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

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

VII SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
MAKEUP EXAMINATIONS, DECEMBER 2017
SUBJECT: ADVANCED DIGITAL SIGNAL PROCESSING [ELE 4012]
REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 28 December 2017** **Max. Marks: 50**

Instructions to Candidates:
- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. Consider the multi-rate structure with input transform $X(e^{j\omega})$ and filter response $H_0(e^{j\omega})$ and $H_1(e^{j\omega})$ as shown in Fig. Q1A. Sketch the following (i) $X_1(e^{j\omega})$; (ii) $X_2(e^{j\omega})$; (iii) $Y_0(e^{j\omega})$ and (iv) $Y_1(e^{j\omega})$ ***(04)***

1B. Determine the transfer function from each input to each output for the multi-rate discrete-time system shown in Fig.Q1B and also show that the system is time-invariant. ***(04)***

1C. Developed an expression for the output $y[n]$ as a function of input $x[n]$ for multi-rate structure shown in Fig. Q1C. ***(02)***

2A. Develop a computationally efficient realization of a factor of 3 decimator employing a length of 7 linear phase FIR low pass filter. Use the symmetry of the impulse response. ***(04)***

2B. Design an efficient two stages decimator with two suitable pair of decimation factors for the following specification:
Input sampling frequency : 90 kHz; Decimation factor : 30; New output frequency : 3 kHz
The highest frequency of interest after decimation : 1.25 kHz ;
Overall passband ripple $\delta_p = 0.05$ and stopband ripple $\delta_s = 0.01$. Justify the answer with appropriate detailed analysis of computational and storage complexities. ***(04)***

2C. Consider a random experiment where a fair six sided die is thrown once. Its sample space is, $S = \{1, 2, 3, 4, 5, 6\}$ and the following events are defined as:
$A_1 = \{2, 4, 6\}$ -an even number turns up, $A_2 = \{2, 3, 5\}$ - an prime number turns up
Find $P(A_1|A_2)$ ***(02)***

3A. (i)Prove that the variance of Random Variable X is given as:
$\text{Var}(X) = E\{X^2\} - (E\{X\})^2$
(ii)List the important properties of power spectral density (PSD) ***(03)***

3B. Consider a random process is described by $X(t) = \cos(2\pi F_0 t + \theta)$,

where F_0 is constants and θ is random variable which is uniformly distributed over the interval $(-\pi, \pi)$. Show that $X(t)$ is stationary in the mean and stationary in autocorrelation and hence $X(t)$ is wide-sense stationary (WSS)? ***(03)***

3C. A random process signal $X(t)$ has autocorrelation function $R_{XX}(t)$ given as

$R_{XX}(\tau) = \frac{1}{4a} e^{-a|\tau|}$ where, a=7 kHz. Obtain the following: is

(i) the average power (ii) the power spectral density (PSD) of the random signal (iii) BW required which contains 85% of the signal power. ***(04)***

4A. Consider an LTI system that is characterized by impulse response $h(t)$. Show that if the input signal $X(t)$ applied to above LTI system is a wide-sense stationary random process, then the random output response $Y(t)$ from the system is also wide-sense stationary process. ***(04)***

4B. If the sample sequence of a random process has $N = 2500$ samples.

Determine (i) the frequency resolution of the Bartlett, Welch (for 50% overlap), and Blackman-Tukey methods for a quality factor $Q = 20$.

(ii) the record lengths (M) for the Bartlett, Welch (for 50% overlap), and Blackman-Tukey methods. ***(03)***

4C. Considering the single realization of the random process show that the period-gram estimate

$P_{xx}(f)$ 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. What are the advantages of Wavelet Transform? ***(02)***

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

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

Also reconstruct the pixel values from the decomposed pixel values with threshold value of 5 ***(03)***

5C. Consider the DSP system used for noise cancellation application as shown in Figure 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)+w(2)x(n-2) with initial values w(0)=0, w(1)=0, w(2)=0 and u=0.2. Determine LMS algorithm equations for the adaptive filter. Also, perform adaptive filtering for each of n=0, 1, 2. ***(05)***

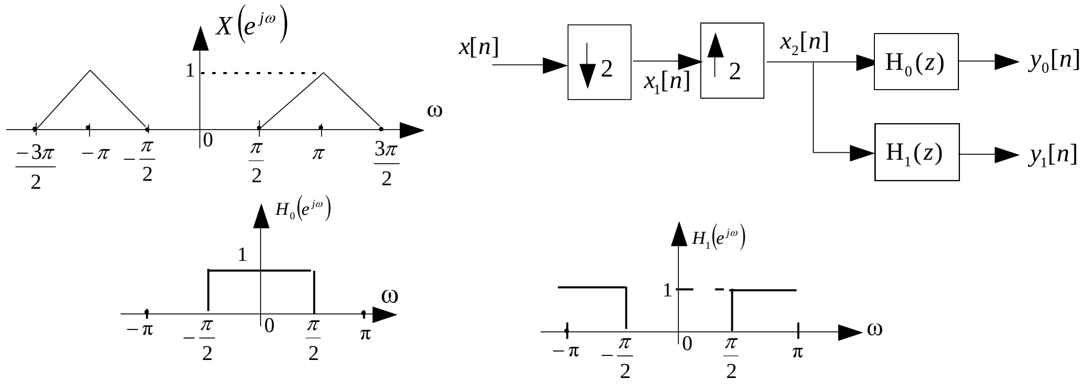

Fig.Q1A

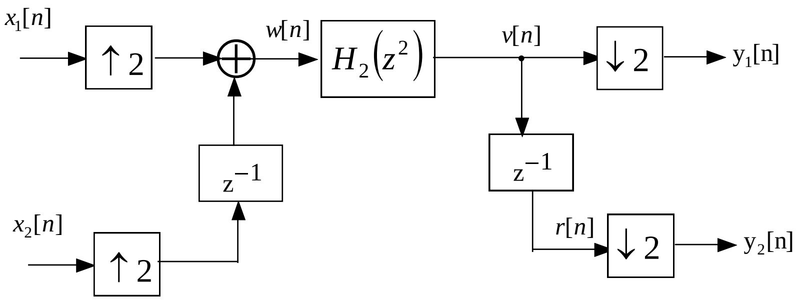

Fig.Q1B

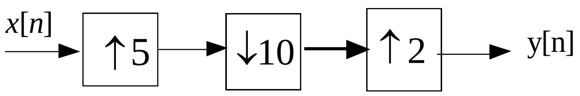

Fig.Q.1C

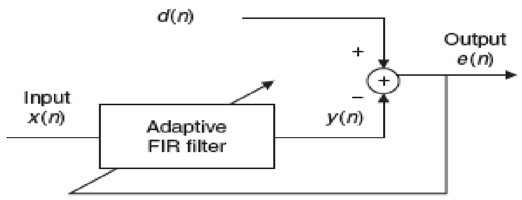

Fig. Q5C