

--	--	--	--	--	--	--	--	--	--

Sixth Semester B.E. Degree Examination, July/August 2022

Digital Signal Processing

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Compute 4-point DFT of casual three sample sequence given by
- $$x(n) = \frac{1}{3}; 0 \leq n \leq 2$$
- $= 0$; else. (06 Marks)
- b. State and prove linearity property of DFT. (06 Marks)
- c. Find the circular convolution of two finite duration sequences $x_1(n)$ and $x_2(n)$ using concentric circle method. Where $x_1(n)$ and $x_2(n)$ are given by
- $$x_1(n) = \{1, -1, -2, 3, -1\}$$
- $$x_2(n) = \{1, 2, 3\}.$$
- (08 Marks)

OR

- 2 a. Compute circular convolution using Stockham's method for following sequences:
 $x_1(n) = \{2, 3, 1, 1\}$ and $x_2(n) = \{1, 3, 5, 3\}$. (10 Marks)
- b. Find the output $y(n)$ of a filter whose impulse response $h(n) = (1, 2)$ and input signal $x(n) = \{1, 2, -1, 2, 3, -2, -3, -1, 1, 1, 2, -1\}$ using overlap save method. Use block length of $N = 4$. (10 Marks)

Module-2

- 3 a. Develop decimation in time algorithm for finding FFT. Draw signal flow graph for $N = 8$ for DIT algorithm. (10 Marks)
- b. Find the 8 point DFT of sequence $x(n) = \{1, 1, 0, 0, -1, -1, 0, 0\}$ using DIT FFT algorithm. Draw signal flow graph. (10 Marks)

OR

- 4 a. Develop a decimation in frequency FFT algorithm for $N = 8$. Draw signal flow graph. (10 Marks)
- b. The DFT $X(k)$ of sequence is given as, $X(k) = \{0, 2\sqrt{2}(1-j), 0, 0, 0, 0, 2\sqrt{2}(1+j)\}$. Determine the corresponding time sequence $x(n)$ using DIF-FFT algorithm. Write its signal flow graph. (10 Marks)

Module-3

- 5 a. A system function of the normalized lowpass filter is given below:

$$H(s) = \frac{1}{s^2 + \sqrt{2}s + 1}$$
 Determine $H(z)$ using impulse invariant transformation.
 Consider $T = 1$ sec. (08 Marks)
- b. Design an analog filter with maximally flat response in the passband and an acceptable attenuation of -2dB at 20radians/second. The attenuation in the stop band should be more than 10dB beyond 30 radian/second. (12 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
 2. Any revealing of identification, appeal to evaluator and/or equations written eg, $42+8=50$, will be treated as malpractice.

OR

- 6 a. Transform the analog filter $H(s) = \frac{s+0.1}{(s+0.1)^2+9}$ into a digital filter using bilinear transformation. The digital filter should have resonant frequency $\omega_r = \pi/4$. (05 Marks)
- b. Design an analog Chebyshev filter with the following specifications:
Passband ripple: 1dB for $0 \leq \Omega \leq \text{rad/sec}$.
Stopband attenuation : -60dB for $\Omega \geq 50 \text{ rad/sec}$. (10 Marks)
- c. Let $H(s) = \frac{1}{s^2 + \sqrt{2}s + 1}$ represent the transfer function of a lowpass filter with a passband of 1 rad/sec. Use frequency transformation to find the transfer functions of the following analog filters.
i) A lowpass filter with pass band of 10rad/sec
ii) A high pass filter with cut-off frequency of rad/sec. (05 Marks)

Module-4

- 7 a. Compare Butterworth and Chebyshev filter approximations. (05 Marks)
- b. Design a digital low pass filter to satisfy the following pass band ripple $1 \leq H(j\Omega) \leq 0$, for $0 \leq \Omega \leq 1404\pi \text{ rad/sec}$ and stop band attenuation $|H(\Omega)| > 60\text{dB}$ for $\Omega \geq 8268 \pi \text{ rad/sec}$ sampling interval $T_s = \frac{1}{10^4} \text{ sec}$. Use BLT for designing. (15 Marks)

OR

- 8 A discrete time system $H(z)$ is expressed as

$$H(z) = \frac{10 \left(1 - \frac{1}{2}z^{-1}\right) \left(1 - \frac{2}{3}z^{-1}\right) (1 + 2z^{-1})}{\left(1 - \frac{3}{4}z^{-1}\right) \left(1 - \frac{1}{8}z^{-1}\right) \left[1 - \left(\frac{1}{2} + j\frac{1}{2}\right)z^{-1}\right] \left[1 - \left(\frac{1}{2} - j\frac{1}{2}\right)z^{-1}\right]}$$

- a. For the discrete time system defined by $H(z)$, find the difference equation of the system. (02 Marks)
- b. For the discrete time system, $H(z)$ realize the system in direct form-I and II. (08 Marks)
- c. For the discrete time system $H(z)$, realize parallel and cascade forms using second order sections. (10 Marks)

Module-5

- 9 a. The desired frequency response of the low pass filter is given by

$$H_d(e^{j\omega}) = H_d(\omega) = \begin{cases} e^{-j3\omega}; & |\omega| < 3\pi/4 \\ 0; & 3\pi/4 < |\omega| < \pi \end{cases}$$

Determine the frequency response of FIR filter if the hamming window is used, with $N = 7$. (08 Marks)

- b. Design an ideal band pass filter with frequency response.

$$H_d(e^{j\omega}) = 1, \text{ for } \frac{\pi}{4} \leq |\omega| \leq \frac{3\pi}{4}. \text{ Use rectangular window with } N = 11 \text{ in the design. (12 Marks)}$$

OR

- 10 a. Determine the impulse response $h(n)$ of a filter having desired frequency response.

$$H_d(e^{j\omega}) = \begin{cases} e^{-j(N-1)\omega/2} & \text{for } 0 \leq |\omega| \leq \pi/2 \\ 0 & \text{for } \frac{\pi}{2} \leq |\omega| \leq \pi \end{cases} \quad N = 7, \text{ use frequency sampling approach. (10 Marks)}$$

- b. Realize the following system function $H(z) = 1 + \frac{3}{4}z^{-1} + \frac{17}{8}z^{-2} + \frac{3}{4}z^{-3} + z^{-4}$ in

- i) Direct form ii) Cascaded form. (10 Marks)