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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

June / July 2025 Semester End Main Examinations

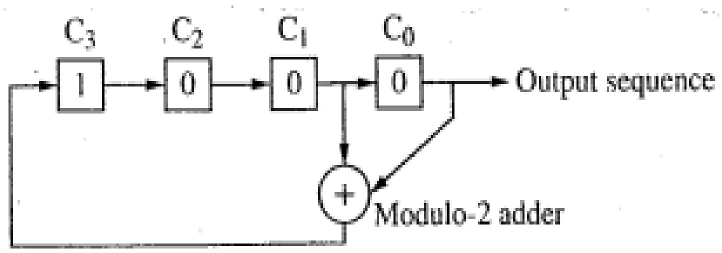
Programme: B.E. **Semester: V**
Branch: Electronics and Communication Engineering **Duration: 3 hrs.**
Course Code: 23EC5PCDCT **Max Marks: 100**
Course: Digital Communication Theory

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			CO	PO	Marks
		UNIT - I			
1	a)	Derive the expression for Signal to Quantization noise ratio for PCM system that employs linear quantization technique. Assume that the amplitude of signal is uniformly distributed.	CO 2	PO 2	**08**
	b)	What is Companding. Compare μ-law and A-law companding.	CO 1	PO 1	**07**
	c)	A 10 kHz sinusoid with amplitude levels of ±1 volt is to be sampled and quantized by rounding off. How many bits are required to ensure a quantization SNR of 45 dB? What is the bit rate of the digitized signal if the sampling rate is chosen as twice the Nyquist rate?	CO 1	PO 1	**05**
		OR			
2	a)	Identify the type of modulation which removes the redundant information before encoding and increases the efficiency of the coded signal. Explain its working with the help of a transmitter and receiver block diagram and give corresponding equations.	CO2	PO 2	**10**
	b)	For the given binary stream 101011100 sketch the digital format waveforms corresponding to Unipolar NRZ, Polar-NRZ, RZ-Polar, Bipolar-NRZ, Manchester code formats.	CO 1	PO 1	**05**
	c)	A computer outputs binary data at the rate of 50,000 bits/sec. The transmitter uses binary PAM with raised Cosine spectrum in shaping of optimum pulse width. Determine the bandwidth of the transmitted waveform if the roll –off factor is i) $\alpha=0$ ii) $\alpha= 0.25$ iii) $\alpha=0.5$ iv) $\alpha=0.75$ v) $\alpha=1$	CO 2	PO 2	**05**
		UNIT - II			
3	a)	Derive an expression for the probability of error P_e of a coherent Binary-Amplitude Shift Keying (BASK) modulation.	CO 1	PO 1	**10**

		b)	Explain the generation of Binary Phase Shift Keying (BPSK) system with block diagram and relevant mathematical expressions.	*CO 2*	*PO 2*	**05**
		c)	A Binary FSK System transmits data at a rate of 2 Mbps over an AWGN channel. The noise is Zero mean with power spectral density $N_o/2= 10^{-20}$ W/Hz. The amplitude of received signal in the absence of noise is 1μv. Determine the average probability of error for coherent detection of FSK.	*CO 1*	*PO 1*	**05**
			OR			
	4	a)	With relevant logical expressions, explain the working of DPSK system with its transmitter and receiver block diagrams. Also Illustrate the generation of the DPSK signal for the data 10010011 indicating transmitted phase.	*CO 2*	*PO 2*	**10**
		b)	What are the advantages of QPSK over PSK? Write the constellation diagram of QPSK.	*CO 2*	*PO 2*	**05**
		c)	A Binary FSK System transmits data at a rate of 10^6 bps over AWGN channel. The noise power spectral density $N_o/2= 10^{-10}$ W/Hz. Find the average carrier power required to maintain an average probability of error $P_e \leq 10^{-4}$ for non-coherent binary FSK. Determine the channel bandwidth required.	*CO 2*	*PO 2*	**05**
			UNIT - III			
	5	a)	Analyze the working of model of Direct Sequence Spread Spectrum Binary Phase Shift Keying (DS-BPSK) with its block diagram and corresponding equations.	*CO 2*	*PO 2*	**10**
		b)	Derive for Jamming margin or Antijam characteristics of a Direct Sequence Spread Spectrum and express the obtained equation in decibels.	*CO 1*	*PO 1*	**06**
		c)	In a Direct Sequence Spread Spectrum modulation, it is required to have a jamming margin greater than 26 dB. The ratio is set at 10. Determine the minimum processing gain and the minimum number of stages required to generate the maximum length sequence.	*CO 2*	*PO 2*	**04**
			OR			
	6	a)	Explain the working of Fast-Frequency Hopping Spread Spectrum with the help of transmitter and receiver block diagram.	*CO 1*	*PO 1*	**10**
		b)	Illustrate the variation of the slow frequency hopping with FH/MFSK signal for one complete Period of the PN sequence. Assume that the carrier hops to a new frequency after carrier hops to a new frequency after transmitting two MFSK symbols or four information bits. A PN sequence is generated using 4- stage linear feedback shift registers as shown in figure below with initial conditions ($C_3C_2C_1C_0$) =1000 and input binary data: 10001101000111111001	*CO 2*	*PO 2*	**10**



Assume Number of MFSK tones M=4, number of bits/symbol K= 2, length of PN segment per hop k=3, and total number of frequency hops =8.

