Reg. No.											

MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal 576104)

V SEM B.Tech (BME) DEGREE MAKE-UP EXAMINATIONS, DEC/JAN 2018-19

SUBJECT: DIGITAL SIGNAL PROCESSING (BME 3104)
(REVISED CREDIT SYSTEM)
Sunday, 30th December 2018: 2 PM to 5 PM

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to Candidates:

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

1. a) Consider a discrete time sequence $x(n) = \begin{cases} 1+\frac{n}{3}, & -3 \le n \le -1 \\ 1, & 0 \le n \le 3 \\ 0, & otherwise \end{cases}$. With neat graphical representation of each step, compute $x(n-1)\delta(n-3)$. (3)

   b) The second derivative $y(n)$ of a sequence $x(n)$ at time instant n is usually approximated by $y(n) = x(n+1) - 2x(n) + x(n-1)$. If $y(n)$ and $x(n)$ denotes the output and input of a discrete-time system, then examine the linearity, stability and causality of the system. (3)

   c) Determine the response $y(n)$ of the LTI system whose impulse response $h(n) = \begin{cases} 1 & -2 \le n \le 2 \\ 0 & otherwise \end{cases}$ and the input $x(n) = \begin{cases} \frac{n}{3} & 0 \le n \le 6 \\ 0 & otherwise \end{cases}$ (4)

2. a) Let $x(n) = \{4,2,0,-2\}$ and $y(n) = \{3,1,-1,-3\}$ be 4-point sequences. Then compute $x(n) \circledast y(n)$ using circular convolution property of DFT. (3)

   b) Let $x(n)$ be an arbitrary signal, not necessarily real-valued, with Fourier transform $X(\omega)$. Express the Fourier transform of $y(n) = \begin{cases} x\left(\frac{n}{2}\right), for\ n\ even \\ 0, \quad for\ n\ odd \end{cases}$ in terms of $X(\omega)$. (3)

   c) Determine the z-transform of the sequences $x(n) = \left(\frac{1}{4}\right)^n u(n+4)$ and its ROC. Show that the ROC includes the unit circle for each z-transform. Compute the z-transform evaluated on the unit circle for each sequence and show that it is precisely the DTFT of the respective sequence. (4)

3. a) Let $G(k)$ and $H(k)$, denote the 8-point DFTs of two length-8 sequences, $g(n)$ and $h(n)$ respectively. If $G(k) = \{3.2 + 4.6i,\ 4.1 + 4.7i,\ -3.8 - 3.5i, 4.2 + 4.8i,\ 1.3 + 4.6i,\ -4.1 - 0.1i, -2.2 + 3i,\ 0.5 - 3.6i\}$ and $h(n) = g(\langle n - 5\rangle_8)$, then determine $H(k)$ using DFT and then find $h(n)$ using IDFT. (5)

b) Consider the M-point Moving Average System characterized by its difference equation $y(n) = \frac{1}{M}\sum_{k=0}^{M-1} x(n-k)$. Determine the Frequency Response $H(e^{j\omega})$ of this system. Plot the Magnitude and phase spectrum of the Frequency Response $H(e^{j\omega})$ for $M = 5$ point Moving Average System. (5)

4. a) Consider an IIR digital filter with the transfer function $H(z) = \frac{0.9+0.4z^{-1}+0.9z^{-2}}{1+0.4z^{-1}+0.8z^{-2}}$. Design an digital filter which is doubly complementary pair of $H(z)$. (3)

b) Design the simple 2nd order IIR digital Band stop Filter with center frequency $\omega_0 = \frac{\pi}{2}\ radians$ and for the following Bandwidth $BW = \frac{\pi}{6}\ radians$. Plot the Frequency response using Magnitude and phase spectrum. (3)

c) Design a length-12 Type-4 linear-phase FIR filter has the following zeros: $z_1 = 2.2 + j3.4,\ z_2 = 0.6 + j0.9, z_3 = -0.5$ (4)

5. a) Design an IIR digital Low Pass filter for the specifications as shown in the below figure by transforming an analog Low Pass filter using Bilinear transformation. Consider analog Chebyshev Low pass filter design for the given specifications. Plot the magnitude spectrum of IIR digital Low Pass filter. (10)