31 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2074 Ashwin

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

Subject: - Digital Signal Analysis and Processing *(CT704)*

- ✓ 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**.*
- ✓ *Assume suitable data if necessary.*

1. Define Energy and Power type discrete time signal. Check whether signal $x[n]=e^{j(\pi n/3+\pi/4)}$ is periodic or not. If it is periodic, state its periodic time. [2+2]

2. Find the output of LTI system having impulse response $h[n]=(1/2)^n\{u[n+2]-u[n-2]\}$ and input signal $x[n]=\{2, 1, 0.5, -1\}$. Also check the answer. [3+2]

3. State and explain the properties of a Region of Convergence (ROC). Find the inverse z-transform of $X(z)=z^2\left[1-\frac{3}{2}z^{-1}\right](1+z^{-1})(1-z^{-1})$ [3+3]

4. Plot the pole-zero in z-plane and Draw Magnitude Response (not to the scale) of the system described by difference equation
$y[n]-0.4y[n-1]+0.2y[n-2]=x[n]+0.5x[n-1]+0.6x[n-2]+0.8x[n-3]$ [3+7]

5. Draw the direct form and Lattice structure of a filter with system function
$H(z) = 1+0.7z^{-1}+1.2z^{-2}-z^{-3}$. [3+7]

6. Why Kaiser window is better than other fixed windows in FIR filter design? Find out first six coefficients of impulse response of a low pass FIR filter having Pass band edge frequency $\omega_p=0.2\pi$, Stop band edge frequency $\omega_s=0.5\pi$ and Stop band attenuation $\alpha_s=41\text{dB}$ using any appropriate window function. [2+6]

7. What is an optimum filter? Show mathematical expression of the Remez exchange algorithm for FIR filter design with flow chart. [1+6]

8. Design a low pass discrete IIR filter by Bilinear Transformation method to an approximate Butterworth filter having specifications as below: [15]

   Pass bandedge frequency $(\omega_p) = 0.27\pi$ radians
   Stop bandedge frequency $(\omega_s) = 0.58\pi$ radians
   Passband ripple $(\delta_p) = 0.11$
   Stopband ripple $(\delta_s) = 0.21$, Consider sampling frequency 0.5 Hz.

9. Compute the 8-point DFT of the sequence $x[n]=\left\{\frac{1}{2},\frac{1}{2},\frac{1}{2},\frac{1}{2},0,0,0,0\right\}$ using Decimation in Frequency Fast Fourier Transform (DIF-FFT) algorithm. [7]

10. What is a zero padding? If $X_1(k)$ and $X_2(k)$ are DFT of sequence $x_1[n] = \{1, 2, 0, 1, -2\}$ and $x_2[n] = \{1, 0, 1, 1, 2\}$ respectively then find the sequence $x_3[n]$; If DFT of $x_3[n]$ is given by $X_3(k) = X_1(k), X_2(k)$. [1+7]

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31 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Chaitra

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

Subject: - Digital Signal Analysis and Processing *(CT704)*

- ✓ 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**.*
- ✓ *Assume suitable data if necessary.*

