34 TRIBHUVAN UNIVERSITY
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 $x[n] = 5e^{j\pi n/2}$ 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]

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

   $|H(e^{jw})| \le 0.01$, 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 0.25π radians and maximum deviation of 1 dB below 0 dB gain in the passband. The maximum gain of -15 dB and frequency is 0.45π radians in stopband; Consider sampling frequency 1 Hz. [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 $X_3(k) = X_1(k) \cdot X_2(k)$. [2+6]

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TRIBHUVAN UNIVERSITY INSTITUTE OF ENGINEERING	Exam.	[illegible]		
Examination Control Division	Level	BE	Full Marks	80
2071 Shawan	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**.*
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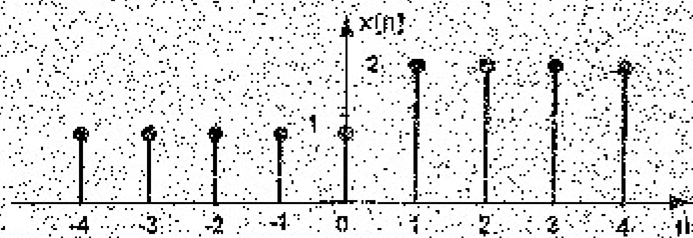
1. Find the odd and even part of the following signal: [4+5]



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 $x[n] = Ae^{jn\pi}$.

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 if 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]

5

37. TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Chaitra

Exam.	[redacted]		
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. 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 $(w_p) = 0.25\,\pi$ 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 0.5 Hz.

   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 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]

    $x(n) = \{1, 0, 0, 0, 0, 0, 0, 0\}$

6

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36 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 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.*
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- ✓ *Assume suitable data if necessary.*

1. Determine which of the following signals are periodic and compute their fundamental period: [3]
   i) $\text{Cos}(\pi n^2/8)$
   ii) $\text{Cos}(n/2)\cos(\pi n/4)$
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. $y[n] - 0.3\,y[n-1] + 0.225y[n-2] = x[n] - 0.5x[n-1]$ [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]
    $$0.8 \le |He^{jw}| \le 1 \qquad \text{for } 0 \le w \le 0.2\pi$$
    $$|He^{jw}| \le 0.2 \qquad \text{for } 0.6\pi \le w \le \pi$$
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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41 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Bhadra

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

Subject: - Digital Signal Analysis and Processing *(EG774CT)*

- ✓ 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 $x[n] = u[n+8] - u[n-4]$. [3]

2. What is the period of following signals? [4]
   (a) $x[n] = \cos\left(\frac{11\pi}{3}n\right)$
   (b) $x[n] = e^{j\frac{7}{5}n}$

3. What is a sampling? How are the spectrum of continuous time signal and the spectrum of signal obtained by sampling the continuous time signal related? Illustrate with diagram. [6]

4. Write about the following properties of discrete time system: [a] linearity, [b] time invariance, [c] memory, [d] causality [e] stability. [5]

5. Find the frequency response $H(e^{j\omega})$ of the system characterized by difference equation $y[n] - 0.8\,y[n-1] + 0.15\,y[n-2] - x[n] = 0$. Plot the frequency response of the system. [6]

6. Realize the system function
$$H(z) = \frac{1}{(1-0.5z^{-1})\left(1-0.7e^{-j\frac{\pi}{4}}z^{-1}\right)\left(1-0.7e^{j\frac{\pi}{4}}z^{-1}\right)(1-0.3z^{-1})}$$
in terms of cascade of second order sections. Draw the block diagram of the cascade realization. [6]

7. Write about the sign magnitude and 2's complement representation of binary fractional number. Write about truncation error and rounding error. [6]

8. Describe digital Butterworth filter design using impulse invariance technique. What are the limitations of impulse invariance technique? [15]

