



Digital Filtering

preparing for the exam - part 4,
bilinear transform & equalizers

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Theoretical Examples

1. A 1st order analog low pass filter is described by its transfer function

$$H(s) = \frac{\omega_c}{s + \omega_c}.$$

Knowing the bilinear transform (without pre-warping) is defined as

$$s = 2f_s \frac{z - 1}{z + 1}$$

find the coefficients of a corresponding digital filter.

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$$\begin{aligned} H_{LP}(z) &= \frac{\omega_c}{2 \cdot f_s \frac{z-1}{z+1} + \omega_c} = \frac{\omega_c \cdot (z+1)}{2 \cdot f_s (z-1) + \omega_c (z+1)} = \\ &= \frac{\omega_c \cdot z + \omega_c}{z \cdot (2 \cdot f_s + \omega_c) + (\omega_c - 2 \cdot f_s)} = \\ &= \frac{\omega_c + \omega_c \cdot z^{-1}}{(2 \cdot f_s + \omega_c) + (\omega_c - 2 \cdot f_s) \cdot z^{-1}} = \\ &= \frac{\frac{\omega_c}{2 \cdot f_s + \omega_c} + \frac{\omega_c}{2 \cdot f_s + \omega_c} \cdot z^{-1}}{1 + \frac{\omega_c - 2 \cdot f_s}{\omega_c + 2 \cdot f_s} \cdot z^{-1}} = \\ &= \frac{b_0 + b_1 \cdot z^{-1}}{1 + a_1 \cdot z^{-1}} \end{aligned}$$

Practical Examples

2. In Sigma Studio, create a project for ADAU1701 processor that implements a stereo parametric equalizer consisting of three 2nd order sections:
 1. A low-shelf filter with gain -5 dB, cutoff frequency 200 Hz, and quality factor 1.0 ,
 2. a peaking filter with gain -8 dB, cutoff frequency 1 kHz, and quality factor 2.1 ,
 3. a low-pass filter with cutoff frequency 5 kHz, and quality factor 0.8 .

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