ELECTRIC CIRCUITS
ECSE-2010

Lecture 27

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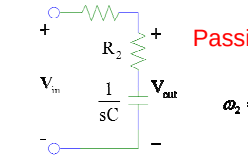
LECTURE 22.1

- Filter design principles
- Example

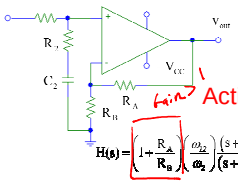
PASSIVE VS. ACTIVE FILTER



Passive Filter

$$\omega_2 = \frac{1}{R_2 C}; \quad \omega_{12} = \frac{1}{(R_1 + R_2)C}$$

$$H(s) = \frac{\omega_{12}(s+\omega_2)}{\omega_2(s+\omega_{12})}$$



Active Filter

$$H(s) = \left(1 + \frac{R_A}{R_B}\right)\left(\frac{\omega_{12}}{\omega_2}\right)\frac{(s+\omega_2)}{(s+\omega_{12})}$$

PASSIVE VS. ACTIVE FILTER

- Active Filter Better
  - Provide frequency selectivity comparable to passive RLC plus gains greater than one
  - They have Op Amp outputs so chain rule applies in cascade design
  - They do not require inductors, which are large and lossy and expensive at low freq.

CHAIN RULE

- $H(s)=H_1(s) \times H_2(s) \times H_3(s) \times \ldots H_n(s)$
- Stages can be either first or second order
- Design an active filter by controlling the poles introduced by each stage of a cascade connection
  - Denominator controls location of poles and critical frequencies
  - Numerator controls zeros and type of filter

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SECOND ORDER CIRCUITS

- Critically damping is equivalent to cascaded first order circuits (-6 dB corrections at one frequency)
- Overdamping is equivalent to cascaded first order circuits (Two -3dB corrections at two different frequencies)
- Underdamping can achieve a flat(ter) passband with the same stopband

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EXAMPLE

- Low pass filter, $\omega_c = 10^8$
- Stopband rolloff 60 dB
- Cutoff frequency $H(j\omega)$ is -9dB relative to passband

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