SUMMER – 2022 EXAMINATION

Subject Name: Digital Communication System. **Subject Code:** 22428

Model Answer

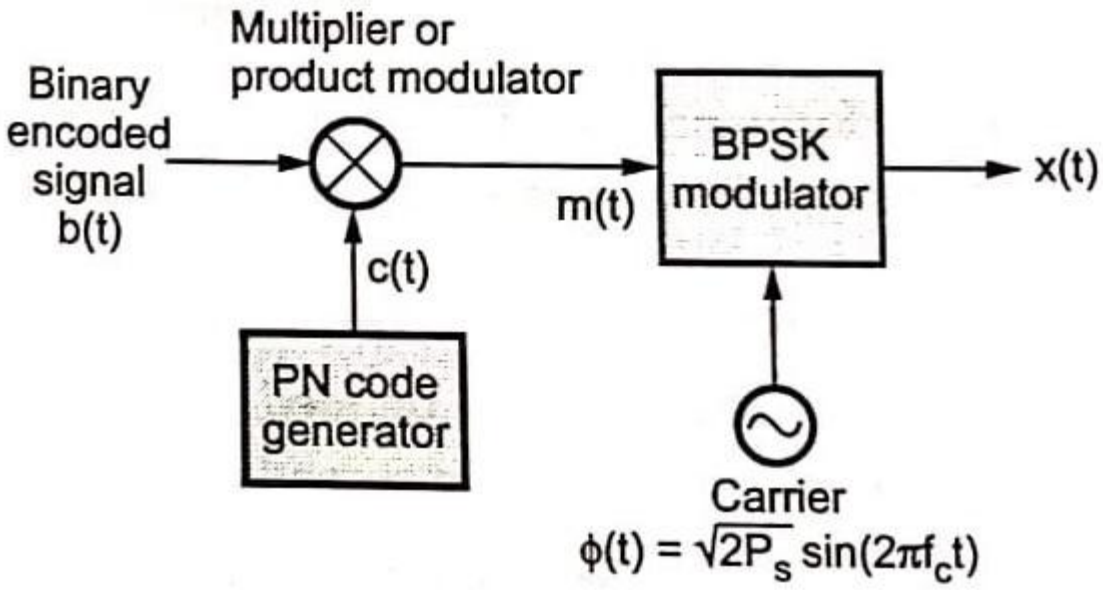
Important Instructions to examiners:

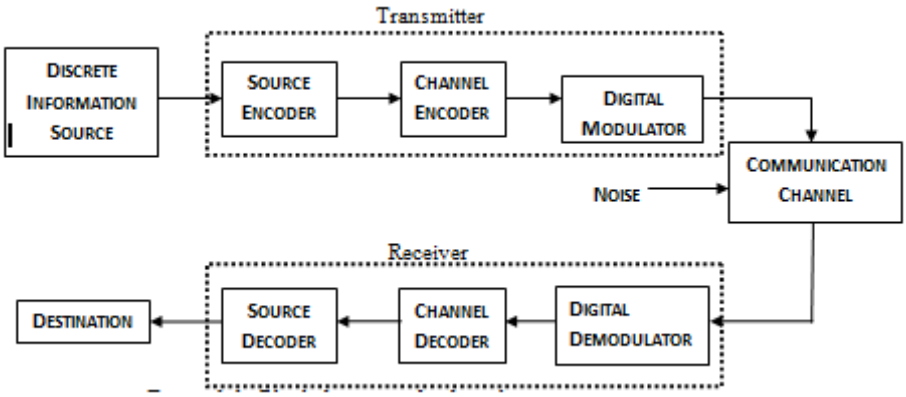
1) **The answers should be examined by key words and not as word-to-word as given in the model answer scheme.**
2) **The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.**
3) **The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.**
4) **While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.**
5) **Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.**
6) **In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.**
7) **For programming language papers, credit may be given to any other program based on equivalent concept.**
8) **As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.**

