Ref. No.: Ex/IEE/PC/B/T/225/2023

B.E. INSTRUMENTATION AND ELECTRONICS ENGINEERING SECOND YEAR
SECOND SEMESTER - 2023
DIGITAL SIGNAL PROCESSING

Time: 3Hrs. Full Marks: 100

Module-1 CO1: Answer all questions.

1. a) Given the signal $x(n) = 2\cos\left(6\pi t - \frac{\pi}{3}\right) + 4\sin(10\pi t)$. Find out if this signal is periodic or not. If so find out its period. 4

b) Determine whether the following systems are time-invariant or not

i) $y(n) = e^{x(n)}$ ii. $y(n) = x(n) + nx(n-1)$ iii. $y(n) = x(n^2)$ 3x2=6

c) Determine whether the following systems are causal or non-causal

i. $y(n) = |x(n)|$ ii. $y(n) = cosx(n)$ iii. $y(n) = x(2n)$ 3x2=6

d) Compute the convolution of $x(n) = \{1,1,\underset{\uparrow}{0},1,1\}$ and $h(n) = \{1,-2,\underset{\uparrow}{-3},4\}$ 4

Module-2 CO2: Answer any two questions.

2. a) Find the Z-transformation of $x(n) = nu(n)$ 6

b) a) Determine the z-transform and sketch the ROC of 5

$$x(n) = \left(\frac{1}{3}\right)^n \quad for \quad n > 0$$

$$\left(\frac{1}{2}\right)^{-n} \quad for \quad n < 0$$

c) c) Determine the Z-transform and ROC of 4

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

d) Using differentiation property obtain the Z-transformation of unit ramp sequence. 5

3) a) Find inverse Z-transform: 5

$$X(Z) = log(1 + aZ^{-1}). \quad |Z| > |a|$$

b) Find inverse Z-transform 5

$$X(Z) = \frac{Z^2}{\frac{1}{2} - \frac{3}{2}z + Z^2}$$

c) Determine inverse z-transform of: 5

$$X(Z) = \frac{1 - \frac{1}{2}Z^{-1}}{1 + \frac{1}{8}Z^{-2} + \frac{3}{4}Z^{-1}} \quad |Z| > \frac{1}{2}$$

d) Determine inverse z-transform of: 5

$$X(Z) = \frac{1 - \frac{1}{2}Z^{-1}}{1 - \frac{1}{4}Z^{-2}} \quad |Z| > \frac{1}{2}$$

[Turn over

4) a) Obtain the N-point DFT of the sequence $x(n) = a^n u(n)$ for $0 \leq n \leq N-1$ 5

b) Compute the circular convolution of the following sequence and compare the results with the linear convolution $x(n) = \{\underset{\uparrow}{1},1,1,1,-1,-1,-1,-1\}$ and $h(n) = \{\underset{\uparrow}{0},1,2,3,4,3,2,1\}$ 5

c) Describe the cyclic property of the twiddle factor in DFT 5

d) Find the N point DFT of x(n) 5

$$x(n) = 1 \qquad 0 \leq n \leq N-1$$
$$= 0 \qquad \text{otherwise}$$

Module-3 CO3: Answer any one question.

5) a) Describe the impulse invariance method to design a digital filter 5

b) The transfer function of the analog filter is 6

$$H(s) = \frac{3}{(s+2)(s+3)}$$

With $T_s = 0.1$ seconds. Design a digital filter using Bilinear transformation method.

c) What is the frequency warping problem that arises in Bilinear transformation? state how to overcome this problem. 2+2=4

d) Find out H(Z) using the impulse invariance method at 5HZ sampling frequency The transfer function of the analog filter is 5

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

6) a)Discuss the design of the FIR filter using the window method. 8

b) Obtain Direct form-I and II of the system described by 4+4

$$y(n) - \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = x(n) + \frac{1}{2}x(n-1)$$

c) Compare Bi-linear and impulse invariance methods. 4

Module-4: CO4: Answer all the questions

7) a. What does *multi-rate* mean? b. Discuss the use of multi-rate DSP. c) State the Various advantages of Multirate DSP d) What are the categories of multi-rate? e) Discuss the basic sampling rate alteration devices. 4+4+4+4+4