**King Saud University**

**College of Computer and Information Sciences**

**Computer Engineering Department**

**First Semester 1438/1439 Academic Year.**

**CEN352 – Digital Signal Processing**

# Mid Term Exam 1

Time: 90 minutes 10/02/1439 – 30/10/2017

Student Name: Student No:

Section:

Write your answers on these pages and **show your work**. If you feel that a question is not fully specified, state any assumptions you need to make in order to solve the problem.

**Question Score Max Score**

**1 \_\_\_\_\_\_ 7**

**2 \_\_\_\_\_\_ 6**

**3 \_\_\_\_\_\_ 7**

**TOTAL \_\_\_\_\_\_ 20**

**Question 1:**

Given an analog signal x(t)whose frequency content is given by

a) Draw X(f).

Draw the spectrum of the sampled signal xs(t) and of the recovered signal y(t) for the following cases. Assume that the signal is recovered from the samples with a low pass filter with a cutoff frequency of 5 Hz. Draw the spectrum from 0 until 20 Hz.

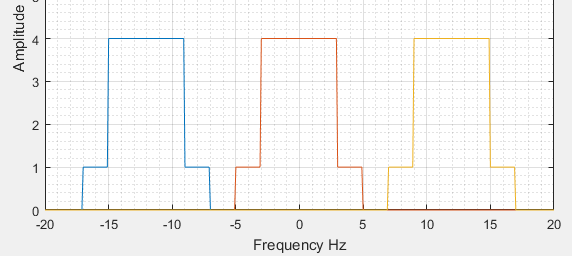
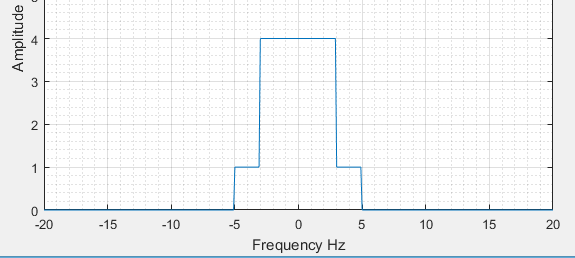
1. Sampling rate is 12 Hz.
2. Sampling rate is 10 Hz.
3. Sampling rate is 9 Hz.

e) Comment on the results of parts b, c and d.

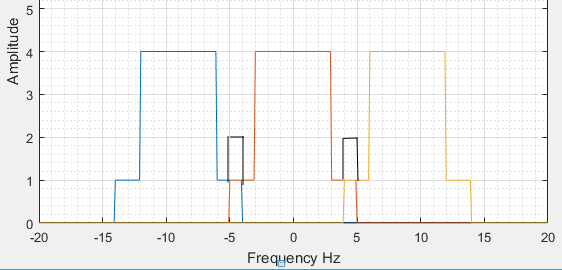
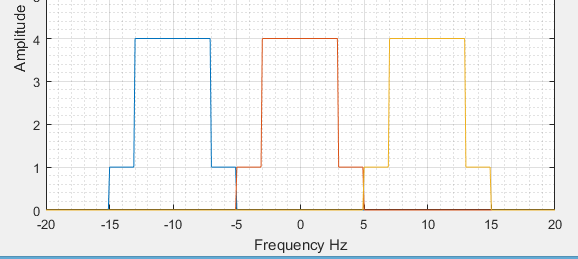
***Sol***

1.5

1



Fs = 12Hz;



Fs = 10Hz; Fs = 9Hz

1.5

1.5

Comments

0.5

b) No aliasing, the signal can be totally recovered.

c) We need to use an ideal filter to recover the signal.

0.5

d) Frequency overlapping, the signal is noised.

0.5

**Question 2:**

Assume that a 5-bit ADC channel accepts analog input ranging from 0 to 4 volts, determine the following:

1. Number of quantization levels
2. Step size of the quantizer.
3. Quantization level, binary code, and quantization error when the analog voltage is 2.4 volts.
4. Quantization level, binary code, and quantization error when the analog voltage is the third sample of the signal x(t) = | 3 sin (2πt) | sampled at 16 sample/sec. *(Note that 1st sample is at n = 0)*
5. Quantization level, binary code, and quantization error when the analog voltage is the sample at n = 6 of the signal x(t) = |3 sin (2πt) | sampled at 16 sample/sec.

**Sol**

0.5

Number of quantization levels = 32

Resolution = 0.125 v

0.5

For v=2.4 v

0.5

Quantization level for 2.4 = 19

Quantization value of 2.4 = 2.375

0.5

Quantization error = 0.025

0.5

Binary code: 1 1 0 0 1

1

0.5

0.5

Quantization level for 2.1213 = 17

Quantization value of 2.1213 = 2.125

0.5

Quantization error = -0.0037

0.5

Binary code: 1 0 0 0 1

0.5

**Question 3**

Consider the following sequence

x(0) = 1, x(1) = 0, x(2) = -2, and x(3) = 1.

Assume that

1. Evaluate the DFT of x(n) using Hamming window given by



1. Determine the frequency resolution and mapped frequencies for the DFT.
2. Compute the amplitude, phase, and power at the second and third frequencies of the spectrum.

**Sol:**

x(n) = 1 0 -2 1

0.5

w(n) = 0.0800 0.7700 0.7700 0.0800

0.5

xw(n) = 0.0800 0 -1.5400 0.0800

dft formula

1.5

2

X(k) = -1.38 1.6200 + j 0.08 -1.5400 1.6200 – j 0.08

0.5

formula f = 0 50 100 150

0.5

0.5

A = 0.4055 0.3850

0.5

Phi = 2.827 180

P = 0.1644 0.1482

0.5