Department of Electrical and Computer Engineering
The University of Alabama in Huntsville
Spring 2023

CPE 381: Fundamentals of Signals and Systems for Computer Engineers

Homework #5

Due: Wednesday, April 19 at 9:35 am

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1. (20 points) A discrete time IIR system with input x[n] and output y[n] is represented by the equation:

$$y[n] = 0.4 \cdot y[n-2] + x[n] \qquad n \geq 0$$

   a) find the impulse response *h(n)* of the system, by assuming that initial conditions are zero (y[n]=h[n]=0, n<0) and x[n]=δ[n].
   b) find the impulse response alternatively by using recursive relation between x[n] and y[n].
   c) plot h[n] using MATLAB function filter.

2. (20 points) An FIR filter is represented as:

$$y[n] = \sum_{k=0}^{5} k \cdot x[n-k]$$

   a) find and plot the impulse response of this filter.
   b) is this a causal and stable filter? Explain.
   c) find and plot the unit-step response s[n] for this filter.
   d) what is the maximum value of the output if the maximum input is 4?
   e) plot h[n] and s[n] using MATLAB function filter.

3. (16 points) Let x[n] = {0, 1, 1, 1, 0} and h[n] = {1.4, 1, 0.3}.

   Compute and plot the convolution y[n] = x[n] * h[n].

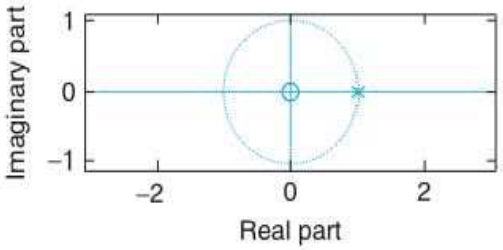
4. (18 points)

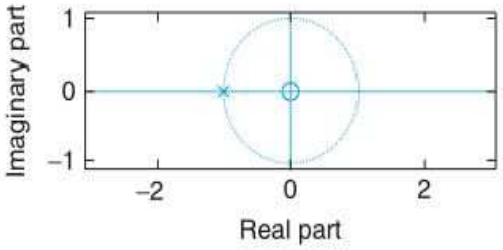
   a) (6 points) Explain the difference between hard and soft real-time systems.

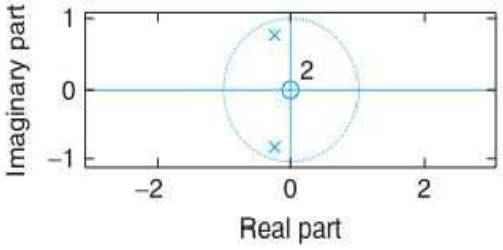
   b) (7 points) Maximum frequency of the input is 600Hz. The microcontroller processes each sample in 1300 clock cycles with clock frequency F_c = 1MHz. Can this system run in real-time?

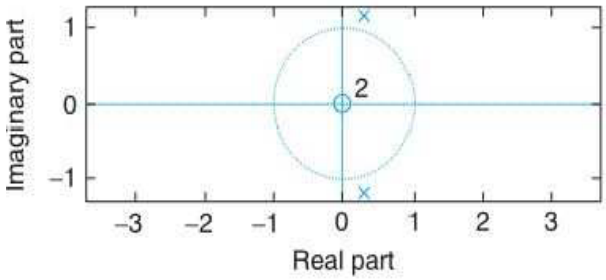
   c) (5 points) What is the minimum frequency of the clock that allows real-time operation with 2x oversampling of the input?

5. (20 points) Describe the effect of pole location on the inverse Z-transform for the following cases.









6. (6 points) If X(z) is the Z-transform of a causal signal x[n], then

   Initial value is x[0] = _____

   Final value is $\lim_{n\to\infty} x[n] =$ _____