

December 2023

B. Tech (RAI) 5<sup>th</sup> SEMESTER

Digital Signal Processing (PCC-RAI-502-21)

Time: 3 Hours

Max. Marks:75

Instructions:

1. It is compulsory to answer all the questions (1.5 marks each) of Part -A in short.
2. Answer any four questions from Part -B in detail.
3. Different sub-parts of a question are to be attempted adjacent to each other.
4. Any other specific instructions

**PART -A**

- Q1 (a) State and prove scaling property of DFT. (1.5)
- (b) Write the significance of ROC for Z-Transform. (1.5)
- (c) What is meant by stability and causality of signal? (1.5)
- (d) Differentiate between linear and circular convolution. (1.5)
- (e) State signal flow graph? (1.5)
- (f) What is the significance of Fast Fourier Transform in signal processing. (1.5)
- (g) Derive the twiddle factor's value for  $N/2$  and  $N$  point values of DFT. (1.5)
- (h) Differentiate between FIR and IIR filters. (1.5)
- (i) What do you mean by windowing technique of digital filters? (1.5)
- (j) Draw the frequency response of a Low pass, High pass and Band pass filters. (1.5)

**PART -B**

- Q2 (a) Explain the frequency domain sampling process in detail with an example. (7.5)
- (b) Determine the relationship of DFT with other transforms. (7.5)
- Q3 (a) Two discrete sequences are given below: (7.5)
- $$x[n] = \{2, 1, 1, 0, 5\} \text{ and } h[n] = \{1, 1, 1, 1\}$$
- Determine the convolution of the sequences using
- (i) Tabular method
  - (ii) Circular method
- (b) Determine the inverse z-transform of  $X(z) = z/(3z^2 - 4z + 1)$ . If the ROC are (7.5)
- (i)  $|z| > 1$
  - (ii)  $|z| < 1/3$
  - (iii)  $1/3 < |z| < 1$
- Q4 Derive the bilinear transformation technique used to transform an analog IIR filter to digital IIR filter. (15)
- Use bilinear transformation method to obtain  $H(Z)$  for  $T = 1$  sec if:
- $$H(s) = 1/(s^2 + \sqrt{2}s + 1)$$
- Q5 (a) A filter is to be designed with following desired frequency response: (7.5)
- $$H_d(e^{j\omega}) = \begin{cases} e^{-j2\omega} & , -\pi/4 \leq \omega \leq \pi/4 \\ 0 & , \pi/4 < \omega \leq \pi \end{cases}$$
- Determine the filter coefficients  $h_d(n)$  if window function is defined as:
- $$W(n) = \begin{cases} 1 & , 0 \leq n \leq 4 \\ 0 & , \text{otherwise} \end{cases}$$
- Also, Determine the frequency response  $H(e^{j\omega})$  of designed filter.
- (b) Differentiate between Butterworth and Chebyshev filters. Also write the formula of their impulse response and draw the Gain vs Frequency graph. (7.5)
- Q6 How a system of digital filters can be designed with the help of Direct, Cascade and Parallel form. Explain with suitable example. (15)
- Q7 Write short note on with example: (15)
- (a) Z-Transform
  - (b) Multirate Digital Signal Processing