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

(An Autonomous Institution affiliated to VTU, Belagavi)

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

Semester End Examination; May/June - 2019

Digital Signal Processing

Time: 3 hrs *Max. Marks: 100*

Note: *Answer FIVE full questions, selecting ONE full question from each unit.*

UNIT - I

1 a. Given $X(K) = \{1, 0, 1, 0\}$ compute its 4-point IDFT $x(n)$. 4

b. Compute 4-point DFT of the following sequences using Matrix transformation representation : 6

$i)\ x(n) = \cos \pi n \quad 0 \le n \le 3 \qquad ii)\ x(n) = \sin\frac{\pi n}{2} \quad 0 \le n \le 3$

c. A filter has impulse response $h(n) = \{1, 0, -1\}$ if an input signal $x(n) = (n+1)\ 0 \le n \le 9$ is passed through the filter, determine its output response $y(n)$ using overlap add method. Take length of input section to be 4. 10

2 a. i) If $x(n) = \{1, 2, 0, 3\}$ find $x_1(n) = x((n-3))_4$

ii) If $x(n) = \delta(n) + 2\delta(n-5)$ and $x(K)$ as its DFT, find $y(n)$ given, 6

$$y(K) = X(K)e^{\frac{-j2\pi}{10}}3k$$

b. State and prove linearity property of DFT. 4

c. An input sequence $x(n) = (n+1)\quad 0 \le n \le 9$ is passed through a filter with impulse response $h(n) = \{1, 0, -1\}$. Determine the output $y(n)$ using overlap save method. Use 6-point circular convolution in the computations. 10

UNIT - II

3 a. Explain the concept of Butterfly operation, Inplace computation and Bit reversed as applicable to FFT. 6

b. Compute the 8-point DFT of the sequence $x(n) = \cos\frac{n\pi}{2}$ using the DIT-FFT algorithm and required flow graph. Show all intermediate computations. 9

c. Find the DFT of the sequence $x(n) = \{4, 3, 2, 1\}$ using DIF-FFT algorithm. 5

4 a. Compare DIT and DIF-FFT algorithms for similarities and differences. 4

b. Derive the scheme to compute 2N-point DFT of a real valued sequence using an N-point FFT algorithm only once. 6

c. Compute the IDFT of a 8-point real sequence given five DFT samples as below using DIF-FFT algorithm : $X(k) = \{7,\ -0.707 - j0.707, -j, 0.707 - j0.707, 1\}$ 10

UNIT - III

5 a. Design a linear-phase FIR low pass filter with the following desired frequency response : 10

$$H_d(e^{jw}) = \begin{cases} e^{-j2w} & 0 \le |w| \le \frac{\pi}{4} \\ 0 & \frac{\pi}{4} < |w| \le \pi \end{cases}$$

. Use a hamming window. Also determine $H(e^{jw})$.

b. A linear phase low-pass FIR filter satisfying the following specification need to be designed:
Pass band: 0 – 5 kHz, sampling frequency : F_s = 18 kHz, Filter length : M = 9 — 10
Determine the filter coefficient using Frequency sampling method.

6 a. Design a linear-phase low-phase filter given that: $H_d(e^{jw}) = \begin{cases} e^{-j3w} & 0 \le |w| \le \frac{\pi}{2} \\ 0 & \frac{\pi}{2} < |w| \le \pi \end{cases}$ using the Bartlett worth window. Determine the impulse response coefficient of the filter and $H(e^{jw})$. — 10

b. A low-pass digital filter has the desired frequency response as below :

$$H_d(e^{jw}) = \begin{cases} e^{-j3w} & 0 \le |w| \le \frac{\pi}{2} \\ 0 & \frac{\pi}{2} < |w| \le \pi \end{cases}$$ — 10

Determine the filter coefficients $h(n)$ for M = 7 using frequency sampling technique.

UNIT - IV

7 a. Discuss the advantages and disadvantages of Impulse Invariant method. — 4

b. Transform the analog filter transfer function $H_a(s) = \frac{4s+7}{s^2+5s+4}$ into a digital filter $H(z)$ using Impulse Invariant method at $F_S = 2Hz$ — 6

c. Design a IIR low pass Butter worth filter using Bilinear transformation for the following specifications: — 10
Pass band: $0.8 \le \left|H\left(e^{jw}\right)\right| \le 1 \quad |w| \le 0.2\pi;$ Stop band: $\left|H\left(e^{jw}\right)\right| \le 0.2 \quad 0.6\pi \le |w| \le \pi;$ Assume $T = 1\,s$.

8 a. Discuss the advantages and disadvantages of Bilinear-Transformation method. — 4

b. Derive the relationship between analog and digital frequencies in a Bilinear Transformation. — 6

c. Design an IIR low pass Butter worth filter using the Impulse-Invariant method for the following specification. — 10
Pass band : $0.8 \le \left|H\left(e^{jw}\right)\right| \le 1 \quad |w| \le 0.2\pi;$ Stop band: $\left|H\left(e^{jw}\right)\right| \le 0.2 \quad 0.6\pi \le |w| \le \pi;$ Assume T = 1 s.

UNIT - V

9 a. Check whether following filter function has linear phase or Not, if yes, obtain a linear phase structure for the same $H(Z) = 1 + \frac{1}{2}Z^{-1} + \frac{1}{3}Z^{-2} + \frac{1}{6}Z^{-3} + \frac{1}{3}Z^{-4} + \frac{1}{2}Z^{-5} + Z^{-6}$ — 6

b. Obtain the cascade and parallel form realization of the LIT system represented by difference equation $y(n) = \frac{5}{8}y(n-1) - \frac{1}{16}y(n-2) + x(n) - 3x(n-1) + 3x(n-2) - x(n-3)$ — 8

c. Explain Linear Predictive Coding (LPC) system and its uses. — 6

10 a. Obtain the direct form-I and II, cascade and parallel form realization structures for the following system : $y(n) = -0.1y(n-1) + 0.7^2 y(n-2) + 0.7x(n) - 0.25x(n-2)$ — 10

b. A filter response is given by, $H(z) = \sum_{k=0}^{5} (2Z)^{-k}$. Obtain the direct form structure and its difference equation representation. — 5

c. Explain speech recognition system with neat block diagram. — 5

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