

EECS 16B

Designing Information Devices and Systems II

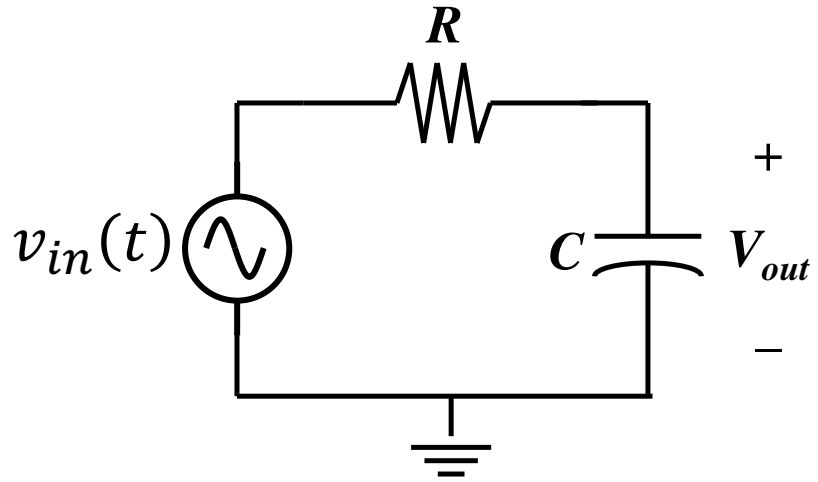
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Lecture 8: Bode Plots, Poles and Zeros

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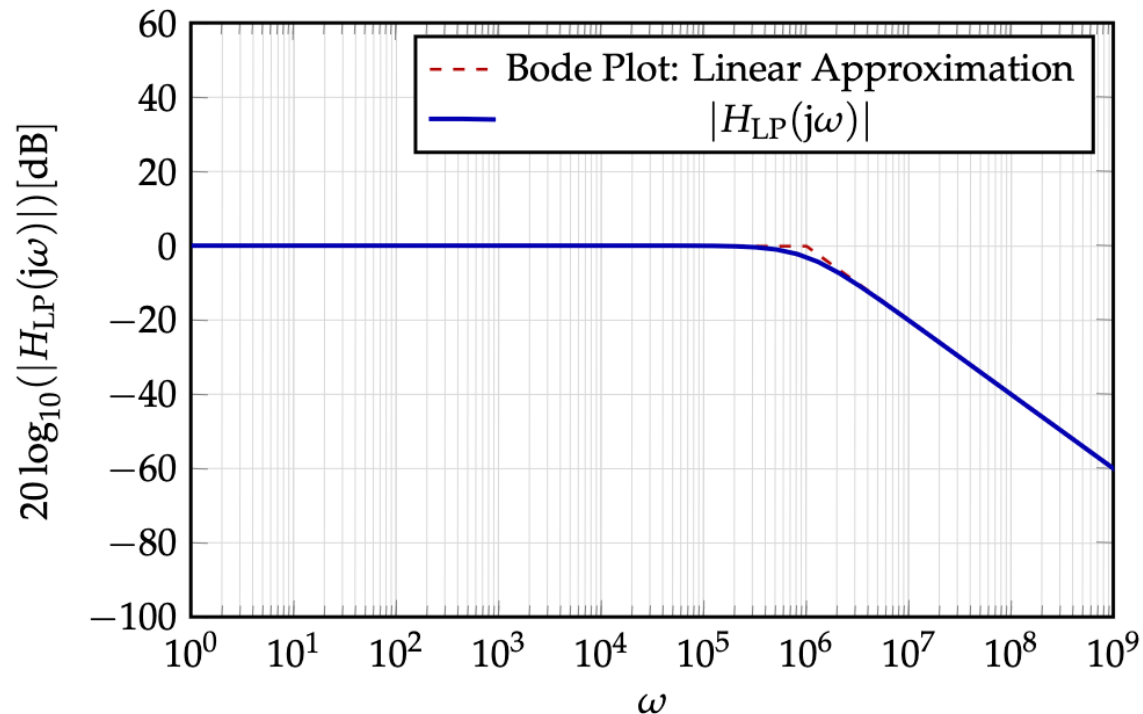
Low-Pass Filter with RC Circuit



