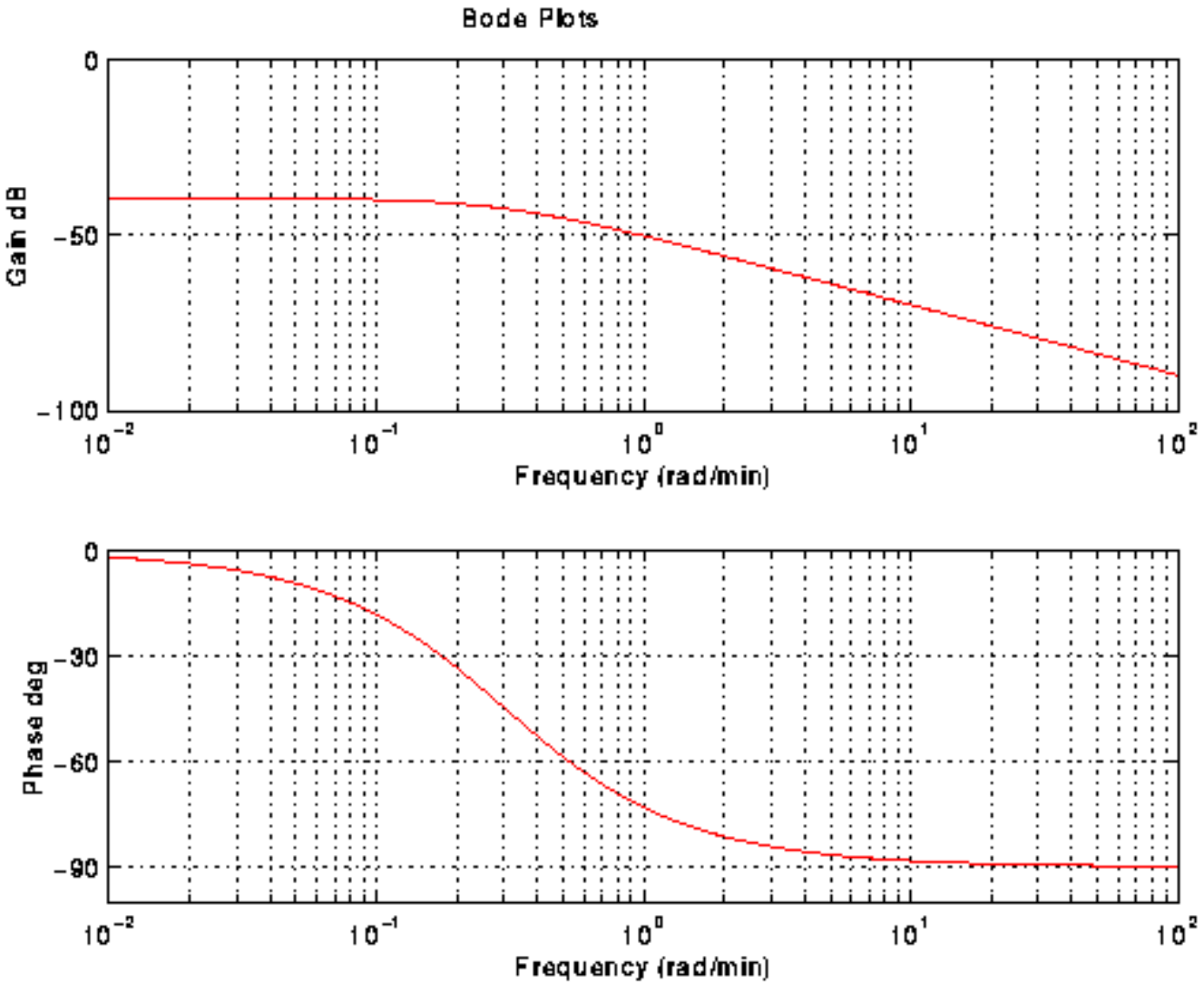
- Amplitude-overdracht in dB
- Fase-overdracht in graden
- Logaritmische frequentie-assen

