Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

V SEMESTER B.Tech.(BME) DEGREE MAKE-UP EXAMINATIONS DEC/JAN 2016-17
SUBJECT: BIOMEDICAL DIGITAL SIGNAL PROCESSING (BME 309)
(REVISED CREDIT SYSTEM)
Thursday, 5th January 2017, 2 pm to 5 pm

TIME: 3 HOURS **MAX. MARKS: 100**

Instructions to Candidates:

1. **Answer any FIVE full questions.**
2. **Draw labeled diagram wherever necessary**

1. (A) The impulse responses associated with the two LSI systems, are given by: 08

$h_1(n) = \left(\frac{1}{5}\right)^n u(n)$ and $h_2(n) = 2\delta(n-1) + 5\delta(n-2)$

Find the overall impulse response, if the two systems are connected:

(i) in cascade, and (ii) in parallel

(B) State and derive the condition for stability and causality of LSI systems. 06

(C) Perform the convolution of the following two sequences using the Z-transform. 06

$x(n) = \delta(n) - 2\delta(n-2)$ $h(n) = 2\delta(n) - 2\delta(n-1) + 3\delta(n-2) + \delta(n-3)$

2. (A) (a) Find the DFT $X[k]$ of the sequence, $x[n] = \{\underset{\uparrow}{0}, 1, 2, 3\}$ using the Matrix method. 06

(b) Find the IDFT $x[n]$ from $X[k]$ obtained in part (a) using the Matrix method.

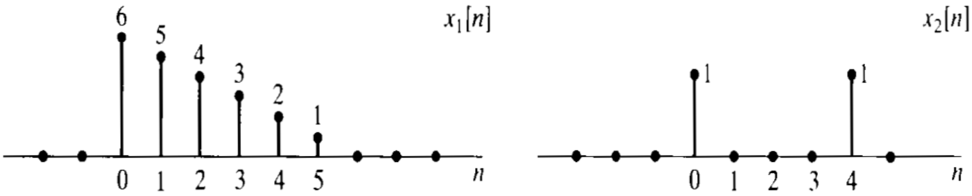
(B) Determine the frequency response associated with a linear-phase FIR band pass filter having cutoff frequencies of w_{c1} =1 radians and w_{c2}= 2 radians. Use hanning window of length 5. 08

(C) A causal system produces an output sequence $y[n] = \delta[n] + \frac{2}{5}\delta[n-1]$ for the input $x[n] = \delta[n] - \frac{7}{10}\delta[n-1] + \frac{1}{10}\delta[n-2]$. Determine the impulse response of the system and its difference equation. 06

3. (A) List the characteristics of FIR filters. 04

(B) Consider a FIR filter with impulse response $h(n) = \{\underset{\uparrow}{3}, 2, 1, 1\}$. If the input to the filter is $x(n) = \{\underset{\uparrow}{1}, 2, 3, 3, 2, 1, -1, -2, -3, 5, 6, -1, 2, 0, 2, 1\}$, find the output using Overlap-add method of convolution. 08

(C) (a) The figure below, shows two finite-length sequences. Sketch their N-point Circular convolution, for N=6 and N=10. 08



(b) Interpret the results.

4. (A) A signal $x(t) = \cos(5\pi t) + 0.5\cos(10\pi t)$ is sampled. The interval between the samples is T_s seconds. 04

(i) Find the maximum allowable value of T_s.

(ii) What is the minimum bandwidth of a low pass filter required to reconstruct the signal without distortion?

(B) Consider a causal system described by the difference equation, 08

$y(n) = \frac{3}{4}y(n-1) - \frac{1}{8}y(n-2) + x(n)$. Using the Z-transform, determine

(i) the unit sample response of the system.

(ii) the output of the system, if the input $x(n) = \delta(n) - \frac{1}{4}\delta(n-1)$.

(C) Calculate the 8-point DFT of the sequence $x[n] = \{\underset{\uparrow}{0},1,2,3,4,5,6,7\}$, using DIT-FFT radix-2 algorithm. 08

5. (A) Assume that we have a 1194-point data sequence. We zero pad the sequence to change its length to $N = 2^{11}$, so that we can use a radix-2 FFT algorithm. 04

(i) How many multiplications and additions are required to compute the DFT using a radix-2 FFT algorithm?

(ii) How many multiplications and additions would be required to compute 1194-point DFT directly?

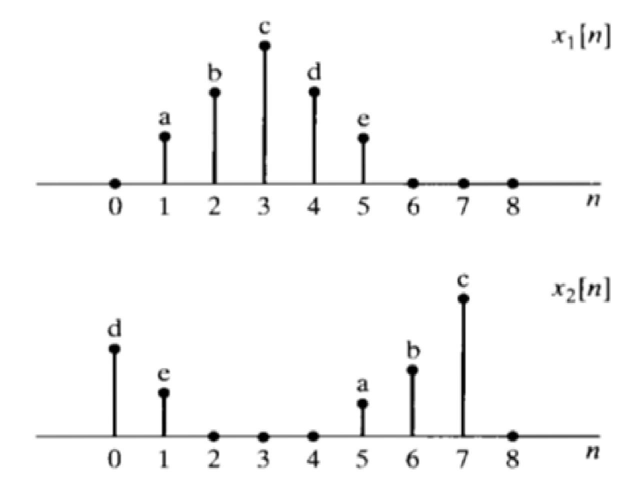
(B) Design a digital Chebyshev low pass filter that satisfies the following constraints: 08

$$0.8 \leq |H(w)| \leq 1\ ;\ \ 0 \leq w \leq 0.2\pi$$

$$|H(w)| \leq 0.2\ ;\ \ 0.6\pi \leq w \leq \pi$$

Use Impulse Invariant transformation.

(C) The two 8-point sequences $x_1[n]$ & $x_2[n]$ shown in figure below have DFTs $X_1(k)$ & $X_2(k)$, respectively. Observe the two sequences carefully, and determine the relationship between $X_1(k)$ & $X_2(k)$. 08



6. (A) What is the necessary and sufficient condition for a discrete-time filter to have linear- phase? An FIR filter is specified by the following impulse response: 06

$h(n) = -\frac{1}{3}\delta(n) + \frac{1}{2}\delta(n-1) - \frac{1}{3}\delta(n-2)$. Is this a linear-phase filter?

(B) An analog Butterworth low pass filter has to meet the following specifications: 08

(i) Pass band gain, K_p= -1dB at Ω_p=4rad/sec

(ii) Stopband attenuation greater than or equal to 20dB at Ω_s=8rad/sec

Determine the transfer function and frequency response of the Butterworth filter to meet the above specifications.

(C) Illustrate the concepts of sampling and quantization with an example each. 06