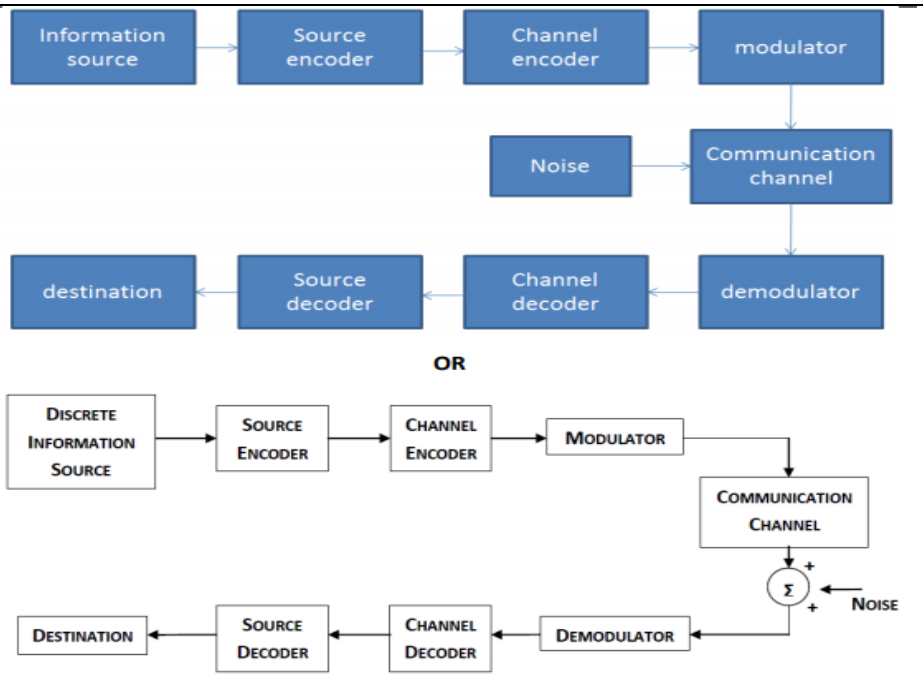
Q. No.	Sub Q. N.	Answers	Marking Scheme
1	(A)	**Attempt any FIVE of the following:**	10-Total

			Marks
	(a)	**Define the terms:** **i) Bit rate** **ii) Baud rate**	**2M**
	Ans:	(i)Bit rate: - Bit rate is simply the number of bits transmitted during one second and is expressed in bits per second (bps). Mathematically bit rate is given by:- Rb =1 / Tb where Tb is time interval of one bit (ii)Baud rate: - Baud is the unit of symbol rate. Baud rate is the number of symbols transmitted during one second and is expressed in symbols per second or baud. Baud rate is expressed as, Rs= 1 / Ts Where, baud rate = symbol rate (symbols per second) and Ts = time interval of one symbol	1M each
	(b)	**State Shannon Hartley theorem.**	**2M**
	Ans:	Shannon's Hartley theorem: The channel capacity of a white, band limited Gaussian channel is given By $C = B\log_2(1+S/N)$, Where, B = Channel Bandwidth S = Signal Power N = Noise within the channel bandwidth	2M
	(c)	**State minimum sampling rate using Nyquist criteria.**	**2M**

	Ans:	This is also known as the uniform sampling theorem. The sampling rate of **2 W samples per second** for a signal bandwidth W Hz is called the Nyquist rate. OR **minimum sampling rate (Fs)= 2W**	**Any definati on 2M**
	(d)	**List the Digital Modulation Schemes.**	**2M**
	Ans:	**List of Different Digital Modulation technique:-** (i) Amplitude shift keying -ASK (ii) Phase shift keying - PSK (iii) Frequency shift keying - FSK (iv) Quadrature Phase shift keying - QPSK (v) Differential Phase shift keying -DPSK (vi) Quadrature amplitude modulation- QAM	ANY 4 2M
	e)	**State the types of Multiplexing techniques.**	**2M**
	Ans:	Frequency-division multiplexing (FDM). ... Wavelength-division multiplexing (WDM). ... Time-division multiplexing (TDM). ... Code-division multiplexing (CDM). ... Space-division multiplexing (SDM). .	ANY 4 2M
	f)	**State the need of Multiplexing.**	**2M**
	Ans:	**Need of multiplexing** • In the application like telephony there are large numbers of users involved. It is not	**2M**

		possible to lay a separate pair of wires from each subscriber to the other entire subscriber; this is very expensive and practically impossible. • In the Process of multiplexing two or more individual signals are transmitted over a single communication channel. Here we used medium as a coaxial cable or an optical fiber cable because of multiplexing bandwidth utilization is effectively possible.	
	g)	**Draw the neat block diagram of Direct Sequence Spread spectrum transmitter.**	**2M**
	Ans:	**block diagram of Direct Sequence Spread spectrum transmitter**  	**Any correct diagram 2M**

Q. No.	Sub Q. N.	Answers	Marking Scheme
2		**Attempt any THREE of the following:**	**12-Total Marks**
	a)	**Draw the basic block diagram of Digital communication system. State the function of source encoder and channel encoder.**	**4M**
	Ans:	**Block diagram of digital communication system:-**  **OR**	**Block diagram = 2M, Explanation = 2M**