Bepalen overdracht

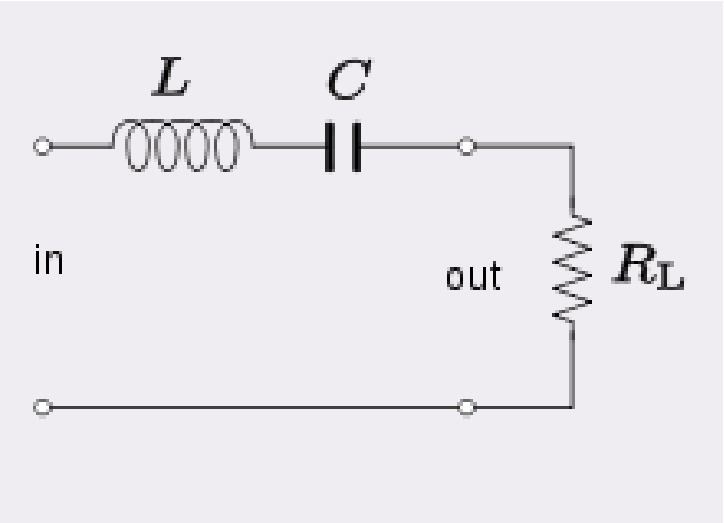


$$\frac{V_0}{V_i} = \frac{Z_C}{Z_R + Z_C} = \frac{1}{1 + j\omega RC}$$

Bepalen overdracht

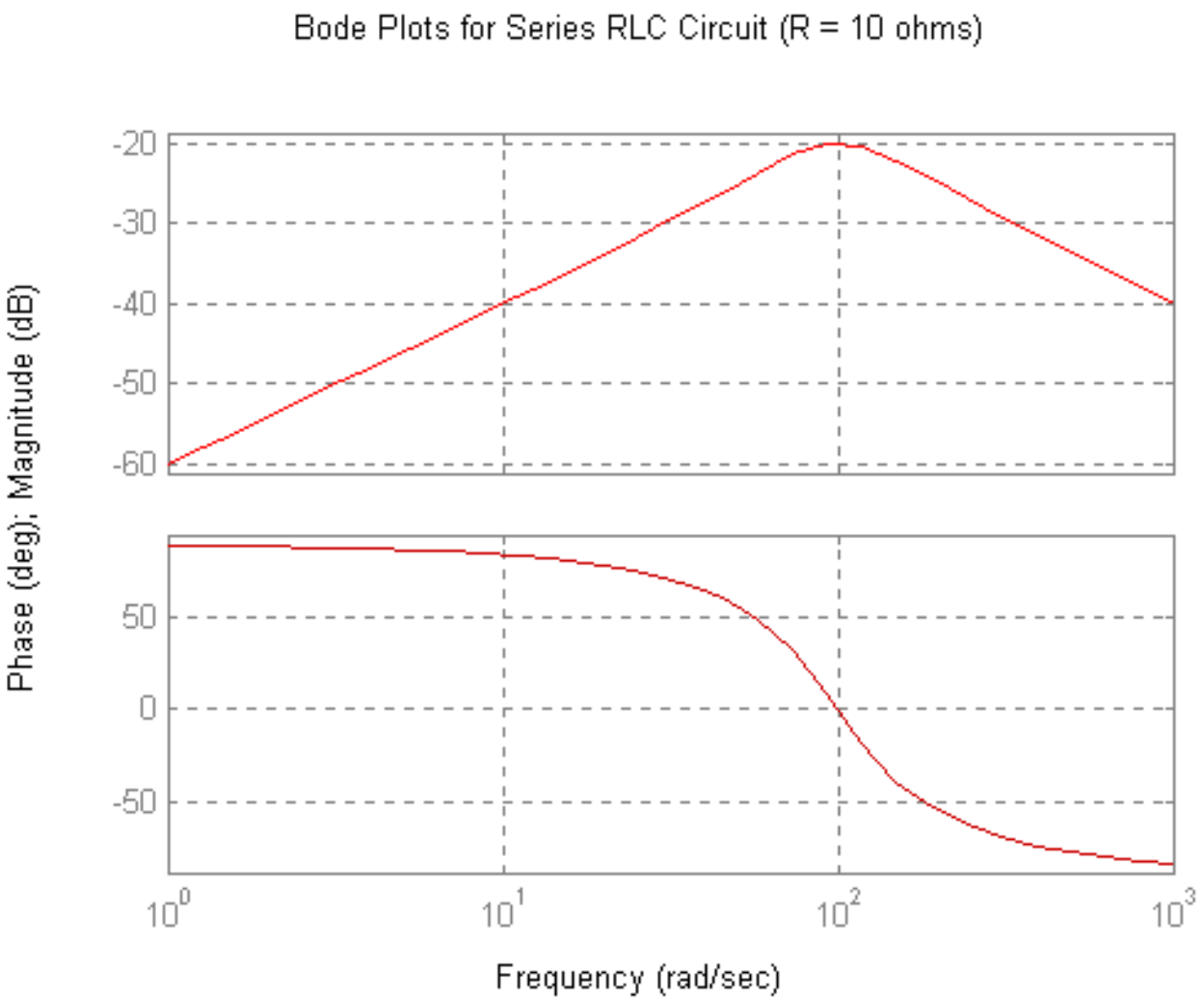


Bepalen overdracht



$$\frac{V_0}{V_i} = \frac{Z_R}{Z_R + Z_C + Z_L} = \frac{j\omega RC}{(j\omega)^2 LC + j\omega RC + 1}$$

Bepalen overdracht



Overdrachtsfunctie

In het algemeen geldt:

$$H(j\omega) = H(s) = \frac{T(s)}{N(s)} = K_0 \frac{(s - z_1)(s - z_2)\square\ (s - z_m)}{(s - p_1)(s - p_2)\square\ (s - p_n)}$$

De wortels van T(s) en N(s) bepalen de vorm van de bode-plot. Terminologie:

- T(s) = 0 $\rightarrow$ Nulpunten
- N(s) = 0 $\rightarrow$ Polen

Overdrachtsfunctie

Andere notatie:

$$H(j\omega) = K_0 \frac{j\omega \cdot (1 + j\omega\tau_1) \cdot [1 + 2\zeta_2 (j\omega\tau_2) + (j\omega\tau_2)^2]}{(1 + j\omega\tau_3) \cdot [1 + 2\zeta_4 (j\omega\tau_4) + (j\omega\tau_4)^2]}$$

