SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

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Department of Electronics and Communication Engineering

Question Bank

1906501 – DIGITAL COMMUNICATION

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1906501 – DIGITAL COMMUNICATION

UNIT I – INFORMATION THEORY			
Discrete Memoryless source, Information, Entropy, Mutual Information – Discrete Memoryless channels – Binary Symmetric Channel, Channel Capacity – Hartley – Shannon law – Source coding theorem – Shannon – Fano & Huffman codes.			
PART - A			
Q.No	**Questions**	**BT Level**	**Competence**
1.	Draw the basic block diagram of digital communication system.	BTL 3	Applying
2.	What are the merits of digital communication?	BTL 1	Remembering
3.	State the concept of discrete memory less source.	BTL 1	Remembering
4.	Write the two properties of information.	BTL 2	Understanding
5.	Define information rate.	BTL 2	Understanding
6.	Calculate the amount of information if $p_k = 1/4$.	BTL 3	Applying
7.	Prove the following statement "if receiver knows the message being transmitted, the amount of information carried is zero".	BTL 4	Analyzing
8.	Find the total amount of information, when a source emits 02 symbols whose probabilities are 0.2 and 0.1.	BTL 1	Remember
9.	Write the formulae to find the code length and code efficiency.	BTL 3	Apply
10.	State entropy.	BTL 1	Remembering
11.	Write the two properties of entropy.	BTL 2	Understanding
12.	Identify the entropy of the system for an event that has six possible outcomes with probabilities 1/2,1/4,1/8,1/16,1/32?	BTL 2	Understanding
13.	What is mutual information?	BTL 1	Remembering
14.	List out the properties of mutual information.	BTL 4	Analyzing
15.	Outline the concept of discrete memory less channel.	BTL 3	Applying
16.	Write down the expression for Kraft-McMillan inequality.	BTL 3	Applying
17.	List out the special type of channels apart from the continuous and discrete channels.	BTL 2	Understanding
18.	State the concept of BSC.	BTL 4	Analyzing
19.	Examine the channel capacity.	BTL 4	Analyzing
20.	Write down the formulae of Hartley law.	BTL 4	Analyzing

21.	Point out the concept of Shannon law.	BTL 4	Analyzing
22.	Name the source coding techniques.	BTL 1	Remembering
23.	Write the steps for Huffman coding algorithm.	BTL 3	Applying
24.	Why is Huffman code called as minimum redundancy code?	BTL 2	Understanding

PART – B					
1.	(i)	Sketch the block diagram of digital communication system and elaborate it.	(9)	BTL 1	Remembering
	(ii)	Write the merits of digital communication	(4)		
2.	(i)	Explain about the information source, amount of information.	(6) (7)	BTL 2	Understanding
	(ii)	Find the total amount of information, when a source emits 03 symbols whose probabilities are 0.2, 0.3 and 0.1.			
3.	Discuss the following (i) Discrete memoryless source (ii) Channel matrix (iii)List the types of channel		(4) (5) (4)	BTL 3	Applying
4.	Explain the following (i) Entropy (ii) Comentropy (iii)Properties of Entropy		(2) (3) (8)	BTL 2	Understanding
5.	(i)	Write the extension of a discrete memoryless source.	(3)	BTL 1	Remembering
	(ii)	Define rate of information.	(3)		
	(iii)	How the error-free communication will be achieved and calculate the entropy of a source which emits 2 symbols which are equally likely. S_1 and S_2 = ½.	(7)		
6.	Explain the types of channels in detail.		(13)	BTL 3	Applying
7.	(i)	Elaborate the conditional and joint entropies.	(5)	BTL 4	Analyzing
	(ii)	Write the mutual information properties with proof.	(8)		
8.	(i)	What is the main idea of discrete memory-less channel and its matrix form involving transition probabilities?	(6)	BTL 1	Remembering
	(ii)	Explain the concept of Binary symmetric channel with Binary communication channel.	(7)		

