Department of Electrical and Computer Engineering
The University of Alabama in Huntsville
Spring 2015

CPE 381: Fundamentals of Signals and Systems for Computer Engineers

Homework #4

Due: Wednesday, April 8 at 2:15 pm
Please bring hardcopy to the class and upload softcopy to Angel

Student name:

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1 20	2 20	3 10	4 10	5 10	6 15	7 15	Total

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1. (20 points) Pr. 5.38 (textbook).

Magnitude response from poles and zeros—MATLAB

Consider the following filters with the given poles and zeros and dc constant:

$H_1(s)$: $K = 1$ poles $p_1 = -1, p_{2,3} = -1 \pm j\pi$; zeros $z_1 = 1, z_{2,3} = 1 \pm j\pi$

$H_2(s)$: $K = 1$ poles $p_1 = -1, p_{2,3} = -1 \pm j\pi$; zeros $z_{1,3} = \pm j\pi$

$H_3(s)$: $K = 1$ poles $p_1 = -1, p_{2,3} = -1 \pm j\pi$; zero $z_1 = 1$

Use MATLAB to plot the magnitude responses of these filters and indicate the type of filters they are.

2. (20 points) An ideal low pass filter *H(s)* with zero phase and magnitude response:

$$|H(j\Omega)| = \begin{cases} 1 & -\pi \le \Omega \le \pi \\ 0 & otherwise \end{cases}$$

a) Find the impulse response *h(t)* of the low-pass filter. Plot it and indicate whether this filter is causal system or not.

b) What is the effect of shifting the central frequency of the ideal filter for 5π ?

3. (10 points)

A 12-bit AD converter is used to digitize signal with negative reference $V_{R-} = 0.5V$ and positive reference $V_{R+} = 2.5V$.

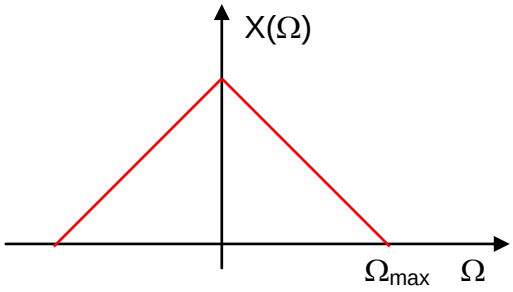
a) (3 points) What is the quantization step?

b) (3 points) What is the output of the AD converter for $V_{in} = 2.2$ V ?

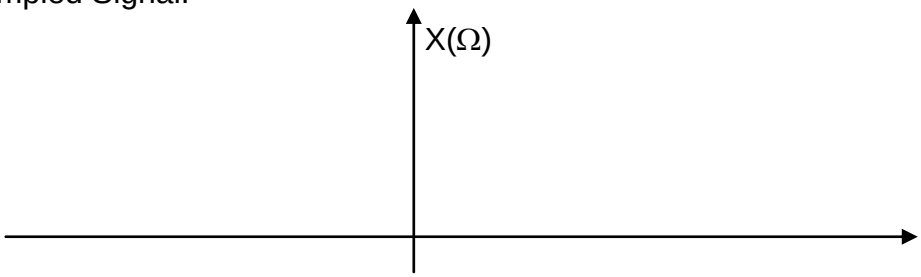
c) (2 points) What is the output of the AD converter for $V_{in} = 0.4$ V ?

d) (2 points) What is the output of the AD converter for $V_{in} = 3$ V ?

4. (10 points) Figure below represents spectrum of band limited signal with maximum frequency $\Omega_{max} = 100$ Hz. Represent spectrum of the same signal sampled at Fs = 150 Hz. Describe the effect.



Sampled Signal:



5. (10 points) We are trying to decide between a 12-bit and 16 bit ADC. The signals in this application are known to have frequencies that do not exceed 5KHz. The dynamic range of the signal is 2.5V. Determine an appropriate sampling period and compare the percentage of error the two ADCs of interest.

6. (15 points) A discrete time IIR system with input x[n] and output y[n] is represented by the equation:

$$y[n] = 0.2 \cdot y[n-2] + x[n] \qquad n \geq 0$$

   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.

7. (15 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 5?
   e) plot h[n] and s[n] using MATLAB function filter.