CBCS SCHEME - Make-Up Exam

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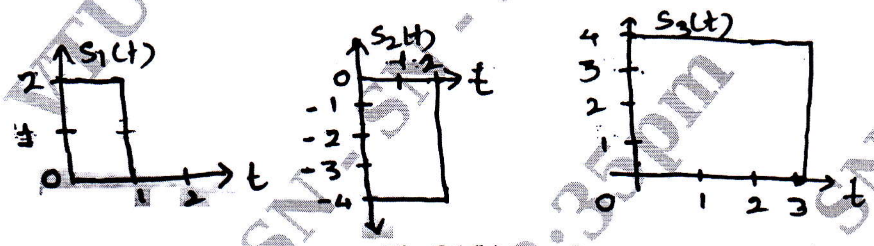
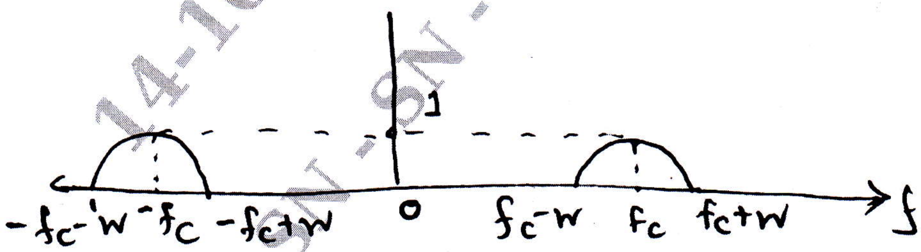
BEC503

Fifth Semester B.E./B.Tech. Degree Examination, June/July 2025
Digital Communication

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.

		Module – 1	M	L	C
Q.1	a.	Define Hilbert transform. Mention its applications. Show that a signal g(t) and its Hilbert transform are orthogonal over the entire time interval $(-\infty, \infty)$.	6	L2	CO1
	b.	Using Gram-Schmidth orthogonalization proceducer calculate a set orthonormal basis functions to represent the three signals $S_1(t)$, $S_2(t)$ and $S_3(t)$ shown in Fig.Q1(b). Also express each of these signals in terms of the set of basis functions.  Fig.Q1(b)	8	L3	CO1
	c.	Describe the correlation receiver with the neat diagrams and the maximum – likelihood decoder.	6	L2	CO1
		OR			
Q.2	a.	Express band pass signal s(t) in canonical form. Represent the in phase and quadrature components of the bandpass signal s(t).	6	L2	CO1
	b.	Determine pre-envelope and complex – envelope of the signal shown in Fig.Q2(b).  Fig.Q2(b)	6	L3	CO1
	c.	Discuss the operation of matched filter receiver with necessary diagram.	8	L2	CO1

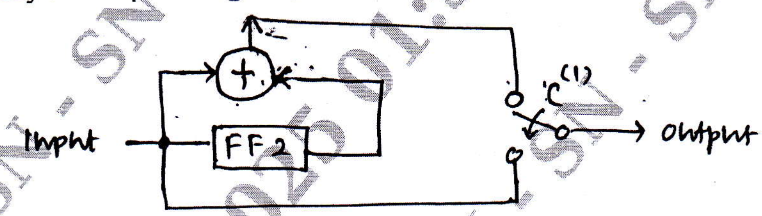
		Module – 2			
Q.3	a.	Describe the generation and reception of BPSK signal with a necessary equation and constellation diagram.	10	L3	CO2
	b.	The binary sequence 1100100010 is applied to the DPSK transmitter : (i) Sketch the resulting waveform at the transmitter output (ii) Applying this waveform to the DPSK receiver show that in the absence of noise, the original binary sequence is reconstructed at the receiver output.	6	L2	CO2
	c.	Explain M-ary QAM. Mention its advantage over M-ary PSK system. Obtain the constellation of QAM for M = 4 and draw signal space diagram.	4	L2	CO2
		OR			
Q.4	a.	Derive the expression for error probability of BFSK using coherent detection.	8	L3	CO2
	b.	Binary data are transmitted over a microwave link at the rate of 10^6 BPS and PSD of noise at the receiver is 10^{10} watts/Hz. Compute the average carrier power required to maintain an average probability of error $P_e \le 10^{-4}$ for the following cases : (i) Binary PSK using coherent detection (ii) DPSK Note : take $\text{erfc}(2.63) = 2 \times 10^{-4}$ $Q(3.7) = 10^{-4}$	6	L2	CO2
	c.	With a neat block diagram outline the generation and coherent detection of QPSK signal.	6	L2	CO2
		Module – 3			
Q.5	a.	Briefly discuss entropy and information rate. Derive the expression of average information content of a zero memory source.	6	L2	CO3
	b.	An international Morse code uses a sequence of symbols of dots and dashes to transmit letters of English alphabet. The dash is represented by a current pulse of duration 2 msec and dot by a duration of 1 msec. The probability of dash is half that of dot. Consider 1 msec duration of gap is given in between symbols. Calculate : (i) Self information of a dot and a dash (ii) An average information content of a dot-dash code (iii) Average rate of information.	6	L3	CO3
	c.	An information source produces a sequence of independent symbols having the following probabilities. $S = \{s_1\ s_2\ s_3\ s_4\ s_5\ s_6\ s_7\},\ P = \left\{\frac{1}{3}, \frac{1}{27}, \frac{1}{3}, \frac{1}{9}, \frac{1}{9}, \frac{1}{27}, \frac{1}{27}\right\}$ Construct the binary and ternary code using Huffman encoding procedure. Find its efficiency and redundancy.	8	L3	CO3

