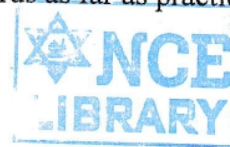


TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2081 Bhadra

Exam.	Regular
Level	BE
Programme	BCT, BEI
Year / Part	IV / I
Full Marks	80
Pass Marks	32
Time	3 hrs.

Subject: - Digital Signal Analysis and Processing (CT 704)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
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- Determine if the signal $x[n] = \cos\left(\frac{2\pi n}{5}\right) + \sin\left(\frac{\pi n}{3}\right)$ is periodic or not. If the signal is periodic, find its fundamental period. [4]
- Find the output of an LTI System with impulse response $h[n] = 2\delta[n+1] + 2\delta[n-1]$ when an input of $x[n] = \delta[n] + 2\delta[n-1] - \delta[n-3]$ is applied to it. [5]
- Define ROC of z-transform. Find the inverse z-transform using partial fraction expansion of

$$X(z) = \frac{2z^3 - 5z^2 + z + 3}{(z-1)(z-2)} \text{ for ROC } |z| < 1 \quad [1+5]$$

- Plot the pole – zero in z plane and draw magnitude response (not to the scale) of the system described by difference equation [3+7]

$$y[n] - 0.4 y[n-1] + 0.25 y[n-2] = x[n] - 0.4 x[n-1]$$

- Compute the lattice and ladder coefficients and draw lattice-ladder structure for the given IIR system [6+4]

$$H(z) = \frac{1 + z^{-1} + z^{-2}}{(1 + 0.5z^{-1})(1 + 0.3z^{-1})(1 + 0.4z^{-1})}$$

- Design a low pass FIR filter using suitable window to meet following specifications: [8]

$$0.99 \leq |H(e^{jw})| \leq 1.01 \text{ for } 0 \leq |w| \leq 0.3\pi$$

$$|H(e^{jw})| \leq 0.01 \text{ for } 0.35\pi \leq |w| \leq \pi$$

- What do you mean by optimum filter? Describe the Remez exchange algorithm for FIR filter design along with the flowchart. [1+6]

- Design a digital low pass IIR filter using Bilinear transformation to meet following specifications: [12+3]

$$0.9 \leq |H(e^{jw})| \leq 1 \text{ for } 0 \leq |w| \leq \frac{\pi}{2}$$

$$|H(e^{jw})| \leq 0.2 \text{ for } \frac{3\pi}{4} \leq |w| \leq \pi$$

Use Butterworth approximation for design with sampling frequency of 1Hz. Compare Impulse Invariance Method and Bilinear Transformation method.

- How does FFT reduce computational complexity compared to direct calculation of DFT? Compute 8-point DFT of $x[n] = \{1, -2, -4, 3, 0, 1\}$ using DIT-FFT algorithm. [2+7]

- If $X_1(k)$ and $X_2(k)$ are the 5-point DFT of $x_1(n) = 3^n$ $0 \leq n \leq 4$ and $x_2(n) = 2^n$ $0 \leq n \leq 4$. Find $x_3(n)$ if $X_3(k) = X_1(k)X_2(k)$ [6]

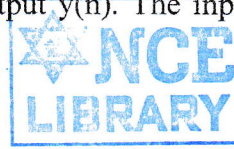
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEI, BCT	Pass Marks	32
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Subject: - Digital Signal Analysis and Processing (CT 704)

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1. A discrete time system has input $x(n)$ and output $y(n)$. The input output relation of the system is given by

$$y(n) = \sum_{k=0}^n x(k)$$



Check whether the system is memory less, time invariant and stable or not? [2+2+2]

2. Determine whether the given signal is periodic or not. If the signal is periodic, determine

the fundamental period $x[n] = e^{j\frac{\pi n}{16}} \cos\left\{\frac{n\pi}{17}\right\}$. [5]

3. Define the Region of Convergence (ROC) [1+6]

Find the inverse of $H(z) = (1 + 2z^{-1} + z^{-2}) / (1 - 0.75z^{-1} + 0.125z^{-2})$; ROC $0.25 < |z| < 0.5$

4. Plot the pole-zero on the z -plane and draw Magnitude response (not to the scale) of an LTI system described by the equation, $y(n) = x(n) + 0.8x(n-1) + 0.8x(n-2) + 0.49y(n-2)$. [3+7]

5. Draw the Lattice structure from the following system function.

$$H(z) = \frac{1}{1 - 0.2z^{-1} + 0.4z^{-2} + 0.6z^{-3}} \quad [10]$$

6. Design the symmetric FIR Low Pass Filter (LPF) for which the desired frequency response is expressed as [10]

$H_d(W) = e^{-jW\tau}$, $|W| \leq W_c$ and 0 elsewhere. The length of the filter should be 7 and $W_c = 1$ rad/sample. Make use of the Hanning window.

7. Kaiser window is to be used to design a linear phase FIR filter that meets following specification [2+2+2]

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

$$0.95 \leq |H(e^{j\omega})| \leq 1.05, \quad 0 \leq |\omega| \leq 0.19\pi.$$

Calculate the optimum value of ripple, attenuation and window length.

