Reg. No.											

MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal 576104)

V SEMESTER B.Tech (BME) DEGREE MAKE UP EXAMINATIONS, DEC/JAN 2019-20

SUBJECT: DIGITAL SIGNAL PROCESSING (BME 3104)
(REVISED CREDIT SYSTEM)
Monday, 30th December 2019: 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) Is the causal discrete time sequence $x(n) = 1 + \frac{1}{n}$ is an absolutely summable sequence? Justify? (2)

b) Consider the discrete time sequence $x(n) = \begin{cases} |n| & -3 \le n \le 3 \\ 0 & otherwise \end{cases}$, determine even and odd part of $x(n)$. (2)

c) Consider the discrete time sequence, (3)

$$x(n) = \begin{cases} 1 & -1 \le n \le 2 \\ 0.5 & 3 \le n \le 4 \\ 0 & otherwise \end{cases}$$

Express the signal $x(n)$ in terms of unit step sequence.

d) Consider two cascaded LTI systems having impulse responses as: (3)

$$h_1(n) = \left(\frac{1}{2}\right)^n \delta(n - n_1) \; and \; h_2(n) = \left(\frac{1}{4}\right)^n \delta(n - n_2). \quad n_1, n_2 \in Z$$

respectively. Determine the overall impulse response.

2. a) Determine the zero-state response of the system described by the first-order difference equation $y(n) + \frac{1}{2}y(n-1) = x(n)$, to the input $x(n) = \{1,2,1\}$. (2)

b) Show that the necessary and sufficient condition for a relaxed LTI system with an impulse response $h(n)$ to be causal is $h(n) = 0, \; n < 0$ (3)

c) Let $x(n)$ be a discrete time sequence with the magnitude spectrum defined in the interval $-\pi \leq \omega < \pi$ as shown in Fig 1. (2)

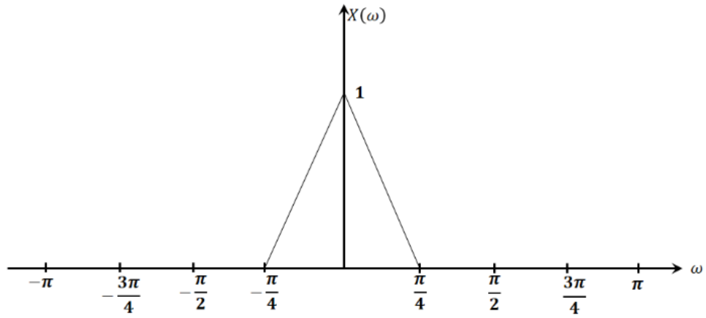

Fig. 1

Determine and sketch the magnitude spectrum of the signal $y(n) = x(n)\cos\left(\frac{\pi n}{2}\right)$ in the interval $-\pi \leq \omega < \pi$.

d) Consider the discrete time sequence, (3)

$$x(n) = \alpha^n \sin(\omega_0 n)\, u(n),$$

Give the conditions for Fourier Transform existence and determine the Discrete Time Fourier Transform of the sequence.

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

$$x(\langle -n \rangle_8) - x(\langle n-3 \rangle_8)$$

b) Consider the 8-point sequence, (3)

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

Determine the Discrete Fourier Transform using Radix-2 Decimation-in-time Fast Fourier Transform algorithm.

c) Determine the z-transforms of the sequence $x(n) = \alpha^n u(-n)$ 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 and also mention the ROC for which inverse z-transform doesn't exist for the given z-transforms: (3)

$$X(z) = \frac{3z^2 + 0.1z + 0.87}{z^2 + 0.3z - 0.18}$$

4. a) A length-12 Type-2 linear-phase FIR filter has the following zeros: $z_1 = 3.1,\ z_2 = -2 + j4, z_3 = 0.8 + j0.4$. (4)

   i). Determine the locations of the remaining zeros.

   ii). Design the filter.

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

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

   Design this IIR Band Stop Filter with notch 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

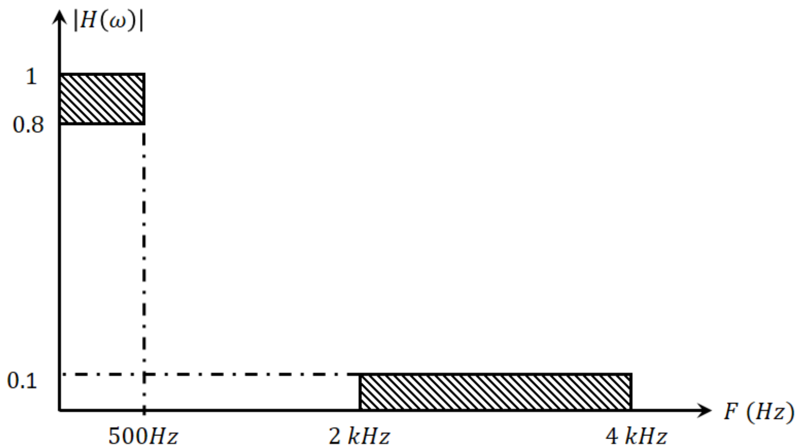

Fig. 2

Determine the following:

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

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