Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL

A Constituent Institution of Manipal University

V SEM B.TECH. (BME) DEGREE END SEMESTER EXAMINATIONS, NOVEMBER 2017

SUBJECT: DIGITAL SIGNAL PROCESSING (BME 3104)

(REVISED CREDIT SYSTEM)

Friday, 24th November 2017, 2 PM-5 PM

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

Instructions to Candidates:

1. **Answer ALL questions.**
2. **Draw labeled diagram wherever necessary**

Consider the following

DFT	Discrete Fourier Transform	LTI	Linear Time Invariant
DTFT	Discrete Time Fourier Transform	FIR	Finite Impulse Response
ROC	Region Of Convergence	IIR	Infinite Impulse Response
BIBO	Bounded Input Bounded Output		

1. (a) Express the length-5 sequence $x(n) : \{2,\ -1,\ \underset{\uparrow}{0},\ 3,\ -4\}$ in terms of unit step sequence, and represent it also graphically. **[4]**

(b) Show that the necessary and sufficient condition for a relaxed LTI system to be BIB0 stable is: **[6]**

$$\sum_{n=-\infty}^{\infty} |h(n)| \leq M_h < \infty$$

where $h(n)$ is the impulse response of the LTI system and M_h some finite constant.

(c) Consider the LTI system with impulse response **[10]**

$$h(n) = \begin{cases} a^n & n \geq 0 \\ b^n & n < 0 \end{cases}$$

Determine the range of values of 'a' and 'b' for the system to be stable.

2. (a) Consider a sequence $x(n) = \{-1,\ 3,\ 1,\ \underset{\uparrow}{0},\ 3,\ 2\}$, calculate the following using $\mathcal{L}p$- norm, for $p = 1, 2, \infty, and - \infty$ **[5]**

   i. Root-mean-square (rms) value of $x(n)$.
   ii. Peak absolute value of $x(n)$.
   iii. Mean absolute value of $x(n)$.

(b) Classify the Discrete-Time System whose input-output relation is given by **[5]**

$$y(n) = x(n) + nx(n-1)$$

with respect to the properties: Linearity and Time invariance

(c) Determine the transfer function of the simple 2nd order IIR Band Pass Filter for a given center frequency $\omega_0 = \frac{\pi}{2}\ rad/sample$ and Bandwidth $B = \frac{\pi}{6}\ rad/sample$. Plot the magnitude and phase of the frequency response, with clear labelling of the specifications. **[10]**

3. (a) Determine the conjugate-symmetric and conjugate-anti-symmetric sequences associated with the finite length complex sequence *x(n)* of length-7: **[5]**

$$x(n) : \{-j,\quad -4+j,\quad 1+j2,\quad -2j,\quad \underset{\uparrow}{j+3},\quad 0,\quad j5-2\},$$

(b) Determine the 4-point DFT of the sequence, $x(n) : \{\underset{\uparrow}{0}, -1, 2, -3\}$ using the matrix representation method. **[5]**

(c) Determine the Discrete Time sequence $x(n)$ if z-transform $X(z)$ is given by

$$X(z) = \frac{1 + 3z^{-1}}{1 + 3z^{-1} + 2z^{-2}}$$ **[10]**

using the Partial Fraction Expansion Method. Sketch the pole-zero plot with possible ROCs.

4. (a) Given the sequence, $x(n) = \begin{cases} |n|, & -4 \le n \le 4 \\ 0, & otherwise \end{cases}$, and $y(n) = \{\underset{\uparrow}{1},\ 2, -3\}$.

Find the sequence $z(n) = x(2n) - y\left(\frac{n}{2}\right)$. Explain each operation performed on the sequences and also illustrate the operations graphically. **[5]**

(b) Derive the relation between DFT and DTFT. **[5]**

(c) Explain the algorithm for Radix-2 Decimation in Time FFT to find 8-point DFT of a sequence $x(n)$ with the butterfly diagram. **[10]**

5. (a) Show that,

i. $u(n) - u(n-1) = \delta(n)$

ii. $u(n) = \sum_{k=-\infty}^{n} \delta(k) = \sum_{k=0}^{\infty} \delta(n-k)$ **[5]**

where $\delta(n)$ the unit impulse sequence, and $u(n)$ is the unit step sequence.

(b) Explain the simple first order FIR High Pass Filter using the magnitude and phase plot of its frequency response. **[5]**

(c) Consider the two sequences,

$$x(n) : \{\underset{\uparrow}{1}, 2, 1\}$$

$$y(n) = (-1)^n, for\ 0 \le n \le 1$$ **[10]**

By using, Convolution property of DFT, determine the Linear convolution $y_L(n)$ using the Circular convolution of $x(n)$ and $y(n)$. Use the matrix representation method to compute DFT.