8. Using Bilinear transformation, design a Butterworth low pass filter which satisfies following conditions:

$$0.9 \leq |H(e^{jw})| \leq 1, \quad \text{for } 0 \leq w \leq \frac{\pi}{2}$$

$$|H(e^{jw})| \leq 0.2, \quad \text{for } \frac{3\pi}{4} \leq w \leq \pi \quad [12]$$

Consider sampling frequency of 1 Hz.

9. Compute 8-point DIF-FFT of sequence $x(n) = \{2, 1, 2, 1, 1, 2, 1, 2\}$. [8]

10. Obtain the circular convolution of the following sequences:

$$x_1(n) = \{1, 2, 3, 1\} \text{ and } x_2(n) = \{4, 3, 2, 2\} \quad [6]$$

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Subject: - Digital Signal Analysis and Processing (CT 704)

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1. A discrete-time LTI system is given by difference equation $y(n) = x(n) + e^a y(n-1)$. Check this system for BIBO stability. [5]
2. Find the output $y(n)$ of LTI system having impulse response $h(n) = \left(\frac{1}{3}\right)^n u(n-3)$ and input $x(n) = \left(\frac{1}{6}\right)^{n-6} u(n)$. [6]
3. Determine the inverse z-transform of $X(z) = \frac{1}{1-0.8z^{-1}+0.12z^{-2}}$. (i) if ROC is $|z| > 0.6$ (ii) if ROC is $|z| < 0.2$ (iii) if ROC is $0.2 < |z| < 0.6$ [2+2+3]
4. Plot the pole-zero in z plane and draw the magnitude response (not to the scale) of the system described by difference equation $y(n) = 0.67 x(n) - 0.3 x(n-1) + 2.75 y(n-1)$ [3+7]
5. a) Draw the cascaded form structure of $H(z) = 10(1-0.25z^{-1})(1-0.667z^{-1})(1+2z^{-1})/(1-0.75z^{-1})(1-0.125z^{-1})\{1-(0.5+j0.5)z^{-1}\}\{1-(0.5-j0.5)z^{-1}\}$ [5]
b) Draw the lattice structure for the given FIR filter and also check whether the system is stable. $H(z) = 1 + (13/24)z^{-1} + (5/8)z^{-2} + (1/3)z^{-3}$ [5]
6. Design a linear phase FIR filter using suitable window to meet following specifications:

$$0.99 \leq |H(e^{jw})| \leq 1.01, \quad \text{for } 0 \leq |w| \leq 0.3\pi$$

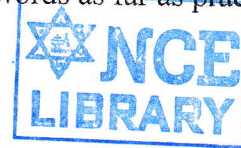
$$|H(e^{jw})| \leq 0.01, \quad \text{for } 0.35\pi \leq |w| \leq \pi$$
[10]
7. What is Gibbs phenomenon and how can it be minimized? Why Kaiser window is better than other fixed windows in FIR filter design? [3+3]
8. Differentiate between bilinear transformation and impulse invariance. Design a Butterworth digital IIR lowpass filter using bilinear transformation by taking $T = 0.1$ second, to satisfy the following specifications. [2+10]
$$0.6 \leq |H(e^{j\omega})| \leq 1, \quad 0 \leq \omega \leq 0.35\pi$$

$$|H(e^{j\omega})| \leq 0.1, \quad 0.7\pi \leq \omega \leq \pi$$
9. Why Decimation in Time Fast Fourier Transform (DITFFT) Algorithm is better than direct computation of DFT? Find 4 point DFT of the sequence $x(n) = \{2, 2, 4\}$ using DITFFT algorithm. [2+6]
10. Compute circular convolution of the following two sequences using DFT. $x(n) = \{1, 2, 4, 5\}$ and $h(n) = \{2, 1, 6, 8\}$ [6]

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1. Check whether following signals are periodic or not. If yes, state their periodic time. [2+2]
 - a) $x[n] = \sin(n\pi) + \cos(n\pi)$
 - b) $x[n] = \sin(3n\pi/5) + \cos(4n\pi/7)$
2. Find the output of LTI system having impulse response $h[n] = (1/2)^n u[n]$ and input $x[n] = 5e^{jn\pi/3}$ for $-\infty < n < \infty$. [5]
3. Define ROC. Find inverse z-transform of $X(z) = (1+2z^{-1}+z^{-2})/(1-1.5z^{-1}+0.5z^{-2})$, ROC: $|z| > 1$. [1+5]
4. Differentiate between FIR system and IIR System. The poles of a system are located at $0.45 \pm j1.6$ and zeros at $0.58 \pm j2.06$. Map the poles and zeros in the z-plane and plot the magnitude response (not in scale) of the system. [4+6]
5. Compute Lattice-ladder coefficients and draw lattice structure for given system
 $H(z) = (2 - 0.7z^{-1} + 0.5z^{-2})/(1 - 0.3z^{-1} + 0.25z^{-2})$. [6]
6. Realize the given system in Cascade Form of 2nd order section flow graph representation.
 $H(z) = \{(1 - 0.4z^{-1})(1 + 0.2z^{-1})(1 - 0.3e^{j\pi/6}z^{-1})(1 - 0.3e^{-j\pi/6}z^{-1})\} / \{(1 - 0.5e^{j\pi/3}z^{-1})(1 - 0.5e^{-j\pi/3}z^{-1})(1 + 0.7e^{j\pi/4}z^{-1})(1 + 0.7e^{-j\pi/4}z^{-1})\}$. [4]
7. In which case do we choose FIR filter and IIR filter? Design a linear phase FIR filter using Kaiser Window to meet the following specifications: [2+8]

