Electronics II

Lecture 20
Filters III

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Last Lecture

- Types of Filters
  - Low Pass Filter.
  - High Pass Filter.
  - Band Pass Filter

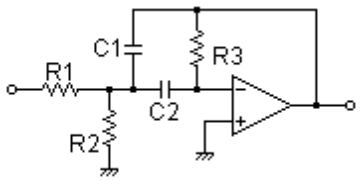
Session Overview

Topic	Filters
Concepts	Band Pass Filter, Q Factor, Band Stop Filter, All Pass Filter.
Recommended Reading	Section 14-6 of [1] Section 11-5 of [2] Section 1.2 of [3]
Keywords	Filter, Band Stop, Active, Passive, Q Factor, Notch.

Band Pass Filter

- Band pass filter can be implemented by a combination of low pass and high pass filters.
- Another configuration for band pass filter is *'Infinite Gain Multiple Feedback' (IGMF)*.
- Both configurations have their own advantages and disadvantages.

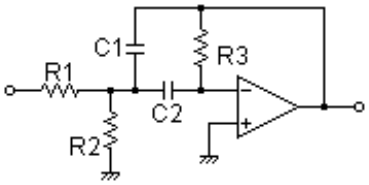
- BW= $1/\pi R_3 C$.
- $G_o = R_3/2R_1$.
- $f_o = 1/(2\pi C(\sqrt{(R1||R2)R3}))$



Theodore F. Bogart, Jeffery S. Beasley, Guilermo Rico, Electronics Devices and Circuits, 6th Edition, Pearson Education Inc, ISBN: 978-81-775-8887-3

Band Pass Filter

- *Example 11-14 (Bogart):* Calculate the Bandwidth (BW), Gain at center frequency (G_o), and Center frequency (f_o) for the given band pass filter with C_1=C_2= 50nF, R_1= 10kΩ, R_2= 22Ω and R_3= 20kΩ.



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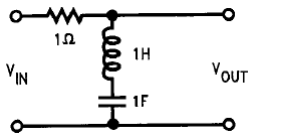
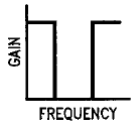
Band Stop/Reject or Notch Filter

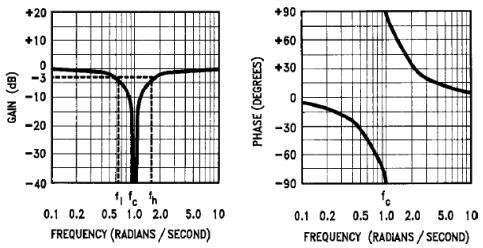
- A filter with the functionality opposite to that of a band pass filter.
- It stops/ rejects the frequencies in a specific band while passes all other frequencies.

$$H_N(s) = \frac{V_{OUT}}{V_{IN}} = \frac{s^2 + 1}{s^2 + s + 1}$$

- What exactly is *'Notch Filter'?*



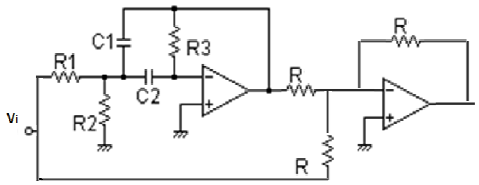


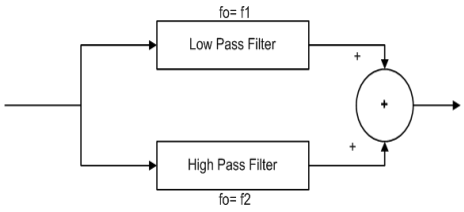


Application Note 779: A Basic Introduction to Filters- Active, Passive and Switched Capacitor, Texas Instruments Inc.

Band Stop Filter

- Band stop filter can be made using multiple designs. One approach is to design a specific circuitry for it.
- Another method is to use a subtracting operation on the band pass filter with a unity gain.





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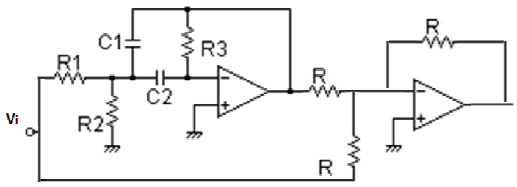
Band Stop Filter

- *Example 11-15 (Bogart):* Design a band stop filter with the center frequency o 1kHz and a 3 dB rejection band of 150 Hz. Use the circuit given in the figure with Unity Gain.



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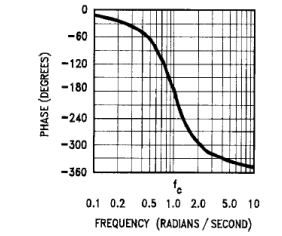
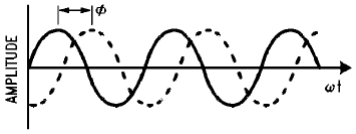
All Pass Filter

- A filter that has no effect on the magnitude of the input signal. It only affects the phase of the input signal.
- It is also called phase shift filter.
- For periodic waveforms, time and phase can be interchanged. So we can represent phase shift as a time delay.
- $T_D = \Theta/2\pi w$.

$$H_{AP}(s) = \frac{s^2 - s + 1}{s^2 + s + 1}$$





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Next Lecture

- Butterworth Filter Response.
- Chebyshev Filter Response.
- Elliptic Filter Response.
- Bessel Filter Response.

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References

[1] Robert L. Boylestad, *Electronic Devices and Circuit Theory,* 8th Edition, Pearson Education Inc, ISBN: 81-7808-590-9.

[2] Theodore F. Bogart, Jeffery S. Beasley, Guilermo Rico, Electronics Devices and Circuits, 6th Edition, Pearson Education Inc, ISBN: 978-81-775-8887-3

[3] Kerry Lacanette. Application Note 779: A Basic Introduction to Filters-Active, Passive and Switched Capacitor, Texas Instruments, Literature Number: SNOA224A, April 2010 .
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