9.	A source "S" emits a symbols S1, S2 and S3 with probabilities of 0.25, 0.5 and 0.25. Calculate self-information and Entropy of a source S. (13)	(13)	BTL 2	Understanding
10.	Express the expression for channel capacity of a continuous channel. Comment on the trade-off between SNR and capacity.	(13)	BTL 1	Remembering
11.	A voice grade telephone channel has a bandwidth of 3400 Hz. Calculate channel capacity of the telephone channel for a SNR of 30 dB and estimate minimum SNR required to support a rate of 4.8 kbps.	(13)	BTL 4	Analyzing
12.	A source generates five messages m_0,m_1,m_2,m_3 and m_4 with probabilities 0.55,0.15,0.15,0.10 and 0.05 respectively. The successive messages emitted by the source are statistically independent. Determine the code words for the messages and efficiency using Shannon Fano Algorithm.	(13)	BTL 3	Applying
13.	Write Shannon's first theorem on Source Coding and deduce the equations for average number of bits, coding efficiency and redundancy.	(13)	BTL 2	Understanding
14.	Four symbols of the alphabet of discrete memory less source and their probabilities are given as {S_1,S_2,S_3,S_4} and {1/3, 1/6, 1/4, 1/4}. Point out the symbols using Shannon fano coding and calculate the average code word length and efficiency.	(13)	BTL 4	Analyzing
15.	A source emits one of four symbols S_1,S_2,S_3 and S_4 with probabilities {1/3, 1/6, 1/4, 1/4}. Calculate Entropy, average code word length and coding efficiency using Huffman coding.	(13)	BTL 4	Analyzing
16.	(i) Calculate the Huffman code for a discrete memoryless source with probability statistics {0.1,0.1,0.2,0.2,0.4}. (ii) Identify the drawbacks of Huffman coding.	(9) (4)	BTL 3	Applying
17.	Five symbols of the alphabet of discrete memory less source and their probabilities are given as {S_1,S_2,S_3,S_4,S_5) and {0.4,0.19,0.16,0.15,0.15}. Construct using Shannon fano Coding and calculate the code efficiency.	(13)	BTL 4	Analyzing

PART – C					
1.	The source of information A generates the symbols $\{A_1,A_2,A_3,A_4,A_5,A_6\}$ with the corresponding probabilities {0.2,0.3,0.11,0.16,0.18,0.05}. Explain the code for source symbols using Huffman and Shannon-Fano encoder and compare its efficiency.		(15)	BTL 4	Analyzing
2.	(i)	Deduce by Shannon's theorem on source coding with need, average no of bits, code efficiency, redundancy and variance.	(8)	BTL 2	Understanding
	(ii)	Find out the average number of bits per symbol for the code words 10, 11,010,011,000 and 001.	(7)		
3.	Summarize the different data compaction entropy coding algorithms and give detail on the differences between them.		(15)	BTL 4	Analyzing
4.	Five sources messages are probable to appear as symbols {m1, m2, m3, m4, m5} with the corresponding probabilities {0.4, 0.15, 0.15, 0.15, 0.15}. Find the code for source symbols using Huffman and Shannon-Fano encoder and compare its efficiency.		(15)	BTL 1	Remembering
5.	Consider a discrete memoryless source with source alphabet X = $\{x_1, x_2, x_3\}$ and source statistics {0.7, 0.15, 0.15}. Calculate the Entropy of a source X and the Entropy of the second order extension of the source and also verify that $H(S^2) = 2\ H(S)$.		(15)	BTL 3	Applying

UNIT II - WAVEFORM CODING & REPRESENTATION			
Prediction filtering and DPCM - Delta Modulation - ADPCM & ADM principles-Linear Predictive Coding- Properties of Line codes- Power Spectral Density of Unipolar / Polar RZ & NRZ – Bipolar NRZ – Manchester – HDBP.			
PART - A			
Q.No	**Questions**	**BT Level**	**Competence**
1.	What is linear predictor? On what basis are predictor coefficients are determined.	BTL 1	Remembering
2.	Identify the need of prediction filtering.	BTL 3	Applying
3.	List the two properties of linear prediction.	BTL 4	Analyzing
4.	What are the disadvantages of DPCM?	BTL 1	Remembering
5.	State the principle of working of DM.	BTL 2	Understanding

6.	Write the advantages of delta modulator.	BTL 2	Understanding
7.	Explain the techniques to overcome slope overload and granular noise in delta modulation system.	BTL 2	Understanding
8.	Why delta modulation is superior to differential pulse code modulation?	BTL 1	Remembering
9.	State the concept of ADPCM.	BTL 4	Analyzing
10.	Define APF.	BTL 1	Remembering
11.	What is meant by Pulse code modulation?	BTL 1	Remembering
12.	What are the drawbacks of ADM?	BTL 1	Remembering
13.	Outline the concept of APB.	BTL 4	Analyzing
14.	Give the difference between DM and ADM.	BTL 3	Applying
15.	Mention the concept of quantization.	BTL 3	Applying
16.	Assess the principle of linear predictive coder.	BTL 3	Applying
17.	Sketch the model of LPC.	BTL 4	Analyzing
18.	Summarize the need of line codes.	BTL 2	Understanding
19.	Mention the properties of line coding.	BTL 3	Applying
20.	Compare unipolar and RZ code for the binary data 01101001.	BTL 4	Analyzing
21.	Draw the power spectral density for Bipolar NRZ format.	BTL 3	Applying
22.	Infer the technique of Manchester coding.	BTL 4	Analyzing
23.	Express the data 10011 using the Manchester code format.	BTL 2	Understanding
24.	Summarize the concept of HDBP waveform coding.	BTL 2	Understanding

