EECS 16B CSM

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Computer Science Mentors

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Overview

Logistics

- internet whoopsie last week
- Pertinent facts

Filters

Why?

- allows us to isolate desired frequency ranges
- color organ: basically just a spectrogram
- Afrotechmods video

Types

- low-pass: let in low ω
- high-pass: let in high ω
- band-pass: let in range of ω
- band-stop: block out range of ω

Transfer Functions

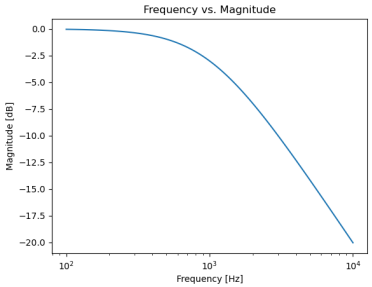
$$H(j\omega) = \frac{V_{out}}{V_{in}} = \frac{(j\omega)^{N_z}}{(j\omega)^{N_p}} \frac{\alpha_0 + (j\omega)\alpha_1 + \cdots + (j\omega)^n \alpha_n}{\beta_0 + (j\omega)\beta_1 + \cdots + (j\omega)^m \beta_m} \tag{1}$$

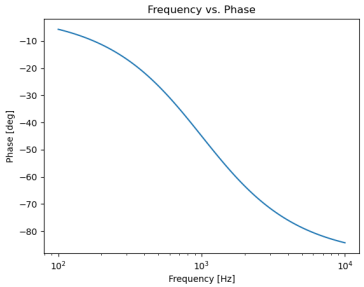
$$= K \frac{(j\omega)^{N_z}}{(j\omega)^{N_p}} \frac{\left(1 + j\frac{\omega}{\omega_{z1}}\right)\left(1 + j\frac{\omega}{\omega_{z2}}\right)\cdots\left(1 + j\frac{\omega}{\omega_{zn}}\right)}{\left(1 + j\frac{\omega}{\omega_{p1}}\right)\left(1 + j\frac{\omega}{\omega_{p2}}\right)\cdots\left(1 + j\frac{\omega}{\omega_{pn}}\right)} \tag{2}$$

- N_z: number of zeroes
- N_p: number of poles
- ω_{zn}: n-th zero
- ω_{pn}: n-th pole

Bode Plots

Definition





- comes in pairs: magnitude & phase
- above: low-pass filter

Features

- magnitude
  - x-axis: log frequency (Hz)
  - y-axis: $|H(j\omega)|$ (dB or intensity)
  - **cutoff frequency**: $|H(j\omega)| = \frac{1}{\sqrt{2}} = -3\,\text{dB}$
- phase
  - x-axis: log frequency (Hz)
  - y-axis: phase offset ($^\circ$ or rad)

Why?

- allows us to characterize a filter very fast
- quick visual tool

Resonance

- whenever you see an inductor & a capacitor
- energy is oscillating back and forth
- when voltage is at resonant frequency $\frac{1}{\sqrt{LC}}$, inductor and capacitor act as short