(3 Hours) **[Total Marks : 80]**

N.B. : (1) Question No 1 is Compulsory.
(2) Attempt any three questions out of the remaining five.
(3) All questions carry equal marks.
(4) Assume Suitable data, if required and state it clearly.

1. Attempt any Four:-
(a) Define Probability. Explain CDF and PDF. **05**
(b) Explain linearity and cyclic properties of a cyclic code. **05**
(c) Derive an expression for Entropy. When is entropy maximum? **05**
(d) Compare: Binary phase shift keying and binary frequency shift keying. **05**
(e) Write a short note on ISI equalizers. **05**

2. (a) A discrete memoryless source has an alphabet of seven symbols with probabilities for its output as described in Table **10**

Symbol	S_0	S_1	S_2	S_3	S_4	S_5
Probability	0.3	0.25	0.15	0.12	0.10	0.08

1. Generate Huffman code.
2. Determine its average word length.
3. Find entropy of the source.
4. Determine its efficiency and redundancy.

(b) Explain the necessity of line codes for data transmission. State different types of line codes. **10**

3. (a) Draw and explain the block diagram of QPSK transmitter and receiver and Sketch the waveform. **10**
(b) Calculate the error probability of the matched filter. **10**

4. (a) Explain 16-ary QASK transmitter and receiver and draw the signal space representation and calculate the Euclidean distance between two symbols. **10**
.
(b) The parity check matrix of a (7,4) linear block code is given by: **10**

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

1. Find the generator matrix (G).
2. List all code vectors.
3. What is the minimum distance between the code vectors?
4. How many errors can be detected? How many errors can be corrected?

5. (a) Encode the message 101 in systematic form using polynomial division and the generator polynomial $g(X) = 1 + X + X^2 + X^4$ **10**

(b) Generator vectors for a rate 1/3 convolutional encoder are $g_1 = (100)$, $g_2 = (101)$, $g_3 = (111)$ **10**

i) Draw the encoder diagram

ii) Draw the trellis diagram.

iii) Using trellis find code vector if message vector is (101100)

6. (a) Explain the central limit theorem for random variables **10**

(b) Draw and explain the block diagram of BFSK transmitter and receiver **10**

Time: 3 hours **Max. Marks: 80**

N.B. :1) Question no. 1 is compulsory
2) Answer any 3 questions from remaining five questions

Q1 Answer **any four** questions

a. What are the three axioms of probability? **05**
b. Define central limit theorem. What is the significance of central limit theorem? **05**
c. A continuous random variable x that can assume any value between x = 2 and x = 5 has a density function given by f(x) = k (1+x). Find P(X<4) **05**
d. Define SSS process. How it is different from WSS? **05**
e. Define autocorrelation function and state its properties **05**

Q2 a. In a binary Symmetric channel, the probability that a transmitted '0' is received as '0'is 0.9 and the probability that a transmitted '1' is received as '1'is 0.95. If the probability that a '0' is transmitted is 0.55, find **10**
i) The probability that a '1'was transmitted given that a '1' was received.
ii) The probability that a '0'was transmitted given that a '0' was received.
iii) Error probability

b. i. Three balls are drawn at random without replacement from a box containing 2 white, 3 red and 4 black balls. If X denotes the number of white balls drawn and Y denotes the number of red balls drawn, find the joint probability distribution of (X,Y) **05**
ii. State and Prove Bayes Theorem **05**

Q3 a. The joint pdf of two dimensional RV (X,Y) is given by **10**

$$f(x,y) = x^2 + \frac{xy}{3}; 0 \le x \le 1, 0 \le y \le 2$$. Find

i. P(Y<0.5/X<0.5)
ii. Are x and y independent random variables?

b. State and prove Chebyshev inequality. **10**

Q4 a. Derive the moment generating function for Poisson distribution. By using the moment generating function, derive the mean and variance of Poisson distribution **10**

b. If the joint pdf of (X,Y) is given by f (x,y)=x+y ; $0 \le x,y \le 1$, find the pdf of U=XY **10**