OR

			Marks	Level	CO
Q.6	**a.**	Define mutual information. Derive the expression for mutual information and joint entropy interms of probabilities.	6	L2	CO3
	b.	For the JPM given below compute individuality H(X), H(Y), H(X, Y), H(X/Y), H(Y/X). $$P(X,Y)=\begin{bmatrix}0.05 & 0 & 0.2 & 0.05\\ 0 & 0.1 & 0.1 & 0\\ 0 & 0 & 0.2 & 0.1\\ 0.05 & 0.05 & 0 & 0.1\end{bmatrix}$$	7	L3	CO3
	c.	A binary symmetric channel has the following noise matrix with source probabilities of $P(x_1)=\frac{2}{3}$ $P(x_2)=\frac{1}{3}$ $P(Y/X)=\begin{bmatrix}3/4 & 1/4\\ 1/4 & 3/4\end{bmatrix}$ Determine : i) H(X), H(Y) , H(X, Y), H(Y/X), H(X/Y) and I(X, Y) ii) Channel capacity iii) Channel efficiency and redundancy.	7	L3	CO3

Module – 4

			Marks	Level	CO
Q.7	**a.**	Calculate the generator matrix G and parity check matrix H for a linear block code with matrix H for a linear block code with minimum distance three and a message block size of eight bits.	4	L3	CO4
	b.	Draw the general block diagram of syndrome calculation circuit for cyclic codes and explain its operation.	6	L2	CO4
	c.	For a systematic (7, 4) linear block code, the parity matrix P is given by $$[P]=\begin{bmatrix}1 & 1 & 1\\ 1 & 1 & 0\\ 1 & 0 & 1\\ 0 & 1 & 1\end{bmatrix}$$ (i) Calculate all possible valid code-vectors (ii) Draw the corresponding encoding circuit (iii) A single error has occurred in each of these received vectors. Detect and correct those errors. a) R_A = [0 1 1 1 1 1 0] b) R_B = [1 0 1 1 1 0 0] c) R_C = [1 0 1 0 0 0 0] (iv) Draw syndrome calculation circuit.	10	3	CO4

		OR			
Q.8	**a.**	The generator polynomial for a (15, 7) cyclic code is $g(x) = 1 + x^4 + x^6 + x^7 + x^8$ (i) Compute the code = vector is systematic form for the message $D(x) = x^2 + x^3 + x^4$ (ii) Assume that the first and last bit of the code vector V(x) for $D(x) = x^2 + x^3 + x^4$ suffer transmission errors. Calculate the syndrome of V(x).	6	L3	CO4
	b.	With a neat block diagram and suitable example, describe error – control – based communication system.	6	L2	CO4
	c.	Consider a (6, 3) linear code whose generator matrix is $G = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 1 \end{bmatrix}$ Calculate : i) All code vectors ii) All the hamming weights and distances iii) Minimum weight parity check matrix iv) Draw the encoder circuit for the above codes.	8	L3	CO4
		Module – 5			
Q.9	**a.**	Describe decoding of convolution codes using viterbi algorithm with a suitable example.	10	L2	CO5
	b.	Consider the convolution of encoder shown in Fig.9(b). The code is systematic i) Represent the state diagram ii) Relate the code tree iii) Calculate the endoder output produced by the message sequence 1 0 1 1 1 iv) Verify the output using time-domain approach.  Fig.Q9(b)	10	L3	CO5
		OR			
Q.10	**a.**	Illustrate recursive systematic convolution codes with a suitable example.	6	L2	CO5
	b.	Consider a (3, 1, 2) convolution encoder with $g^{(1)} = 110$, $g^{(2)} = (101)$, $g^{(3)} = 111$. (i) Encoder block diagram (ii) State table (iii) State transition table (iv) State diagram (v) Compute encoder output traversing through the state diagram for input message sequence of (11101) (vi) Draw the code trellis and obtain the output of the encoder for the same input sequence of (11101).	14	L3	CO5

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