$$0.99 \leq |H(e^{jw})| \leq 1.01 \quad \text{for } 0 \leq w \leq 0.016\pi$$

$$|H(e^{jw})| \leq 0.01 \quad \text{for } 0.08\pi \leq w \leq 2\pi$$
8. Explain in detail about how Gibb's oscillation arise while using the rectangular window in FIR filter design. [5]
9. Design a low pass digital IIR filter by Bilinear Transformation method to an approximate Butterworth low pass filter, if passband edge frequency is 0.26π radians and maximum deviation of 0.99 dB below 0 dB gain in the passband. The maximum gain of -14.99 dB and frequency is 0.58π radians in stopband, Consider sampling frequency 0.5 Hz. [11]
10. Describe digital domain Spectral Transformation features and parameters for low pass to high pass in IIR Filter design. [4]
11. How fast is FFT? Find 8-point DFT of sequence $x[n] = \{1, 1, 0, 0, 1, 1, 2\}$ using Decimation in Time Fast Fourier Transform(DITFFT) algorithm. [2+6]
12. Write the complexity of DFT and FFT? Obtain the circular convolution of the following sequences: [2+5]

$$X_1[n] = \{1, 2, 3, 1\} \text{ and}$$

$$X_2[n] = \{4, 3, 2, 2\}$$

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Year / Part	IV / I	Time	3 hrs.

Subject: - Digital Signal Analysis And Processing (CT 704)

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1. Define energy and power signal. Determine whether the signal $x[n] = \cos\left[\frac{2\pi n}{5}\right] + \sin\left[\frac{\pi n}{3}\right]$ is periodic or non-periodic and if it is periodic, find its fundamental period. [2+2]
2. Find the output of LTI system having input signal $x[n] = \delta[n] + 2\delta[n-1] - \delta[n-3]$ and $h[n] = 2\delta[n+1] + 2\delta[n-1]$. [5]
3. Find inverses Z-transform of $X(z) = (2z^4 + 2z^3 - 3z + 2)/(z^2 - 1.5z - 1)$, ROC: $|z| < 0.5$, using partial fraction expansion method. [6]
4. Plot the pole-zero in z-plane and draw the magnitude response (not to the scale) of the equation of the system describe by difference equation:
 $y[n] - 0.35y[n-1] + 0.25y[n-2] = x[n] - 0.75x[n-1]$. [3+7]
5. Draw direct form I and Direct form II realization of the following system.
 $y[n] - 0.25y[n-2] = x[n] + 0.4x[n-1] + 0.5x[n-2]$ [2+2]
6. Given a 3-stage lattice filter for all zero polynomial with coefficients $K_1 = 1/4$, $K_2 = 1/2$ and $K_3 = 1/3$. Obtain the system function and FIR filter coefficients of this filter. [6]
7. Define Gibb's phenomenon. Design the FIR filter using Kaiser window technique for the specifications: [2+8]

$$\begin{aligned} 0.899 \leq |H(e^{jw})| \leq 1 & \quad \text{for } |w| \leq 0.2\pi \\ |H(e^{jw})| \leq 0.01 & \quad \text{for } 0.4\pi \leq w \leq \pi \end{aligned}$$

8. Discuss the Remez exchange algorithm for FIR filter design. [5]
9. Design a low pass discrete time Butterworth filter using bilinear transformation having following specifications: [11+4]

Passband frequency (W_p) = 0.25π radians

Stopband frequency (W_s) = 0.55π radians

Passband ripple (δ_p) = 0.11

Stopband ripple (δ_s) = 0.21. Consider sampling frequency of 0.5 Hz.

Also, covert the obtained digital low pass filter to high pass filter with new pass band frequency, $W'_p = 0.45\pi$ using digital domain transformation.

10. Why we need FFT? Find the 8-point DFT of the following sequence using radix-2 DITFFT algorithm. [2+6]
11. If $X_1(k)$ and $X_2(k)$ are DFT of sequence $x_1[n] = \{1, 0, 0, 1\}$ and $x_2[n] = \{2, 0, 2\}$ respectively then find the sequence $X_3[n]$; if DFT of $x_3[n]$ is given by $X_3(k) = X_1(k) \cdot X_2(k)$. [7]