BACHELOR OF ELECTRONICS AND TELECOMMUNICATION ENIGINEERING EXAMINATION, 2018

(3^{rd} Year, 2^{nd} Semester)

DIGITAL SIGNAL PROCESSING

Time : Three Hours | Full Marks : 100

1. (a) Determine whether the following signal is periodic or not. If periodic, find its fundamental period.

$$x(n) = \sin \frac{\pi}{8} n^2$$

(b) A discrete time system is given by

$$T\{x(n)\} = x(n) \cdot x(n-1)$$

Check its linearity and shift invariance.

(c) Develop the relation between $x(n)$ and $y(n)$ from the following block diagram of a discrete time system shown in Fig. 1.

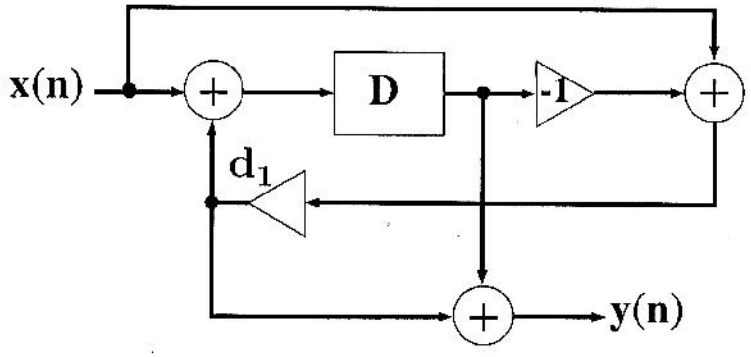

Figure 1

4+6+10

2. (a) Find the impulse response of the system defined by

$$y(n) - 0.8y(n-1) + 0.12y(n-2) = 0.3x(n) + 0.4x(n-1) + 0.2x(n-2)$$

(b) Obtain the result of the convolution of $x(n)$ with itself, where

$$x(n) = (\frac{2}{3})^n u(n)$$

(c) Consider the discrete time system of Fig. 2 composed of an interconnection between four simple discrete time systems with impulse responses given by,

$$\begin{aligned} h_1(n) &= \delta(n) + \frac{1}{2}\delta(n-1) \\ h_2(n) &= \frac{1}{2}\delta(n) - \frac{1}{4}\delta(n-1) \\ h_3(n) &= 2\delta(n) \\ h_4(n) &= -2(\frac{1}{2})^n u(n) \end{aligned}$$

Find the overall impulse response.

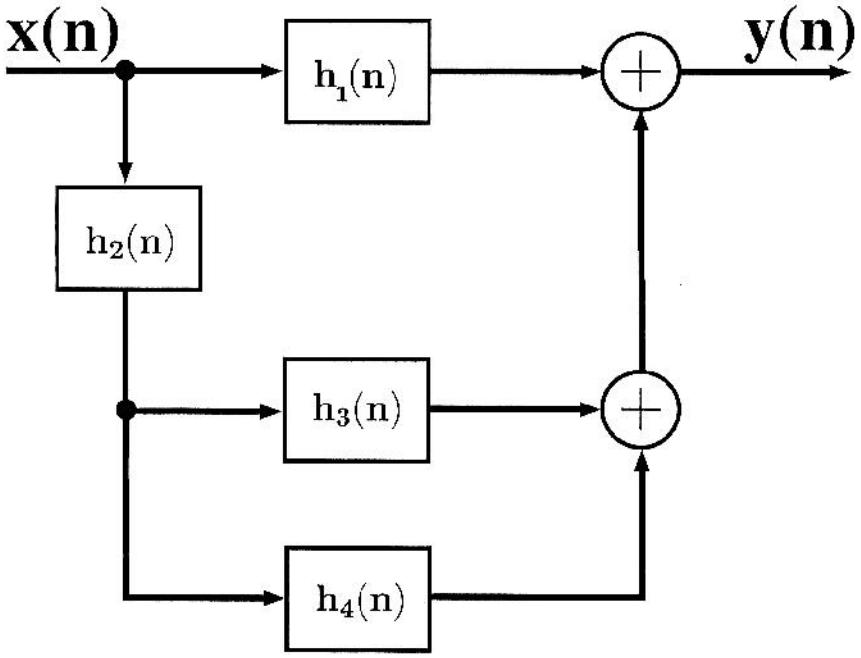

Figure 2

(d) Check the causality and BIBO stability for the following :

$$h(n) = (\frac{1}{2})^n u(n+1)$$

5+5+8+2

3. (a) Given the following digital system with a sampling rate of 8000 Hz,

$$y(n) = 0.5x(n) + 0.5x(n-1)$$

Find the frequency response and sketch its magnitude and phase over the range $0 \leq \omega \leq \pi$. Comment on the frequency selective nature of the system and suggest suitable applications of the system keeping in view, its phase response.

(b) Compute the IDFT of the sequence

$$X(k) = \{7, -0.707 - j0.707, -j, 0.707 - j0.707, 1, 0.707 + j0.707, j, -0.707 + j0.707\}$$

using decimation-in-time FFT algorithm.

10+10

4. (a) Consider the causal system defined by the pole-zero pattern shown in Fig. 3.

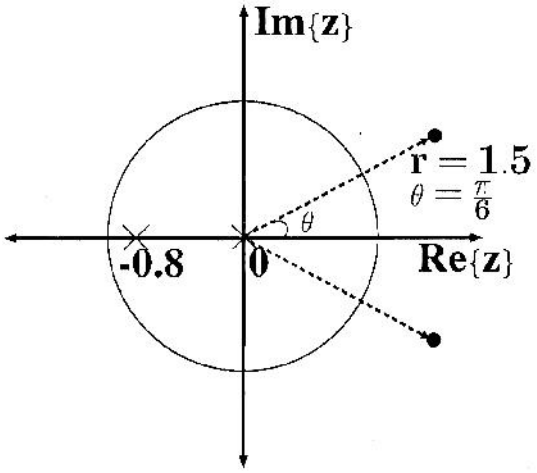

Figure 3

(i) Determine the system function, given that $H(z)|_{z=1} = 1$. Is the system stable ?

(ii) Determine the corresponding difference equation.

(iii) Sketch an appropriate realisation of the system and hence obtain the impulse response directly from this structure.

(b) Derive and sketch the cascade and parallel structures for the system with the following system function.

$$H(z) = \frac{2(z+2)}{(z-0.1)(z-0.5)(z+0.4)}$$

(3+2+5)+10

5. (a) Design a 5-tap FIR bandstop filter with a lower cutoff frequency of 2000 Hz, an upper cutoff frequency of 2400 Hz and a sampling rate of 8000 Hz using the Hamming window method. Determine the system function.

(b) Design an FIR filter that completely blocks the frequency $\omega = \frac{\pi}{4}$ and then compute its output if the input is

$$x(n) = \left(\sin \frac{\pi}{4} n\right) u(n) \text{ for } n = 0, 1, 2, 3, 4$$

Does the filter fulfill your expectations? Explain.

10 + 10

5(OR). (a) Design a digital lowpass Butterworth filter to satisfy the following constraints

$$0.9 \leq |H(e^{j\omega})| \leq 1 \ , \ 0 \leq \omega \leq 0.2\pi$$

$$|H(e^{j\omega})| \leq 0.2 \ , \ 0.4\pi \leq \omega \leq \pi$$

Use bilinear transformation and consider a sampling interval of one second.

(b) Explain the role of a barrel shifter in a Digital Signal Processor. Design an 8-bitbarrel shifter using appropriate functional blocks.

15+5