PART - B

1.	(i) (ii)	Evaluate in detail speech generation model. Assess the process of LPC encoder and decoder.	(7) (6)	BTL 4	Analyzing
2.	(i) (ii)	In a binary PCM system, the output signal to quantization noise ratio is to be minimum of 40 dB. Determine the number of required levels and find the corresponding output signal to quantization noise ratio. A binary channel with bit rate = 36,000 bits/sec is available for PCM voice transmission. Find number of bits per sample, number of quantization levels and sampling frequency assuming highest frequency component of voice signal is 3.2 kHz.	(6) (7)	BTL 4	Analyzing

3.	Explain DPCM system transmitter and receiver with suitable diagrams.		(13)	BTL 1	Remembering
4.	Describe delta modulation transmitter and receiver with their block diagrams.		(13)	BTL 1	Remembering
5.	A signal having bandwidth of 3 kHz is to be encoded using 8 bit PCM and DM system. If 10 cycles of signal are digitized, state how many bits will be digitized in each case if sampling frequency is 10 kHz? Also find bandwidth required in each case.		(13)	BTL 3	Applying
6.	(i)	Consider a DM system designed to accommodate analog message signals limited to bandwidth W = 5 kHz. A sinusoidal test signal of amplitude A = 1 volt and frequency f_m = 1 kHz is applied to the system. The sampling rate of the system is 50 kHz. (a) Calculate the minimum step size Δ required to minimize slope overload. (b) Calculate signal-to (quantization) noise ratio of the system for the specified sinusoidal test signal.	(8)	BTL 1	Remembering
	(ii)	Compare time domain and frequency domain coder.	(5)		
7.	State and explain the functioning of ADPCM system with neat block diagrams.		(13)	BTL 2	Understanding
8.	Explain ADM with transmitter and receiver block diagrams.		(7)	BTL 2	Understanding
9.	(i)	Summarize the advantages of adaptive delta modulation.	(5)	BTL 2	Understanding
	(ii)	Distinguish between the temporal waveform and spectral waveform coding.	(8)		
10.	Explain about the linear prediction with necessary equations.		(13)	BTL 2	Understanding
11.	(i)	Write down the properties of linear prediction.	(5)	BTL 3	Applying
	(ii)	Compare source coding methods with various parameters.	(8)		
12.	Briefly explain the properties of line coding.		(13)	BTL 3	Applying
13.	What is the need for line coding of signals? Explain on the power spectral properties of different line coding signals.		(13)	BTL 1	Remembering
14.	Analyze with waveforms of different types of line coding signals with their signal representation equations.		(13)	BTL 4	Analyzing
15.	For the following bit sequence 1101010011 draw the waveforms for RZ unipolar, NRZ polar, AMI, Manchester, RZ polar and NRZ line coding techniques.		(13)	BTL 4	Analyzing

16.	Consider a binary sequence with a long sequence of 1's followed by a single '0' and then a long sequence of 1's. Draw the waveform for this sequence using the following signaling formats such as Unipolar NRZ, Bipolar RZ, AMI RZ and Manchester signaling.	(13)	BTL 3	Applying
17.	Formulate on slope overload distortion which occurs if $A_m>(\delta/2\pi f_m T_s)$ for a sine wave of frequency f_m and amplitude A_m applied to a delta modulator of step size δ, where T_s is the sampling period.	(13)	BTL 4	Analyzing

