LUMBINI ENGINEERING MANAGEMENT AND SCIENCE COLLEGE
Bhalwari, Tilottama

Level: Bachelor
Programme: BE
Course: Digital Signal Analysis and Processing (Comp.5th Semester)

Year: 2025
Full Marks: 100
Pass Marks: 45
Time: 3 hrs.

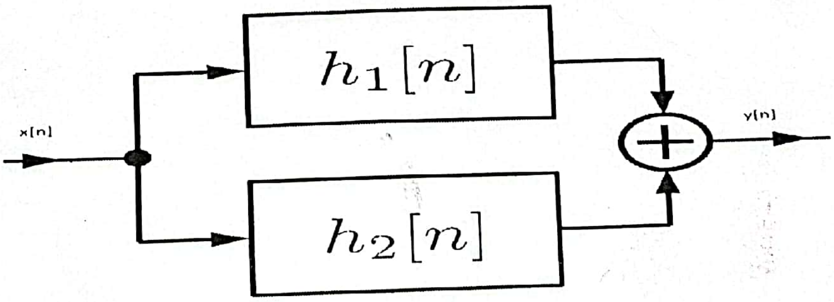
Candidates are required to give their answers in their own words as far as practicable.
The figure in the margin indicates full marks.
Attempt all the questions.

1.

a. A digital communication link carries binary code words representing smpls of an input signal; $x_a(t) = 5\cos 600\pi t + 7\cos 800\pi t$. The link is operated at 1000 bits/sec and each input sample is quantized into 1024 different voltage levels. [2+1+2+2]

   i. What is the sampling frequency and folding frequency?
   ii. What is the Nyquist rate for the signal $x_a(t)$?
   iii. What are the frequencies in the resulting discrete time signal x[n]?
   iv. What is the resolution 'Δ'?

b. Two subsystems $h_1[n]$ and $h_2[n]$ are interconnected as shown in the block diagram. Determine the response of the system if; $h_1[n]=\{1,4,2\}$ and $h_2[n]=\{2, 3\ 1\}$, when excited by input; $x[n]=\{2, 4\}$. [8]



2.

a. Prove that a discrete time LTI system is stable if and only if it's impulse response is absolutely summable. Determine whether the given discrete time system described by LCCDequation is [5+2]

   i. Time invariance

$$y[n] = -2y^2[n-1] + 3x[n] + 2x[n-1]$$

[8]

b. Determine the inverse Z-transform of

$$X(Z)=\frac{1}{1-1.5z^{-1}+0.5z^{-2}};\ \text{when the ROC is}$$

   i. ROC: $|z|>1$
   ii. ROC: $|z|<0.5$
   iii. ROC: $0.5<|z|<1$

Also specify the causality and stability in each case.

[OR]

State the condition for the stability for the Z-transformed of sequence x[n]. Also state and prove the convolution property of Z-transform

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a. Compute the 4-point DFT of the sequence

$X_a(t)=4\cos 200\pi t$, with sampling frequency of 500 Hz. 7

b. Determine the response of the system using FFT algorithm, if the input x[n]and impulse response h[n] are given as under;

x[n]={2, 2, 4} and h[n]={1, 1} 8

a. Determine the cascade and parallel realization of the discrete time system described by differential equation. [8]

$$y[n] = -\frac{3}{4}\, y[n-1] + \frac{1}{4}\, y[n-2] + x[n] + \frac{1}{2}\, x[n-1]$$

b. Obtain the lattice ladder structure of the discrete time system described by the differential equation [7]

$$y[n] = -\frac{3}{4}\, y[n-1] + \frac{1}{4}\, y[n-2] + x[n] + \frac{1}{2}\, x[n-1]$$

Also check the stability of the filter

5.

a. Design a digital low pass Butterworth filter by applying bilinear transformation technique for the given specifications. [8]

Pass band edge = 120Hz

Pass band attenuation = 1dB

Stop band edge = 170Hz

Stop band attenuation = 16 dB Assume sampling frequency of 512 Hz

b. Obtain H(z) using the impulse invariant techniques for an analog system function which is given by: [7]

$$H_a(s) = \frac{1}{(s+0.5)(s^2+0.5\,s+2)}$$

6.

a. Design a low pass digital filter to be used in A/D and D/A structure that will have -3 dB cut-off at $30\pi\, rad/sec$ and an attenuation of 50 dB at $45\,\pi \frac{rad}{sec}$, the filter is required to have a linear phasse and the system uses sampling rate of 100 samples/second. [7]

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

$$0.99 \le |H(e^{i\omega})| \le 1.01, \quad \text{for } 0 \le |\omega| \le 0.19\pi,$$
$$|H(e^{i\omega})| \le 0.01, \quad \text{for } 0.21\pi \le |\omega| \le \pi$$

7. Write short note on(Any two) 2*5=10

a. Recursive and non-recursive system

b. FIR Vs IIR

c. Circular Convolution Vs linear convolution