**King Saud University**

**College of Computer and Information Sciences**

**Computer Engineering Department**

**First Semester 1437/1438 Academic Year.**

**CEN352 – Digital Signal Processing**

# Mid Term Exam 2

Time: 90 minutes 21/03/1438 – 20/12/2016

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:** (7) (use Z-transform)

A relaxed (zero initial conditions) DSP system is described by a difference equation

a. Determine the transfer function of the system.

b. Determine the impulse response due to the impulse sequence.

c. Determine the system response due to the unit step function excitation.

**Solution 1:**

1. Applying the z-transform

2

1. To obtain the impulse response,

1

Which gives the impulse response

1

1. To obtain the response due to a unit step function, the input sequence is set to be

1

Then the z-transform of the output sequence

Using the partial fraction expansion method as before gives

1

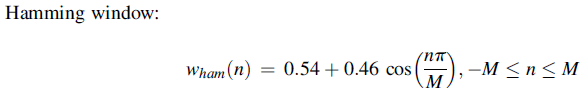
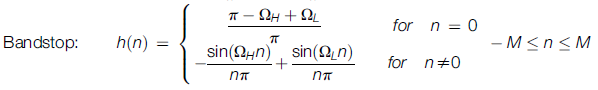
and the system response is

1

**Question 2:** (6)

Design the a 5-tap FIR band-stop filter with a lower cutoff frequency of 1,000 Hz and an upper cutoff frequency of 3,000 Hz and a sampling rate of 8,000 Hz using Hamming window.

1. Find the FIR filter normalized cutoff frequencies.
2. Find the FIR filter transfer functions
3. Find the FIR filter transfer function



**Solution 2:**

1

1

1

1

1. 0.3183 -0.0000 0.5000 -0.0000 0.3183

0.08 0.54 1 0.54 0.08

0.0255 -0.0000 0.5000 -0.0000 0.0255

2

**Question 3** (7)

Design a second-order digital band-pass Butterworth filter with the following specifications:

* Upper cutoff frequency of 1.7 kHz.
* Lower cutoff frequency of 1.3 kHz.
* Sampling frequency of 8 kHz.



1st order LPF prototype:

**Solution 3:**

the filter is: bpf

Upper Cutoff frequency fH = 1700

Lower Cutoff frequency fL = 1300

Sampling frequency Fs= 8000



Digital frequencies: wdl = 8.1681e+03, wdh = 1.0681e+04,

1

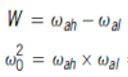
pre-warped analog frequency:

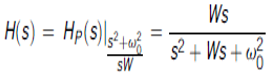
wal = 8.9604e+03, wah = 1.2613e+04,

1



1





Applying transformation LPF to BPF:

0.5

H(s) analog filter

B = [3653 0]

1.5

A = [1 3653 11302 e+04]



Applying BLT:

0.5

H(z) digital filter

b = [0.1367 0.0000 -0.1367]

1.5

a = [1.0000 -0.6690 0.7265]