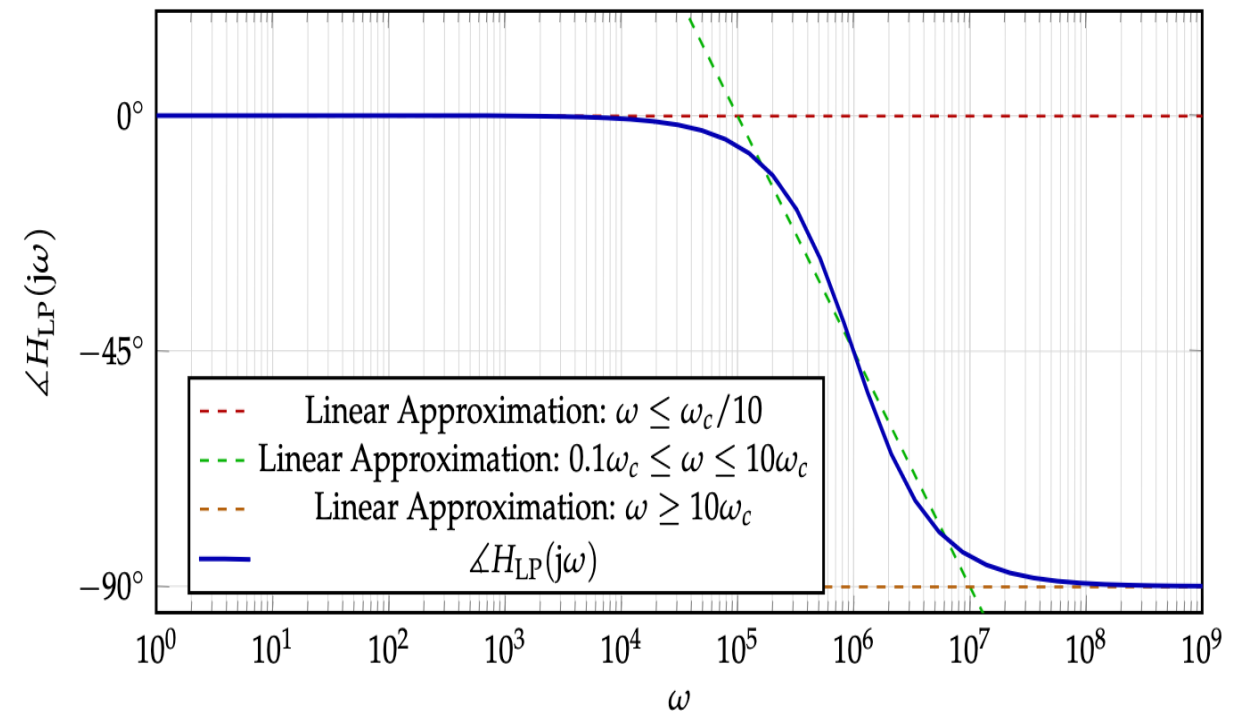
Bode Plot – Single Pole

$$H(j\omega) = \frac{1}{1 + j\frac{\omega}{\omega_c}}$$

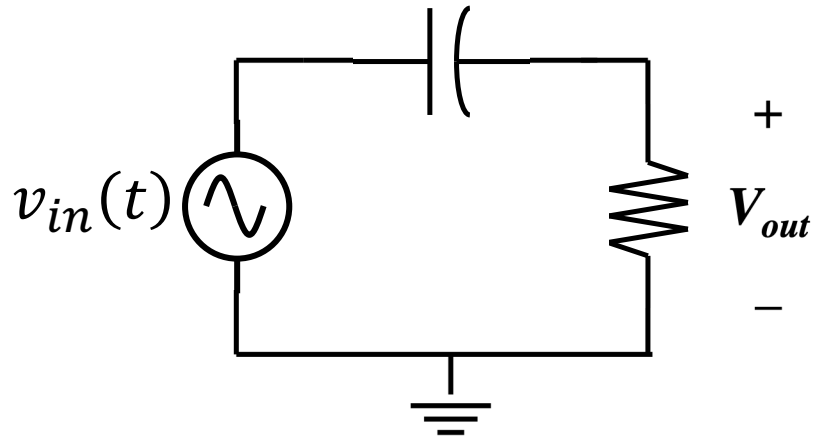
- Magnitude



- Phase



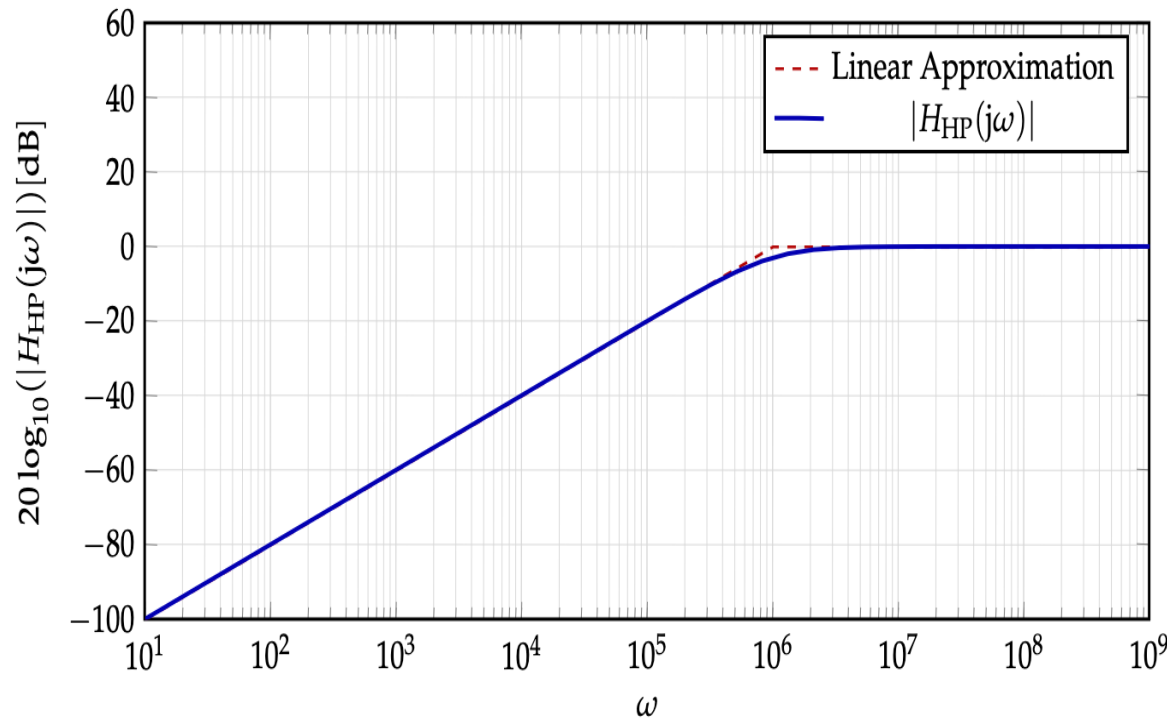
Low-Pass Filter with RC Circuit



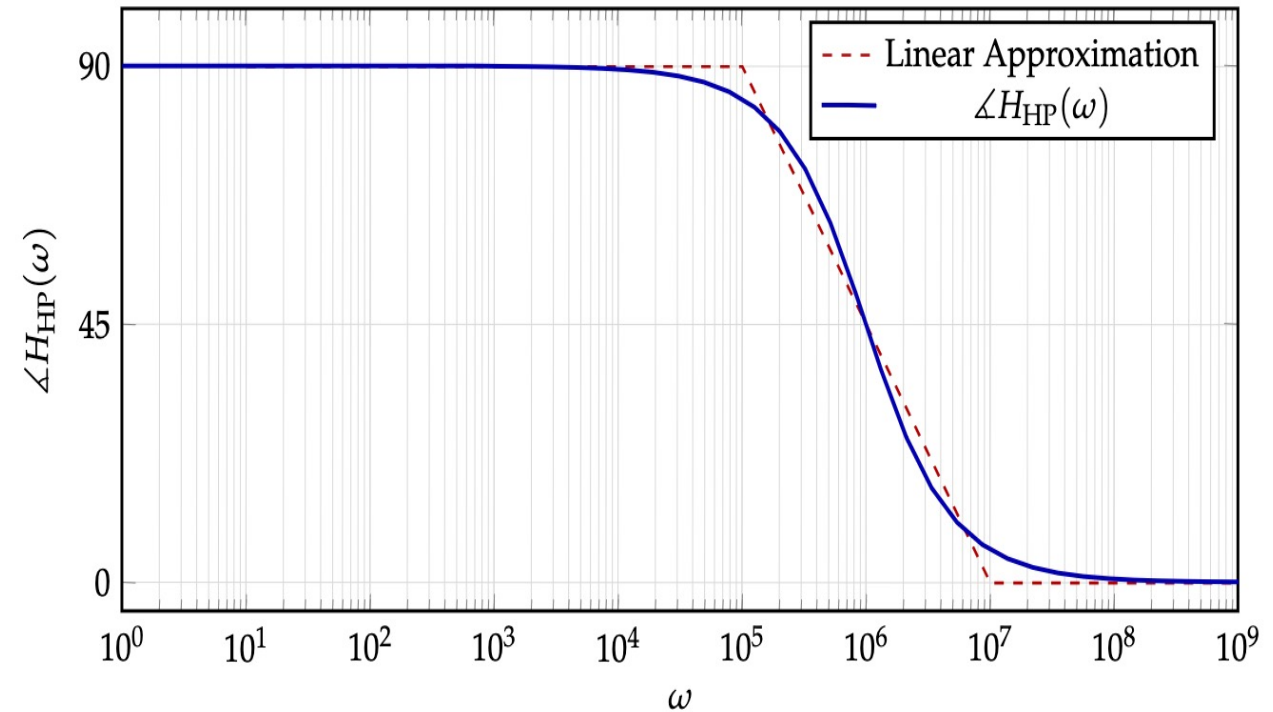
Bode Plot – Pole and Origin Zero

$$H(j\omega) = \frac{j \frac{\omega}{\omega_C}}{1 + j \frac{\omega}{\omega_C}}$$

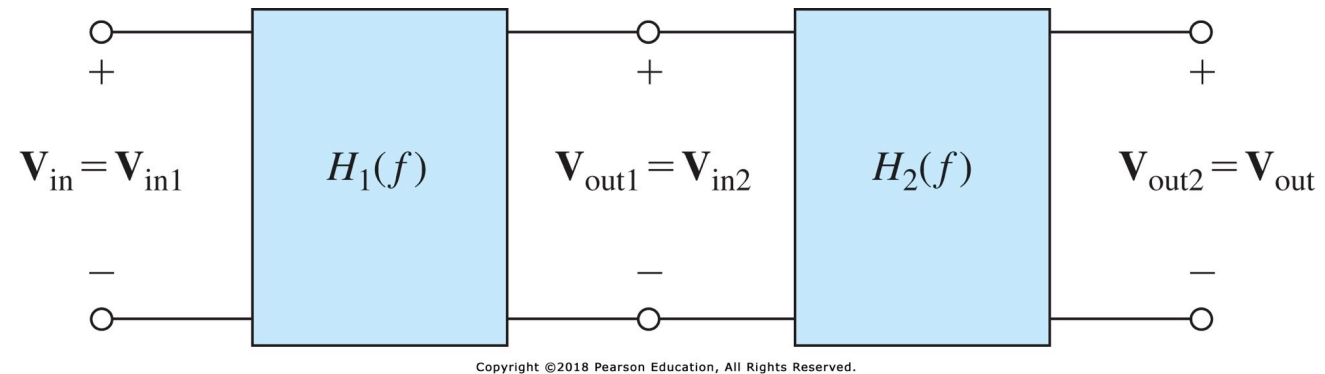
- Magnitude



- Phase



Cascaded Networks



Cascaded Networks

- Needs to consider source and load resistance

Cascaded Network with Unity Gain Buffer

Rational Transfer Functions

- $H(j\omega) = K \frac{N(j\omega)}{D(j\omega)}$