PART - C

1.		A DM system is designed to operate at 3 times the Nyquist rate for a signal with 3 kHz bandwidth. The quantizing step size is 250 mV.		BTL 4	Analyzing
	(i)	Determine the maximum amplitude of a 1 kHz input sinusoid for which delta modulator does not show slope overload.	(8)		
	(ii)	Evaluate the post filtered output SNR for the signal.	(7)		
2.		In a single integration DM scheme the voice signal is sampled at a rate of 64 kHz, the maximum signal amplitude is 1 volt, voice signal bandwidth is 3.5 kHz.		BTL 4	Analyzing
		(i) Determine the minimum value of step size to avoid slope overload.	(5)		
		(ii) Evaluate the granular noise N_o.	(5)		
		(iii)Assuming the signal to be sinusoidal, calculate the signal power and signal to noise ratio.	(5)		
3.		A 1 kHz signal of voice channel is sampled at 4 kHz using 12 bit PCM and a DM system. If 25 cycles of voice signal are digitized. Solve in each case.		BTL 2	Understanding
		(i) Signaling rate	(5)		
		(ii) Bandwidth required	(5)		
		(iii)No of bits required to be transmitted.	(5)		
4.		For the sequence 11001001 sketch the waveforms for bipolar NRZ, Split phase Manchester, Polar RZ and AMI. Sketch also their power spectral densities for the same.	(15)	BTL 3	Applying
5.		List and compare the various line coding techniques with necessary diagrams.	(15)	BTL 1	Remembering

UNIT III - BASEBAND TRANSMISSION & RECEPTION

ISI – Nyquist criterion for distortion less transmission – Pulse shaping – Correlative coding –Eye pattern – Receiving Filters- Matched Filter, Correlation receiver, Adaptive Equalization.

PART - A			
Q.No	**Questions**	**BT Level**	**Competence**
1.	Outline the causes for ISI.	BTL 3	Applying
2.	Justify the statement 'ISI cannot be avoided'.	BTL 3	Applying
3.	Devise a method to minimize ISI in communication system.	BTL 4	Analyzing
4.	List the practical difficulties of ideal Nyquist channel.	BTL 1	Remembering
5.	Summarize the Nyquist criteria for distortionless baseband transmission	BTL 2	Understanding
6.	Distinguish the Nyquist second and third criteria to realize zero ISI.	BTL 4	Analyzing
7.	Outline the concept behind the raised cosine spectrum.	BTL 2	Understanding
8.	Define roll off factor.	BTL 1	Remembering
9.	The output of a digital computer is at a rate of 64 kbps. If the roll off factor α = 0.5, find the bandwidth required to transmit the data in each case.	BTL 3	Applying
10.	Discuss how pulse shaping reduce ISI.	BTL 2	Understanding
11.	Examine correlative coding.	BTL 4	Analyzing
12.	Draw the frequency response of duo binary conversion filter.	BTL 1	Remembering
13.	Mention the drawbacks of duo binary system.	BTL 4	Analyzing
14.	Mention the need of precoding in a duobinary scheme.	BTL 2	Understanding
15.	Interpret the performance of the system from the width and height of the eye pattern.	BTL 3	Applying
16.	Illustrate Eye pattern with diagram.	BTL 3	Applying
17.	Outline the features of a matched filter.	BTL 2	Understanding
18.	When does the matched filter is called as integrate and dump filter?	BTL 2	Understanding
19.	Compare the matched filter and correlation receiver.	BTL 3	Applying
20.	State the assumptions based on which the average probability of the symbol error can be minimized.	BTL 1	Remembering
21.	Write the necessity of Equalization.	BTL 1	Remembering
22.	Categorize the methods to implement the adaptive equalizer.	BTL 4	Analyzing
23.	What is the need of adaptive equalization in a switched telephone network?	BTL 1	Remembering
24.	Classify the modes of operation of an adaptive equalizer.	BTL 4	Analyzing

PART – B					
1.	Elaborate how ISI occurs in base-band binary data transmission system.		(13)	BTL 2	Understanding
2.	What is ISI? List the different methods to remove ISI in s communication system. Also state and prove Nyquist first criterion for Zero ISI.		(13)	BTL 1	Remembering
3.	(i)	Summarize the benefits of Nyquist pulse shaping.	(7)	BTL 3	Applying
	(ii)	Explain the information provided in eye diagram.	(6)		
4.	Explain how Nyquist criterion eliminates interference in the absence of noise for distortion less baseband binary transmission.		(13)	BTL 2	Understanding
5.	(i)	Outline the concept of Matched filter receiver.	(7)	BTL 2	Understanding
	(ii)	Determine the principle of signal reception using a correlator type receiver.	(6)		
6.	Illustrate "raised cosine spectrum". Discuss how it helps to avoid ISI.		(13)	BTL 2	Understanding
7.	Categorize the M-ary baseband system and explain in detail with an example.		(13)	BTL 4	Analyzing
8.	Examine the principle of obtaining eye pattern and mark important observations made from the eye pattern.		(13)	BTL 4	Analyzing
9.	(i)	Analyze the differential encoder with neat block diagram.	(7)	BTL 4	Analyzing
	(ii)	Identify the merits and demerits of Duo binary signaling.	(6)		
10.	Describe the modified Duo binary coding technique and its performance by illustrating its frequency and impulse response.		(13)	BTL 1	Remembering
11.	(i)	Draw the simple duo-binary encoder without precoder and explain in detail.	(7)	BTL 1	Remembering
	(ii)	Explain the frequency response of duo-binary encoding scheme.	(6)		
12.	Illustrate the basic idea of correlative coding with a specific example.		(13)	BTL 3	Applying
13.	(i)	Draw the sub systems of a correlation receiver and explain in detail.	(7)	BTL 1	Remembering
	(ii)	Write about an optimum receiver based on the matched filter with an appropriate block diagram.	(6)		
14.	(i)	Interpret the pulse shaping method to minimize ISI.	(7)	BTL 3	Applying
	(ii)	Explain how eye pattern illustrates the performance of data transmission system with respect to Inter Symbol Interference with neat sketch.	(6)		