Explanation:-

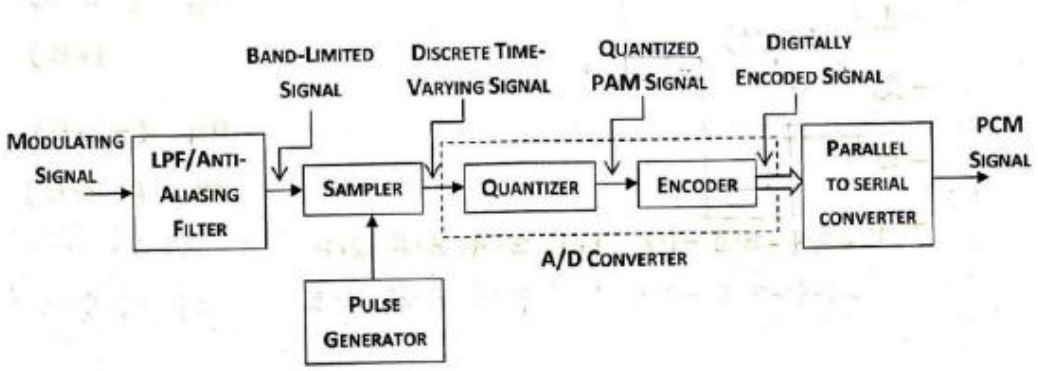
SOURCE ENCODER :

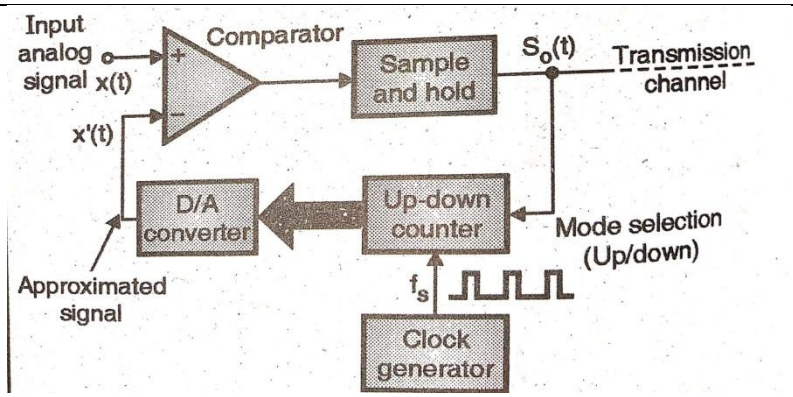
- The source encoder therefore reduces the redundancy by performing a one to one mapping of its input bit stream in to another bit stream at its output, but with fewer digits.
- Thus in a way it performs data compression.

CHANNEL ENCODER:

- The channel encoder is intended to introduce controlled redundancy into the bit stream at its input in order to provide some amount of error- correction capability to the data being transmitted.

	b)	**Describe the working of** **i) Quantizer and**	**4M**

		ii) Encoder, blocks of PCM generator **Also draw the block diagram of PCM transmitter.**	
	Ans:	 *PCM Transmitter* Quantizer The quantization process is the process of approximation of the sampled signal. It assigns a particular level to which the sampled value is near to. Encoder The encoder converts each quantized level into an N-bit digital word (binary pattern).	**Block diagram 2M,function of Quantizer 1M,Enc-oder 1M**
	c)	**Draw the block diagram of DM transmitter. Explain its working in brief.**	**4M**
	Ans:	**Block diagram of DM transmitter**	**block diagram and**

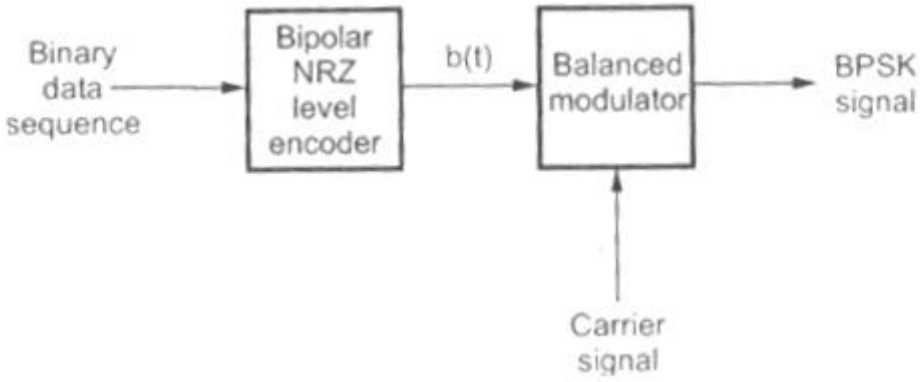
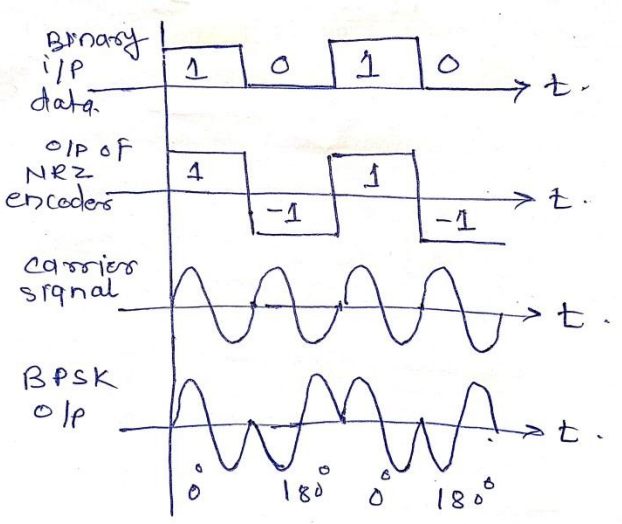