Constante term

Pool/nulpunt op ω=0

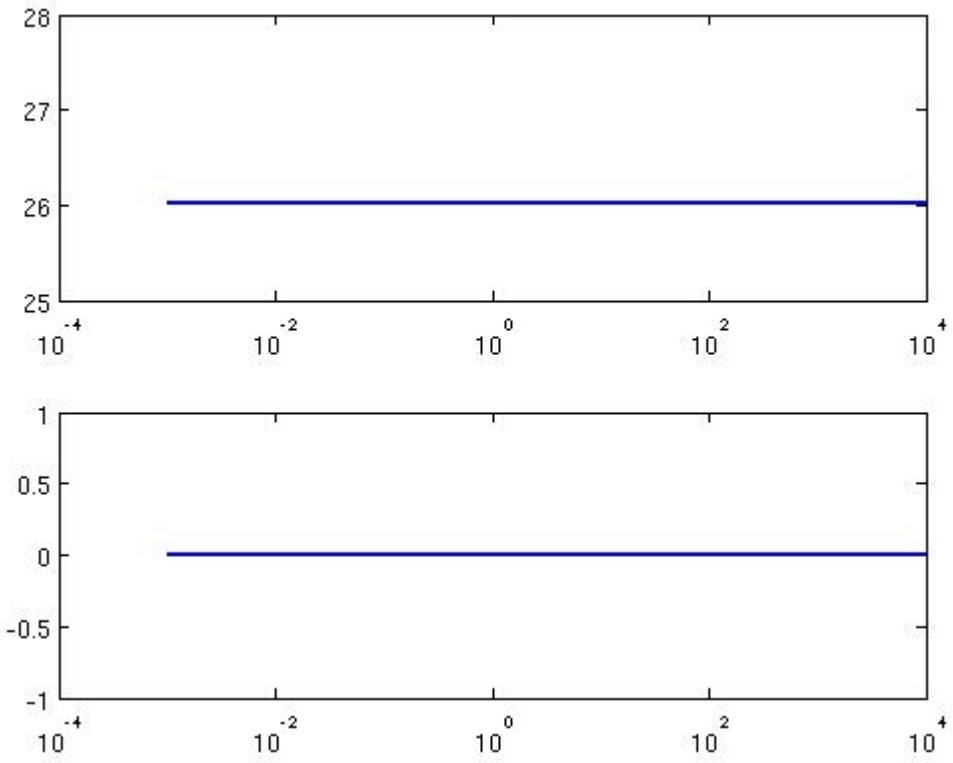
Pool/nulpunt op ω=1/τ rad/s

Complex pool/nulpunt paar op ω=1/τ rad/s

Bode plot tekenen

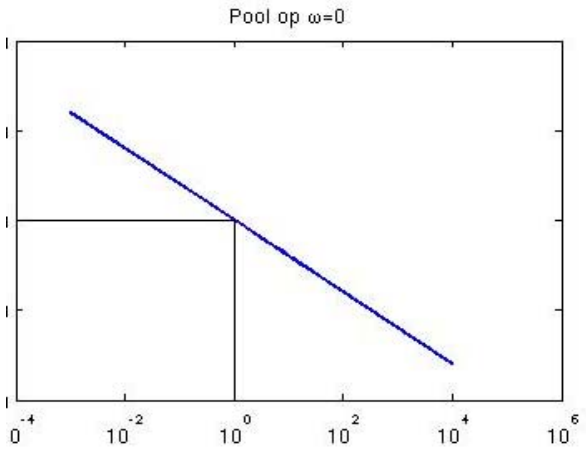
Constante term

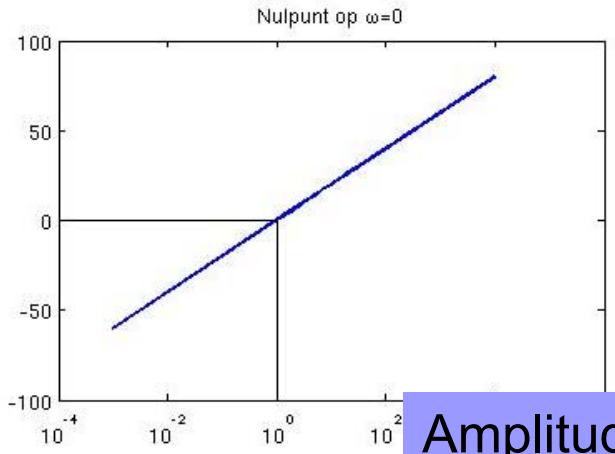
Amplitude: K_0