UNIT - IV

7 a) Analyze the representation of a discrete communication channel as a "Channel Matrix" with (r x s) number of conditional probabilities and indicate the usage of Baye's rule for finding input conditional probabilities P (a_i/b_j). — *CO* 2 | *PO* 2 | **10**

b) In a communication system, a transmitter has 3 input symbols A= {a_1, a_2, a_3} and receiver also has 3 output symbols B = {b_1, b_2, b_3}. The Matrix shows Joint Probability Matrix (JPM) with some marginal probabilities. — *CO* 2 | *PO* 2 | **10**

ai \ bj	b1	b2	b3
a1	1/12	*	5/36
a2	5/36	1/9	5/36
a3	*	1/6	*

	b1	b2	b3
P (bj)	1/3	14/36	*

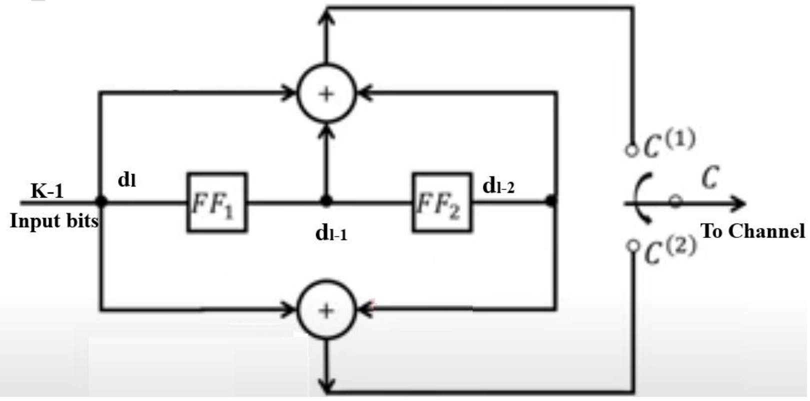
i. find the missing probabilities (*) in the table
ii. find P (b_3/ a_1) and P (a_1/ b_3)
iii. Are the events a_1 and b_1 events statistically independent? why?

OR

8 a) Using Shannon-Fano encoding algorithm, find the code word for the probability 0.30, 0.25, 0.15, 0.12, 0.10, 0.08 for the symbols S1 to S6. Also calculate efficiency and redundancy. — *CO* 2 | *PO* 2 | **10**

b) Consider a sequence of letters from English alphabet with their probability of occurrence as A=0.1, I=0.1, X=0.2, M=0.1, N=0.1, O=0.2, P=0.1 & Y=0.1. Compute the following for this alphabet: — *CO* 2 | *PO* 2 | **10**

i. Huffman code
ii. entropy
iii. average whole word length
iv. variance of code word length

			UNIT - V			
	9	a)	Construct the encoding circuit for a systematic (6, 3) Linear Block Code for the given parity matrix P and find all possible code vectors. $$[P] = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 0 \end{bmatrix}$$	***CO*** *3*	***PO*** *3*	**10**
		b)	A single error has occurred in each of the following received vectors, detect and correct those errors. i. R_A = [0111110] ii. R_B = [1011100] iii. R_C = [1010000] Also construct the syndrome calculation circuit for a (7, 4) Linear Block Code, the parity matrix P is given by $$[P] = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 1 \end{bmatrix}$$	***CO*** *3*	***PO*** *3*	**10**
			OR			
	10	a)	Consider a (2,1,3) convolution encoder with $g^{(1)} = 1011$ and $g^{(2)} = 1111$. Find the output sequence (code word) corresponding to the information sequence d=10111 using any one of the following methods i. Time domain approach ii. Transfer domain approach Draw the convolution encoder block diagram.	***CO*** *1*	***PO*** *1*	**10**
		b)	For a (2,1,2) convolution encoder with impulse response $g^{(1)} = 111$ and $g^{(2)} = 101$ and input D=[10111], write the state table, state transition table and draw the corresponding state diagram. 	***CO*** *1*	***PO*** *1*	**10**

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Error Function Table :

Table Error Function

u	erf(u)	u	erf(u)
0.00	0.00000	1.10	0.88021
0.05	0.05637	1.15	0.89612
0.10	0.11246	1.20	0.91031
0.15	0.16800	1.25	0.92290
0.20	0.22270	1.30	0.93401
0.25	0.27633	1.35	0.94376
0.30	0.32863	1.40	0.95229
0.35	0.37938	1.45	0.95970
0.40	0.42839	1.50	0.96611
0.45	0.47548	1.55	0.97162
0.50	0.52050	1.60	0.97635
0.55	0.56332	1.65	0.98038
0.60	0.60386	1.70	0.98379
0.65	0.64203	1.75	0.98667
0.70	0.67780	1.80	0.98909
0.75	0.71116	1.85	0.99111
0.80	0.74210	1.90	0.99279
0.85	0.77067	1.95	0.99418
0.90	0.79691	2.00	0.99532
0.95	0.82089	2.50	0.99959
1.00	0.84270	3.00	0.99998
1.05	0.86244	3.30	0.999998