1. Plot the sequence $x[n]=u[n]-u[n-3]+5\delta[n-4]=nu[n-6]$. List out the properties of LTI system. [3+2]
2. Determine whether the following system are: [3+3]
   a) $y[n]=y[n-4]+x[n-4]$ is Time-invariant or not
   b) $y[n]=x^2[n]$ is Linear or Nor-linear
3. Define a ROC. What are the properties of ROC of z-transform? Find the inverse Z-transform of $X(z)=(2z^2+2z^2+3z+5)/(z^2-0.1z-0.2)$, ROC : $|z|<0.4$. [1+3+5]
4. The poles of a system are located at: 0.45-0.77i and -2±0.3i. Map the poles and zero in the z-plane and plot the magnitude response of the system. [2+8]
5. Obtain the Direct Form I and Direct Form II realization of the following system. [5]
   $3y[n]+y[n-1]+2y[n-4]=2x[n]+x[n-3]$
6. Determine the lattice coefficients coefficients corresponding to the FIR filter with the system function: [5]
   $$H(z)=A_3(z)=1+\frac{52}{96}z^{-1}+\frac{25}{40}z^{-2}+\frac{1}{3}z^{-3}$$
7. Design a digital low-pass filter with the following specification: [12]
   i) Pass-band magnitude constant to 0.7 dB below the frequency of 0.15π
   ii) Stop-band attenuation at least 14 dB for the frequencies between 0.6π to π
   Use Butter worth approximation as a prototype and use impulse invariance method to obtain the digital filter.
8. Design a FIR linear phase filter using Kaiser window that meets the following specifications: [9+3]
   $|H(e^{jw})|\le 0.01,\ 0\le |w|\le 0.25\pi$
   $0.95\le |H(ejw)|\le 1.05,\ 0.35\pi\le|w|\le 0.6\pi$
   $|H(e^{jw})|\le 0.01,\ 0.65\pi\le |w|\le \pi$
   Also determine the minimum length (M+1) of the impulse response and Kaiser window parameter β.
9. Why do we need DFT? Draw the butterfly structure to compute the DFT of the following signal using Radix-2 DIFFFT algorithm, and compute X(2) and X(1) only $x[n]=\{1.5,-1,1.8,0.6,3,1.7\}$ [3+7]
10. Define zero padding. Find the linear convolution through circular convolution with padding of zeros for the following sequences: $x[n]=\{1,1,1,1\}$ and $h[n]\{2,3\}$. [1+5]

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Examination Control Division

2073 Shrawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCT	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Digital Signal Analysis and Processing *(CT704)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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1. Explain the process of calculating fourier series coefficients. [3]
2. Determine the system output y(n) of the following signals: $h(n) = \{1,1,1\}$ and $x(n) = \{1,1,1,1\}$ [6]
3. Define a ROC. Find inverse Z-transform of $X(z) = z/\{(z-0.4)(z+1.5)^2\}$, ROC: $|z| < 0.4$ [1+5]
4. State linear constant coefficient difference equation and corresponding system function.

   Determine the output sequence of the system with impulse response $h[n] = (1/2)^n u[n]$ when the input signal is $x[n] = 10 - 5\sin(\pi n/2) + 20\cos\pi n \quad -\infty < n < \infty$. [3+7]
5. The system function of a filter is $H(z) = 2 + 1.8z^{-1} - 1.6z^{-2} + z^{-3}$. Draw the Direct Form and Lattice Structure implementation of the above filter. [3+7]
6. Explain in detail about how rectangular window is used in FIR filter design. How Gibb's oscillations arise in this process. [6]
7. Explain about Remaz exchange algorithm with suitable derivation and flow chart. [9]
8. Using bilinear transformation, design a butterworth low pass filter which satisfies the following Magnitude Response. [12]

   $0.89125 \le |H(e^{jw})| \le 1 \quad$ for $0 \le \omega \le 0.2\pi$

   $|H(e^{jw})| \le 0.17783 \quad$ for $0.3\pi \le \omega \le \pi$
9. Explain briefly about bilinear transformation method of IIR filter design. [3]
10. Why do we need DFT? Find 8-point DFT of sequence $x[n] = \{1,-1,2,2,1,1,2,2\}$ using Fast Fourier Transform algorithm. [2+6]
11. Find $x_3[n]$ if DFT of $x_3[n]$ is given by $X_3(k) = X_1(k)\,X_2(k)$ where $X_1(k)$ and $X_2(k)$ are 5-point DFT of $x_1[n] = \{1,-2,2,1,4\}$ and $x_2[n] = \{2,1,-3,-1\}$ respectively. [7]

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31 TRIBHUVAN UNIVERSITY INSTITUTE OF ENGINEERING **Examination Control Division** **2073 Chaitra**	**Exam.**		**Regular**	
	Level	BE	**Full Marks**	80
	Programme	BCT	**Pass Marks**	32
	Year / Part	IV / I	**Time**	3 hrs.

