Digital filtering

Signal processing

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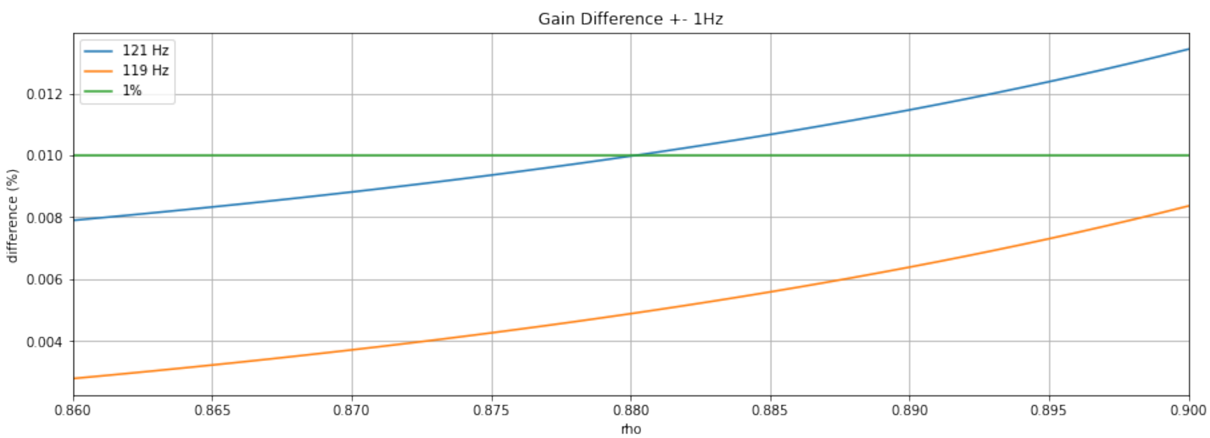
1 Approximation of second order filters

Band-pass filter:

1. Find θ : we compute $\theta = \frac{f}{2\pi} Fe = 1.88$.
2. Find ρ : we set K = 1 and we draw this graph representing the height difference between {120Hz,121Hz} and {119Hz,120Hz}.



