U.S.N

P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Fourth Semester, B.E. - Electronics and Communication Engineering

Semester End Examination; June - 2016

Digital Signal Processing

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit*
ii) Filter tables are NOT needed.

UNIT - I

1 a. Find the N – point DFT of the sequence

$$x(n)=\begin{cases}1 & \text{for } 0\le n\le N-1\\ 0 & \text{otherwise}\end{cases}\quad \text{, for } N = 10$$ 5

Also sketch the DFT of the sequence.

b. State and prove time reversal property of DFT. 5

c. Given: $x(n)=\begin{cases}2 & \text{for } n = \text{even}\\ 0 & \text{for } n = \text{odd}\end{cases}$ for $0 \le n \le N-1$ 10

Find the DFT of the sequence *x(n)* for N = even positive integer.

2 a. Let $X_{a(t)}$ be an analog signal with a Bandwidth B = 4 kHz. We wish to use $N = 2^m$ - point DFT to compute the spectrum of the signal with a resolution less than or equal to 50 Hz. Determine; (i) The minimum sampling rate 2

(ii) The minimum number of required samples.

b. Let $x_p(n)$ be a periodic sequence with Fundamental period N. The N – point DFT of $x_p(n)$ is $X_1(k)$. The sequence $x_p(n)$ is also periodic with period 3 N. The 3 N – point DFT of the sequence is $X_3(k)$. What is the relationship between $X_1(k)$ and $X_3(k)$. 10

c. Find the filter output *y(n)* of a filter whose impulse response *h(n)* = {1, 3, -2} and input signal *x(n)* = {2, -3, 4, -1, 10, 7, 6} using overlap and add method for block length N = 6. (Length used with circular convolution). 8

UNIT - II

3 a. The time required to perform one complex addition is 10 ns and the time required to perform one complex multiplication is 14 ns. What is the time required to perform 256 – point DFT using DITFFT? 4

b. Compute the DFT of the sequence *x(n)* = {3, -2, 3, -4, 3, 2, 3, 4} using Decimation In Time Fast Fourier Transform. 10

c. Find the IDFT of the sequence *x(n)* = {14, 2-2j, -2, 2+2j} using decimation In Time Fast Fourier Transforms. 6

4 a. What are the advantages of FFT over direct DFT? 4

Contd….2

b. Find the DFT of the sequence, 10
X(n) = {2, -1, 3, -1, 4, -2, 6, 2} using Decimation in frequency fast Fourier transform.

c. Find the IDFT of the sequence, X(k) = {3, 5 -j8, -1, 5 +j8} using decimation in frequency fast Fourier transform. 6

UNIT - III

5 a. Design an analog low pass Chebyshev type-1 Filter that has -3 dB cut-off frequency of 2 radians/sec and stop band attenuation of 25 dB or greater for all radian frequencies greater than 5 radians/sec. 12

b. A fifth order analog low pass Butterworth filter has a pass band edge frequency 2 kHz and maximum pass band attenuation of -2 dB. What is the actual attenuation in dB of the low pass filter at a frequency 4 kHz? 8

6 a. A low pass FIR filter is to be designed with the following desired frequency response,

$$Hd\left(w\right)=\begin{cases} e^{-j2w} & \text{for} \left|w\right|<\dfrac{\pi}{4} \\ 0 & \text{for } \dfrac{\pi}{4}<\left|w\right|<\pi \end{cases}$$ 10

Determine FIR filter coefficients using windowing method. The length of filter N = 5. Window to be used in HANNING window.

b. A low pass FIR filter has the desired frequency response,

$$Hd\left(w\right)=\begin{cases} e^{-j3w} & \text{for} < w<\dfrac{\pi}{2} \\ 0 & \text{for } \dfrac{\pi}{2}<w<\pi \end{cases}$$ 10

Determine the impulse response of the filter by frequency sampling methods. The length of the filter N = 7.

UNIT - IV

7 a. Design a digital Low pass Butterworth filter using Bilinear transformation for the following specifications, 12
$W_P = 0.2\,\pi$, $W_s = 0.6\,\pi$, $K_P = -2$ dB, $K_s = -14$ dB
Assume T = 2 seconds.

b. Derive the transformation required to convert analog filter into digital filter using impulse invariant technique. Explain the mapping of poles from S-domain to Z-domain using impulse invariant techniques. 8

8 a. Derive the transformation to convert analog filter into digital filter using Bilinear transformation. Derive until 10

$$s=\frac{2}{T}\left(\frac{1-z^{-1}}{1+z^{-1}}\right).$$

Contd….3

b. Let $H(S)=\dfrac{(s+a)}{(s+a)^2+b^2}$ be the second order transfer function. Show that the transfer function H(z) obtained using impulse invariant technique is, 10

$$H(z)=\frac{1-e^{-aT}\cos bTz^{-1}}{1-2\cos bTe^{-aT}z^{-1}+e^{-2aT}Z^{-2}}$$

UNIT - V

9 a. Realize the following transfer function using Direct form-I, 12

$$H(z)=\frac{1}{1-0.5z^{-1}}+\frac{(-2)}{1-0.25z^{-1}}+\frac{3}{1+0.75z^{-1}}$$

b. Let the coefficients of a two stage FIR lattice structure be $K_1 = 0.1$ and $K_2 = 0.25$. Find the coefficients of direct form - I. 8

10 a. Obtain the parallel direct form II realization of the transfer function : 10

$$H(z)=\frac{(1+z^{-1})}{(1+0.5z^{-1})(1+0.25z^{-1})(1+0.125z^{-1})}$$

b. Let the transfer function of the filter be $H(z) = 1 + 0.18z^{-1} + 0.236z^{-2} + 0.3z^{-3}$. Find the Lattice structure coefficients, K_1, K_2 and K_3 and draw the structure. 10

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