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: DIGITAL SIGNAL PROCESSING (BME 3104)
(REVISED CREDIT SYSTEM)
Thursday, 5th January 2017, 2 pm to 5 pm

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

Instruction to Candidates:

Answer all the questions.

1. (A) The signal $x(n) = \{1, 0.5\}$ is applied to a system with frequency response $H(w)$, and the resulting output is $y(n) = \delta(n) - 2\delta(n-1) - \delta(n-2)$. Find the impulse response $h(n)$, of the system. 06
   $\uparrow$

   (B) A discrete-time signal is given by $x[n] = \{1, 2, 3, 2, 1\}$. 08
   $\uparrow$
   Sketch each of the following versions of the signal:
   (i) $x[2n-1]$ (ii) $x[1-n]$ (iii) $x[-2n]$ (iv) $x[n+1]$.

   (C) The unit sample response of a LSI system is given by $h(n) = \left(\frac{1}{2}\right)^n u(n)$. Let $y(n)$ be the output of the system with the input, $x(n) = 2\delta(n) + \delta(n-3)$. Find $y(1)$ and $y(4)$. 06

2. (A) Design a FIR low-pass filter having cutoff frequency of 3π/4 radians. Use hamming window of length 7. 10

   (B) 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.

   (C) Investigate the causality and stability of the following LSI systems (justify your answer): 06
   (i) $h(n) = \left(-\frac{1}{2}\right)^n u(n-1)$ (ii) $h(n) = (2)^n u(-n)$
   (iii) $h(n) = \cos\left(\frac{\pi}{8}n\right)\{u(n) - u(n-10)\}$

3. (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) $T_s = 0.5\text{x}10^{-3}$ Sec (ii) $T_s = 2\text{x}10^{-3}$ Sec (iii) $T_s = 10^{-4}$ Sec

(B) (a) Determine the Z-transform of the signal $x(n) = \{1, 2, -1, 1\}$. Use the Z-transform to determine the DTFT of $x(n)$. 08

(b) Using the Z-transform, find the impulse response of a causal system described by the difference equation, $y(n) - \frac{1}{4}y(n-1) - \frac{3}{8}y(n-2) = -x(n) + 2x(n-1)$. Check for stability of the system (justify your answer).

(C) Find the 4-point circular convolution of the sequences $x(n) = \{1,1,1,1\}$ & $h(n) = \{1,0,1,0\}$, using radix-2 DIT-FFT algorithm. 08

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

(B) Compute the DTFTs of the following sequences and sketch the magnitude responses over $-\pi \leq w \leq +\pi$. 08

(i) $x(n) = \delta(6 - 3n)$ (ii) $x(n) = u(n+1) - u(n-2)$

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

5. (A) We would like to linearly convolve a 3000-point sequence with a LSI filter whose impulse response is 60 points long. To utilize the computational efficiency of the FFT, the filter is to be implemented using 128-point DFT's & IDFT's. If the overlap-add method is used, how many DFT's & IDFT's are needed to complete the filtering operation? 04

(B) The impulse response of a LSI system is given by $h(n) = \left(\frac{1}{2}\right)^n u(n) + \left(-\frac{1}{3}\right)^n u(n)$. 08

(i) Find the Z-transform of $h(n)$ & its ROC. (ii) Is the system Causal?

(iii) Is the system Stable? (iv) Obtain the difference equation of the system.

(C) The 4-point DFT of the sequence $x(n)$ is $X(K) = (1,\ j,\ 1, -j)$. Using the properties of DFT, find the DFT of the following sequences: 08

(i) $x_1(n) = (-1)^n x(n)$ (ii) $x_2(n) = x\big((n+1)\big)_4$ (iii) $x_3(n) = x\big((4-n)\big)_4$.