AR – 2542

Third Semester M. Sc. (AE) Examination

DIGITAL SIGNAL PROCESSING

Paper - 3 AE 2

(USC - 15036)

P. Pages : 4

Time : Three Hours] [Max. Marks : 80

Note : (1) Due credit will be given to neatness and adequate dimensions.
(2) Assume suitable data wherever necessary.
(3) Illustrate your answer wherever necessary with the help of neat sketches.

1. (a) State and prove Time Invariant and Time Variant System and prove that the following systems are time variant or time invariant.

   (i) $y(n) = e^{x(n)}$

   (ii) $y(n) = n\,x(n)$ 7

   (b) State and prove any three properties of discrete convolution. 6

OR

2. (a) What do you mean by

   (i) Stability ?

   (ii) Causality of a system ?

   Determine whether the following discrete time system is stable.

   $y(n) = 3x(n) + \cos[0{\cdot}2(n+1)\pi]$ 7

   (b) Obtain the convolution of

   $x(n) = \{1, 2, 3, 4, 5, 6\}$ and

   $h(n) = \{2, -4, 6, -8\}$ 6

3. (a) State and prove convolution property of z-transform. 7

(b) If $x(n) = n^2 u(n)$ find $X(z)$ 7

OR

4. (a) If $X(z) = \dfrac{1+2z^{-1}+3z^{-2}}{z^{-3}-2z^{-2}+4z^{-1}+3}$, find causal signal x(n) 7

(b) $x(z) = \dfrac{1+z^{-1}}{1-\frac{3}{2}z^{-1}+\frac{1}{2}z^{-2}}$, find x(n) by Residue method only. 7

5. (a) Determine the circular convolution by using DFT and IDFT method of given sequences.

$x(n) = u(n) - u(n-3)$ and

$h(n) = \{2, 1, 3\}$ 6

(b) Compute the 8-point DFT of x (n) and verify the result by IDFT

$$x(n) = \begin{cases} 1, & 0 \le n \le 3 \\ 2, & 4 \le n \le 7 \end{cases}$$ 7

OR

6. (a) Perform the circular convolution and then linear convolution by using the method of circular convolution.

$x(n) = \delta(n) - \delta(n-1) + 2\delta(n-2) - 3\delta(n-3)$ and $h(n) = 2\delta(n) - 3\delta(n-1) - \delta(n-3)$ 6

(b) Compute 8 point DFT of the sequence x(n), using radix 2 decimation in time algorithm

$x(n) = \cos\left[\frac{\pi}{2}n\right]$ $0 \le n \le 7$ 7

7. (a) Develop a direct form I and direct form II realisation of the difference equation.

$$y(n) = b_0\ x(n) + b_1\ x(n-1) + b_2\ x(n-2)$$
$$+ b_3\, x(n-3) - a_1\ y(n-1)$$
$$- a_2 y(n-2) - a_3\ y(n-3)$$ 7

(b) Obtain a cascade and parallel realisation of the system function :

$$H(z) = \frac{2(z+2)}{z(z-0{\cdot}1)\ (z+0{\cdot}5)\ (z+0{\cdot}4)}$$ 7

OR

8. Determine the coefficients of a linear phase FIR filter length M = 15 has a symmetric unit sample response and a frequency response that satisfies the conditions :

$$H\left\{\frac{2\pi k}{15}\right\} = \begin{cases} 1, & \text{for } k = 0, 1, 2, 3 \\ 0, & \text{for } k = 4, 5, 6, 7, 8, 9, 10 \end{cases}$$

Also determine the transfer function and freq. response of the same. 14

9. (a) Let $H(s) = \dfrac{1}{(s+1)\ (s+2)}$

(i) Find H(z) using impulse invariant method.

(ii) If $F_s = 5$ samples per second, determine H(z) 7

(b) Explain the concept with the relation of s-plane to z-plane. 6

OR

10. (a) An analog filter transfer function is given by

$$H(s) = \frac{1}{(s+3)\ (s+5)}$$

Obtain transfer function H(z) of IIR filter using impulse invariant transformation. 7

(b) Derive the bilinear transformation

$$S = \frac{2}{T}\left(\frac{1-z^{-1}}{1+z^{-1}}\right) \text{ and}$$

investigate the freq. mapping characteristics of bilinear transformation from s-plane to z plane. 6

11. (a) Explain in detail the up-sampler used in multirate DSP. 6

(b) Explain in detail the down-sampler used in multirate DSP. 7

OR

12. Explain the polyphase structure for decimeter used in multirate DSP with suitable diagrams. 13