EX/ET/PC/B/T/321/2024

BACHELOR OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING EXAMINATION, 2024

(3rd Year, 2nd Semester)

DIGITAL SIGNAL PROCESSING

Time: Three Hours **Full Marks: 100**

Group A (CO1 : 20 marks)

Answer any two

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

$$x(n) = sin\left(\left(\frac{5\pi}{8}\right).n + 6\right)$$

(b) Find the even and odd components of the following signal.

$$x(n) = \{2, \underset{\uparrow}{} -2, 6, -2\}$$

5+5=10

2. (a) Check the linearity and time-invariance of the following system.

$$T[x(n)] = (e)^{x(n)}$$

(b) Find the linear convolution of the following signals.

$$x(n) = \{1, 1, \underset{\uparrow}{0}, 1, 0, 1\}$$

$$h(n) = \{1, 2, \underset{\uparrow}{1}, 1, 2, 1\}$$

5+5=10

3. (a) Check the causality and BIBO stability for the following.

$$h(n) = (5)^n u(3-n)$$

(b) Find the circular convolution of the following signals using matrices.

$$x(n) = \{1, \underset{\uparrow}{2}, 3, 4\}$$

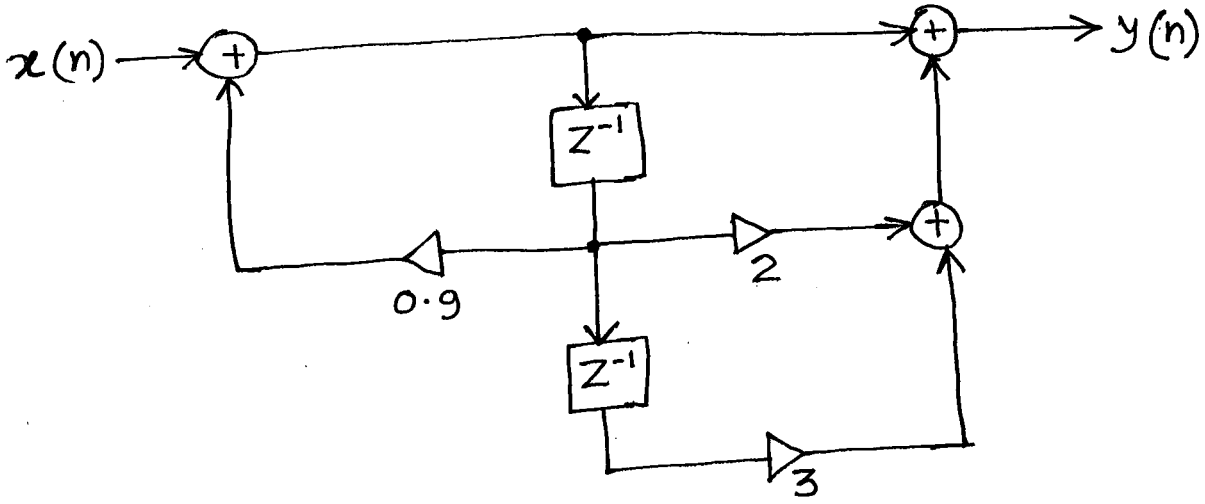
$$h(n) = \{2, \underset{\uparrow}{1}, 2, -1\}$$

5+5=10

Group B (CO2 : 30 marks)

Answer any three

4. Determine the system function, difference equation, and the impulse response of the following system. 10



5. An IIR filter is described by the following difference equation.

$$y(n) = b\,x(n) + 0.9\,y(n-1)$$

Obtain the frequency response and hence determine b so that dc gain equals to 1. Determine the cutoff frequency of the filter. Is this filter lowpass bandpass or highpass? 10

6. Given a three stage FIR lattice filter with coefficients K1 = 0.25, K2 = 0.5, K3 = 1/3; determine the system function of the filter. 10

7. An LTI discrete-time system is characterized by the system function

$$H(z) = \frac{(3 - 4z^{-1})}{(1 - 3.5z^{-1} + 1.5z^{-2})}$$

Specify the ROC of H(z) and determine h(n) for the following conditions:

(i) The system is causal and unstable.
(ii) The system is noncausal and stable.
(iii) The system is anti-causal and unstable. .

10

Group C (CO3 : 20 marks)

Answer all

8. An FIR filter is described by the following difference equation.

$$y(n) = x(n) - x(n-6)$$

Compute and sketch its magnitude and phase response. What is the name of this filter? What is its possible use? 10

OR

Derive the Butterfly structure for 8-point FFT using the decimation-in-frequency method. 10

9. Obtain the frequency spectrum of the DT signal given below. 10

$$x(n) = \{.....,2, 3, 6, 3, 2, 3, 6, 3, 2, 3, 6, 3,.....\}$$
$$\uparrow$$

Group D (CO4 : 30 marks)

Answer all

10. Design an FIR digital notch filter that will reject a very strong 60 Hz sinusoidal interference contaminating a 200 Hz useful sinusoidal signal. Determine the gain of the filter so that the useful signal does not change amplitude. The filter works at a sampling frequency of 500 samples/sec. 10

11. Design a 5-tap FIR bandpass filter with a lower cut-off frequency of 2000 Hz and an upper cut-off frequency of 2400 Hz at a sampling rate of 8000 Hz using the rectangular window method. 10

12. Develop a parallel realization structure for the digital filter with the following system function. 10

$$H(z) = \frac{\left(1 - 0.9z^{-1} - 0.1z^{-2}\right)}{\left(1 + 0.3z^{-1} - 0.04z^{-2}\right)}$$