Reg. No.											

MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal 576104)

V SEM B.Tech (BME) DEGREE END-SEMESTER EXAMINATIONS, NOV/DEC 2018.

SUBJECT: DIGITAL SIGNAL PROCESSING (BME 3104)
(REVISED CREDIT SYSTEM)
Wednesday, 28th November 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) A discrete time signal $x(n)$ is as shown in Figure 1. With neat graphical representation of each step, compute $x(n+2)u(2-n)$. 3

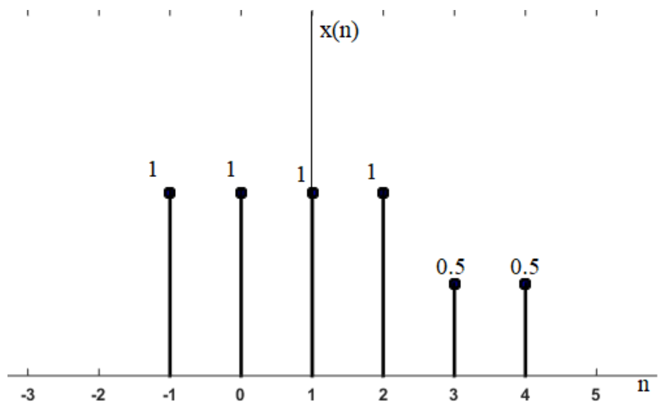

Figure 1

b) A discrete-time systems defined as $y(n) = \alpha x(n+2),\ \alpha\ is\ a\ non-zero\ real\ constant$, where $y(n)$ and $x(n)$ are, respectively the output and the input sequences the system. Examine the linearity, stable, and shift-invariant of the system. 3

c) Consider the interconnection of LTI systems as shown in Figure 2: 4

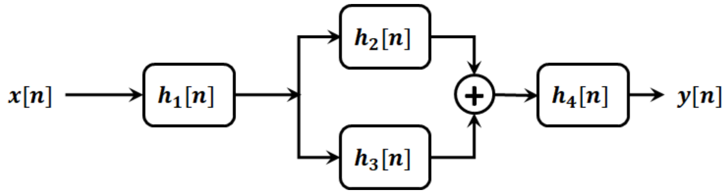

Figure 2

Determine the overall impulse response $h(n)$ of the system and then compute the response of the system if $x(n) = \delta(n+2) + 3\delta(n-1) - 4\delta(n-3)$,

$h_1(n) = \left\{\frac{1}{2}, \frac{1}{4}, \frac{1}{2}\right\}, h_2(n) = -u(n-1), h_3(n) = u(n)$ *and* $h_4(n) = \delta(n+1)$

2. a) Let $x(n) = \{4,3,2,1,0,-1,-2,-3\}$ be an 8-point sequence. Compute and plot $x(\langle n+1\rangle_8) + x(n) - x(\langle n-3\rangle_8)$. 3

b) Let $x(n)$ be a bandlimited signal with Fourier transform $X(\omega)$ as shown in Figure 3. Determine the Fourier transform $X_1(\omega)$ of $x_1(n) = x(n)\cos\left(\frac{\pi n}{2}\right)$. Sketch the $X_1(\omega)$. Comment on $X(\omega)$ and $X_1(\omega)$. 3

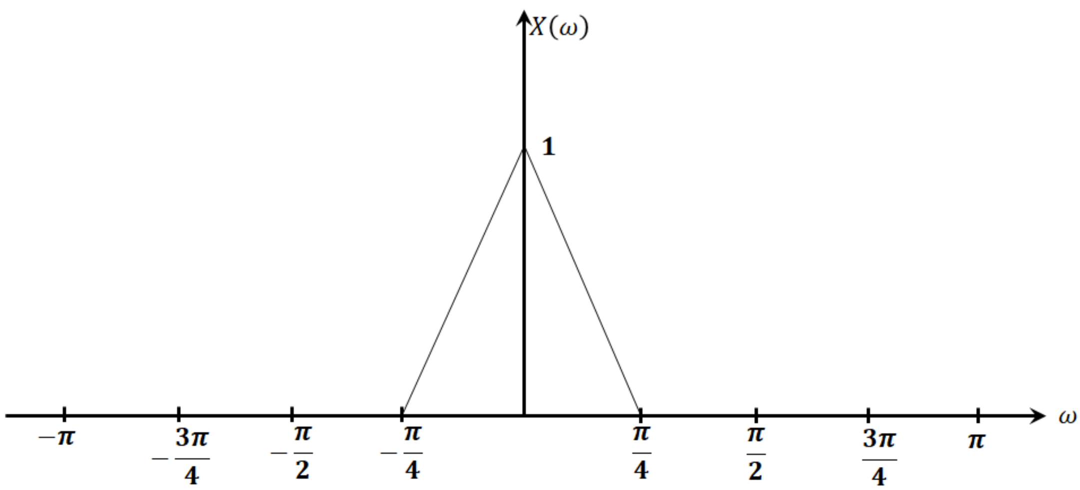

Figure 3

c) Let $x(n) = \{4,2,0,-2\}$ and $y(n) = \{2,-2,1,-1\}$ be 4-point sequences. Compute the linear convolution $x(n) * y(n)$ using the circular convolution. 4

3. a) Consider the z-transform of $x(n)$ as $(z) = \frac{1}{4}\frac{1+6z^{-1}+z^{-2}}{\left(1-3z^{-1}+2z^{-2}\right)\left(1-0.5z^{-1}\right)}$. Evaluate the inverse z-transform for all possible ROCs and also mention the ROC for which inverse z-transform doesn't exist for the given z-transform. Determine whether DTFT exists for $x(n)$. 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=7-point Moving Average System. 5

4. a) Design the simple 2nd order IIR digital Band Pass 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

b) Consider an IIR digital filter with the transfer function $(z) = \frac{0.1(1-z^{-2})}{1+0.4z^{-1}+0.8z^{-2}}$. Design an digital filter which is doubly complementary pair of $H(z)$. 3

c) Design a length-13 Type-3 linear-phase FIR filter with the following zeros: $z_1 = 0.1 - j0.599,\ z_2 = -0.3 + j0.4,\ z_3 = 2$. 4

5. Design an IIR digital Low Pass filter for the specifications as shown in the Figure 4 by transforming an analog Low Pass filter using Bilinear transformation. Consider analog Butterworth Low pass filter design for the given specifications. Plot the magnitude spectrum of IIR digital Low Pass filter. 10

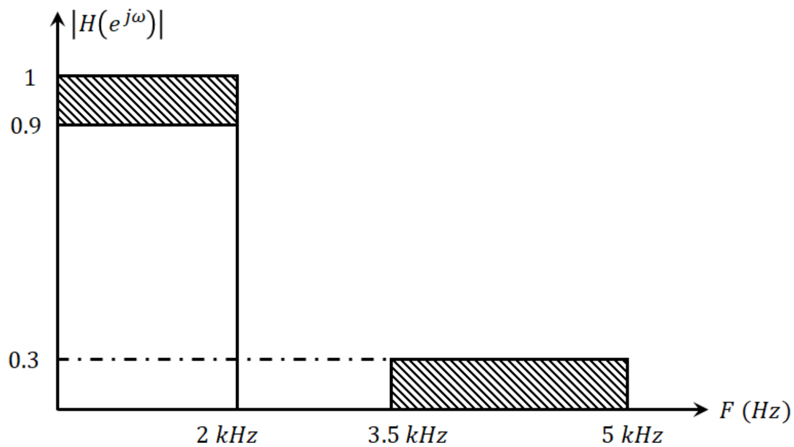

Figure 4