Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

(A Constituent Institute of Manipal University)
Manipal – 576 104

V SEMESTER B.Tech (BME) DEGREE END-SEM EXAMINATIONS, NOV / DEC 2015
SUBJECT: BIOMEDICAL DIGITAL SIGNAL PROCESSING (BME 309)
(REVISED CREDIT SYSTEM)
Friday, December 04, 2015: 2.00p.m. - 5.00p.m.

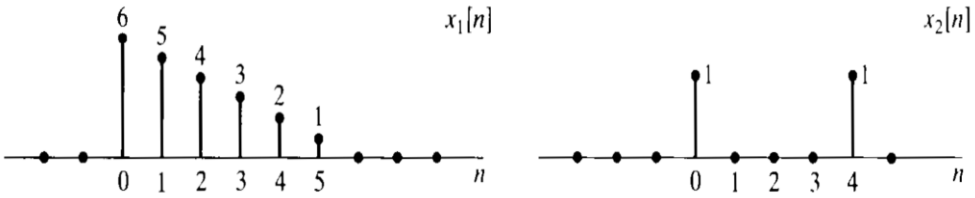
TIME: 3 HOURS **MAX. MARKS: 100**

Instruction to Candidates:
Answer any FIVE full questions.

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

   B. Compare the characteristics of FIR and IIR filters. (04)

   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.

2. A. Show that the filter described by the difference equation: (04)
   $y(n) = 0.1x(n) + 0.5x(n-1) + 0.9x(n-2) + 0.5x(n-3) + 0.1x(n-4)$,
   has a finite impulse response. What is the length of the response?

   B. A causal LSI system is characterized by the difference equation, (06)
   $y(n) - \frac{5}{6}y(n-1) + \frac{1}{6}y(n-2) = x(n)$.
   (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.

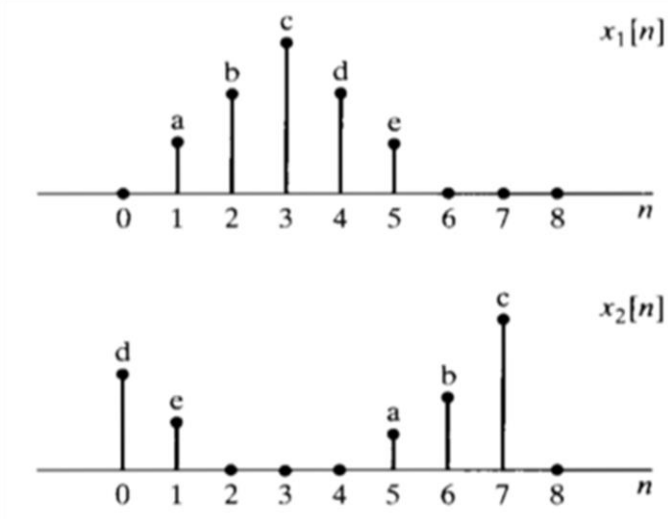
   C. Determine the impulse response associated with a linear-phase FIR low pass filter which will meet the following specifications: (10)
   Pass band edge frequency: 10kHz Sampling frequency: 50kHz
   Transition width: 5kHz Minimum stop band attenuation: 50dB

3. 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. 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)



C. 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

4. A. An FIR filter is specified by the following impulse response: (06)

$h(n) = -\frac{1}{3}\delta(n) + \frac{1}{2}\delta(n-1) - \frac{1}{3}\delta(n-2)$

(i) Is this a linear-phase filter?

(ii) Is this a causal filter?

Justify your answer.

B. Determine the frequency response associated with a linear-phase FIR band stop filter having cutoff frequencies of w_{c1} =1 radians and w_{c2}= 2 radians. Use rectangular window of length 7. (10)

C. 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?

5. A. Use the Z-transform to perform the convolution of the following two sequences: (04)

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

B. Determine the sequence $y[n]$ obtained by a periodic convolution of the pair of periodic sequences, each of period 6, one period of which is given below: (08)

$x[n] = \{0, 0, 1, 1, 0, 0\}, \quad h[n] = \{1, 1, 1, 1, 0, 0\}, \quad 0 \le n \le 5$

C. Determine the transfer function associated with an analog low pass Butterworth filter that will have a -1dB cutoff frequency at 75Hz and have greater than 20dB of attenuation for all frequencies greater than 150Hz. (08)

6. A. 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. (04)

B. Determine the transfer function associated with an analog low pass Chebyshev filter that will meet the following specifications: (10)

Pass band ripple: ≤ 2dB Pass band edge: 1 rad/sec

Stop band attenuation: ≥ 20dB Stop band edge: 1.3 rad/sec

C. 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-add" method of convolution. (06)