Subject: - Digital Signal Analysis and Processing *(CT704)*

- ✓ 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**.*
- ✓ *Assume suitable data if necessary.*

1. Define and plot a discrete time unit step signal. Explain its relation with unit impulse signal. [1+2]
2. Calculate y[n], if x[n] is x[-2] = 0.5, x[0] = 1, x[1] = 0.75, x[3] = 0.5 and n[n] is n[0] = 1, n[1] = 0.75 and n[2] = 0.5 and verify your result. [6]
3. Define a ROC. Find inverse Z-transform of $X(z) = (2z^3+2z^2+3z+5) / (z^2-0.1z-0.2)$, ROC: $|z| < 0.4$ [1+5]
4. Define the difference equation with example. The Poles of a system are located at:- $0.45 + 0.77i$ and $2 \pm 0.7i$ and zeros at: $1.2 \pm 0.43i$. Plot the magnitude response of this system. [2+8]
5. Draw the Lattice Structure from the following system function: [10]

$$\frac{1+\frac{1}{3}z^{-1}+\frac{9}{8}z^{-2}+\frac{4}{3}z^{-3}+z^{-4}}{1+\frac{2}{3}z^{-1}+\frac{5}{8}z^{-2}+\frac{2}{3}z^{-3}+z^{-4}}$$

6. Design a digital Butterworth low pass filter satisfying the constraints

$$\begin{cases} 0.707 \le |H(e^{jw})| \le 1 & 0 \le w \le \frac{\pi}{2} \\ |H(e^{jw})| \le 0.2 & \frac{3\pi}{4} \le w \le \pi \end{cases}$$

With T = 1sec using bilinear transformation method. Realize the filter using the most convenient realization form. [11+4]

7. Design an FIR linear phase filter using Kaiser window to meet the following specifications: [8]

$$0.98 \le |H(e^{jw})| \le 1.02, for\ 0 \ge w \ge 0.9\pi$$

$$|H(e^{jw})| \le 0.01, for\ 0.14\pi \le w \le \pi$$

8. Draw the Howchart of Remez-Exchange theorem and explain it. [7]
9. Why we need FFT? Find 8-point DFT of sequence x[n] = {1, -1, 3, 2, 1, 1, 3, -2} using Decimation in frequency Fast Fourier Transform (DIFFFT) algorithm. [2+6]
10. Find $x_3[n]$ if DFT of $x_3[n]$ is given by $X_3(k) = X_1(k)\ X_2(k)$ where $X_1(k)$ and $X_2(k)$ are 5-point DFT of $x_1[n]$ = {1, -2, 5, 1, 2} and $x_2[n]$ = {1, 2, -3, -2} respectively. [7]

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INSTITUTE OF ENGINEERING

Examination Control Division

2072 Kartik

Exam.	**New Back (2066 & Later Batch)**		
Level	BE	**Full Marks**	80
Programme	BCT	**Pass Marks**	32
Year / Part	IV / I	**Time**	3 hrs.

Subject: - Digital Signal Analysis and Processing *(CT704)*

- ✓ 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**.*
- ✓ *Assume suitable data if necessary.*

1. Define energy and power signal. Check the signal $x[n] = u[n]$ and $x[n] = \delta[n]$ is Energy or Power type. [2+3]

2. Find the output of LTI system having impulse response $h[n] = (1/3)^n \{u[n+1]-u[n-2]\}$ and input signal $x[n] = \{2,1,0.5,3\}$. [5]

3. State the properties of region of convergence (ROC). Drive the convolution property of Z-transform. [3+3]

4. Find the output of LTI System having impulse response $h[n] = (1/2)^n u[n]$ and input signal $x[n] = 5e^{j\pi n/3}$ for $-\infty < n < \infty$. [4]

5. Plot Magnitude Response (not to the scale) of the system described by difference equation. [6]

   $y[n]-0.5y[n-1]+0.3y[n-2] = x[n]+0.7x[n-1]$

6. Determine the Direct Form II realization of the following system [4]

   $y(n) = -0.1y(n-1)+0.72y(n-2)+0.7x(n)-0.252x(n-2)$

7. Compute the lattice coefficients and draw the lattice structure of following FIR system [6]

   $H(z) = 1+2z^{-1}-3z^{-2}+4z^{-3}$

8. Draw the flowchart of Remez-Exchange theorem and explain it. Design an FIR linear phase filter using Kaiser window to meet the following specifications: [6+8]

