B.Sc. Engg. CSE 6th Semester — 29 August 2019 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION — **SUMMER SEMESTER, 2018-2019**
DURATION: 1 Hour 30 Minutes — **FULL MARKS: 75**

CSE 4631: Digital Signal Processing

Programmable calculators are not allowed. Do not write anything on the question paper.
There are **4 (four)** questions. Answer any **3 (three)** of them.
Figures in the right margin indicate marks.

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1. a) Name four key contribution areas of Digital Signal Processing. Which one among them is your favorite? Why? 2+4

   b) Determine if each of the following signals is periodic or not. If the signal is periodic, determine its fundamental period. 9

   i. $x_1(t) = e^{(-1+j)t}$
   ii. $x_2(n) = u(n) + u(-n)$
   iii. $x_3(n) = \cos(\frac{\pi}{2}\, n)\cos(\frac{\pi}{4} n)$

   c) A discrete-time signal $x(n)$ is shown in Figure 1. Sketch and label each of the following signals: 10

   i. $x(-n)$
   ii. $x(3-n)$
   iii. $x(n-1)\delta(n-2)$

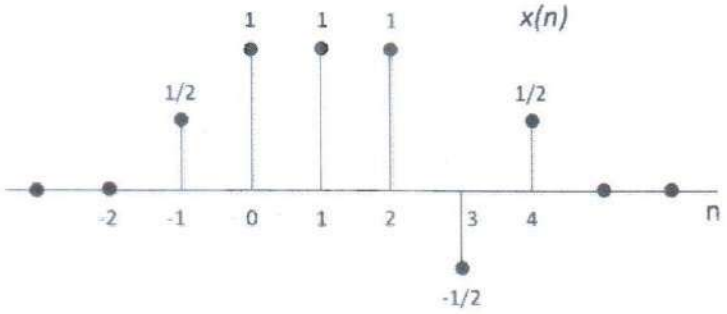

Figure 1: $x(n)$

2. a) Echoes are added to audio signals to make the listener "feel" that they are in a particular size of room. Assume that an audio signal is sampled at 44 kHz, and that sound propagates at 332 meters/second. In a "small" room, a person stands about 3 meters from the walls. 8

   i. In a small room, how long is the delay between a person making a sound and its echo from the walls?
   ii. How many samples does this correspond to in the digital signal?
   iii. What is the impulse response of a digital system simulating this echo, if the amplitude of the echo is 20%?

   b) Why would you use Polar notation instead of Rectangular notation? What are the nuisances associated with polar notation? 3+7

c) Why is decomposition important? Determine and sketch the even and odd parts of the signal depicted below: 3+4

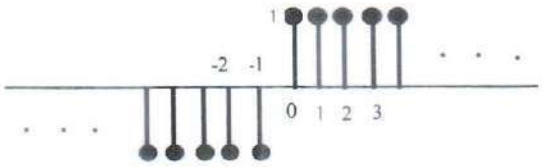

Figure 2: Signal

3. a) Two signals, x(n) and h(n), are defined as follows: 8
x(n): 1, 0, 2, 3, 2, 1,-1,-2,-1, 0, 2, 3, 3, 2, 1, 1 (samples 0-15)
h(n): 1, 2, 3,-3,-2,-1 (samples 0-5)

If y(n) = x(n)*h(n),
i. Use the input side algorithm to determine the contribution to y(n) from x(4).
ii. Use the output side algorithm to determine the value of y(10)

b) From calculus, you know that the derivative and integral are inverse operations; one undoes the effect of the other. Prove that the first difference and the running sum are also inverse operations. That is, show that the cascade of these two systems is identical to the delta function. 7

c) Why is correlation important? Compute the correlation of the following signals. [Bold signals denote origin] 3+7
$x(n) = \{\mathbf{1}, 2,3,4,5,6\}$; $h(n) = \{\mathbf{2}, 3,4\}$

4. a) You have taken a 256 point DFT of a sinusoid and in the DFT, a peak appears at index number 19. 10
i. What is the frequency of the peak expressed as a fraction of the sampling rate?
ii. What is the frequency of the peak expressed as a natural frequency?
iii. What is the sampling rate if the peak corresponds to 21.5 kHz in the analog signal?

b) Describe a real time use of Spectral Analysis. Why is Hamming Window used in spectral analysis? 4+4

c) A signal containing 1000 points is to be convolved with a signal containing 128 points. 7
i. What is the length of the resulting signal?
ii. If frequency domain convolution is used, what length of DFT is appropriate?
iii. If a 1024 point DFT is used, how many samples are correct, and how many are corrupted by circular convolution?