15.	Deduce the expression for the maximum signal to noise ratio of a matched filter.		(13)	BTL 4	Analyzing
16.	(i)	Outline the importance of the matched filter in a communication system.	(7)	BTL 3	Applying
	(ii)	Summarize the properties of the matched filter in detail.	(6)		
17.	Explain the types of adaptive equalizers in detail with neat diagrams.		(13)	BTL 1	Remembering

PART - C				
1.	Explain in detail about the realizations of the receiving filters based on the signal correlator and matched filter.	(15)	BTL 3	Applying
2.	Analyze in detail about inter symbol interference (ISI) and the Nyquist criterion for minimizing ISI. Elaborate the difficulties in implementing it in a practical system.	(15)	BTL 4	Analyzing
3.	Describe in detail about correlative coding to eliminate ISI.	(15)	BTL 1	Remembering
4.	Consider the input binary sequence 0010110 to a precoded duobinary scheme and explain the process of generating original binary sequence with the necessary diagram.	(15)	BTL 4	Analyzing
5.	Summarize the adaptive equalization techniques with neat diagram.	(15)	BTL 2	Understanding

UNIT IV - DIGITAL MODULATION SCHEME

Geometric Representation of signals - Generation, detection, PSD & BER of Coherent BPSK, BFSK & QPSK - QAM - Carrier Synchronization - Structure of Non-coherent Receivers - Principle of DPSK-–MSK–Gaussian MSK.

PART - A

Q. No	**Questions**	**BT Level**	**Competence**
1.	Outline the need for geometric representation of signals.	BTL 2	Understanding
2.	Draw the block diagram of a coherent BFSK receiver.	BTL 1	Remembering
3.	Interpret the decision rule for BFSK.	BTL 3	Applying
4.	Identify the difference between BPSK and QPSK techniques.	BTL 2	Understanding
5.	What is QPSK? Write down the expression for the QPSK signal.	BTL 4	Analyzing
6.	Sketch the BER curve for ASK, FSK and BPSK digital modulation schemes.	BTL 1	Remembering

7.	How to improve the Bit Error Rate of a system?	BTL 1	Remembering
8.	A BFSK system employs two signaling frequencies f_1 and f_2. The lower frequency f_1 is 1200 Hz and signaling rate is 500 Baud. Compute f_2.	BTL 3	Applying
9.	A BPSK system makes errors at the average rate of 100 errors per day. Data rate is 1 kbps. The single-sided noise power spectral density is 10 W/Hz. Assume the system to be wide sense stationary, predict the average bit error probability.	BTL 3	Applying
10	Compare coherent and non-coherent reception.	BTL 2	Understanding
11	Distinguish the error probability for BPSK and QPSK.	BTL 4	Analyzing
12	Summarize the features of DPSK.	BTL 2	Understanding
13	Indicate why PSK always preferable over ASK in Coherent detection?	BTL 2	Understanding
14	Examine the special features of QAM.	BTL 4	Analyzing
15	Illustrate the signal space diagram for QAM signal for M=8.	BTL 3	Applying
16	Write about the constellation diagram.	BTL 1	Remembering
17	Define carrier synchronization.	BTL 1	Remembering
18	When does the non coherent receiver is preferred?	BTL 4	Analyzing
19	State the principle of Differential Phase Shift Keying.	BTL 1	Remembering
20	Express the error probability of DPSK in terms of E_b/N_o.	BTL 3	Applying
21	Why MSK referred to as fast FSK? Justify.	BTL 3	Applying
22	Differentiate between MSK and GMSK.	BTL 2	Understanding
23	Analyze the concept of spectral efficiency.	BTL 4	Analyzing
24	Outline the importance of a Gaussian filter in GMSK	BTL 4	Analyzing