- $H(j\omega) = K \frac{(j\omega)^{N_{z0}} \left(1 + j\frac{\omega}{\omega_{z1}}\right) \left(1 + j\frac{\omega}{\omega_{z2}}\right) \dots \left(1 + j\frac{\omega}{\omega_{zn}}\right)}{(j\omega)^{N_{p0}} \left(1 + j\frac{\omega}{\omega_{p1}}\right) \left(1 + j\frac{\omega}{\omega_{p2}}\right) \dots \left(1 + j\frac{\omega}{\omega_{pm}}\right)}$

Bode Plot – Single Pole

- $$H(j\omega) = \frac{1}{\left(1 + j\frac{\omega}{\omega_{p1}}\right)}$$

Bode Plot – Single Zero

- $H(j\omega) = \left(1 + j \frac{\omega}{\omega_{z1}}\right)$

Bode Plot – Pole at Origin

- $H(j\omega) = \frac{1}{j\omega}$

Bode Plot – Zero at Origin

- $H(j\omega) = j\omega$

Rational Transfer Function – Example 1

$$H(j\omega) = \frac{\left(1 + j \frac{\omega}{10^3}\right) \left(1 + j \frac{\omega}{10^7}\right)}{\left(1 + j \frac{\omega}{10^1}\right) \left(1 + j \frac{\omega}{10^5}\right)}$$

Rational Transfer Function – Example 2

$$H(j\omega) = \frac{(j\omega) \left(1 + j \frac{\omega}{10^3}\right) \left(1 + j \frac{\omega}{10^7}\right)}{\left(1 + j \frac{\omega}{10^1}\right) \left(1 + j \frac{\omega}{10^5}\right)}$$

Rational Transfer Function – Example 3

$$H(j\omega) = \frac{\left(1 + j \frac{\omega}{10^3}\right) \left(1 + j \frac{\omega}{10^7}\right)}{(j\omega) \left(1 + j \frac{\omega}{10^1}\right) \left(1 + j \frac{\omega}{10^5}\right)}$$