TE (Bio) SEM-V (CBGS) 06/12/14

Biomedical Digital Signal processing

QP Code : 14942

(3 Hours) **[Total Marks : 80**

N.B. (1) Question No. **1** is **compulsory**.
(2) Answer any **three** questions from the remaining **five** questions.
(3) Assume **any data if necessary**. Mention **clearly** the same.

1. (a) Determine the response of the following system to the input signal. **5**

$x(n) = |n|;\ -3 \le n \le 3$
$= 0$ otherwise

$$y(n) = \frac{1}{3}[x(n+1) + x(n) + x(n-1)].$$

(b) Prove the circular convolution property of DFT. **5**

(c) Compute the DFT's of the sequence x(n) = [1, 2, 3, 4] using DIT FFT algorithm. **5**

(d) Determine H(z) using impulse invariant technique if the corresponding analog system function is given by $H(s) = \frac{1}{s^2 + 3s + 2}$. T = 1 second. **5**

2. (a) Determine the signal x(n) if $X(z) = \log(1 + az^{-1})$ for $|z| > |a|$. **5**

(b) Determine the unit sample response of the system, if the system is described by the difference equation. **5**

$y(n) = \frac{1}{2}y(n-1) + 2x(n)$ where y(n) is the output and x(n) is the input.

(c) Find the DTFT of the signal **4**

$x(n) = \frac{1}{4}$ for $0 \le n \le 2$
$= 0$ otherwise

(d) By means of DFT, IDFT method only determine **6**

$x_3(n) = x_1(n) \circledast x_2(n)$ where $x_1(n) = [\underset{\uparrow}{2}, 1, 2, 1]$
$x_2(n) = [\underset{\uparrow}{1}, 2, 3, 4]$

3. (a) Derive and draw the flow graph for an 8-point DIFFFT using radix-2 algorithm. Find X(k) if x[n] = [1, 2, 3, 4, 4, 3, 2, 1] from the above **10**

(b) Determine IDFT of X(k) = [3, 2 + j1, 1, 2 − j1]. **5**

(c) If $x(n) \xleftrightarrow[N]{DFT} X(k)$ **5**

then show that $x(n-\ell)_N \xleftrightarrow[N]{DFT} X(k) \cdot e^{-j\left(\frac{2\pi}{N}\right)k\ell}$

[TURN OVER

4. (a) Obtain the system function for normalised analog Butterworth filter of order N = 5. 5

(b) Find the order of a digital Chebyshev filter to satisfy the following specification : 5

$$0{\cdot}707 \le |H(e^{j\omega})| \le 1 \qquad 0 \le |\omega| \le 0{\cdot}2\pi$$
$$|H(e^{j\omega})| \le 0{\cdot}1 \qquad 0{\cdot}5\pi \le |\omega| \le \pi$$

using bilinear transformation $T_s = 1$ sec.

(c) Determine H(z) for Butterworth filter satisfying the following constraints : 10

$$0{\cdot}707 \le |H(e^{j\omega})| \le 1 \qquad 0 \le |\omega| \le \pi/2$$
$$|H(e^{j\omega})| \le 0{\cdot}2 \qquad \frac{3\pi}{4} \le |\omega| \le \pi$$

with T = 1 sec, apply bilinear transformation.

5. (a) Obtain FIR linear-phase realisations of the system function. 5

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

(b) A low-pass filter has a desired frequency response as given below :— 8

$$H_d(e^{j\omega}) = e^{-j3\omega} \qquad 0 \le |\omega| \le \pi/2$$
$$= 0 \qquad \pi/2 < |\omega| \le \pi$$

Determine the filter co-efficients h(n) for M = 7 using type-I, frequency sampling technique.

(c) A low pass filter is to be designed with the following desired frequency response. 7

$$H_d(e^{j\omega}) = e^{-j2\omega} \qquad -\pi/4 \le \omega \le \pi/4$$
$$= 0 \qquad \pi/4 < |\omega| \le \pi$$

Determine the filter co-efficients $h_d(n)$ if the window function is defined as

$w(n) = 1 \qquad 0 \le n \le 4$

6. (a) Develop the parallel realisation of a causal IIR filter with transfer function given by $H(z) = \dfrac{5z(3z-2)}{(z+0{\cdot}5)(2z-1)}$. 7

(b) Write briefly the biomedical application of digital signal processing. 8

(c) Draw and explain briefly the architecture of any one processor. 5
