Seminar 7: Filter design

The time domain representation of a second order ARMA filter is given by the difference equation

\[ Y[n] = a_0 x[n] + a_1 x[n-1] + a_2 x[n-2] + b_1 y[n-1] + b_2 y[n-2] \]

This equation expresses the output sequence \( y[n] \) in terms of the input sequence, \( x[n] \), and a set of real coefficients \( \{a_m\} \) and \( \{b_m\} \). Suppose the input is given by a signal \( s(t) \) corrupted by an additive sinusoidal disturbance, that is

\[ x(t) = s(t) + \cos(2\pi F_0 t) \]

Assume the input is sampled at \( F_s = 44 \) kHz and that the disturbance frequency is \( F_0 = F_s/4 \).

Your task is to design a second order ARMA filter which stops the disturbance and whose output is as close as possible to the original signal. In order to do this:

1. First, write down the transfer function of such filter, \( H(z) \).
2. Derive the correspondent time domain representation, that is find the values of the coefficients \( \{a_m\}, \{b_m\} \).
3. Sketch the block diagram representation of the filter.
4. Finally implement the filter using Matlab.