Working:

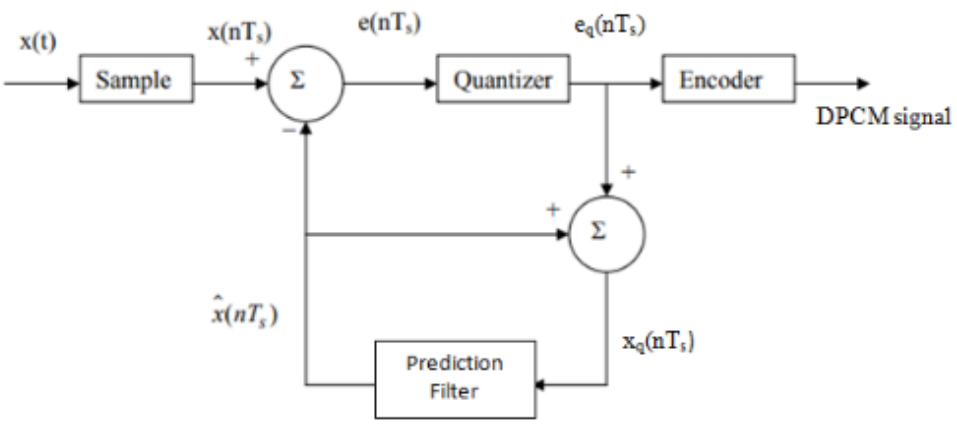
1. **X(t) is the analog input signal and x'(t) is the approximated version of x(t) both signals are applied to a comparator.**
2. **Comparator output goes high if x(t) > x'(t) and it goes low if x(t) <x'(t).thus comparator output is 1 or 0 . the sample and hold circuit will hold this level 1 or 0 for the entire clock cycle period.**
3. **The output of sample and hold circuit is transmitted as the output of the DM system. Here one bit per clock cycle is being sent. This will reduce the bit rate and hence band width..**
4. **Transmitted signal is also used to decide the mode of operation of an up/down counter. Counter output is increments by 1 if So(t) =1 and it decremented by 1 if So(t)= 0 , at the falling edge of clock pulse.**

working 2M each

	d)	**Describe the working of BPSK transmitter using block diagram. Also draw its**	**4M**

		waveforms.	
	Ans:	 **Working of BPSK transmitter:** **1.** Binary data signal (0 or 1)is converted into a NRZ bipolar signal by NRZ encoder. which is then applied to a balanced modulator. **2.** Other input to the balanced modulator is carrier signal. **3.** The BPSK output corresponding to 0 binary input is 180^0 phase shifted and for 1 binary input is 0^0 phase shifted which is shown in following wave forms. **BPSK transmitter output waveforms:** 	**Block diagram & wave forms 1.5 M each ,working 1M**

Q. No.	Sub Q. N.	Answers	Marking Scheme
3		**Attempt any THREE of the following:**	**12- Total Marks**
	a)	**Define and state the expression of** **i) Entropy ii) Information rate**	**4M**
	Ans:	i) **Entropy:** Entropy is defined as the average number of bits per symbol needed to encode long sequences of symbols emitted by the source. Its unit is bits/symbol. $H = \sum_{i=1}^{M} p_i \log_2 (1/p_i)$ bits/symbol $= p_1 \log_2 (1/p_1) + p_2 \log_2 (1/p_2) + \ldots\ldots + p_M \log_2 (1/p_M)$ ii) **Information rate:** It is defined as the average number bits per second needed to encode the source output. It is represented by R. **R = r * H** Where r = number of messages or symbols per second H = average information per message or symbol	**1M definition & 1M expression each**
	b)	**Draw the block diagram of DPCM transmitter and explain its working**	**4M**
	Ans:	**Block diagram of DPCM transmitter:**	**Block**