9. Derive the expression for frequency response of symmetric linear phase filter of length M, where M is odd. [6]

10. Use the Hanning window to design a digital low-pass FIR filter with Pass band frequency $(\omega_p) = 0.25\pi$ and Stop band frequency $(\omega_s) = 0.3\pi$. [8]

11. Perform circular convolution of the sequences $x[n] = [1\ \ 0\ \ 1]$ and $h[n] = [1\ \ 0\ \ 2\ \ 1]$. [5]

12. Write about multiplication and convolution property of Discrete Fourier Transform. [6]

13. Draw the flow diagram of four point decimation in time Fast Fourier Transform algorithm. [4]

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41 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2068 Bhadra

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

Subject: - Digital Signal Analysis and Processing

- ✓ 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. Find the energy and power of the signal $x[n] = u[n]$. [5]

2. Find the period of the signal $x[n] = \sum_{n=-\infty}^{\infty} \delta[n-2-3m]$. Find the Fourier series coefficients of the signal $x[n]$. [6]

3. State whether or not the system $y[n] = e^{x[2n]}$ is (a) linear (b) time invariant (c) memoryless (d) causal. Where x[n] is input to system and y[n] is output of system. [5]

4. Convolve the sequences $x[n] = 3^n u[-n-5]$ and $y[n] = u[n-5]$. [5]

5. Find the frequency response of the linear time invariant system characterized by difference equation $y[n] - \frac{10}{24}y[n-1] + \frac{1}{24}y[n-2] = x[n]$. If input to the system is $x[n] = \sin\left(\frac{\pi}{3}n\right) + \sin\left(\frac{\pi}{5}n\right)$ then determine output y[n] of the system. [7]

6. Realize the overall system function: [9]

$$H(z) = \frac{(1-\frac{1}{5}e^{-j\frac{\pi}{5}}z^{-1})(1-\frac{1}{3}z^{-1})(1-\frac{1}{5}e^{j\frac{\pi}{5}}z^{-1})}{(1-\frac{4}{5}z^{-1})(1-\frac{1}{7}e^{j\frac{\pi}{7}}z^{-1})(1-\frac{1}{5}z^{-1})(1-\frac{1}{7}e^{-j\frac{\pi}{7}}z^{-1})}$$

In terms of direct from I and direct from II structures. Draw the corresponding block diagrams of direct from I and direct from II structures.

7. How the spectrum of continuous time signal is related to spectrum of corresponding discrete time signal obtained by sampling the continuous time signal? Explain. Discuss what is aliasing and how it occurs. [8]

8. If passband edge frequency $\omega_p = 0.25\pi$, stopband edge frequency $\omega_s = 0.45\pi$, passband ripple $\delta_p = 0.17$ and stopband ripple $\delta_p = 0.27$ then design a digital lowpass Butterworth filter using bilinear transformation technique. [18]

9. Use Blackman window method to design a digital low-pass FIR filter with passband edge frequency $\omega_p = 0.24\pi$, stopband edge frequency $\omega_s = 0.34\pi$ where main lobe width of Blackman window is $\frac{12\pi}{M}$, M is filter length. [9]

10. Use the Fast Fourier Transform decimation in frequency algorithm to find the discrete Fourier Transform of the sequence x[n] = [1 -2 2 1]. [8]

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36 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Ashad

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. 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:
$$y(n)=x(n)+x(n-2)$$ [2+6+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) = 0.25π, stop-band edge frequency (w_s) = 0.35π where main lobe width of Hanning window is 8π/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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36 TRIBHUVAN UNIVERSITY
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.*
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1. Define Energy and Power type signal with suitable example. Check the signal $x[n]=\text{Cos}(2n\pi/5)+\text{Sin}(\pi n/3)$ 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]
   $y[n]-0.4y[n-1]+0.2y[n-2]=x[n]+0.1x[n-1]-0.06x[n-2]$
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) = 0.25π radians
   Stop band frequency (w_s) = 0.55π radians
   Pass band ripple (δ_p) = 0.11
   And stop band ripple (δ_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) = 0.45π 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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41 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2067 Mangsir

