B.E. INSTRUMENTATION AND ELECTRONICS ENGINEERING
SECOND YEAR
SECOND SEMESTER EXAM 2024
DIGITAL SIGNAL PROCESSING

Time: 3Hrs. Full Marks: 100

Module 1: Answer all the questions from Module-1 (1x 20= 20 marks)

1. a) Comparison between energy and power signal.
   b) Obtain energy for the signal
   $x(n) = a^n u(n) \quad where \quad |a| < 1$
   c) Determine whether the following systems are time-invariant or not.
   $$y(n) = x(n^2)$$
   d) Explain the given systems with respect to the following properties:
   i) Dynamic ii) time invariance iii) linearity iv) causality v) stability
   A) $y(n) = \sum_{k=-\infty}^{n} x(k)$ B) $y(n) = \text{sgn}[x(n)]$

e) Determine whether or not the following signals are periodic. If periodic specify its fundamental period
   A) $x(n) = \cos(n/8)\cos(\pi n/8)$
   B) $x(n) = \cos(n\pi/2) - \sin(n\pi/8) + 3\cos(\pi n/4 + \pi/3)$

f) Obtain the linear convolution of the following sequence

$x(n) = \{1,2,1,2\} \quad and \quad h(n) = \{1,1,1\}$

(1+4+4+5+4+2)=20

Module 2: Answer any two questions from Module-2 (2x 20= 40 marks)

2. a) Obtain **DTFT** of the below signals
A) $x(n) = a^n u(n) + a^n u(-n-1)$
B)
$x(n) = A \quad for \quad 0 \le n \le L-1$
$0 \quad otherwise$
b) Calculate the DFT of the sequence $x(n) = \{1,1,0,0\}$

c) Given the two sequences of length 4 are:

$x(n) = \{0,1,2,3\}$

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

Find the circular convolution in the graphical method

d) Compute the 8-point circular convolution for the following sequence

$x_1(n) = \{1,1,1,1,0,0,0,0\}$

$x_2(n) = \sin(\frac{3\pi n}{8}) \quad 0 \le n \le 7$

{(2+3)+5+5+5}=20

3)

a) Determine the z-transform and sketch the ROC of :

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

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

b) Using differentiation property to obtain the Z-transformation of unit ramp sequence

c) Determine the Z-transform and ROC of

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

d) Find the Z-transform of $x(n) = \frac{a^n}{n!} \quad , \quad n \ge 0$

e) Obtain the Z-transform of the signal

$x(n) = na^n u(n)$

(4+4+4+4+4)=20

4.

a) Find inverse Z-transform:

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

b) Find the linear convolution of $x_1(n)$ and $x_2(n)$ using Z-transform

$x_1(n) = \{1, 2, 3, 4\}$ and $x_2(n) = \{1, 2, 0, 2, 1\}$.

↑ ↑

c) Determine inverse z-transform of:

$X(Z) = \frac{4Z^{-2} + 3Z^{-1} + 2}{\frac{1}{2}Z^{-2} - \frac{3}{2}Z^{-1} + 1}$ for causal sequence

d) Find the frequency response and impulse response of an LTI system whose input and output satisfy the difference equation

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

(5+5+5+5)=20

Module-3: Answer any one question from Module-3 (1x 20= 20 marks)

5. a) Develop direct form-II realization the transfer function

$$X(Z)=\frac{3+3.6Z^{-1}+0.6Z^{-2}}{1+0.1Z^{-1}-0.2Z^{-2}}$$

b) The transfer function of the discrete-time causal system is given by;

$$X(Z)=\frac{1-Z^{-1}}{1+0.2Z^{-1}-0.15Z^{-2}}$$ draw cascade and parallel realization of the system.

c) Develop the parallel form realization for the digital filter with transfer function

$$X(Z)=\frac{1+2Z^{-1}+Z^{-2}}{1-0.75Z^{-1}+0.125Z^{-2}}$$

d) Discuss bilinear transformation method to design digital filter

4+5+4+7=20

6.

a.

A digital low pass IIR filter is to be designed with butter- worth approximation using bilinear transformation technique. Find the order of filter to meet the following specifications.

(i) Passband magnitude is constant within 1 dB for frequencies below 0.2 π.

(ii) Stopband attenuation is greater than 15 dB for frequencies between 0.3 π to π.

b. Discuss the design of the FIR filter using the window method.

c.

Design a linear phase FIR low pass filter of order seven with cut-off frequency 1 rad/sec using rectangular window.

6+7+7=14

Module-4: Answer all the questions Module-4 (1x 20= 20 marks)

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=20