PART – B					
1.	(i)	Define basis set. In what way it is useful in representing the signal.	(5)	BTL 1	Remembering
	(ii)	With an example explain how the basis set is determined by Gram Schmidt procedure.	(8)		
2.	(i)	Explain about digital modulation schemes.	(7)	BTL 2	Understanding
	(ii)	Elaborate the geometrical representation of signal and explain in detail for BPSK signal.	(6)		
3.	Describe the process of generation and detection of a coherent binary PSK signal and derive the power spectral density of binary PSK signal and plot it.		(13)	BTL 2	Understanding
4.	A Bandpass transmission uses a signaling scheme with $x_1(t) = A\cos 2\pi f_o t$		(13)	BTL 3	Applying

	$x_2(t) = A\cos 2\pi f_o t$, $0 \leq t \leq Tb$ where the bit duration is 0.2ms. The carrier amplitude at the receiver is 1 mV and the PSD of AWGN is 10^{-12} W/Hz. Assume that ideal correlation receiver is used. Calculate the probability of bit error for the given signaling scheme.				
5.	Describe the coherent detection of FSK signal and derive the expression for the probability of error.		(13)	BTL 2	Understanding
6.	Draw the transmitter, receiver block diagram of QPSK and explain its signal space diagram in detail.		(13)	BTL 1	Remembering
7.	In a QPSK system, the bit rate of NRZ stream is 10 Mbps and carrier frequency is 1GHz. Determine the symbol rate of transmission and bandwidth requirement of the channel.		(13)	BTL 3	Applying
8.	(i)	Describe QPSK signaling with diagrams.	(7)	BTL 2	Understanding
	(ii)	Sketch the constellation diagram of QPSK scheme and explain.	(6)		
9.	Compare the BER of coherent PSK, coherent QPSK and coherent FSK.		(13)	BTL 4	Analyzing
10.	(i)	State the principle of working of an “early late bit synchronizer”.	(6)	BTL 1	Remembering
	(ii)	Obtain the expression for bit error probability of QPSK system.	(7)		
11.	With neat block diagram explain the transmitter and receiver of a QAM signal.		(13)	BTL 4	Analyzing
12.	Explain the power spectral density and bandwidth of QAM signal with neat diagrams and mention its advantages.		(13)	BTL 4	Analyzing
13.	(i)	Distinguish how QAM differs from QPSK, explain in detail.	(7)	BTL 4	Analyzing
	(ii)	Analyze the error performance of coherent detection QAM system	(13)		
14.	(i)	Illustrate about Carrier Synchronization.	(7)	BTL 3	Applying
	(ii)	Summarize the features of the non-coherent receivers.	(6)		
15.	Identify the principle of DPSK? Explain the transmitter and receiver of DPSK scheme.		(13)	BTL 3	Applying
16.	How would you describe the generation and demodulation of Minimum Shift Keying (MSK) signals? Explain in detail.		(13)	BTL 1	Remembering
17.	Explain in detail about Gaussian Minimum Shift Keying (GMSK) transmission and reception with necessary block diagram.		(13)	BTL 1	Remembering

PART - C				
1.	A set of binary data is sent at the rate of R_b= 100 Kbps over a channel with 60 dB transmission loss and power spectral density $\eta = 10^{-12}$ W/Hz at the	(15)	BTL 3	Applying

	receiver. Evaluating the transmitted power for a bit error probability $P_e = 10^{-3}$ for the following modulation schemes. (a) FSK (b) PSK (c) DPSK (d) 16 QAM			
2.	Draw the signal space diagram of a coherent QPSK modulation scheme and also find the probability of error if the carrier takes on one of four equally spaced values at 0^o,90^o, 180^o and 270^o.	(15)	BTL 1	Remembering
3.	In digital CW communication system, the bit rate of NRZ data stream in 1 Mbps and carrier frequency is 100 MHz. Solve for the symbol rate of transmission and bandwidth requirement of the channel in the following cases of different techniques used. (i) BPSK system (ii) QPSK system (iii) 16-ary PSK system	(15)	BTL 2	Understanding
4.	(i) Find the error probability of BFSK system for following parameters. PSD of white noise $N_o/2 = 10^{-10}$ Watt/Hz Amplitude of carrier is , A = 1mV at receiver input. Frequency of baseband NRZ signal is f_b=1kHz.	(5)	BTL 4	Analyzing
	(ii) Binary data is transmitted using PSK at rate 2Mbps over RF link having bandwidth 2MHz. Find signal power required at the receiver input so that error probability is less than or equal to 10^{-4} Assume noise PSD to be 10^{-10}Watt/Hz.	(10)		
5.	Determine the average probability of error and Euclidean distance of BPSK and BFSK and compare the values. Consider the following parameters: Data rate : 2.5 Mbps PSD of AWGN ($N_o/2$) : 10^{-20} W/Hz Received carrier amplitude : 1μV	(15)	BTL 4	Analyzing