Q5 a. If the joint pdf of (X,Y) is given by f (x,y)=24y(1-x), $0 \le y \le x \le 1$, Find E(XY) **10**

b. Given a random process x (t) = A Cos (ωt+Θ) where A and ω are constants and Θ is a random variable with uniform distribution over (-π, π), Verify whether x (t) is a WSS process or not. **10**

Q6 a. Discuss the properties of linear time invariant system if input is a WSS process. **10**

b. Find linear regression equation for the following two sets of data. Predict the output when input x=7. State any two applications of linear regression. **10**

x	2	4	6	8
y	3	7	5	10

(3 Hours) **[Total Marks : 80]**

N.B.: (1) Question No 1 is Compulsory.
(2) Attempt any three questions out of the remaining five.
(3) All questions carry equal marks.
(4) Assume suitable data, if required and state it clearly.

1 Attempt any FOUR **[20]**

a What is modulation? What are the types of modulation?

b Explain different error control systems

c Compare BASK, BPSK, BFSK, 4-ary FSK and 8-ary PS in terms of bandwidth

d Calculate 4-bits checksum for the data 110011111011

e Calculate CRC bits for the data 10000 using $g(x) = x^8 + x^2 + x + 1$

2 **a** Explain Shannon-Hartley Theorem and determine the channel capacity if the bandwidth is infinite **[10]**

b Write the algorithms for determining Huffman code and Shannon-Fano code and select a suitable example to show the code generation **[10]**

3 **a** What is line code? What are the parameters need to be considered for selecting a line code for a specific allocation. **[10]**

b Draw the shift register circuit for (7,4) systematic cyclic code encoder with $g(x) = x^3 + x^2 + 1$ and generate parity bits for the data 1000 and 1010 **[10]**

4 **a** Explain error detection and correction procedure for systematic linear block code **[10]**

b Derive the PSD of QPSK signal, draw the power spectrum and find the bandwidth **[10]**

5 **a** Sketch the signal space diagram of MSK and determine the error probability **[10]**

b Explain 16-ary QASK modulator and demodulator with suitable equations **[10]**

6 **a** Show that the performances of matched filter and correlator are identical **[10]**

b Explain Viterbi's decoding algorithm with a suitable example **[10]**

Duration: 3hrs **[Max Marks:80]**

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1 Attempt any **FOUR** **[20]**

a If $x(n) = \{2,3,4,5\}$
i) Find DFT of $x(n)$using DIT-FFT
ii) If $y(n) = x(n-1)$Find DFT of $y(n)$ using property not otherwise.

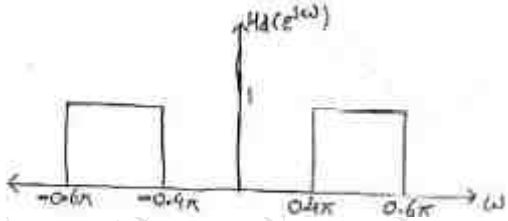
b A digital filter is described by the following difference equation
$$y(n) = 0.9y(n-1) + bx(n)$$
i) Determine b such that $|H(0)| = 1$
ii) Identify the filter type based on pass band.

c Obtain computational complexity of FFT algorithm.

d Define group delay and phase delay.

e Explain the frequency warping in bilinear transformation.

2 a Design digital FIR filter for the following specification. Use hanning window and assume M = 7. **[10]**



b Compute circular convolution of the following sequence using DITFFT-IFFT **[10]**
x1 (n) = {1, 2, 1, 2} and x2 (n) = {1, 2, 1}.

3 a Compute the DFT of the sequence x (n) = {1, 2, 3, 4, 4, 3, 2, 1} using DIF-FFT algorithm. Compare the computational complexity of the above algorithm with DFT. **[10]**

b For the second order IIR filter **[10]**
$$H(z) = \frac{1}{(1-0.5z^{-1})(1-0.45z^{-1})}$$
Study the effect of shift in pole location with a 3-bit coefficient.