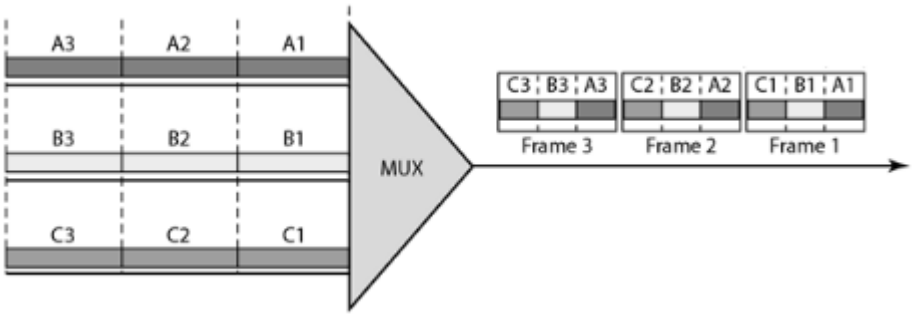
		 **DPCM TRANSMITTER Explanation:** 1. DPCM system is particularly efficient when there is high correlation between adjacent samples. In video and audio transmission, the information signal does not rapidly change from one sample to the other. 2. These highly correlated samples are encoded using standard PCM system, the resultant encoded signal contains redundancy (repeated code-words are transmitted) which leads to larger bandwidth utilization in PCM. Before encoding, this redundancy can be removed. 3. Correlation between the adjacent samples suggests that it should be possible to predict the present value of the message signal from the knowledge of its immediate past behavior. 4. The DPCM system employs a predictor which predicts the present sample value making use of immediate past samples. 5. If the prediction is good the difference between the actual value and predicted value,called the error will have a smaller dynamic range than the original message itself and therefore needs far fewer bits per each error sample than that would have required for the original sample.	**Diagram 2M & Explanation 2M**
	c)	**State the advantages and disadvantages of FDM system.**	**4M**
	Ans:	**Advantages of FDM:** 1. A large number of signals or channels can be transmitted simultaneously	**Any 2 advanta**

		2. FDM does not need synchronization between its transmitter and receiver for proper operation. 3. Demodulation of FDM is easy. 4. Due to slow narrow band fading only a single channels gets affected. **Disadvantages of FDM:** 1. The communication channel must have a very large bandwidth 2. Intermodulation distortion takes place. 3. Large number of modulators and filters are required. 4. FDM suffers from the problem of crosstalk's. 5. All the FDM channels get affected due to wideband fading	**ges & 2 disadva ntages 1M each**
	d)	**Compare TDMA and CDMA on the basis of following points-** **a) Guard band b) Guard time** **c) Codeword d) Synchronization**	**4M**
	Ans:		**1M each**

Parameter	**TDMA**	**CDMA**
Guard band	*Guard band between adjacent time slots are not required*	*Guard bands are required* if it uses FDMA also. Otherwise not required.
Guard time	Guard time between adjacent time slots are required	Guard times are required if it uses TDMA also. Otherwise not required.
Code word	Code word is not required	Code words are required

		Synchronization	Time synchronization is essential.	Code Synchronization is required.		

Q. No.	**Sub Q. N.**	**Answers**	**Marking Scheme**
4		**Attempt any THREE of the following:**	**12- Total Marks**
	(a)	**State the advantages of Digital communication.**	**4M**
	Ans:	**Advantages of Digital communication:** 1. Digital signals are better suited than analog signals for procession and combining using technique called multiplexing. 2. Digital transmission systems are more resistant to analog systems to additive noise because they use signal regeneration rather than signal amplification. 3. Digital signals are simpler to measure and evaluate than analog signals. 4. In digital systems transmission errors can be corrected and detected more accurately. 5. Using data encryption only permuted receivers can be allowed to detect the transmission data. 6. Wide dynamic range. 7. Because of the advances of IC technologies and high speed computers, digital communication systems are simpler and cheaper. 8. Digital communication is adaptive to other advance branches of data processing such as digital.	**1 M each Any 4**