UNIT V - ERROR CONTROL CODING

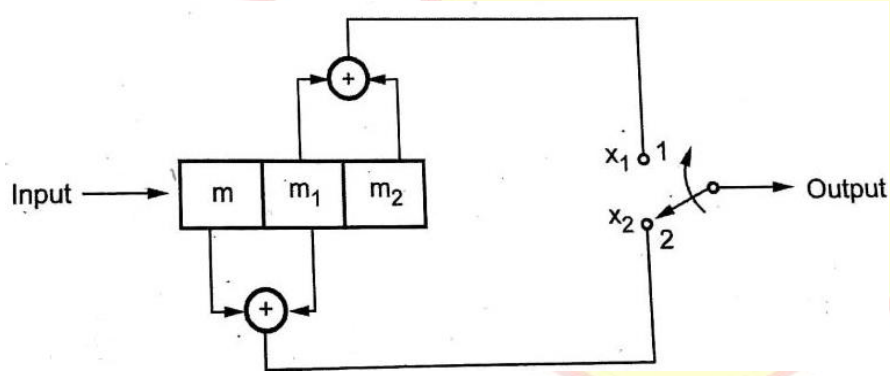
Channel coding theorem - Linear Block codes - Hamming codes - Cyclic codes - Convolutional codes - Viterbi Decoder.

PART - A

Q.No.	Questions	BT Level	Competence
1.	State Channel Coding Theorem and its need.	BTL 1	Remembering
2.	Analyze the need for error control codes.	BTL 4	Analyzing
3.	List the applications of error correction codes.	BTL 1	Remembering
4.	Outline the features of linear code.	BTL 2	Understanding
5.	Point out the code rate of a block code.	BTL 3	Applying
6.	Mention the significance of minimum distance of a block code.	BTL 2	Understanding
7.	Express the syndrome properties of linear block code.	BTL 2	Understanding
8.	Distinguish Hamming Distance and Hamming weight.	BTL 4	Analyzing
9.	Deduce the Hamming distance between 101010 and 010101. If the minimum Hamming distance of a (n, k) linear block code is 3, what is the minimum Hamming weight?	BTL 3	Applying
10.	Summarize the advantages and disadvantages of Hamming codes.	BTL 2	Understanding
11.	Interpret the properties of Cyclic codes.	BTL 3	Applying
12.	Illustrate the systematic code word with its structure.	BTL 3	Applying
13.	Discuss the properties of Generator polynomial.	BTL 2	Understanding
14.	When does a binary code is said to be cyclic codes?	BTL 1	Remembering
15.	Write the generator polynomial of a cyclic codes.	BTL 1	Remembering
16.	Generate the cyclic code for (n, k) syndrome calculator.	BTL 2	Understanding
17.	The code vector [1110010] is sent, the received vector is [1100010]. Calculate the Syndrome.	BTL 4	Analyzing
18.	What is meant by constraint length of a convolutional encoder?	BTL 1	Remembering
19.	Compute the code rate of a convolutional encoder with ‘n’ modulo 2 adders, ‘m’ flip flops and ‘L’ input bits.	BTL 4	Analyzing
20.	Define convolutional code. How is it different from block codes?	BTL 1	Remembering
21.	Mention the drawback of code tree approach in convolutional codes.	BTL 3	Applying
22.	Outline the techniques/algorithms used. in encoding and decoding of Convolutional code.	BTL 3	Applying

23.	Classify the approaches to identify the output sequence in a convolutional encoder.	BTL 4	Analyzing
24.	Examine how Trellis diagram is used to represent the code generated by convolutional coder and mention its advantages.	BTL 4	Analyzing

