EX/ET/PC/B/T/321/2023(s)

BACHELOR OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING EXAMINATION, 2023

(3rd Year, 2nd Semester, Supplementary Exam)

DIGITAL SIGNAL PROCESSING

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

Answer Any Five Questions

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

$$x(n) = cos\left(\left(\frac{5\pi}{9}\right).n\right)$$

(b) The input to a linear shift-invariant system is the unit step sequence and the corresponding response is the unit sample sequence. Find the unit sample response of the system.

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

$$T[x(n)] = nx(n)$$

(d) Find the convolution of the following.

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

(e) Check the causality and BIBO stability for the following.

$$h(n) = \left(-\frac{1}{2}\right)^n u(n)$$

(5×4)

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2. Determine the system function and the impulse response of the system described by the following difference equation. Assume that the system is initially at rest. (20)

$$y(n) = x(n) + 0.2\, y(n-1)$$

3. A digital filter is described by the following difference equation

$$y(n) = \frac{1}{2} \cdot [x(n) + x(n-2)]$$

Compute and sketch its magnitude and phase response. Discuss the sketch that you have obtained. (20)

4. What is the difference between linear convolution and circular convolution? Explain different methods for computing linear convolution. (20)

5. What is a finite impulse response (FIR) filter? Explain the design of a Type I linear-phase FIR filter. (20)

6. (a) Design a first-order allpass filter whose pole position is at $z = -0.6$.

(b) Design an FIR notch filter to eliminate a sinusoid with the frequency $\pi/3\ rad.$

(c) Derive the Butterfly structure for a 4-point FFT following the decimation-in-frequency method. (5+5+10)

7. Design a first-order FIR lowpass filter through the intuitive placement of pole and zero. Calculate its 3 dB cut-off frequency. Comment on the result and hence suggest a scheme to have better control over the cut-off frequency. (20)

8. Discuss in detail any practical application of Digital Signal Processing. (20)