Reg. No.											

MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal 576104)

V SEM B.Tech (BME) DEGREE END SEMESTER EXAMINATIONS, NOVEMBER 2019.

SUBJECT: DIGITAL SIGNAL PROCESSING (BME 3104)
(REVISED CREDIT SYSTEM)
Monday, 25th November 2019: 2 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 the sequence (2)

$$x(n) = \{-3,\quad 4,\quad 2,\quad 0,\quad 1,\quad \underset{\uparrow}{-1},\quad 3,\quad -2\}$$

Explain each operation performed on the sequence $x(n)$ graphically to find the resultant sequence $y(n) = x(-n-1)$.

b) Is the sequence $x(n) = \cos(\sqrt{8}\pi n)$, a periodic sequence or aperiodic sequence? Justify? (2)

c) Consider the sequence (3)

$$x(n) = \beta e^{\frac{j2\pi n}{N}}, \qquad \beta \in \mathbb{R}$$

Determine the conjugate symmetric and conjugate anti-symmetric parts of $x(n)$.

d) Consider the Discrete Time System defined as (3)

$$y(n) = \beta + \sum_{l=0}^{n} \alpha^{l} x(n-l), \quad \beta \in \mathbb{R}$$

Examine whether or not the system is causal, stable, and shift-invariant.

2. a) Determine the zero-input response of the system described by the second-order difference equation $x(n) - \alpha y(n-1) - \beta y(n-2) = 0$. (2)

b) Show that the necessary and sufficient condition for a relaxed LTI system with an impulse response $h(n)$ to be BIBO stable is (3)

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

For some constant M_h

c) Let $x(n)$ be an arbitrary signal, not necessarily real-valued, with Fourier transform $X(\omega)$. Find the Fourier transform of the signal $y(n) = y(n-1) + \frac{1}{M}[x(n) - x(n-M)]$ in terms of $X(\omega)$. (2)

d) Let $x(n)$ be a signal with the magnitude spectrum defined in the interval $-\pi \le \omega < \pi$ as shown in Fig 1. (3)

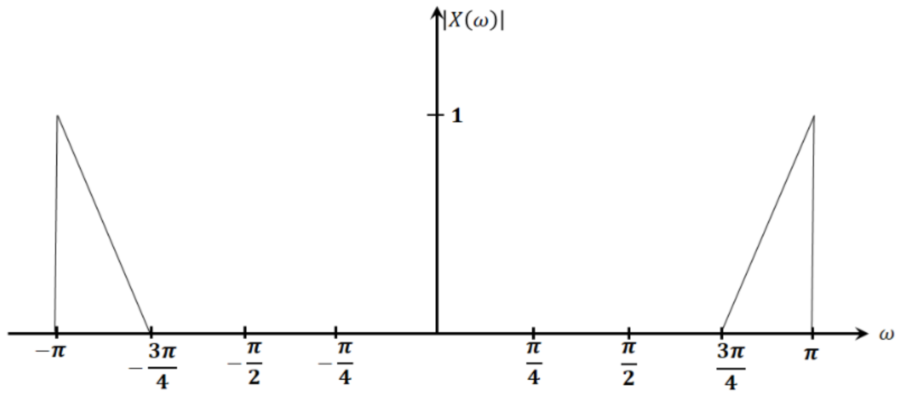

Fig. 1

Determine and sketch the magnitude spectrum of the signal $y(n) = x(n)\cos(\pi n)$ in the interval $-\pi \le \omega < \pi$.

3. a) Let $x(n) = \{4,2,0,-2\}$ and $y(n) = \{2,-2,1,-1\}$ be 4-point sequences. Implement Linear convolution of $x(n)$ and $y(n)$ using Circular convolution. (2)

b) Let $G(k)$ and $H(k)$, denote the 4-point DFTs of two 4-point sequences, $g(n)$ and $h(n)$ respectively. If $G(k) = \{6,\ -(1+i),\ 0,\ i-1\}$ and $h(n) = g(\langle n-3\rangle_4)$, then determine $H(k)$ using DFT and then find $h(n)$ using IDFT. (3)

c) Determine the z-transforms of the sequence $x(n) = -\alpha^n u(-n-3)$ and sketch the corresponding pole-zero pattern with its ROC and state whether or not Discrete Time Fourier Transform exist. (2)

d) Evaluate the inverse z-transform for all possible ROCs for the given z-transforms $X(z)$ and state whether or not Discrete Time Fourier Transform exist for the resultant sequence(s): (3)

$$X(z) = \frac{1}{4}\frac{1 + 6z^{-1}}{(1 - 3z^{-1} + 2z^{-2})}$$

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

i). Determine the locations of the remaining zeros.

ii). Design the filter.

b) The Transfer function of a IIR Bandpass Filter is defined as: (6)

$$H(z) = \frac{1-\alpha}{2}\,\frac{1-z^{-2}}{1-\beta(1+\alpha)z^{-1}+\alpha z^{-2}}$$

Design this IIR Band Pass Filter with center frequency $\omega_0 = \frac{\pi}{2}\ radians$ and the Bandwidth $BW = \frac{\pi}{6} radians$. Plot the Frequency response using Magnitude and phase spectrum.

5. The IIR digital Low Pass filter specifications are as shown in the Fig. 2

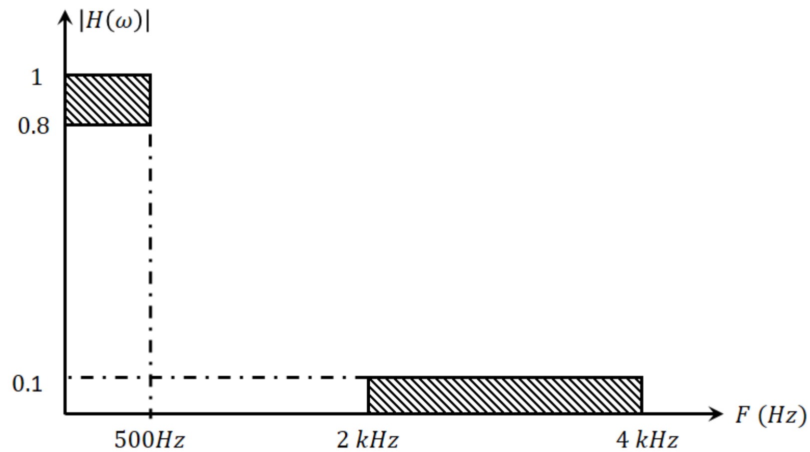

Fig. 2

Determine the following:

a) Design the Analog Butterworth Low Pass Filter. (6)

b) Design the Digital IIR Low Pass Filter from 5(a) using Bilinear Transformation method. (4)