Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL

A Constituent Institution of Manipal University

V SEMESTER B.Tech.(BME) DEGREE END SEM EXAMINATIONS NOV/DEC 2016

SUBJECT: BIOMEDICAL DIGITAL SIGNAL PROCESSING (BME 309)

(REVISED CREDIT SYSTEM)

Saturday, 3rd December 2016, 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) Consider two LSI systems with impulse responses $h_1[n] = \delta[n-2]$ and $h_2[n] = \delta[n-3]$ respectively. Calculate the overall impulse response $h[n]$, if the systems are connected in (i) cascade (ii) parallel. 08

(B) Derive the condition (based on the impulse response), for stability and causality of LSI systems. 06

(C) Use the Z-transform to perform the convolution of the following two sequences: 06

$$h(n) = \begin{cases} \left(\frac{1}{2}\right)^n ; 0 \le n \le 2 \\ 0 \quad ; elsewhere \end{cases} \qquad x(n) = \delta(n) + \delta(n-1) + 4\delta(n-2)$$

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

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

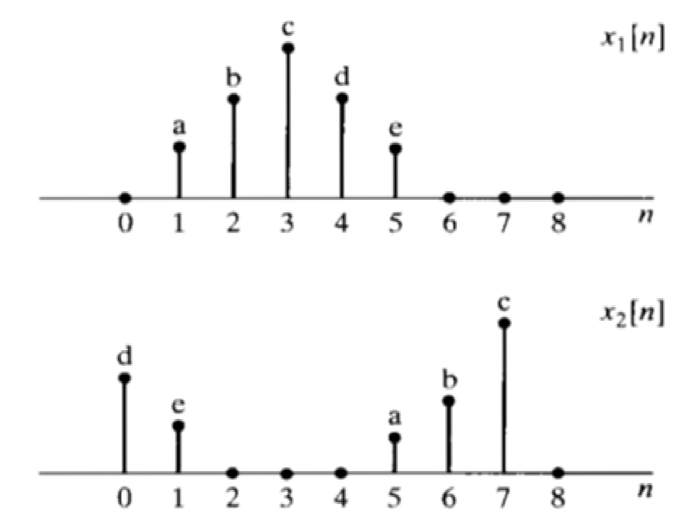
(B) Design a FIR high pass filter having cutoff frequency 1.2 radians using a hamming window of length N=7. 08

(C) State the condition (based on the ROC of the system function, $H(z)$), for stability and causality of LSI systems. Check for causality and stability of the LSI system defined by the unit sample response $h[n] = \alpha^n u[n]$, using the above condition. 06

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

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

(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



4. (A) A continuous-time signal $x(t)$ is obtained at the output of an ideal lowpass filter with cutoff frequency $w_c = 1000\pi\ rad/sec$. If impulse–train sampling is performed on $x(t)$, which of the following sampling periods would guarantee perfect recovery of $x(t)$ from its sampled version using an appropriate lowpass filter? 04

(i) T = 0.5×10^{-3} Sec (ii) T = 2×10^{-3} Sec (iii) T = 10^{-4} Sec

(B) A causal LSI system is characterized by the difference equation, 08

$$y(n) - \frac{5}{6}y(n-1) + \frac{1}{6}y(n-2) = x(n).$$

(a) Determine: (i) the system function, $H(z)$ (ii) the unit sample response, $h(n)$

(b) Determine whether the system is stable. Justify your answer.

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

5. (A) Assume that a complex multiplication takes 1μs and that the amount of time to compute a DFT is determined by the amount of time it takes to perform all of the multiplications. 04

(i) Find the time taken to compute a 1024-point DFT directly?

(ii) What is the computation time if an FFT is used?

(iii) Repeat parts (i) and (ii) for a 4096-point DFT.

(B) An analog Chebyshev low pass filter is to be designed to meet the following specifications: 08

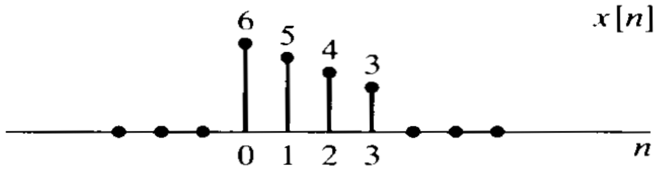
Passband ripple: ≤ 3dB Passband edge: 100 rad/sec

Stopband attenuation: ≥ 25dB Stopband edge: 250 rad/sec

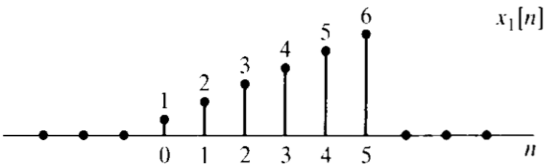
Obtain the Transfer function & Frequency response of the filter.

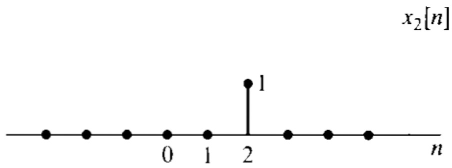
(C) (a) Figure shows a finite length sequence $x[n]$. Sketch the following sequences in the range $0 \le n \le 3$. 08

(i) $x\big((n-3)\big)_4$ (ii) $x\big((n+2)\big)_4$ (iii) $x\big((-n)\big)_4$



(b) Figure shows two finite length sequences $x_1[n]$ & $x_2[n]$. Sketch their 6-point circular convolution.





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) A digital Butterworth low pass filter is to be designed using the impulse invariant method to satisfy the following constraints: 08

$20\log|H(w)|_{w=0.2\pi} \quad \ge \quad -1.9328\ dB$

$20\ \log|H(w)|_{w=0.6\pi} \quad \le \quad -13.9794\ dB$

Obtain the transfer function $H(z)$ of the filter.

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