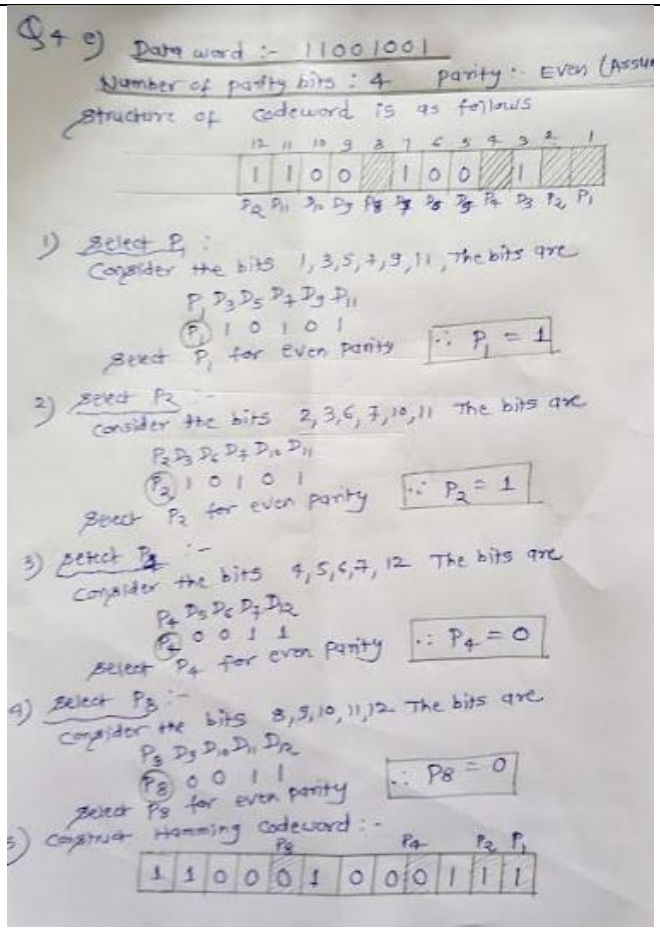
	(b)	**Explain the need of Companding.**	**4M**
	Ans:	1. The process of compression of the signal at the transmitter and expansion at the receiver is called as companding (compression and expansion). 2. The use of companding **allows signals with a large dynamic range to be transmitted over facilities that have a smaller dynamic range capability**. 3. Companding is done in order **to improve SNR of weak signals**. 4. Companding is employed in telephony and other audio applications such as professional wireless microphones and analog recording.	**Explanation 4M**
	(c)	**Explain Synchronous time – division multiplexing using block diagram.**	**4M**
	Ans:	**SYNCHRONOUS TDM:** 1. In synchronous TDM the term synchronous means that the multiplexer always allocates the same time slot to each device whether a device has anything to transmit. 2. For example, time slot 1 is assigned to device 1 alone and cannot be used by any other device. Each time its allocated time slot comes up, a device can send a portion of its data. If a device is unable to transmit or does not have data to send, its time slot remains empty. 3. Time slots are grouped into frames. In a system with "n" input lines (devices), each frame has at least "n" time slots, with each slot allocated to carrying data from a specific device. Thus, the time slots dedicated to a given device occupy the same location in each frame and constitute that device's channel. **Block diagram:** 	**Diagram 2M & Explanation 2M**

(d) **Differentiate the Direct Sequence Spread spectrum with frequency hopping spread spectrum techniques.** **4M**

Ans: **Any 4 Points 1M each**

SR. No	DSSS	FHSS
1	**Definition:** PN sequence of large bandwidth is multiplied with a narrow band information signal.	**Definition:** Data bits are transmitted in different frequency slots which are Changed by PN sequence.
2	**Modulation technique:** BPSK.	**Modulation technique:** M-ary FSK
3	Long acquisition time.	Short acquisition time.
4	DSSS is distance dependent.	In FHSS, effect of distance is less.
5	Processing gain is less.	Processing gain is higher.
6	Bandwidth required is less than FHSS System.	Bandwidth of FHSS system is too high.
7	DSSS radios encounter more randomly distributed errors that are continuous and lower level.	Slow Frequency Hopping suffers from strong burst error.
8	For commercial applications implementation of DSSS radios with large gap can also be costly due to the need of high speed circuits.	Implementation of FHSS radio can be Costly and complex due to the need of high speed frequency synthesizers.

(e) **Generate the Hamming code for the data (11001001).** **4M**

	Ans:			**Structure of code word 1M, 4 steps ½ M each, correct hamming g code 1M(Note: any Parity (even / odd can assume and solve)**

Q 4 e) Data word :- 11001001

Number of parity bits :- 04

Parity :- odd (Assume)

