Reg. No. | | | | | | | | | |

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

VII SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

MAKEUP EXAMINATIONS, MAY 2018

SUBJECT: ADVANCED DIGITAL SIGNAL PROCESSING [ELE 4012]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 08 MAY 2018** **Max. Marks: 50**

Instructions to Candidates:

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

1A. Consider the multi-rate structure shown in Fig. Q 1A with input transform $X(e^{j\omega})$ and filter response $H(e^{jw})$. Sketch the following (i) $X_1(e^{j\omega})$; (ii) $X_2(e^{j\omega})$; and (iii) $Y(e^{jw})$ ***(05)***

1B. Developed an expression for the output $y[n]$ as a function of input $x[n]$ for multi-rate structure shown in Fig. Q1B. ***(05)***

2A. Verify the cascade equivalence of Fig. Q2 A, showing that the position of filter can be swapped with down sampler. ***(04)***

2B. Design an efficient two stages decimator with two suitable pair of decimation factors for the following specification:
Input sampling frequency : 20 kHz; Decimation factor : 100; New output frequency : 200 Hz
The highest frequency of interest after decimation : 40Hz ;
Overall pass-band ripple $\delta_p = 0.01$ and stop-band ripple $\delta_s = 0.002$. Justify the answer with appropriate detailed analysis of computational and storage complexities. ***(06)***

3A. Prove that if the two events A and B are not disjoint then the probability of their union event is defined by:

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$ ***(02)***

3B. If X be a continuous random variable with probability density function (PDF)

$$F_X(x) = \begin{cases} 2x^{-2} & ; for\, 1 < x < 2 \\ 0 & ; otherwise \end{cases}$$

Find (i) the expectation $E(x)$ and (ii) $Var(x)$ ***(03)***

3C. A sinusoidal random process is given by $X(t) = A\cos\left(2\pi F_C t + \theta\right)$,

where $A \,\&\, F_C$ are constants θ is random variable given as

$F_\theta(\theta) = \begin{cases} 1/2\pi & ; -\pi < \theta < \\ 0 & ; \text{ otherwise} \end{cases}$ which is uniformly distributed over the interval $(-\pi, \pi)$. Determine whether $X(t)$ is wide-sense stationary (WSS)? ***(05)***

4A. A random process signal $X(t)$ has autocorrelation function $R_{XX}(t)$ given as

$R_{XX}(\tau) = \frac{1}{2a} e^{-a|\tau|}$ where, a=4 kHz. Obtain the following:

(i) the average power (ii) the power spectral density (PSD) of the random signal (iii) BW required which contains 90% of the signal power. ***(05)***

4B. (a) If the sample sequence of a random process has N=1200 samples. Determine (i) the frequency resolution of the Bartlett, Welch (for 50% overlap), and Blackman-Tukey methods for a quality factor $Q = 10$. (ii) the record lengths (M) for the Bartlett, Welch (for 50% overlap), and Blackman-Tukey methods. ***(02)***

(b) Considering the single realization of the random process show that the estimate of the power Spectrum density is given by

$P_{xx}(f) = \frac{1}{N}|X(f)|^2$ where $X(f)$ is the Fourier transform of the sample sequence $x[n]$ ***(03)***

5A. Determine the DWT Haar decomposition of pixel values x = (6, 12, 15, 15, 14, 12, 120, 116). Reconstruct the original pixel values from the decomposed pixel values. Draw 1D DWT synthesis filter bank structure. Also discuss the applications of Wavelet Transform? ***(05)***

5B. Consider the DSP system used for noise cancellation application as shown in Fig.Q5B 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)***

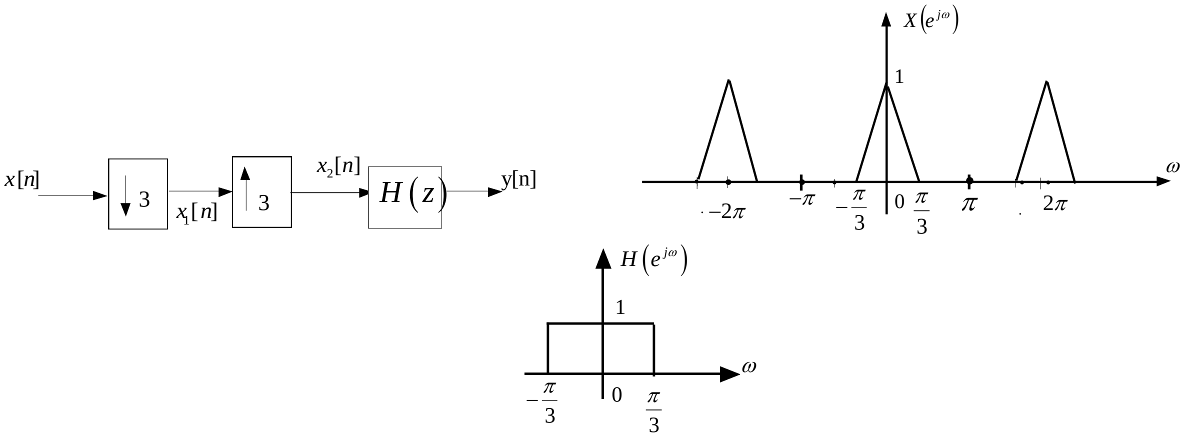

Fig.Q1A

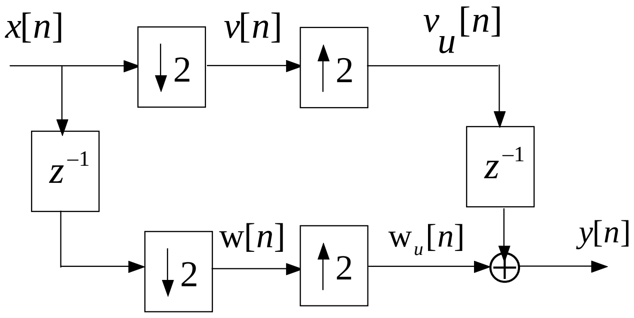

Fig.Q1B

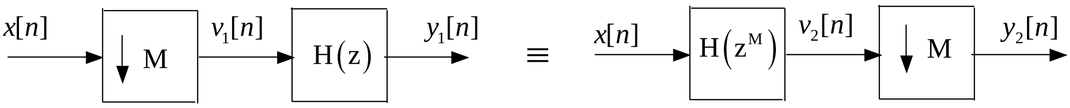

Fig.Q2A

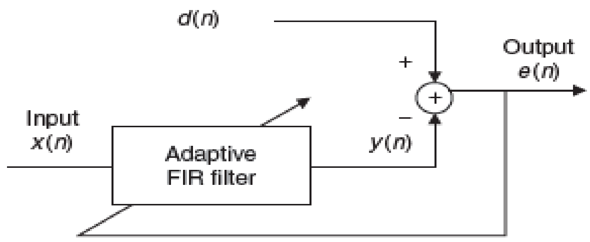

Fig.Q5B