(23)

B.Sc. Engg. CSE 6th Semester — 16 February 2023 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION — **SUMMER SEMESTER, 2021-2022**

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.

Answer **all 3 (three)** questions. Figures in the right margin indicate full marks of questions whereas corresponding CO and PO are written within parentheses.

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1. a) Suppose two linear systems ***L1*** and ***L2*** are arranged in cascade (series). The impulse response of ***L1*** is $h_{L1}[n]=\{2, \hat{4}, -3\}$ and, the impulse response of ***L2*** is $h_{L2}[n]=\{-2, \hat{3}\}$. If a signal $x[n] = \{-1, 4, \hat{5}, 8, -2\}$ is passed through the two systems, determine the final output using the convolution operations. — 10 (CO2) (PO1)

   b) i. During calculating the inverse Discrete Fourier Transform (DFT), why are the first and last values of ***ReX*** *are* scaled differently by dividing them by ***N***, instead of $\frac{N}{2}$. — 5 + 5 (CO3) (PO2)

   ii. Why must the basis functions be orthogonal to each other in order for the DFT algorithm to work?

   c) In Figure 1, a signal in frequency domain is shown where the horizontal axis is labeled from **0** to $\frac{N}{2}$, where ***N*** is the number of samples in the corresponding time domain signal. The signal has a sampling rate of ***24*** KHz. Relabel the horizontal axis in terms of analog frequencies. — 5 (CO2) (PO1)

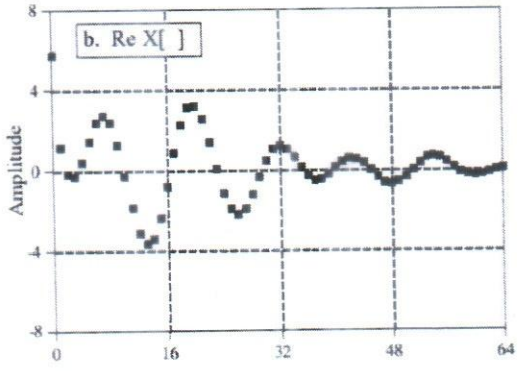

Figure 1: A signal in the frequency domain for Question 1.c)

2. a) Draw a diagram showing the basic parts of an Analog to Digital converter. Explain the functionality of each part in brief. — 8 (CO1) (PO1)

   b) Determine whether or not the following signal is periodic. If yes, then determine its fundamental period. — 5 (CO2) (PO1)

$$x[n] = \cos\left(\left(4n + \frac{\pi}{4}\right)\right.$$

c) Consider the following analog signal, $x_a(t) = 3cos4000\pi t + 5sin3000\pi t + 5cos5000\pi t$ 4+4+4 (CO2) (PO1)

i. What is the Nyquist rate for this signal?

ii. If we sample this signal using a sampling rate of ***3000*** samples/s, what is the discrete-time signal that will be obtained?

iii. If the signal is quantized into ***55*** levels, how many bits will be needed to store each sample of the signal.

3. a) Determine the response $y(n)$, of the following systems for the input signal $x(n)$, 7 + 7 (CO2) (PO1)

$$x(n) = \{-3, 7, 2, 4, -2, 5\}$$

i. $y(n) = x(n+1) + x(n-1)$

ii. $y(n) = \frac{1}{4}[x(n+1) + 2x(n) + x(n-1)]$

b) Rewrite the following signal, $x[n] = \{-2, \widehat{7}, 9, 2, -3, 1\}$, as a summation of weighted step signals. 5 (CO2) (PO1)

c) If a signal containing ***512*** samples is convolved with a signal containing ***128*** points. 3 + 3 (CO2) (PO1)

i. What is the number of samples in the output signal?

ii. Which samples in the output signal might not be useful? Why?