   $0.99 \le |H(e^{jw})| \le 1.01, \text{for } 0 \ge w \ge 0.19\pi$

   $|H(e^{jw})| \le 0.01, \text{for } 0.21\pi \le w \le \pi$

9. Design a low pass digital filter by Bilinear Transformation method to an approximate Butterworth filter, if passband edge frequency is 0.25 π radians and maximum deviation of 1 dB below 0 dB gain in the passband. The maximum gain of -15 dB and frequency is 0.45 π radians in stopband, Consider sampling frequency 1Hz. [15]

10. Find 8-point DFT of sequence $x[n] = \{1,1,0,1,0,1,2\}$ using Decimation in Time Fast Fourier Transform (DITFFT) algorithm. [7]

11. Why we need DFT? If $X_1(k)$ and $X_2(k)$ are DFT of sequence $x_1[n] = \{1,2,4\}$ and $x_2[n] = \{-1,2,3,1\}$ respectively, then find the sequence $x_3[n]$, if DFT of $x_3[n]$ is given by $X_3(k) = X_1(k)\, X_2(k)$. [2+6]

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31 TRIBHUVAN UNIVERSITY

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2072 Chaitra

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Subject: - Digital Signal Analysis and Processing *(CT704)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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1. How fourier series coefficients are calculated? Explain. [4]
2. Find the output of LTI system having impulse response h[n] with h[-2] = 1, h[0] = 2, h[1] = 3 and input signal x[n] with x[0] = 1/2 , x[2] = 2, x[3] = 3. Also check the answer. [3+2]
3. Explain the properties of Region of Convergence with examples. [6]
4. Describe stability and causality characteristics of LTI system in terms of Impulse Response and ROC of its transfer function with suitable examples. [4]
5. Plot the pole-zero in z-plane and Draw Magnitude Response (not to the scale) of the system described by difference equation. [2+4]

   $y[n]-0.4y[n-1]+0.1y[n-2]=x[n]+0.6x[n-1]$
6. Determine the Direct Form I and Direct Form II realization of the following system. [5]

   $y(n)=-0.1y(n-1)+0.2y(n-2)+3x(n)+3.6x(n-2)+0.6x(n-2)$
7. Compute the lattice coefficients and draw the lattice structure of following FIR system. [5]

   $H(z)=1+2z^{-1}+z^{-2}$
8. Describe how digital FIR filter can be design by window method. Why Kaiser window is better than other fixed windows in FIR filter design? [5+3]
9. What is an optimum filter? Show mathematical expression of Remez exchange algorithm for FIR filter design. [1+6]
10. Explain about the advantages of selecting bilinear transformation method over impulse invariance method (I I M). Design a digital low pass Butterworth filter using impluse invariant transformation with pass band and stop band frequencies 200Hz and 500Hz respectively. The pass band and stop band attenuation are -5dB and -12dB respectively. The sampling frequency is 5kHz. Use IIM method. [3+12]
11. Find the FFT of the signal x[n]{1,1,2,4,3,1,2,1} using DIT-FFT algorithm. [8]
12. Compute Circular Convolution of h(n) = {1, 2, 1, -1, 1} and x[n] = {1, 2, 3, 1}. [7]

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36 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Shawan

Exam.	New Back (2066 & Later Batch)		
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Subject: - Digital Signal Analysis and Processing *(CT704)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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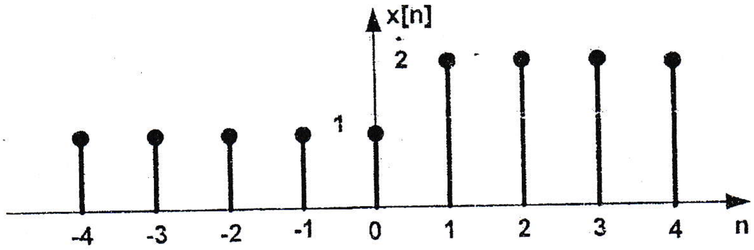
1. Find the odd and even part of the following signal: [4+5]



A discrete time LTI system has input signal and impulse response as,

$x[n] = \begin{cases} 1 & -1 \le n \le 1 \\ 0 & elsewhere \end{cases}$ and $h[n] = \begin{cases} 1 & -1 \le n \le 1 \\ 0 & elsewhere \end{cases}$ Find the output of the system using graphical method,

2. Find the inverse z transform of: [6]

$X(Z) = (1+2z^{-1}+z^{-2})/(1+1.5z^{-1}+0.5z^{-2})$, $|z| > 1$

using partial fraction method.

