

EECS 16B CSM

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Computer Science Mentors

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Overview

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CSM

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Filters

Bode Plots

1 Filters

2 Bode Plots

Logistics

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- Pertinent facts

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Filters

Why?

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

Types

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- 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

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

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

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

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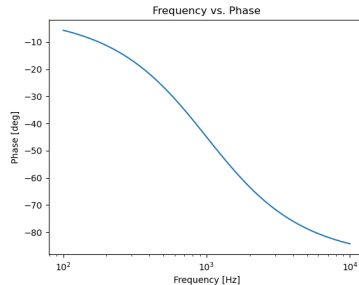
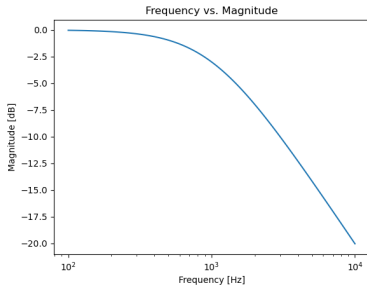
Definition

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

Features

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- 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)

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

Resonance

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- 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