National Academy of Science and Technology

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Pre-University Examination

Level: Bachelor' Semester – Fall Year : 2024
Programme: BE Full Marks : 100
Course: Digital Signal Analysis Processing Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable. The figures in the margin indicate full marks.
Attempt all the questions.

1. a) A digital communication link carries binary-coded words representing samples of an input signal $X_a(t) = 5\cos 300\pi t + 3\cos 900\pi t$. The link is operated at 10,000 bits/s and each input sample is quantized into 1024 different voltage levels. 8

   i) What is the sampling frequency and the folding frequency?

   ii) What is the Nyquist rate for the signal $X_a(t)$?

   iii) What are different frequencies in the resulting discrete-time signals x[n]?

   iv) What is the resolution Δ?

   b) Highlighting the key features of Digital Signal processing, briefly differentiate Digital Signal Processor with Analog Signal Processor. 7

2. a) Define LTI system. Mention and explain the properties of LTI system. 8

   OR

   Show that the multiplication of two DFT sequences results in circular convolution 7

   b) What do you understand by unit step response of an LTI system? Also find the unit step response of the system whose impulse response is given as h[n] = {1, 1, 2, 3, 1}.

   OR

   Obtain a linear convolution of the following two discrete-time signals:

   x(n) ={0,1,2,3} and h(n) = 2n[u(n)-u(n-3)]

3. a) For the given system y[n] = 0.7 y[n-1] - 0.1 y[n-2] + x[n], plot the pole zero diagram and magnitude response of the system 8

   b) Determine the causal signal x[n] having Z-Transform $X(z) = 1/\{(1-2z^{-1})(1-z^{-1})^2\}$. 7

4. a) Define DFT. Also compute 4-point DFT of the following sequence: 7

   x(n) = {2, 0, 1, 2}

   b) Find 8- point DFT of the sequence. {1,-1,2,3,1,1,2,3} using radix 2 DITFFT. 8

5. a) If there is given a three stage lattice filter with coefficient $K_1 = ¼$, $K_2 = ½$, and $K_3 = 1/3$, determine the FIR filter coefficient for the direct-form structure. 8

b) Determine the lattice coefficients corresponding to the FIR filter with system function and also draw the lattice structure. 7

$$H(Z)=1+\frac{13}{24}z^{-1}+\frac{5}{8}z^{-2}+\frac{1}{3}z^{-3}.$$

6. a) Design an IIR filter by using Bi-linear transformation to meet the following specification $w_p = 0.25\pi$, $w_s = 0.55\pi$, $\alpha_s = 15$dB, $\alpha_p = 0.5$dB. 8

OR

Design a linear FIR filter using Kaiser window to meet the following

$$0.99 \leq |H(e^{j\omega})| \leq 1.01, for 0 \leq |\omega| \leq 0.19\pi$$

$$\leq |H(e^{j\omega})| \leq 0.01, for 0.21\pi \leq |\omega| \leq \pi$$

b) Draw the flowchart of Remez algorithm and explain it

7. Write short notes on (**Any Two**): 5×2

a) Gibb's Phenomena

b) Cascade structure for FIR system

c) ROC