EE40
Lecture 21
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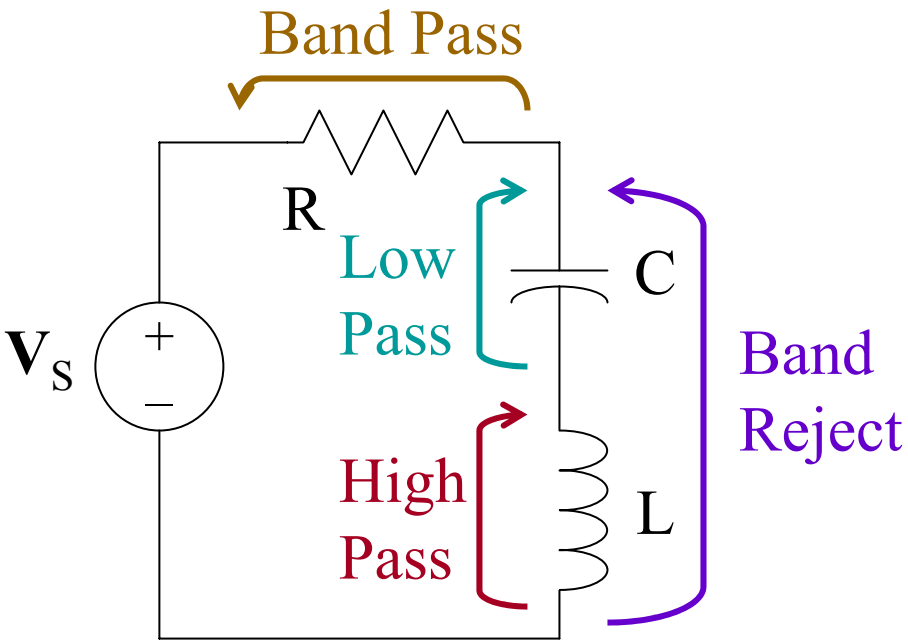
3/14/08

Reading: Chap. 6: Bode plots for second order systems.

Second-Order Filter Circuits



$$\mathbf{Z} = \mathrm{R} + 1/j\omega\mathrm{C} + j\omega\mathrm{L}$$

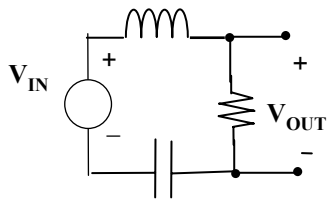
$$\mathbf{H}_{BP} = \mathrm{R} / \mathbf{Z}$$

$$\mathbf{H}_{LP} = (1/j\omega\mathrm{C}) / \mathbf{Z}$$

$$\mathbf{H}_{HP} = j\omega\mathrm{L} / \mathbf{Z}$$

$$\mathbf{H}_{BR} = \mathbf{H}_{LP} + \mathbf{H}_{HP}$$

Series Resonance



Voltage divider

$$\frac{\mathbf{V}_{OUT}}{\mathbf{V}_{IN}} = \frac{\mathbf{Z}_R}{\mathbf{Z}_L + \mathbf{Z}_R + \mathbf{Z}_C}$$

Substitute branch elements

$$\frac{\mathbf{V}_{OUT}}{\mathbf{V}_{IN}} = \frac{R}{j\omega L + R + 1/j\omega C}$$

Rearrange:

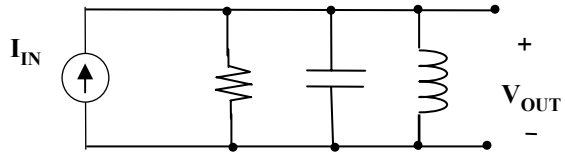
$$\frac{\mathbf{V}_{OUT}}{\mathbf{V}_{IN}} = \frac{R}{R + j(\omega L - 1/\omega C)}$$

Resonance quality factor

$$Q = \frac{\omega_0 L}{R}$$

Bandwidth is f_0/Q in Hz.

Parallel Resonance



Admittance

$$\mathbf{V}_{OUT} = \frac{\mathbf{I}_S}{\mathbf{Y}_L + \mathbf{Y}_R + \mathbf{Y}_C}$$

Substitute branch elements

$$\mathbf{V}_{OUT} = \frac{\mathbf{I}_S}{1/j\omega L + 1/R + jwC}$$

Rearrange:

$$\mathbf{V}_{OUT} = \frac{\mathbf{I}_S}{1/R + j(\omega C - 1/\omega L)}$$

Resonance quality factor

$$Q = \frac{\omega_0 L}{R}$$

Bandwidth is f_0/Q in Hz.