Ex/PG/ETCE/T/116A/16/2017

MASTER OF ENGINEERING EXAMINATION, 2017

(Dist. & Mob. Com., Electrical, E.T.C.E, Illumination Engg., Nuclear)

(1ST SEMESTER)

DIGITAL SIGNAL PROCESSING Time: Three Hours Full Marks: 100

Answer any ***Five*** questions

All questions carry equal marks

1. a) Find the impulse and step responses of the LTI system shown in Fig. 1. 3 + 3

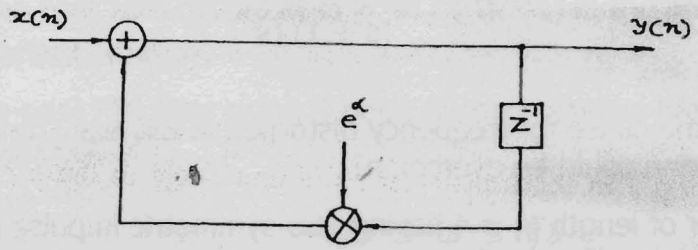

Fig. 1

b) Discuss about the idea for parallel form of realization of an IIR filter. 4

c) Derive the parallel form realization of the system described by the difference equation $y(n) = -0.1\,y(n-1) + 0.72\,y(n-2) + 0.7\,x(n) - 0.252\,x(n-2)$. 10

2. a) Discuss about the mapping of analog poles into the digital domain using Impulse Invariant Transformation. 6

b) Explain the significance of the "Primary Strip" in Impulse Invariant Transformation. 6

c) An analog filter has a transfer function

$$H(s) = \frac{10}{s^2 + 7s + 10}$$

Design a digital filter equivalent to this using Impulse Invariant Transformation. 8

3. a) Derive the relation between s-plane and z-plane in Bilinear Transformation. 10

b) Justify the statement : " In Bilinear Transformation the negative imaginary axis in the s-plane is mapped into the lower-half of the unit circle in the z-plane". 10

4. a) Implement the digital filter to be derived from

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

Assume T = 1 sec. 8

b) Discuss about the cause for frequency distortion in Bilinear Transformation. How this distortion could be overcome? 7 + 5

5. a) For an FIR filter of length M = 4 having anti-symmetric impulse response, derive the expression for the frequency response. 4

b) Determine the impulse response of an FIR filter of length M = 4 having anti-symmetric characteristics. The frequency response is specified as $H_r(\pi/4) = 0.5$ and $H_r(3\pi/4) = 1$. Sketch the magnitude and phase characteristics of the frequency response and make suitable comments. 8+ 3 + 3 + 2

6. A high-pass filter having the following desired frequency response is to be designed using Fourier method.

$$H_d(e^{j\omega}) = \begin{cases} 1 & \pi/3 \leq |\omega| \leq \pi \\ 0 & \text{elsewhere} \end{cases}$$

a) Determine the desired impulse response for N = 11. 7

b) Determine the required co-efficients of the realizable high-pass filter and make suitable comments. 7 + 2

c) Sketch the magnitude response of the high-pass filter. 4

7. a) Discuss about the salient features of N-point Rectangular window and also derive the expression for the frequency response of it. 4 + 6

   b) Sketch the frequency response of a 31-point Rectangular window by computing the responses at $\omega = \pm \pi n/10$ where n = 0, 1, 2 .....10. 10

8. a) Show that the First zero occurs at $\omega = 4\pi / (N - 1)$ in the amplitude response of N-point Bartlett window. 8

   b) Design a low-pass FIR filter using 9-point Bartlett window having desired frequency response of

$$H_d(e^{j\omega}) = \begin{cases} 1 & -\pi/3 \leq \omega \leq \pi/3 \\ 0 & \text{elsewhere} \end{cases}$$

   Derive also the expression for the magnitude response of the above filter. 8 + 4