Fase: 0

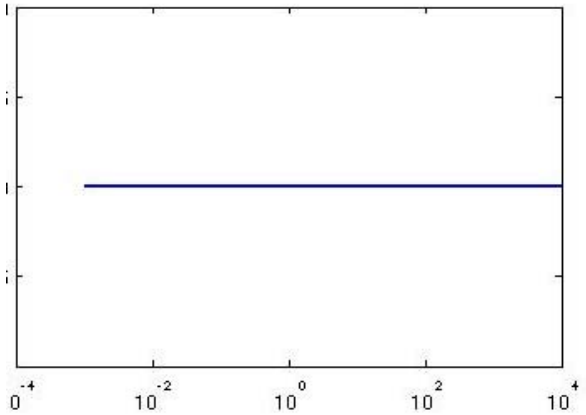


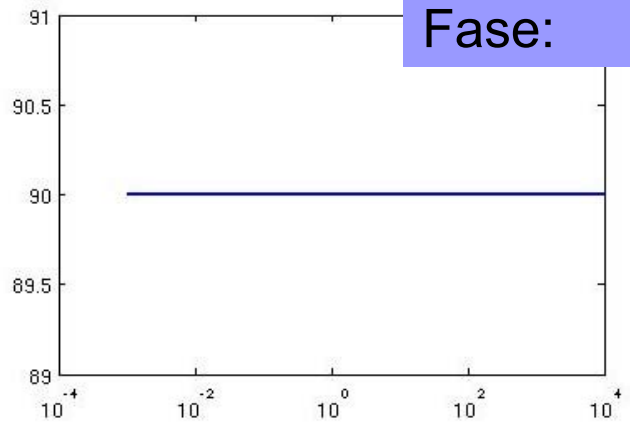
Bode plot tekenen

Pool/nulpunt op ω=0







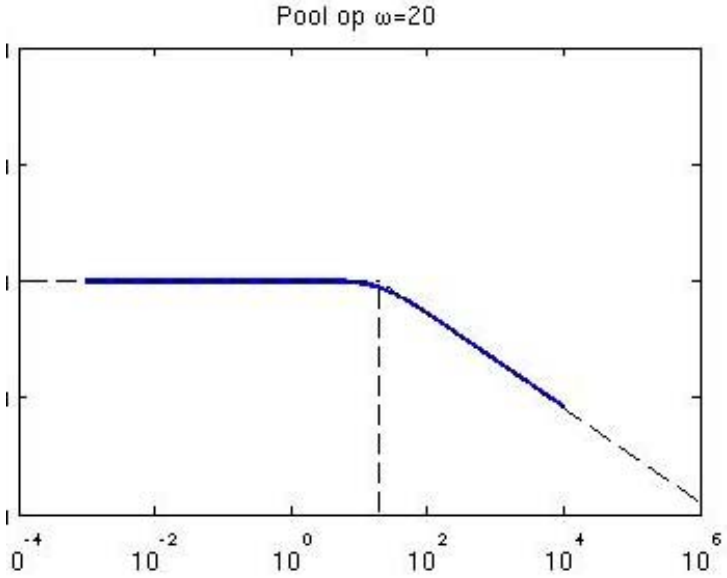


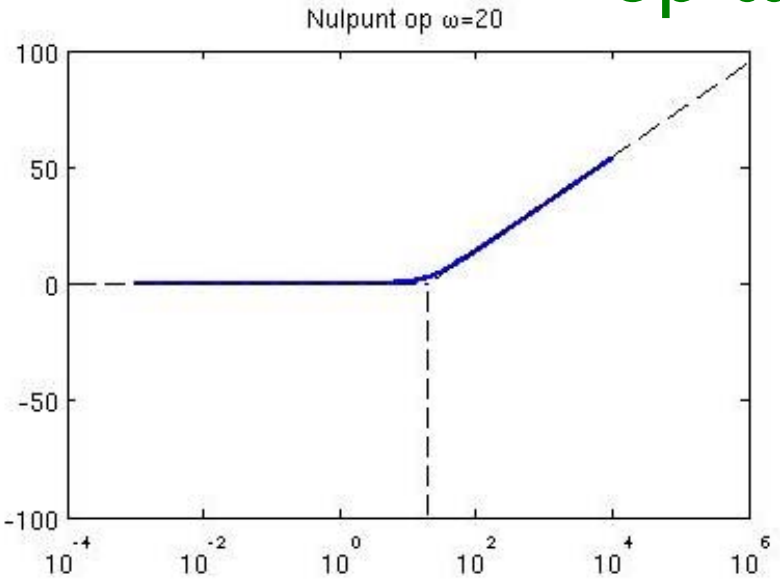
Amplitude: ±20 dB/decade
ω = 1 → 0dB