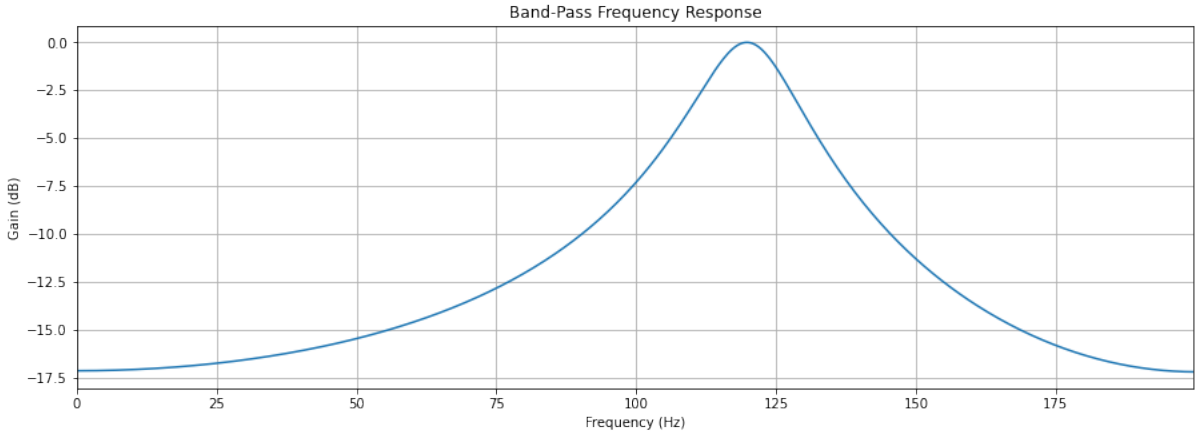
we set $\rho = 0.87$

3. Find K : we computed $K = \frac{1}{A_{120Hz}} = 0.2432$.

The transfer function of the pass-band filter is

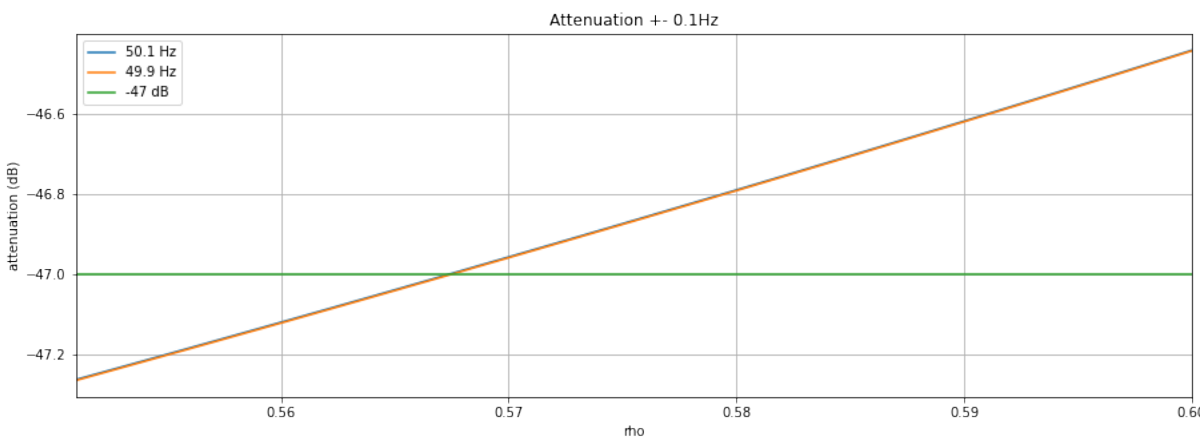
$$H(Z) = K \frac{1 - \cos(\theta) Z^{-1}}{1 - 2\rho \cos(\theta) Z^{-1} + \rho^2 Z^{-2}}$$

where K = 0.2432, $\rho = 0.87$ and $\theta = 1.88$. The frequency response of this filter is the following.



Band-stop filter:

1. Find θ : we compute $\theta = \frac{50}{2\pi} Fe = 0.78$.
2. Find ρ : we set K = 1 and we draw this graph representing the attenuation at 49.9 Hz and 50.1 Hz. We want to attenuate these frequencies at -47dB.



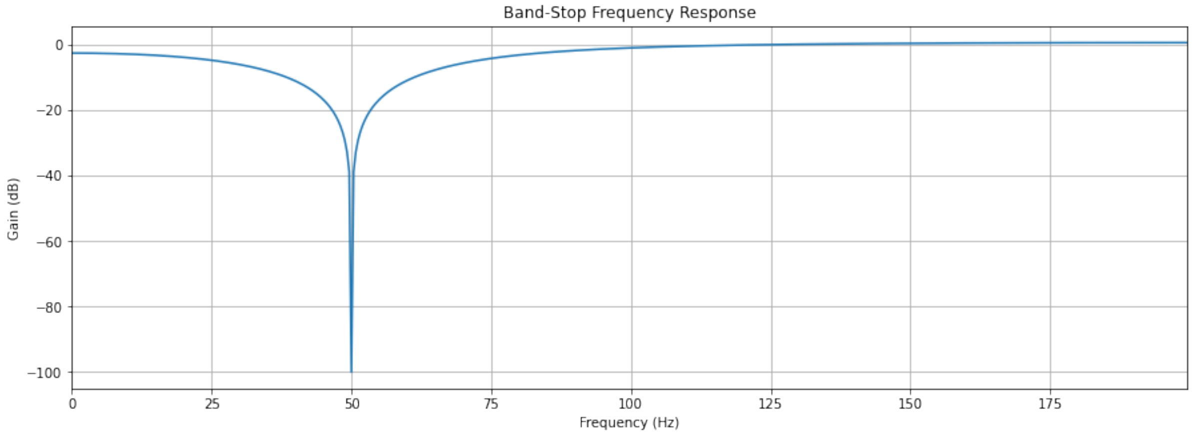
We set $\rho = 0.56$.

3. Find K : we computed $K = \frac{1}{A_{120Hz}} = 0.6713$.

The transfer function of the stop-band filter is

$$H(Z) = K \frac{1 - 2\cos(\theta) Z^{-1} + Z^{-2}}{1 - 2\rho\cos(\theta) Z^{-1} + \rho^2 Z^{-2}}$$

where K = 0.6714, $\rho = 0.56$ and $\theta = 0.78$. The frequency response corresponding is the following.



Band-pass + band-stop filter

Now we can add these two filters together and plot their frequency response.