Reg. No.									

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

VII SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
END SEMESTER EXAMINATIONS, NOVEMBER 2019

ADVANCED DIGITAL SIGNAL PROCESSING [ELE 4012]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date:23 November 2019** **Max. Marks: 50**

Instructions to Candidates:

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

1A. Referring to the figure shown Fig Q1A, determine the output $y(n)$ for the following input signals $x(n)$. Apply the definition of down sampling, and write an expression for the down sampled signal.

i. $x(n) = (-1)^n u(n)$

ii. $x(n) = 2\cos(0.5\pi n)$

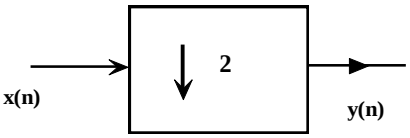

Fig. Q1A

(02)

1B. Determine the polyphase decomposition for the following FIR filters.

i. $H(z) = 2z^4 + z^3 + z^2 - 3z + 2 - 4z^{-3} - 5z^{-4} + 2z^{-5} - 6z^{-6} + 2z^{-7}$, choose M=3

ii. $h(n) = 0.5^n u(n)$, choose M=2 ***(04)***

1C. For the system shown in Fig. Q2B give a more efficient realization in terms of poly-phase decomposition and $H(z) = 1 + z^{-1} + 2z^{-2} - z^{-3} + z^{-4} - z^{-5} + z^{-6}$.

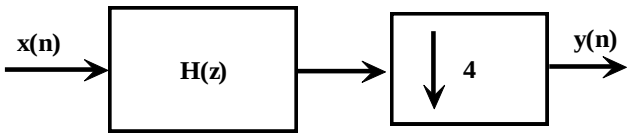

Fig Q2B

(04)

2A. Explain the need for Multirate digital signal processing with suitable example. ***(02)***

2B. Compute the autocorrelation and power spectral density for the signal $X(t) = Bcos(2\pi F_0 t + \theta)$ where B and F_0 are constants. θ is the random variable which is uniformly distributed over the interval $(-\pi, \pi)$. ***(04)***

2C. Let $x(n)$ be a random process that is generated by filtering a unit variance white noise $v(n)$ by an LTI filter having transfer function

$H(z) = \frac{1}{1-0.5z^{-1}}$. Find the autocorrelation of the output process x(n). ***(04)***

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

3B. The block diagram of a three stage decimator which is used to reduce the sampling rate from 3072 kHz to 48 kHz is given in Fig Q3B. The decimator system shown satisfies the following overall specifications.

Input sampling frequency: 3072 kHz

Decimation factor M: 64

Passband ripple: 0.01 dB

Stopband ripple: 60 dB

Frequency band of interest: 0-20 kHz

Determine the bandedge frequencies for the decimating filter at each stage. For the given input and output sampling rates of a decimator give all the possible sets of integer decimation factors assuming

i. Two stages of decimation
ii. Three stages of decimation

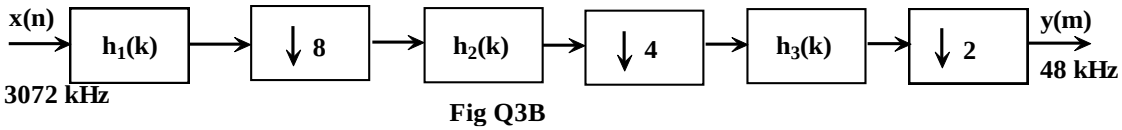

Fig Q3B ***(05)***

4A. Find the autocorrelation sequence corresponding to

$$P_X(\omega) = \frac{1}{5 + 3cos\omega}$$ ***(02)***

4B. What are the limitations of steepest descent algorithm? Starting with the steepest descent algorithm $W_{k+1} = W_k - \mu \frac{dJ}{dW}$ where W_k is the filter weight at the discrete time k, μ controls the stability and rate of convergence, and $\frac{dJ}{dW}$ is the error performance, derive the LMS algorithm. Explain implementation of LMS algorithm. ***(05)***

4C. Consider the single weight adaptive filter as shown in fig Q4C. Suppose that x(n) is a constant:

x(n)=k; for n≥0
=0; otherwise

Find the system function
H(z)=E(z)/D(z).

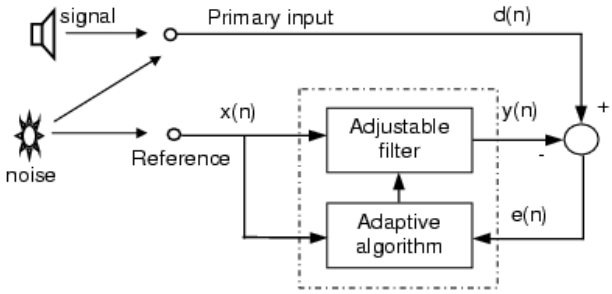

Fig Q4C ***(03)***

5A. Justify the use of adaptive filter instead of conventional filter in inverse modelling in channel equalization application. Explain with the aid of block diagram the operation of adaptive filter. ***(03)***

5B. What are the advantages of Wavelet Transform? Mention any two important properties of Wavelets. ***(02)***

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

$$\begin{bmatrix} 25 & 21 & 67 & 13 \\ 9 & 41 & 56 & 48 \\ 12 & 15 & 34 & 18 \\ 23 & 47 & 33 & 25 \end{bmatrix}$$

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