Structure of codeword is as follows

12	11	10	9	8	7	6	5	4	3	2	1
1	1	0	0		1	0	0		1		
D_{12}	D_{11}	D_{10}	D_9	P_8	D_7	D_6	D_5	P_4	D_3	P_2	P_1

1) Select P_1 :-

Consider the bits 1,3,5,7,9,11 the bits are

P_1 D_3 D_5 D_7 D_9 D_{11}

(P_1) 1 0 1 0 1

Select P_1 for odd parity

$\therefore P_1 = 0$

2) Select P_2 :-

Consider the bits 2,3,6,7,10,11 the bits are

P_2 D_3 D_6 D_7 D_{10} D_{11}

(P_2) 1 0 1 0 1

Select P_2 for odd parity

$\therefore P_2 = 0$

3) Select P_4 :-

Consider the bits 4,5,6,7,12. The bits are

P_4 D_5 D_6 D_7 D_{12}

(P_4) 0 0 1 1

Select P_4 for odd parity

$\therefore P_4 = 1$

4) Select P_8 :-

Consider the bits 8,9,10,11,12 the bits are

P_8 D_9 D_{10} D_{11} D_{12}

(P_8) 0 0 1 1

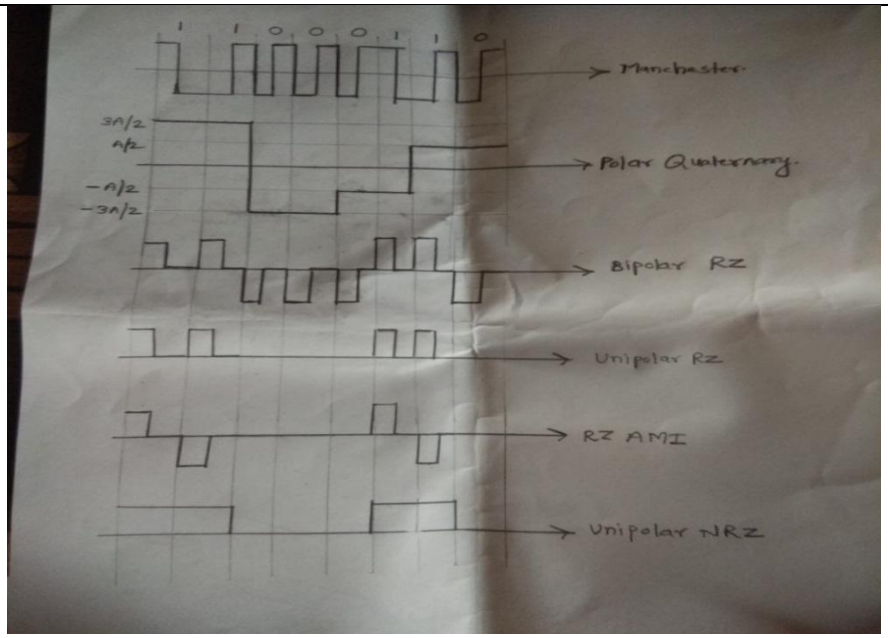
Select P_8 for odd parity

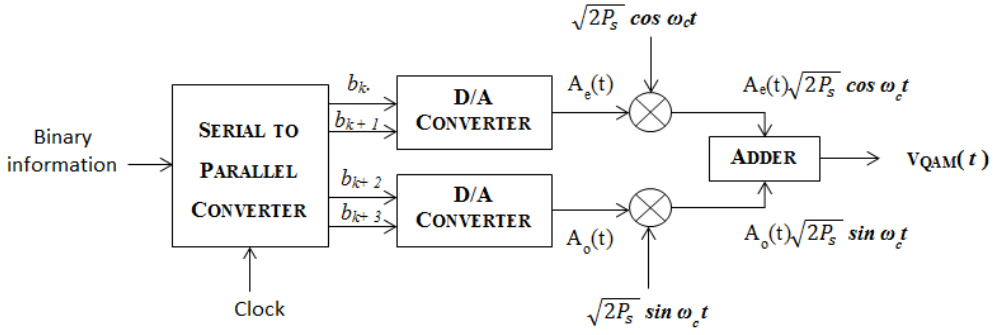
$\therefore P_8 = 1$

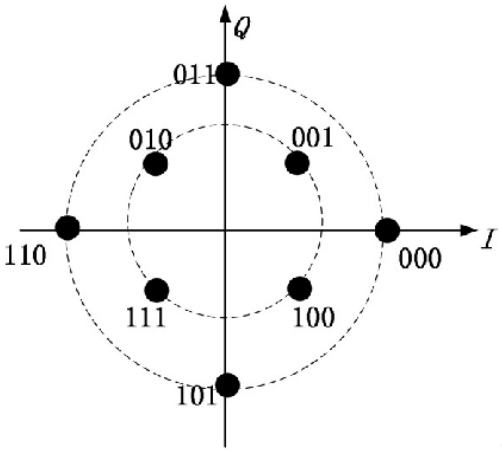
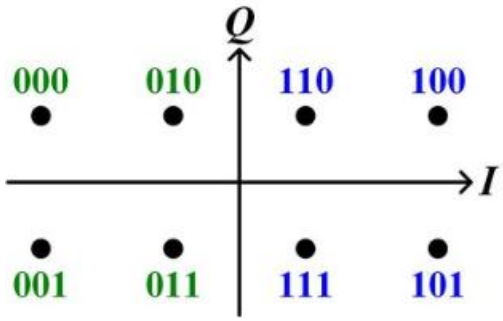
5) Construct Hamming codeword