3. Why do we need difference equation? State linear constant coefficient difference equation and corresponding system function. [2+3+5]
Consider an LTI system with impulse response $h[n]=(1/2)^n u[n]$. Determine y[n], if the input is $x[n] = Ae^{in\pi}$

4. If a 3 stage lattice filter for all pole polynomial has coefficients. [5]

$K_1 = \frac{1}{4}, K_2 = \frac{1}{2}$ and $K_3 = \frac{1}{3}$ Obtain the system function of this filter.

5. What is the importance of quantization in Digital Signal Processing? Which one is better rounding or truncation? Explain about limit cycles in recursive system? Define dead band. [1+1+2+1]

6. Explain in detail about how rectangular window is used in FIR filter design. How Gibb's oscillations arise in this process. [6]

7. What is a Remez exchange algorithm? Derive its equation and draw its flow chart. [9]

8. Design a low pass digital filter by Bilinear Transformation method to an approximate Butter worth filter it passband frequency is 0.2π radians and maximum deviation of 1 db below 0 dB gain in the pass band. The maximum gain of -15 db and frequency is 0.4π radians in stop band, consider sampling frequency 1 Hz. [15]

9. A system has input signal x[n] = {1,2,3,4} and impulse response h[n] = {1,3,5,7} and the DFT of x[n] is X[k] and the DFT of h[n] is H[k]. Find the output of the system y[n] if G[k] = X[k].H[k] [7]

10. Find DFT for {1, 1, 2, 0, 1, 2, 0, 1} using FFT DIT butterfly algorithm and plot the spectrum. [6+2]

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2071 Chaitra

Exam.		Regular	
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1. Find the even and odd part of signal x[n], [3]

$$x[n]=\begin{cases}1 & \text{for } -4\le n\le 0\\ 2 & \text{for } 1\le n\le 4\end{cases}$$

2. A discrete time LTI system has impulse response $h(n)=\{1,3,2,-1,1\}$ for $-1 \le n \le 3$. Determine the system output y(n) if the input x(n) is given by $x(n) = 2\delta(n) - \delta(n-1)$. [6]

3. Define ROC. Find inverse Z-transform of [1+5]

$X(z)= 1/\{(z - 0.5)(z+2)\}$, if
   i) ROC: $0.5 < |z| < 2$
   ii) ROC: $|z| < 0.5$
   iii) ROC: $|z| > 2$

4. The poles of a system are located at: 0.45+0.77i and $-2 \pm 0.3i$ and zeroes at: $1.2 \pm 3i$. Map the poles and zero in the z-plane and plot the magnitude response of the system. [2+8

5. Compute Lattice coefficients and draw lattice structure for given IIR system $H(z) = 1/(1-0.01z^{-1} - 0.23z^{-2}+0.5z^{-3})$. Also check the stability of given system. [4+2+1]

6. What is limit cycle effect in recursive system? Describe with one example showing how it occurs. [3]

7. Design a low pass FIR filter having Pass band edge frequency $\omega_p = 0.3\pi$, Stop band edge frequency $\omega_s = 0.5\pi$ and Stop band attenuation $\alpha_s = 40$ dB using any appropriate window function. [8]

8. What is optimum filter? Show mathematical expression of Remez exchange algorithm for FIR filter design. [1+6]

9. What is the advantage of bilinear transformation? Design a low pass discrete time Butterworth filter applying bilinear transformation having specifications as follows: [2+9+4]
   Pass band frequency (w_p) = 0.25 π radians
   Stop band frequency (w_s) = 0.55 π radians
   Pass band ripple (δ_p) = 0.11
   and stop band ripple (δ_s) = 0.21
   Consider sampling frequency 0.5 Hz.

   Also, convert the obtained digital low-pass filter to high-pass filter with new pass band frequency (w'_P) = 0.45 π using digital domain transformation.

