EECS 16B CSM

Bryan Ngo

Filters

**Bode Plots** 

## EECS 16B CSM

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Computer Science Mentors

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# Overview

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ryan ing

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1 Filters

# Announcement

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■ Google Form later today

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Filter

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# Filters

## Why?

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#### Filters

- allows us to isolate desired frequency ranges
- color organ: basically just a visualizer
- sort of related to Fourier transform
- Afrotechmods video

## Types

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#### Filters

- lacksquare low-pass: let in low  $\omega$
- $\blacksquare$  high-pass: let in high  $\omega$
- $\blacksquare$  band-pass: let in range of  $\omega$
- $\blacksquare$  band-stop: block out range of  $\omega$

### **Transfer Functions**

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

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

- $\blacksquare$   $N_z$ : number of zeroes
- lacksquare  $N_p$ : number of poles
- lacksquare  $\omega_{zn}$ : n-th zero
- lacksquare  $\omega_{pn}$ : n-th pole



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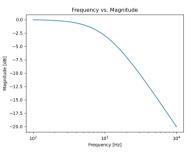
## Definition

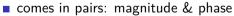
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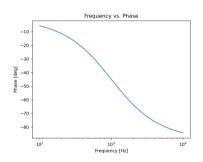
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■ above: low-pass filter



### **Features**

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#### Hilter

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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 (° or rad)

# Why?

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