CBCS SCHEME

USN | | | | | | | | | | |

17EC52

Fifth Semester B.E. Degree Examination, Feb./Mar.2022
Digital Signal Processing

Time: 3 hrs. Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Module-1

1 a. Define DFT. Establish the relationship of DFT with z-transform and DTFT. (05 Marks)

b. Compute the DFT of the sequences :

i) $x(n) = \cos\frac{2\pi}{N}k_0 n$

ii) $x_2(n) = \delta(n) + 2\delta(n-1) + 3\delta(n-2) + 4\delta(n-3)$. (10 Marks)

c. Determine the inverse DFT of the sequence $y(k) = [0, 2-2j, 0, 2+2j]$. (05 Marks)

OR

2 a. Evaluate the circular convolution of the following two sequences using concentric circle method.

$x_1(n) = [2, 1, 2, 1, 3]$, $x_2[n] = [1, 2, 3, 4]$. (10 Marks)

b. The first five points of eight point DFT of a real valued sequence are $(0.25, 0.125 - j0.30, 0, 0.125 - j0.05, 0)$.

Determine :

i) Remaining points ii) $x(0)$ iii) $x(4)$ iv) $\sum_{n=0}^{7} x(n)$ v) $\sum_{n=0}^{7} |x(n)|^2$. (10 Marks)

Module-2

3 a. State and prove the following properties of DFT

i) Circular time reversal

ii) Circular frequency shift

iii) Parseval's theorem. (12 Marks)

b. If X(k) is the DFT of the sequence x(n). Determine the N point DFT of the sequences

$x_c(n) = x(n)\cos\frac{2\pi k_0 n}{N}$ and

$x_s(n) = x(n)\sin\frac{2\pi k_0 n}{N}$ interms of x(k). (08 Marks)

OR

4 a. How many complex multiplications and additions required for computing DFT using direct DFT and FFT algorithm for N = 512. (06 Marks)

b. Consider a FIR filter with impulse response h(n) = [3, 2, 1]. If the input sequence x(n) = [2, 1, −1, −2, −3, 5, 6, −1, 2, 0, 2, 1] using overlap save method. Use 8 point circular convolution. (14 Marks)

Module-3

5 a. Develop 8 – point DIT – FFT algorithm. (10 Marks)

b. Compute DFT of the sequence x(n) = [1, 2, 3, 4, 4, 3, 2, 1] using DIF-FFT algorithm. (10 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

OR

6 a. Perform circular convolution of the sequences $x(n) = [1, 2, 3, 4]$ and $h(n) = [1, 1, 1, 1,]$ using DIF FFT algorithm. **(10 Marks)**

b. With relevant equations, explain Goertzel and chirp Z – transform algorithm. **(10 Marks)**

Module-4

7 a. Design an IIR lowpass analog butter worth filter that meets following specification.

$$0.8 \le |H(j\Omega)| \le 1 \quad \text{for} \quad 0 \le \Omega \le 0.2\pi$$

$$|H(j\Omega)| \le 0.2 \quad \text{for} \quad 0.6\pi \le \Omega \le \pi$$

(12 Marks)

b. Let $H(s) = \dfrac{1}{5^2 + \sqrt{2}s + 1}$ represent the transfer function of low pass filter with a passband of 1 rad/sec. Use frequency transformation to find the transfer function of the following analog filters.

i) A lowpass filter with passband of 10 rad/sec

ii) A high pass filter with cut off frequency of 10 rad/sec. **(08 Marks)**

OR

8 a. Realize the filter described the transfer function :

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

Using cascade and parallel from structure. **(10 Marks)**

b. The system function of an analog filter is given as $H_a(s) = \dfrac{1}{(s+1)(s+2)}$. Obtain H(z) using impulse invariant and bilinear transform method. take sampling frequency of 5 samples/sec. **(10 Marks)**

Module-5

9 a. Realize FIR filter with impulse response $h(n) = [1, 2, 3, 4, 3, 2, 1]$ using direct form and linear phase structure. **(10 Marks)**

b. Draw direct form I and Lattice structure for the filter given by

$$y(n) = x(n) + \frac{2}{5}x(n-1) + \frac{3}{4}x(n-2) + \frac{1}{3}x(n-3).$$

(10 Marks)

OR

10 a. Name any four types of windows used in the design of FIR filters. Write the analytical equations and draw the magnitude response characteristics of each window. **(08 Marks)**

b. Determine the filter coefficients $h_d(n)$ for the desired frequency response of a lowpass filter given by

$$H_d(e^{j\omega}) = \begin{cases} e^{-j2\omega} & \text{for} \quad \frac{-\pi}{4} \le \omega \le \frac{\pi}{4} \\ 0 & \text{for} \quad \frac{\pi}{4} \le |\omega| \le \pi \end{cases}$$

Also determine h(n) and frequency response $H(e^{j\omega})$ using Hamming window. **(12 Marks)**

* * * * *

CBCS SCHEME

USN | | | | | | | | | | |

17EC54

Fifth Semester B.E. Degree Examination, Feb./Mar. 2022
Information Theory and Coding

Time: 3 hrs. Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Module-1

1 a. Define :
   i) Self information
   ii) Entropy of source
   iii) Rate of source information. **(06 Marks)**

b. Explain the properties of entropy. Derive entropy expression for extended source. **(06 Marks)**

c. A binary source is emitting independent sequence of 0's and 1's with probability p and $1 - p$ respectively plot the entropy of this source vs probability $(0 < p < 1)$ write the conclusion. **(08 Marks)**

OR

2 a. Explain the extremal properties of entropy. **(10 Marks)**

b. The state probability of a stationary Markov sources is given below the probabilities of state $i = \frac{1}{2}, i = 1, 2$
   i) Find the entropy of each state
   ii) Find the entropy of source
   iii) Find G_1, G_2 and show that $G_1 > G > H[s]$.