10. Why do we need Discrete Fourier Transform (DFT) although we have Discrete-time Fourier Transform (DTFT)? Find circular convolution between x[n] = {1, 2} and y[n] = u[n] –u[n-4]. [2+5]

11. How fast is FFT? Draw the butterfly diagram and compute the value of X(7) using 8 pt DIT-FFT for the following sequences: [2+6]
    x(n) = {1, 0, 0, 0, 0, 0, 0, 0}

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36 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2070 Ashad

Exam.	New Back (2066 & Later Batch)		
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Subject: - Digital Signal Analysis and Processing *(CT704)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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1. Find the even and odd part of signal x[n], [3]

$$x[n]=\begin{cases}1 & \text{for } -4\le n\le 0\\ 2 & \text{for } 1\le n\le 4\end{cases}$$

2. Illustrate the significance of convolution summation in digital signal analysis. Compute the convolution of the following signals: $h(n)=\{1,0,1\}$ and $x(n)=\{1,-2,-2,3,4\}$ [2+4]

3. Define Region of Convergence. Find inverse Z - transform of $X(z)=z/\{(z-1)(z-2)^2\}$, ROC: $|Z|<1$ [1+5]

4. Given H(z) for a system with the following difference equation: [2+6+2]
$$y(n)=x(n)+x(n-2)$$
Plot its poles and zeros in Z plane. Determine its magnitude response. Also, determine whether system is causal and stable.

5. Draw lattice structure for given pole - zero system [6]
$H(z)=(0.5+2z^{-1}+0.6z^{-2})/(1-0.3z^{-1}+0.4z^{-2})$

6. What do you mean by Limit Cycle? How it occurs in recursive system? [1+3]

7. What is the condition satisfied by Linear phase FIR filter? Show that the filter with $h(n)=\{-1,0,1\}$ is a linear phase filter. [2+4]

8. Use Hanning window method to design a digital low-pass FIR filter with pass-band edge frequency $(w_p)=0.25\pi$, stop-band edge frequency $(w_s)=0.35\pi$ where main lobe width of Hanning window is $8\pi/M$, M is the filter length. [9]

9. Why Spectral Transformation is required? [2]

10. Design a low pass digital filter by impulse invariance method to an approximate Butterworth filter, if passband edge frequency is 0.2 π radians and maximum deviation of 0.5 dB below 0 dB gain in the passband. The maximum gain of -15 dB and frequency is 0.35 π radian in stopband, consider sampling frequency 1Hz. [13]

11. Why do we need Discrete Fourier Transform (DFT) although we have Discrete-time Fourier Transform (DTFT)? Find circular convolution between [2+5]
$x[n]=\{1,2\}$ and $y[n]=u[n]-u[n-4]$.

12. How fast is FFT? Draw the butterfly diagram and compute the value of x(7) using 8 pt DIT-FFT for the following sequences: [2+6]
$x(n)=\{1,0,0,0,0,0,0,0\}$

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2070 Chaitra

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Subject: - Digital Signal Analysis and Processing *(CT704)*