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

Subject: - Digital Signal Analysis and Processing

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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1. Compute and plot even and odd component of the sequence $x(n) = 2u[n] - 2u[n-4]$ where u[n] is unit step sequence. [2]
2. Write whether or not the following sequences are periodic and write the period. [4]

   a) $x[n] = \cos\left(\frac{5\pi}{3} n\right)$

   b) $x[n] = \sin\left(\frac{\pi n}{\sqrt{2}} + \frac{\pi}{8}\right)$

3. Find the discrete Fourier coefficients of the periodic sequence with period N = 11 defined over a period as $x[n] = \begin{cases} 1, & |n| \le 2 \\ 0, & 2 < |n| \le 5 \end{cases}$ [4
4. Show whether or not the system $y(n) = nx[2(n-2)]$, $n > 0$ is (a) linear, (b) time invariant, (c) memoryless. [
5. Find the system function H(z) of the system characterised by difference equation $y[n] - \frac{5}{6} y[n-1] - \frac{1}{6} y[n-2] - x[n] = 0$. Find the poles and zeros of the system. Use the pole-zero diagram to plot the approximate frequency response magnitude of the system. [1
6. Realize the system function $H(z) = \dfrac{\left(1-\frac{1}{3}z^{-1}\right)\left(1-\frac{1}{4}z^{-1}\right)\left(1-\frac{1}{8}z^{-1}\right)}{\left(1-\frac{5}{6}z^{-1}\right)\left(1-\frac{1}{6}z^{-1}\right)\left(1-\frac{3}{4}e^{-j\frac{\pi}{4}}z^{-1}\right)\left(1-\frac{3}{4}e^{-j\frac{\pi}{4}}z^{-1}\right)}$ in terms of cascade of second order sections. Draw the block diagram of the cascade realization.
7. Show by giving examples that the quantization error by truncation for sign magnitude number, e_{tsm}, lies in the range $-(2^{-b} - 2^{-b_u}) \le e_{tsm} \le (2^{-b} - 2^{-b_u})$ and that for the 2's complement number, e_{t2c}, lies in the range $-(2^{-b} - 2^{-b_u}) \le e_{t2c} \le 0$. b_u is the number of bits before quantization and b is the number of bits after quantization.
8. How does an IIR filter differ from an FIR filter?

9. Find the system function for digital filter using impulsive invariance technique from the analog Butterworth filter transfer function $H(s) = \dfrac{1}{(s+1.3)(s-1.3e^{j\frac{2\pi}{3}})(s-1.3e^{-j\frac{2\pi}{3}})}$, $T = 1$ second, and draw the block diagram of the system function, $H(z)$, realized in terms of second order sections. [12]

10. Show that the filter with impulse response $h[n]$, $0 \le n \le N-1$, where $h[n] = h[N-1-n]$, is a linear phase filter. [6]

11. Use the window method to design a digital low-pass FIR filter with Pass band frequency $(\omega_p) = 0.35\pi$, Stop band frequency $(\omega_s) = 0.45\pi$ with stop-band attenuation of at least 54dB. [8]

12. Perform circular convolution of the sequences $x_1[n] = [1,2,1]$, $0 \le n \le 2$ and $x_2[n] = [1,2,0,1]$, $0 \le n \le 3$. [5]

13. The duality property of Discrete Fourier Transform (DFT) is, if $x[n] \xrightarrow{DFT} X[k]$ then $X[n] \xrightarrow{DFT} nx[[-k]]_N$. For input sequence $x[n]$ an algorithm can compute DFT using the formula $X[k] = \sum_{n=0}^{N-1} x[n]e^{-j\frac{2\pi}{N}kn}$. How can this same formula be used to find inverse discrete Fourier transform (IDFT) of input sequence as $X[k]$ with output sequence as $x[n]$ (use duality property)? [8]

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32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2066 Magh