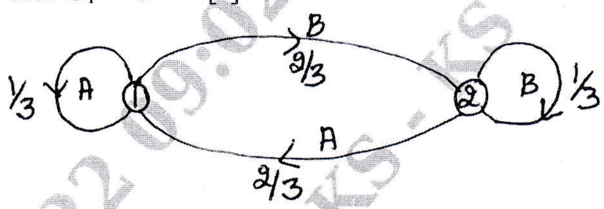

Fig.Q2(b) **(10 Marks)**

Module-2

3 a. Explain the important properties of codes to be considered while encoding a source. **(07 Marks)**

b. Explain how do you test for instantaneous property. **(03 Marks)**

c. Construct binary code for the following source using Shannon's binary encoding procedure $S = \{S_1, S_2, S_3, S_4, S_5\}$, $P = \{0.4, 0.25, 0.15, 0.12, 0.08\}$. Find the coding efficiency. **(10 Marks)**

OR

4 a. Using Shannon Fano – coding, find code words for the probability distribution $[P = \frac{1}{4}, \frac{1}{4}, \frac{1}{8}, \frac{1}{8}, \frac{1}{16}, \frac{1}{16}, \frac{1}{16}]$ code word length efficiency. **(10 Marks)**

b. A discrete memory less source has an alphabet of seven symbols with probabilities as given in the table below :

Symbols	S_1	S_2	S_3	S_4	S_5	S_6	S_7
Prob	0.25	0.25	0.125	0.125	0.125	0.0625	0.0625

Compute Huffman code for this source by moving combined symbols as high as possible. Find efficiency of this code. **(10 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-3

5 a. List the properties of mutual information. Prove that mutual information.

$$I[A,B] = H[A] - H\left[\frac{A}{B}\right] = H[B] - H\left[\frac{B}{A}\right]$$

$$I[A,B] = H[A] + H[B] - H\left[\frac{A}{B}\right].$$ **(10 Marks)**

b. Find H[A], H[B], H[A, B], $H\left[\frac{A}{B}\right]$ and $H\left[\frac{B}{A}\right]$ for the channel shown below :

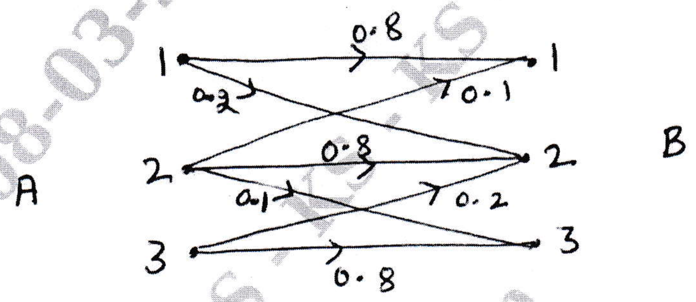

Fig.Q5(b)

$P[A_1] = \frac{1}{3}$, $P[A_2] = \frac{1}{3}$, $P[A_3] = \frac{1}{3}$. **(10 Marks)**

OR

6 a. State and explain Shannon Hartley law and its implications. **(08 Marks)**

b. An analog single has a 4 KHz band width. The signal is sampled at 2.5 times the Nyquist rate and each sample quantized into 256 equally likely levels. Assume that the successive samples are statistically independent.

i) Find the information rate of this source

ii) Can the output of this source be transmitted without errors over, a Gaussian channel of bandwidth 50KHz and S/N ratio of 20dB

iii) If the output of this source is to be transmitted without errors over an analog channel having S/N of 10dB compute the bandwidth requirement of the channel. **(12 Marks)**

Module-4

7 a. For A (6, 3) code find all the code vectors if the co-efficient matrix P is given by

$$P = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 1 \end{bmatrix}$$

i) Find code vector

ii) Implement the encoder

iii) Find the syndrome vector [S]

iv) Implement the syndrome circuit. **(10 Marks)**

b. Obtain the generator and parity check matrices for an (n, k) cyclic with $g(x) = 1 + x + x^3$. **(10 Marks)**

OR

8 a. For a (15, 5) binary cyclic code, generator polynomial is $g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$. Draw the encoder diagram and find the encoded output for a message $D[X] = 1 + X^2 + X^4$. **(12 Marks)**

b. If C is a valid code vector then prove that $CH^T = 0$ where H^T is transpose of check matrix H. **(08 Marks)**

Module-5

9 For a (3, 1, 2) convolutional encoder with generator sequences :

$g^{(1)} = 110, \quad g^{(2)} = 101, \quad g^{(3)} = 111.$

a. Find encoder block diagram
b. Find generator matrix and output for 11101
c. Find code word for 11101 using time domain method
d. Draw the state diagram and tree diagram. **(20 Marks)**

OR

10 Write short notes on :
a. Golay codes
b. Shortened cyclic
c. Burst error correcting codes
d. Burst and random error correcting codes. **(20 Marks)**

* * * * *