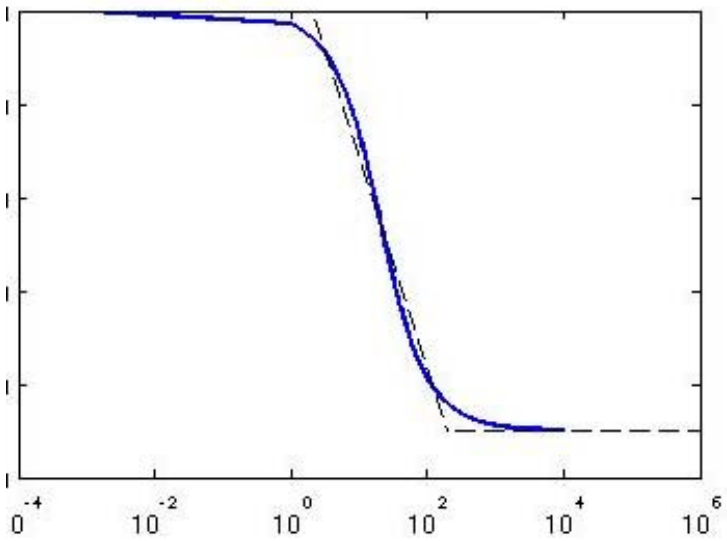
Fase: ±90

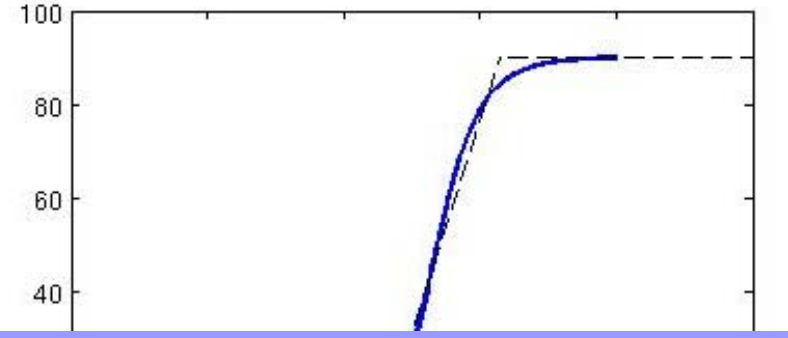
Bode plot tekenen

Pool/nulpunt op $\omega=1/\tau$









Amplitude: $\omega = 0 \rightarrow 0$dB

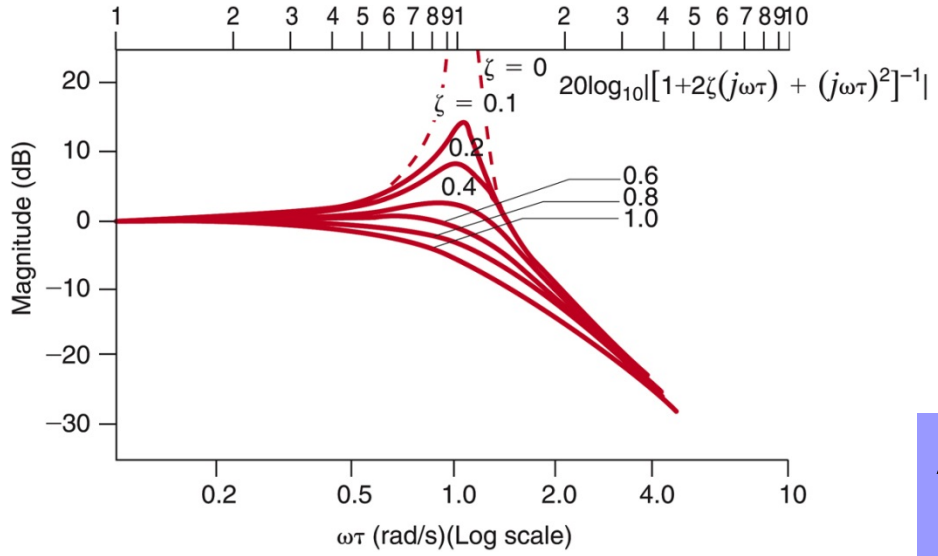
$\omega = 1/\tau \rightarrow \pm 20$ dB/decade

