No. of Printed Pages : 4

Sl. No.

CE1.1-R4 : DIGITAL SIGNAL PROCESSING

DURATION : 03 Hours **MAXIMUM MARKS : 100**

Roll No. : | | | | | | |

Answer Sheet No. : | | | | | | |

Name of Candidate : _____ **; Signature of Candidate :** _____

INSTRUCTIONS FOR CANDIDATES :

- Carefully read the instructions given on Question Paper, Answer Sheet.
- Question Paper is in English language. Candidate has to answer in English Language only.
- **Question paper contains Seven questions. The Question No. 1 is compulsory. Attempt any FOUR Questions from Question No. 2 to 7.**
- **Parts of the same question should be answered together and in the same sequence.**
- **Questions are** to be answered in the **ANSWER SHEET** only, supplied with the Question Paper.
- **Candidate cannot leave the examination hall/ room without signing on the attendance sheet and handing over his/her Answer Sheet to the Invigilator. Failing in doing so, will amount to disqualification of Candidate in this Module/Paper.**
- After receiving the instruction to open the booklet and before answering the questions, the candidate should ensure that the Question Booklet is complete in all respects.

DO NOT OPEN THE QUESTION BOOKLET UNTIL YOU ARE TOLD TO DO SO.

1. (a) Compare and contrast auto-correlation and cross-correlation for sequences.

(b) Find the z-transform of $x(n) = 4^n\, u(n-4)$.

(c) Define ROC of z-transform. State its properties.

(d) Explain Goertzel algorithm for computation of DFT.

(e) Determine the DFT of the sequence :

$$y(n) = \begin{cases} \frac{1}{2} & \text{for } 0 \le n \le 2 \\ 0, & \text{otherwise} \end{cases}$$

(f) Explain frequency warping in Infinite Impulse Response (IIR) filter design.

(g) Illustrate causal systems. Check the stability of the filter for :

$$H(z) = \frac{z^2 + z - 1}{z^2 + z - 1/2}$$

(7x4)

2. (a) Define the following with examples :

(i) LTI system

(ii) Even and Odd signals

(iii) Use of Impulse function in convolution

(iv) Time/Frequency domain analysis.

(b) Find the convolution of the two signals $x(n) = u(n)$ and $h(n) = a^n u(n)$, ROC : $|a| < 1;\ n \ge 0$

(c) Illustrate - Digital Filter Banks.

(8+6+4)

3. (a) Find the z-transform and ROC of the given signal :
$y(n) = [4(2)^n - 3(3)^n]u(n)$

(b) Explain the proof of Initial value theorem and Final value theorem.

(c) By using partial fraction expansion method, find the inverse z-transform of

$$H(z) = \frac{-8 + 16z^{-1}}{1 + 7z^{-1} + 12z^{-2}}$$

(6+6+6)

4. (a) Illustrate the signal flow graphs. Draw signal flow graph of a First-order Digital System.

(b) An averaging filter, defined as :

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

(i) Determine the type of Filter.

(ii) Let $N = 4$. Determine the transfer function, its poles and zeros.

(iii) Determine a general form for zeros and poles for any order N.

(iv) By comparing $y(n)$ and $y(n-1)$ determine a recursive implementation. Also, the transfer function, together with its zeros and poles of the recursive implementation. Looking at this example, can we say that "any" recursive filter is IIR ?

(c) Illustrate the effects of finite word length in digital filters.

(6+8+4)

5. (a) Determine and draw the structures of cascade and parallel realization of :

$$H(z)=\frac{\left(1-z^{-1}\right)^2}{\left(1-\frac{1}{2}z^{-1}\right)\left(1-\frac{1}{8}z^{-1}\right)}$$

(b) Compare FIR with IIR filters explaining their structures.

(c) Given the system function

$$H(z)=\frac{1+4z^{-1}+3z^{-2}}{1+4z^{-1}+6z^{-2}}$$

Realize the system function by ladder structure. **(6+6+6)**

6. (a) Use Bilinear Transformation to the DFT of the sequence :

$$H(s)=\frac{4}{(s+2)(s+6)} \text{ with } T=0.1 \text{ s.}$$

(b) Discuss Power Spectrum Estimation of AR, MA and Autoregressive - moving average (ARMA) models. Which one of them is widely used and why ?

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

$$H_d\left(e^{jw}\right)=\begin{cases} e^{-j4w} & \text{for } -\pi/2 \le \omega \le \pi/2 \\ 0, & \pi/2 \le |\omega| \le \pi \end{cases}$$

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. **(4+6+8)**

7. (a) Explain the Wavelet Transform. Illustrate the application of Wavelet Transform in Image Processing or Signal Processing.

(b) Determine the IDFT of $Y(k)=\{1, (4+j), 3, (4-j)\}$

(c) Given $x(n)=\{1, 2, 4, 6, 6, 4, 2, 1\}$. Find X(k) using DIF FFT algorithm. **(4+8+6)**

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SPACE FOR ROUGH WORK