Exam.	Regular/Back		
Level	BE	Full Marks	80
Programme	BCT (059 & Later Batch)	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Digital Signal Analysis and Processing

- ✓ 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 $x(n) = u(n) - u(n-5) + 5\delta(n-6) + nu(n-7) - nu(n-9)$ where $u(n)$ is the unit step sequence and $\delta(n)$ is unit sample sequence. [2]

2. Write whether or not the following sequences are periodic and write the period. [4]

   a) $x(n) = \cos\left(\frac{3\pi}{8}n + \frac{\pi}{4}\right)$

   b) $x(n) = \text{sing}(0.8n)$

3. Find the expression for discrete Fourier series of the sequence. [4]

   $$x(n) = \sum_{m=-\infty}^{\infty} \delta(n-4m).$$

4. Show whether or not the following systems are (a) linear, (b) time invariant, (c) causal, (d) memoryless, (e) BIBO stable. [10]

   a) $y(n) = 2^{\log_2\{x(n)\}} + 2^{\log_2(x(n))}$

   b) $y(n) = \sin\{x(n) - x(n-1)\}$

5. Perform circular convolution of the sequences $x_1(n) = [1,2],\ 0 \le n \le 1$ and $x_2(n) = [1,2,4,5],\ 0 \le n \le 3.$ [4]

6. Show the computation of DFT of sequence $x(n) = [1,3,4,5]$ using decimation in time FFT algorithm and find the values of $X(k)$. [6]

7. Let a system be characterized by difference equation. [10]

   $y(n) - 0.5y(n-1) - 0.25y(n-2) - x(n) = 0$, where input $x(n) = 0.2^n\,u(n)$, initial conditions $y(-1) = 2$, $y(-2) = 4$.

   Find (a) zero input response of the system, (b) zero state response of the system, (c) total response of the system, (d) system function $H(z)$ (e) poles of $H(z)$.

8. Find the lattice-ladder filter structure for the LTI system with system function. [6]

   $$H(z) = \frac{\frac{1}{2} + \frac{1}{3}z^{-1} + \frac{1}{4}z^{-2} + \frac{1}{5}z^{-3}}{1 + \frac{1}{5}z^{-1} + \frac{2}{5}z^{-2} + \frac{3}{5}z^{-3}}$$

9. For the first order filter, $y(n) = Q\{a\,y(n-1)\} + x(n)$, the product term "$a\,y(n-1)$" has been quantized by rounding it to 3 bits. $y(-1) = 0$, $x(n) = 0.875\delta(n)$, $a = -0.5$. Show whether the filter goes into limit cycle. What is the period of limit cycle? [4]

10. Design a digital low-pass Butterworth filter using Billinear transformation. Filter specifications are as follows: Pass band frequency $(\omega_p) = 0.3\pi$, Stop band frequency $(\omega_s) = 0.4\pi$, Pass band ripple $(\delta_p) = 0.11$, Stop band ripple $(\delta_s) = 0.21$. [15]

    a) Find the order of filter (N)
    b) Find the cutoff frequency (ω_c)
    c) Find the poles (s_k) of the squared magnitude response of analog Butterworth filter
    d) Find H(s)
    e) Find the digital Butterworth filter H(z)

11. Design a digital low-pass FIR filter with the following specifications using Kaiser Window. Pass band frequency $(\omega_p) = 0.25\pi$, stop band frequency $(\omega_s) = 0.65\pi$, Pass band ripple $(\delta_p) = 0.035$, Stop band ripple $(\delta_s) = 0.035$.

    a) Find the order of filter (N)
    b) Find the cutoff frequency (ω_c)
    c) Find the value of shape parameter (β)
    d) Find Kaiser window (w(n))
    e) Find the filter impulse response (h(n))

    Some modified Bessel function values are as given below.

x	0	1.3165	1.7237	1.8455	1.9271	1.93	1.9903	2
$I_0(x)$	1	1.4826	1.8926	2.0508	2.1675	2.1718	2.2642	2.2796

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