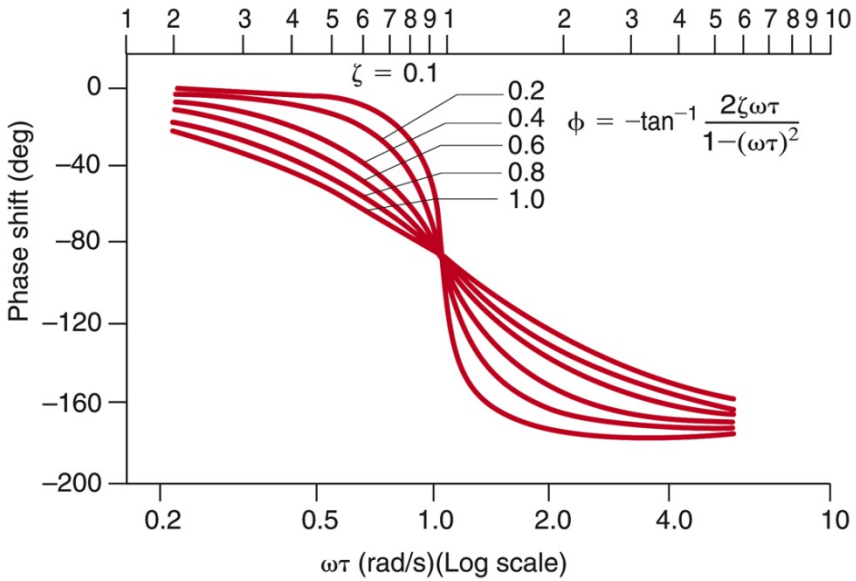
Fase: $\omega < (1/\tau)/10 \rightarrow 0^o$

$\omega > (1/\tau)*10 \rightarrow \pm 90^o$

Bode plot tekenen

Complex Pool/nulpunt paar op ω=1/τ





Amplitude: ω = 0 → 0dB

ω = 1/τ → ±40 dB/decade

ω ≈ 1/τ → ζ-afhankelijk

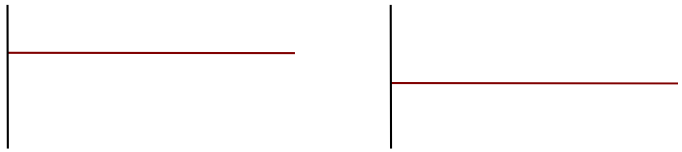
Fase: ω << (1/τ) → 0°

ω >> (1/τ) → ±180°

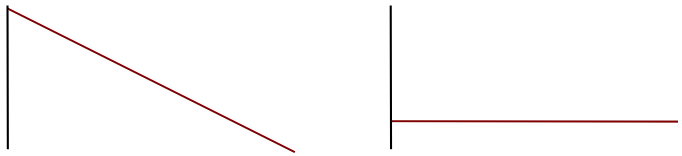
Bode plots: Overzicht

$$H(j\omega) = K_0 \frac{j\omega(1 + j\omega\tau_1)[1 + 2\zeta_2(j\omega\tau_2) + (j\omega\tau_2)^2]}{(1 + j\omega\tau_1)[1 + 2\zeta_2(j\omega\tau_2) + (j\omega\tau_2)^2]}$$

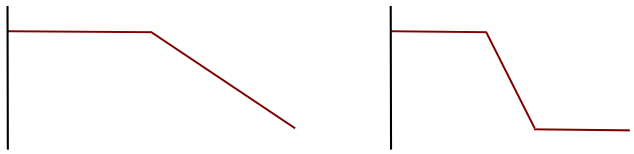
Amplitude:	K_0
Fase:	0



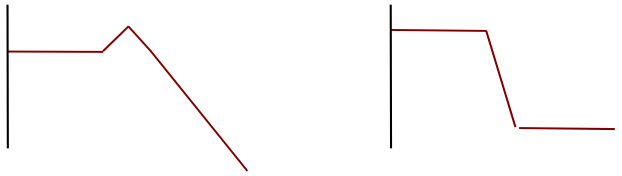
Amplitude:	±20 dB/decade
	$\omega = 1 \rightarrow$ 0dB
Fase:	±90



Amplitude:	$\omega = 0 \rightarrow$ 0dB
	$\omega = 1/\tau \rightarrow$ ±20 dB/decade
Fase:	$\omega < (1/\tau)/10 \rightarrow 0°$
	$\omega > (1/\tau)*10 \rightarrow$ ±90°



Amplitude:	$\omega = 0 \rightarrow$ 0dB
	$\omega = 1/\tau \rightarrow$ ±40 dB/decade
	$\omega \approx 1/\tau \rightarrow \zeta$-afhankelijk
Fase:	$\omega << (1/\tau) \rightarrow 0°$
	$\omega >> (1/\tau) \rightarrow$ ±180°



↑ ↑
Schetsen voor Amplitude en Fase van polen