PART - B				
1.	Consider the (7,4) linear block code with generator matrix $\begin{bmatrix}1000:101\\0100:111\\0010:110\\0001:011\end{bmatrix}$ (i) Find all the code vectors. (ii) Find parity check matrix. (iii)Minimum weight of this code.	(5) (4) (4)	BTL 3	Applying
2.	For a systematic (6, 3) linear block code, P = $\begin{bmatrix}101\\011\\110\end{bmatrix}$. Analyze all the possible code vectors.	(13)	BTL 4	Analyzing
3.	(i) Outline the steps involved in the generation of linear block codes. (ii) Interpret the properties of syndrome.	(7) (6)	BTL 2	Understanding
4.	Illustrate how the errors are corrected using hamming code with an example.	(13)	BTL 2	Understanding
5.	Explain syndrome decoding and explain its property with appropriate example.	(13)	BTL 2	Understanding
6.	Assume that the code word C=10110 for the (6,3) case is transmitted and the vector R=001110 is received. Show how a decoder using the syndrome lookup table can correct the error. Let the generator matrix as G= $\begin{bmatrix}110100\\011010\\101001\end{bmatrix}$	(13)	BTL 3	Applying
7.	An error control code has the following parity check matrix H=$\begin{bmatrix}101100\\110010\\011001\end{bmatrix}$ (i) What is the generator matrix G? (ii) Find the code word that begins with 101… (iii)Decode the received code word 110110. Comment on error correction and detection capability of this code.	(4) (4) (5)	BTL 3	Applying
8.	Describe the cyclic codes with the linear and cyclic property. Also represent the cyclic property of a code word in polynomial notation.	(13)	BTL 2	Understanding

9.		Find the (7,4) systematic and non-systematic cyclic code words of the message word 1101.Assume the generator polynomial as $1+x^2+x^3$	(13)	BTL 1	Remembering
10.		Analyse how to generate the output sequence from a convolutional encoder using the time domain approach and transfer domain approach.	(13)	BTL 4	Analyzing
11.	(i)	Illustrate the significance of generator polynomial with the relevant properties	(7)	BTL 1	Remembering
	(ii)	Consider the message vector m = [1 0 1 1] and generator polynomial $g(X) = 1 + X + X^3$. Compute the code vector using (7,4) systematic cyclic coder.	(6)		
12.		Draw the diagram of the ½ rate convolutional encoder with generator polynomials $G^1(D)=1+D$ $G^2(D)=1+D+D^2$ Compute the encoder output for input sequence 101101.	(13)	BTL 3	Applying
13.		Sketch the state diagram of rate ½ convolutional encoder given in the figure below. 	(13)	BTL 1	Remembering
14.		A convolutional code is described by the following generator sequences, $g^{(1)}= \{1,0,1\}$, $g^{(2)}= \{1,0,0\}$, $g^{(3)}= \{1,1,1\}$.		BTL 4	Analyzing
	(i)	Draw the encoder to this code	(4)		
	(ii)	Draw the state diagram	(5)		
	(iii)	If the message sequence is 10110, Frame the code word.	(4)		
15.	(i)	Compare linear block codes and convolutional codes.	(7)	BTL 1	Remembering
	(ii)	State the advantages, disadvantages and applications of convolutional codes.	(6)		
16.		Construct a convolutional Encoder with the following specifications:	(13)	BTL 4	Analyzing

	Constraint length =3, Code rate =1/2, Generator sequence are $g^{(1)}$ =[1 0 1] , $g^{(2)}$ =[1 1 0] , input sequence =[1 0 0 1 1].Determine the output sequence using Code Tree approach.			
17.	Determine how Viterbi decoding algorithm is used for convolutional code.	(13)	BTL 1	Remembering

PART – C

1.	For a systematic (6,3) linear block code $G=\begin{bmatrix}1 & 0 & 0 & 1 & 0 & 1\\ 0 & 1 & 0 & 0 & 1 & 1\\ 0 & 0 & 1 & 1 & 1 & 0\end{bmatrix}$, (i) Solve for all the code vectors. (ii) Draw encoder circuit for the above code. (iii) Predict minimum hamming weight.	 (5) (5) (5)	BTL 4	Analyzing
2.	For a systematic linear block code, the three parity check digits P_1, P_2, P_3 are given by $P_{k,n-k}=\begin{bmatrix}101\\111\\110\\011\end{bmatrix}$ (i) Construct generated matrix. (ii) Assess the t code generated by the matrix. (iii)Determine error correcting capacity. (iv)Decode the received words with an example.	 (4) (4) (4) (3)	BTL 3	Applying
3.	Find a generator polynomial for a (7,4) cyclic code and find the code word for [1 0 0 0].	(15)	BTL 4	Analyzing
4.	Explain about code tree, code trellis and state diagrams. Compare code tree with trellis diagram.	(15)	BTL 1	Rememberin g
5.	A convolutional code is described by g1 = [1 0 0], g2 = [1 1 1], g3 = [1 0 1] (i) Design the encoder corresponding to the code. (ii) Sketch the code tree and state diagram for this code. (iii)Draw the trellis diagram.	 (5) (5) (5)	BTL 2	Understandin g