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- ✓ *Attempt **All** questions.*
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1. Determine which of the following signals are periodic and compute their fundamental period: [3]
   i) $\cos(\pi n^2/8)$
   ii) $\cos(n/2)\cos(\pi n/4)$
2. Find output, y(n) when: h(n) = {5,4,3,2} and x(n) = {1,0,3,2} [6]
3. List out the properties of Region of Convergence. Find the Z-transform and locate the ROC of the signal. [2+4]
   $$x[n]=\left(-\frac{1}{3}\right)^n u[n]-\left(\frac{1}{3}\right)^n u[-n-1]$$
4. Find the output of LTI System having impulse response [4]
   $h[n] = (1/3)^n u[n]$ and input signal $x[n] = 5e^{j\pi n/2}$ for $-\infty < n < \infty$.
5. Plot Magnitude Response (not to the scale) of the system described by difference equation. $y[n] - 0.3y[n-1] + 0.225y[n-2] = x[n] + 0.5x[n-1]$ [6]
6. Determine the Cascade Form realization of the following system. [4]
   $$y[n]-\frac{3}{4}y[n-1]+\frac{1}{8}y[n-2]-x[n]-2x[n-1]=0$$
7. Compute the lattice coefficients and draw the lattice structure of following FIR system
   $H(z)=1+3.1z^{-1}+5.5z^{-2}+4.2z^{-3}+2.3z^{-4}$ [6]
8. Describe how FIR filter can be designed by window method. Discuss the characteristics of different type of window function. [4+4]
9. What is an optimum filter? Show mathematical expression of Remez exchange algorithm for FIR filter design. [1+6]
10. Using bilinear transformation method, design a digital filter using Butterworth approximation which satisfiers the following conditions: [10]
    $$0.8 \le \left|He^{jw}\right| \le 1 \quad \text{for } 0 \le w \le 0.2\pi$$
    $$\left|He^{jw}\right| \le 0.2 \quad \text{for } 0.6\pi \le w \le \pi$$
11. A digital LPF with cut off frequency $w_c = 0.2575\pi$ is given as $H(Z)=\dfrac{0.1+0.4z^{-1}}{1-0.6z^{-1}+0.1z^{-2}}$
    Design a digital high pass filter with $w'_c = 0.3567\pi$. [5]
12. Define Padding zones. Find 8-point DFT of sequence. [1+6]
    x[n] = {1,1,0,0,1,1,2} using Decimation in Time Fast Fourier Transform (DITFFT) algorithm.
13. Why we need DFT? State and prove Circular Convolution property of DFT. [2+2+4]

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INSTITUTE OF ENGINEERING
Examination Control Division
2069 Chaitra

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

Subject: - Digital Signal Analysis and Processing *(CT704)*

- ✓ 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**.*
- ✓ *Assume suitable data if necessary.*

1. Define Energy and Power type signal with suitable example. Check the signal $x[n]=Cos(2n\pi/5) + Sin(\pi\, n/3)$ is periodic or not. [2+2]
2. Define LTI system. Find the output of LTI system having impulse response $h[n] = 2u[n] - 2u[n-4]$ and input signal $x[n] = (1/3)^n\ u[n]$. [1+4]
3. State the properties of region of convergence (ROC)? Derive the time shifting property of Z-transform. [3+3]
4. Why do we need Difference Equation? Draw Pole-zero in Z-Plane and plot magnitude response (not to the scale) of the system described by difference equation [2+2+6]
$y[n]-0.4\,y[n-1] +0.2y[n-2] = x[n] + 0.1x[n-1] -0.06x[n-2]$
5. Determine the Direct Form II realization of the following system $y(n) = -0.1y(n-1) + 0.72y(n-2) + 0.7x(n) - 0.252x(n-2)$ [4]
6. Compute the lattice coefficients and draw the lattice structure of following FIR system $H(z) = 1+2z^{-1} - 3z^{-2} + 4z^{-3}$ [6]
7. Design a digital FIR filter for the design of the low pass filter having $\omega_p = 0.3\pi$, $\omega_s = 0.5\pi$, $\alpha_s = 40$ dB using suitable window function. [8]
8. What is optimum filter? Describe Remez exchange algorithm for FIR filter design with flow chart. [1+6]
9. What is the advantage of bilinear transformation? Design a low pass discrete time Butterworth filter applying bilinear transformation having specifications as follows: [2+9+4]

   Pass band frequency $(w_p) = 0.25\pi$ radians
   Stop band frequency $(w_s) = 0.55\pi$ radians
   Pass band ripple $(\delta_p) = 0.11$
   And stop band ripple $(\delta_s) = 0.21$

   Consider sampling frequency 0.5Hz

   Also, convert 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 do we need FFT? Find 8-point DFT of sequence $x[n] = \{1,1,2,2,1,1,2,1\}$ using Decimation in frequency FFT (DIFFT) algorithm. [2+7]
11. Find $x_3[n]$ if DFT of $x_3[n]$ is given by $X_3(k) = X_1(k)\, X_2(k)$ where $X_1(k)$ and $X_2(k)$ are 4-point DFT of $x_1[n] = \{1,2,-2\}$ and $x_2[n] = \{1,2,3,-1\}$ respectively. [6]

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