4 a Determine the zeros of the following FIR systems and identify whether the following system is minimum phase, maximum phase, mixed phase. Also comment on stability. **[10]**
(i) $H_1(z) = 6 + z^{-1} + 6z^{-2}$
(ii) $H_2(z) = 1 - z^{-1} - 6z^{-2}$
(iii) $H_3(z) = 1 - \frac{5}{2}z^{-1} - \frac{3}{2}z^{-2}$

b Write a note on frequency sampling realization of FIR filer. **[10]**

5 a Design a digital Butterworth low pass filter that satisfies the following constraint using impulse invariant transformation method. Assume $T = 1\ sec$ **[10]**

$$0.707 \leq |H(w)| \leq 1 \quad ; \qquad for \quad 0 < \omega < 0.3\pi$$
$$|H(w)| \leq 0.2 \quad ; \qquad for \quad 0.75\pi < \omega < \pi$$

b Explain overlap and save method for data filtering. Using this method find output of a system with impulse response h(n) = {1, 2, 1} and input x(n) = {3, -1, 0, 1, 3, 2, 0, 1, 2, 1} **[10]**

6 a Explain application of DSP for Echo cancellation. **[10]**

b The transfer function of discrete time causal system is given by **[10]**

$$H(z) = \frac{1 - z^{-1}}{1 - 0.2z^{-1} - 0.15z^{-2}}$$

Draw cascade and parallel realization.

Duration: 3hrs **[Max Marks:80]**

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(2) Attempt any three questions out of the remaining five.
(3) All questions carry equal marks.
(4) Assume suitable data, if required and state it clearly.

1 Attempt any FOUR [20]

a Differentiate between IIR & FIR filters

b Explain the concept of pipelining in DSP processor

c What is the condition for linear phase in FIR filters? Give examples for four types of linear phase FIR filters.

d Explain product quantization error and input quantization error

e Find the DFT of x[n] = {1, 2, 1, 0}. Using this result, find the DFT of $y[n]=x((n-2))_4$

2 a Find the number of complex additions and complex multiplications required to find the DFT for 32 point signal. Compare them with the number of computations required, if FFT algorithm is used [5]

b State and prove the Parseval's theorem for the sequence x[n] = {1, 2, 1, 0} [5]

c An FIR digital filter has the unit impulse response sequence, x[n] = {2, 2, 1}. Determine the output sequence in response to the input sequence x[n]= {3, 0,-2,0, 2, 1, 0,-2,-1,0} by Overlap and add method [10]

3 a Compute the DFT of the sequence x[n]=sin(nπ/2) for N=4 by DIT-FFT algorithm [5]

b Explain the frequency warping in Bilinear transformation [5]

A Low pass filter has following specifications: [10]

$0.8 \le \left|H(e^{j\omega})\right| \le 1$ for $0 \le \omega \le 0.2\pi$

$\left|H(e^{j\omega})\right| \le 0.2$ for $0.6\pi \le \omega \le \pi$

Find the filter order and analog cut-off frequency by both Bilinear transform & Impulse Invariance methods, for a Butterworth filter

4 a Explain Limit cycle oscillations [5]

b Compute the DFT of the sequence x[n]=sin(nπ/2) for N=4 by DIT-FFT algorithm [5]

c Draw the neat architecture of TMS 320C67XX DSP processor and explain each block [10]

5 a A second order Chebyshev Type-I LPF has a magnitude response of 0.9 at zero frequency. Find the squared magnitude response function [5]

b Show the pole locations of a normalized Butterworth filter of 3rd order [5]

c Design a high pass linear phase FIR filter for the following specifications, [10]
Stop band edge = 2KHz; Pass band edge = 9.5KHz; Sampling frequency = 25KHz;
Stop band attenuation ≥ 40dB and pass band attenuation < 1dB. Use Hanning window.

6 a Write short notes on (i)Sub-band coding (ii) Application of DSP in ECG analysis [10]

b Explain the addressing modes of TMS320C667XX processor [10]

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