Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 80576

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2024.

Fifth/Eight Semester

Electrical and Electronics Engineering

EE 8591 – DIGITAL SIGNAL PROCESSING

(Common to : Electronics and Instrumentation Engineering/ Instrumentation and Control Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State the aliasing effect.

2. Consider the analog signal $X_a(t) = 3\cos 210\pi t$.

   (a) Determine the minimum sampling rate required to avoid aliasing.

   (b) Suppose that the signal is sampled at the rate Fs = 300 Hz. What is the discrete-time signal obtained after sampling?

3. Determine the fourier series of the signals

   (a) $x(n) = \cos\sqrt{2}\pi n$

   (b) $x(n) = \cos \pi n / 5$.

4. Find the circular convolution of the following two sequences:

   $x_1(n) = \{1, 3, 4, 1\}$
   $\uparrow$

   $x_2(n) = \{1, 2, 3, 1\}$
   $\uparrow$

5. Consider the system described by the difference equation

   $y(n) = ay(n-1) - ax(n) + x(n-1)$

   Obtain the direct form II realization of the system.

6. Illustrate the procedure for low pass to band stop filter transformation.

7. Define zero limit cycle oscillation.

8. A low pass filter has the desired response as given below.

$$H_d(e^{jw}) = \begin{cases} e^{-j3w} & 0 \le \omega < \pi/2 \\ 0 & \pi/2 \le \omega \le \pi \end{cases}$$

Determine $H_d(k)$ using frequency sampling technique.

9. Sketch the process involved in Echo cancellation.

10. Differentiate between fixed and floating point DSP Processor.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Compute the convolution y(n) for $x(n) = \{1, 2, 3, 2, 1\}$ and $h(n) = \{1, -2, -2, 1\}$ using graphical method. (8)

(ii) Determine the stability for each of the following linear systems (5)

(1) $y_1(n) < \sum_{k=0}^{\infty} \left(\frac{3}{4}\right)^k x(n-k)$

(2) $y_2(n) = \sum_{k=0}^{\infty} 2^k x(n-k)$.

Or

(b) (i) Compute the cross correlation $r_{xy}(l)$ of the sequences $x(n) = \{0, 1, -2, 3, -4\}$; $h(n) = \{1, 2, 1, 0.5\}$. (7)

(ii) Check whether the given signals are power, energy signal or neither

(1) $x(n) = j^n + j^{-n}$ (2)

(2) $x(n) = xj^n$ (2)

(3) $x(n) = 2^n \cos \pi n$ (2)

12. (a) (i) Determine the Z-transform and ROC for the following sequence

$x(n) = a^n (\cos \omega_n n) u(n-1)$. (6)

(ii) Find the Z-transform of the sequence $x(n) - \frac{1}{2}(n^2 + n)u(n)$. (7)

Or

(b) (i) Using partial fraction expansion, determine $x(n)$ if

$X(z) = 1/(1 - 1.5z^{-1} + 0.5z^{-2})$. (6)

(ii) Consider the signal $x(n) = \left(\frac{1}{2}\right)^n u(n) + \left(\frac{-1}{4}\right)^n u(n)$ Determine $X(z)$ and RoC. (7)

13. (a) (i) Compute the FFT using DIT algorithm for the sequence given by $x(n) = \{2, 1, 3, 1, 4, 1, 5, 1\}$. (8)

(ii) A finite-duration sequence of length L is given as

$$x(n) = \begin{cases} 1, & 0 \le n \le L-1 \\ 0, & otherwise \end{cases}$$

Determine the N-point DFT of this sequence for $N \ge L$. (5)

Or

(b) (i) Compute the inverse using DIF algorithm for the given

$X(k) = \{20, -5.828 - j2.414, 0, -0.172 - j0.414, 0, -0.172 + j0.414, 0, -5.828 + j2.414\}$ (8)

(ii) An FIR digital filter has the unit impulse response sequence given by $h(n) = \{1, 2, 1\}$. Determine the output sequence in response to the input sequence $x(n) = \{1, 2, 4, 4, 3, 1\}$ using overlap-save method. (5)

14. (a) Design a digital low pass Butterworth filter using bilinear transformation technique for the following specification. (13)

Passband ripple (or peak-to-peak ripple): -0.5 dB

Passband edge: 1.2 kHz

Stopband attenuation: -40 dB

Stopband edge: 2.0 kHz

Or

(b) The desired response of a low pass filter is

$$H_d(e^{j\omega}) = \begin{cases} e^{-j5\omega}, & -3\pi/4 \le \omega \le 3\pi/4 \\ 0, & 3\pi/4 \le |\omega| \le \pi \end{cases}$$

Determine $H(e^{j\omega})$ for M=11 using Hanning window. (13)

15. (a) What are digital signal processors? Explain the architecture with illustrative diagram.

Or

(b) List the addressing formats and functional modes. Explain their characteristics with examples.

PART C — (1 × 15 = 15 marks)

16. (a) By means of the DFT and IDFT, determine the sequence $x(n)$ corresponding to the circular convolution of the sequences $x_1(n)$ and $x_2(n)$ $x_1(n) = \{1,2,1,2\}$ and $x_2(n) = \{1,3,3,1\}$.

Or

(b) Realize the following system using cascade and parallel realization

$$H(z) = \frac{(z+1)(z+2)(z-2)}{(z-1)(z+0.5)(z-0.2)}.$$