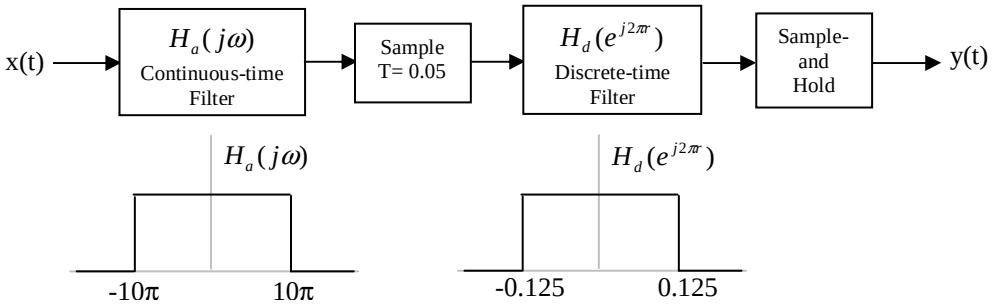
EE422G Homework #11 (10 points)

Due April 3, 2007

1. (2 points) A discrete-time system for processing continuous-time signals is shown below. Sketch the magnitude of the frequency response of an equivalent continuous-time system. Notice that the frequency response of the discrete-time filter $H_d(e^{j2\pi r})$ is written in terms of the normalized frequency r = ωT/(2π).



2. (2 points) A discrete-time system is defined by

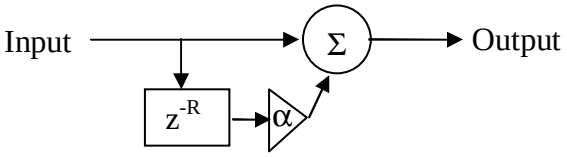
$$y(nT) = x(nT) - a_1 y(nT - T) - a_2 y(nT - 2T)$$

Determine a_1 and a_2 such that the frequency response at ω=0 is 1.0 and the frequency response at $\omega=0.5\omega_s$ is 0.1, where ω_s is the sampling frequency.

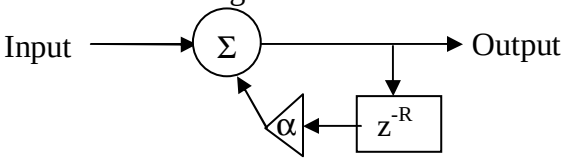
3. (1 points) Show that the following filter has linear phase:

$$H(z) = a_0(z^0 + z^{-2N}) + a_1(z^{-1} + z^{-2N+1}) + \ldots + a_{N-1}(z^{-N+1} + z^{-N-1}) + a_N z^{-N}$$

4. (5 points) Digital Audio Effect: In this exercise, we will use MATLAB to produce echo effect using both FIR and IIR filters. Download the audio file "`singing.wav`" from the course homework website. The sampling frequency of this recording is 44.1 kHz. To create a single echo, we can use a FIR filter described below:



   a. Implement the above FIR filter, choosing an R such that it corresponds to a delay of 0.3 second and select an α such that the dynamic range of the output stays within -1 and 1.
   b. We can also create echo effect using the IIR filter below:



   Implement this filter using the same R as in part a) and select an α such that filter is stable and the output dynamic range stays within -1 and 1. Explain the perceptual difference between the two filters.

For both part a) and b), turn in your MATLAB code as well as the magnitude and phase response of the filters.