Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

VII SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING) MAKEUP EXAMINATIONS, DECEMBER 2019

ADVANCED DIGITAL SIGNAL PROCESSING [ELE 4012]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 28 December 2019** **Max. Marks: 50**

Instructions to Candidates:

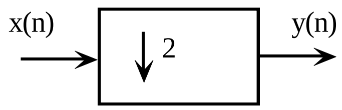
- Answer **ALL** the questions.
- Missing data may be suitably assumed.

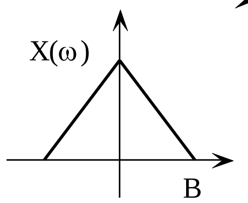
1A. Referring to block diagram given, let the signal x(n) have the discrete-time Fourier Transform X(ω) as shown in the figure. The bandwidth B of the signal is a parameter. Determine Y(ω) of the output signal for each of the following cases:

i. $B = \frac{\pi}{5}$

ii. $B = \pi$

iii. $B = \frac{4\pi}{5}$





(03)

1B. The transfer function of an IIR filter is, $H(z) = \frac{1+0.85z^{-1}}{1-0.65z^{-1}}$. Perform poly-phase decomposition of H(z) to decompose into

i. 2 sections
ii. 4 sections

(04)

1C. A one-stage decimator is characterized by the following:
Decimation factor is 3
Anti-aliasing filter coefficients h(0)=-0.06=h(4)
h(1)=0.3=h(3)
h(2)=0.62
Given the data, x(n), with successive values
[6, -2, -3, 8, 6, 4, -2], calculate and list the filtered output w(n), and the output of the decimator, y(m). ***(03)***

2A. Explain the Bartlett method of power spectrum estimation with supporting mathematical expressions. ***(02)***

2B. Given a random process $X(t) = A\cos(60\pi t + \emptyset)$, where is a random variable with zero mean and variance of 1. A is independent of ∅. ∅ is a random variable uniformly distributed from −π to π. Determine whether $X(t)$ is wide sense stationary. ***(04)***

2C. Determine whether the given autocorrelation sequences are a valid autocorrelation sequence for a WSS random process. If it is not valid, state why not. If it is valid, state why so.

i. $R_{xx}(k) = 3\delta(k) + 2\delta(k-1) + 2\delta(k+1)$

ii. $R_{xx}(k) = 2\delta(k-1) + 2\delta(k+1)$ ***(04)***

3A. Compute the power density spectrum of $x(n) = [\underset{\uparrow}{\mathbf{1}} \quad 1 \quad 1 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0]$ using DFT technique. ***(05)***

3B. Design, at a block diagram level, a two stage decimator that down-samples an audio signal by a factor of 32 and satisfies the specifications given below. Your answer must indicate a suitable pair of decimation factors, with appropriate detailed analysis of computational and storage complexities to justify your choice. Specify the sampling frequencies at the input and output of each stage of decimation, and the following parameters for each of the decimating filters in your design:

The band-edge frequencies

The normalized transition width

Passband and stopband ripples

Filter length

You may assume that the filters are direct form equiripple FIR filter.

Show, with the help of appropriate sketches, that the frequency band of interest (0-3.4 kHz) is protected from aliasing by the decimator.

Input sampling frequency, Fs = 256 kHz

Highest frequency of interest in the data=3.4 kHz

Passband ripple is 0.05
Stopband ripple is 0.01 ***(05)***

4A. List the important properties of power spectral density (PSD). ***(02)***

4B. What is adaptive Filter? Given a quadratic MSE function for the Wiener filter: $J=15+20\omega+10\omega^2$. Use the steepest descent method with an initial guess as ω0=0 and the convergence factor μ=0.04 to find the optimal solution for ω* and determine J_{min} by iterating three times. ***(03)***

4C. Given the following adaptive filter used for noise cancellation application in which d(0)=3, d(1)=-2, d(2)=1, x(0)=3, x(1)=-1, x(2)=2, and there is an adaptive filter with two taps y(n)=w(0)x(n)+w(1)x(n-1) with initial values w(0)=0, w(1)=1, and u=0.1 Determine LMS algorithm equations for the adaptive filter. Also, perform adaptive filtering for each n=0, 1, 2. ***(05)***

5A. Justify the use of adaptive filter instead of conventional filter in echo cancellation application. Explain with the aid of block diagram the operation of adaptive filter. ***(03)***

5B. Explain the properties of Wavelets ***(02)***

5C. Determine the 2D DWT Haar decomposition of 2D pixel values:

$$\begin{bmatrix} 8 & 21 & 67 & 13 \\ 9 & 41 & 25 & 18 \\ 12 & 11 & 14 & 18 \\ 15 & 47 & 33 & 13 \end{bmatrix}$$

Also reconstruct the pixel values from the decomposed pixel values with threshold value of 5. ***(05)***