EE40
Lecture 18
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Reading: Chap. 6: Filters, two-terminal elements, Bode plots.
Transfer Function

• Transfer function is a function of frequency
  – Complex quantity
  – Both magnitude and phase are functions of frequency

\[
H(f) = \frac{V_{out}}{V_{in}} = \frac{V_{out}}{V_{in}} \angle (\theta_{out} - \theta_{in})
\]

\[
H(f) = H(f) \angle \theta
\]
The shape of the frequency response of the complex ratio of phasors $V_{OUT}/V_{IN}$ (i.e. both the magnitude and the phase) is a convenient means of classifying a circuit behavior and identifying key parameters. We will soon discuss quick and dirty ways of approximating this shape via a piecewise linear approximation based on asymptotes, as in the magnitude plot approximations below:

Only positive frequencies need be considered, since the plots for negative frequencies can be inferred from this.

FYI: These are usually log of the ratio vs log frequency plots.
**Example Circuit**

\[ \text{Transfer Function} = \frac{V_{OUT}}{V_{IN}} \]

\[ \frac{V_{OUT}}{V_{IN}} = \frac{AZ_c}{Z_R + Z_c} \]

\[ \frac{V_{OUT}}{V_{IN}} = \frac{A(1/jwC)}{R_2 + 1/jwC} = \frac{A}{(1 + j\omega R_2 C)} \]

- \( A = 100 \)
- \( R_1 = 100,000 \text{ Ohms} \)
- \( R_2 = 1000 \text{ Ohms} \)
- \( C = 10 \mu\text{F} \)
Filters

- Filters are circuits designed to retain a certain frequency range and discard others

  * **Low-pass**: pass low frequencies and reject high frequencies

  * **High-pass**: pass high frequencies and reject low frequencies

  * **Band-pass**: pass some particular range of frequencies, reject other frequencies outside that band

  * **Notch**: reject a range of frequencies and pass all other frequencies
Common Filter Transfer Function vs. Freq

- **Low Pass**: 
  - Frequency
  - $H(f)$

- **High Pass**: 
  - Frequency
  - $H(f)$

- **Band Pass**: 
  - Frequency
  - $H(f)$

- **Band Reject**: 
  - Frequency
  - $H(f)$