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328651(28)

B. E. (Sixth Semester) Examination April-May 2020

(New Scheme)

(Et & T Engg. Br.)

DIGITAL SIGNAL PROCESSING

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Attempt all questions. Part (a) of each question is compulsory. Attempt any two parts from (b), (c) and (d) of each question. Assume suitable data wherever is required.*

Unit - I

1. (a) State the shifting property of the DFT. 2

(b) Find the DTFT of the following finite deviation sequence of length L.

$$x(n)=\begin{cases}A, & \text{for } 0\le n\le L-1\\ 0, & \text{otherwise}\end{cases}$$

Also find the inverse DTFT to verify $x(n)$ for L = 3 and A = 1 V. 7

(c) Compute $x_1(n)*x_2(n)$ if

$x_1(n)=\delta(n)+\delta(n-1)-\delta(n-2)-\delta(n-3)$ and

$x_2(n)=\delta(n)-\delta(n-2)+\delta(n-4)$

Give $N = 5$. 7

(d) Given $x(n)=\{0, 1, 2, 3, 4, 5, 6, 7\}$, find $X(K)$ using DIT-FFT algorithm. 7

Unit - II

2. (a) What are the advantages of representing digital systems in block diagram form? 2

(b) Determine the parallel realisation of the IIR digital filter transfer function : 7

$$H(z)=\frac{3(2z^2+5z+4)}{(2z+1)(z+2)}$$

(c) Give the system function :

$$H(z)=\frac{2+8z^{-1}+6z^{-2}}{1+8z^{-1}+12z^{-2}}$$ 7

Realize using ladder structure.

(d) Obtain FIR linear phase and cascade realizations of the system function :

$$H(z)=\left[1+\frac{1}{2}z^{-1}+z^{-2}\right]\left[1+\frac{1}{4}z^{-1}+z^{-2}\right]$$ 7

Unit - III

3. (a) What is an FIR system? Compare an FIR system with an IIR system. 2

(b) The following transfer function characteristics an FIR filter ($M = 11$). Determine the magnitude response and show that the phase delay and group delays are constant.

$$H(z)=\sum_{n=0}^{M-1}h(n)z^{-n}$$ 7

(c) A filter is to be designed with the following desired frequency response :

$$H_d\left(e^{jw}\right)=\begin{cases}0, & -\pi/4 \le w \le \pi/4 \\ e^{-j2w}, & \pi/4|w| \le \pi\end{cases}$$

Determine the filter coefficient $h_d(n)$ if the window function is defined as :

$$w(n)=\begin{cases}1, & 0 \le n \le 4 \\ 0, & \text{otherwise}\end{cases}$$

Also, determine the frequency response $H(e^{jw})$ of the designed filter. 7

(d) The desired response of a low-pass filter is :

$$H_d^{\left(e^{jw}\right)}=\begin{cases}e^{-j3w}, & -3\pi/4 \le w \le 3\pi/4 \\ 0, & 3\pi/4 < |w| \le \pi\end{cases}$$

Determine $H\left(e^{jw}\right)$ for $M = 7$ using a Hamming window. 7

Unit - IV

4. (a) What are the different design techniques available for IIR filters? 2

(b) Convert the analog filter with system function :

$$H(s) = \frac{s + 0 \cdot 1}{(s + 0 \cdot 1)^2 + 9}$$

Into a digital IIR filter using bilinear transformation. The digital filter should have a resonant frequency of $w_r = \pi/4$. 7

(c) Design a digital Butterworth filter that satisfies the following constraint using bilinear transformation. Assume T = 1 sec.

$$0 \cdot 9 \left| H\left(e^{jw}\right) \right| \leq 1 \qquad 0 \leq w \leq \pi/2$$

$$\left| H\left(e^{jw}\right) \right| \leq 0 \cdot 2 \qquad 3\pi/4 \leq w \leq \pi$$

7

(d) For the analog transfer function :

$$H(s) = \frac{1}{(s+1)(s+2)}$$

Determine $H(z)$ using impulse invariant technique. Assume T = 1 sec. 7

Unit - V

5\. (a) What is the need for multirate signal processing? 2

(b) Obtain the two-fold expanded signal $y(n)$ of the input signal $x(n)$.

$$x(n)=\begin{cases} n, & n>0 \\ 0, & \text{otherwise} \end{cases}$$ 7

(c) Obtain the expression for the output $y(n)$ in terms of $x(n)$ for the multirate systems given as follows :

$$x(n)\rightarrow \boxed{\uparrow 5} \rightarrow \boxed{\downarrow 20} \rightarrow \boxed{\uparrow 4} \rightarrow y(n)$$ 7

(d) Obtain the polyphase decomposition of the IIR system with transfer function :

$$H(z)=\frac{1-4z^{-1}}{1+5z^{-1}}$$ 7