				P_8				P_4		P_2	P_1
1	1	0	0	1	1	0	0	1	1	0	0

Q. No.	Sub Q. N.	Answers	Marking Scheme
5.		**Attempt any TWO of the following:**	**12- Total Marks**
	a)	**Draw data formate for bit stream (11000110):** **i) Manchester** **ii) Polar Quaternary** **iii) Bipolar RZ** **iv) Unipolar NR** **v) AMI** **vi) Unipolar NRZ**	**6M**
	Ans:	**Note:Unipolar NR line code does not exit,Kindly consider it as Uniploar RZ & draw waveform.**	**1M for each correct waveform**



	b)	**Draw the (a) Block diagram of QAM transmitter (b) Constellation diagram of 8 QAM.**	**6M**
	Ans:	**(a) Block diagram of QAM transmitter**  **(b) Constellation diagram of 8 QAM**	**3M each for QAM Traans mitter block diagram and Constell ation diagram of 8 QAM**

		  **OR**	
	c)	**Explain Slope overload and Granular noise in Delta Modulation. Also state the solution to reduce these effects.**	**6M**
	Ans:	**SLOPE-OVERLOAD DISTORTION:** • If the slope of the analog signal x(t) is much higher (steep) than that of the approximated signal xq(t) over a long duration then xq(t) will not follow x(t) at all as shown in Figure • The difference between x(t) and xq(t) is called the slope-overload distortion or the slope-overload error. Thus, slope-overload error occurs when the slope of x(t) is much **higher than xq(t).**	**2M each for Slope overload, Granular noise & solution to reduce these effects.**

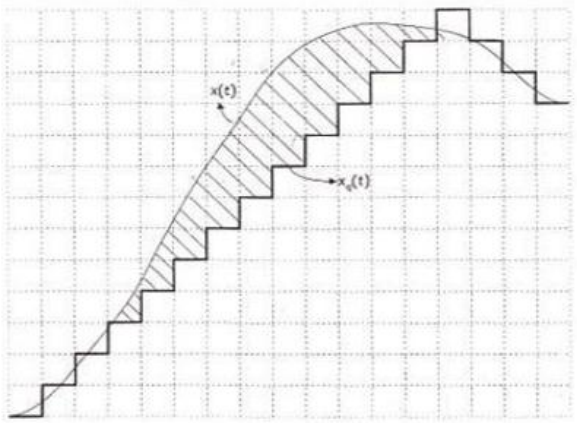


Fig. Illustrating the phenomenon of slope overload in linear delta modulation

Fig : slope-overload problem

An intuitive remedy for this problem is to increase the step-size δ but that approach has another serious problem given below.

GRANULAR NOISE:

- When the input signal x(t) is relatively constant in amplitude with time, the approximated signal xq(t) will hunt above and below x(t) as shown in Figure. This leads to a noise called granular noise.

- It increases with increase in step size δ. To reduce granular noise, the step size should be as small as possible. However, this will increase slope-overload distortion.

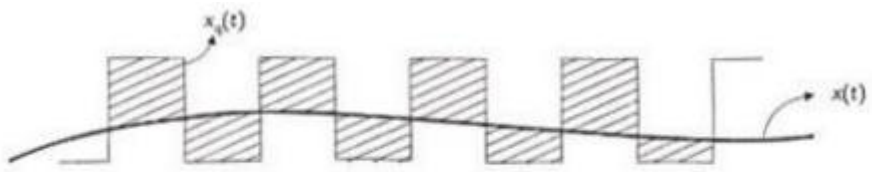
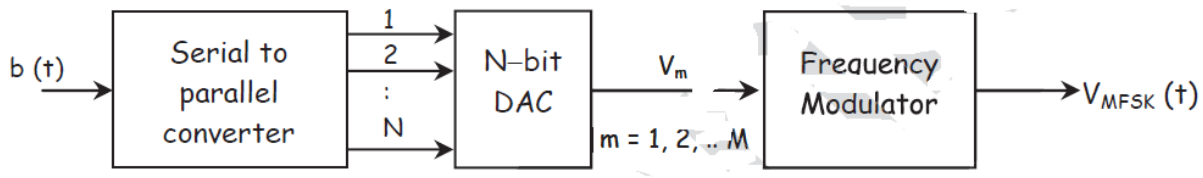
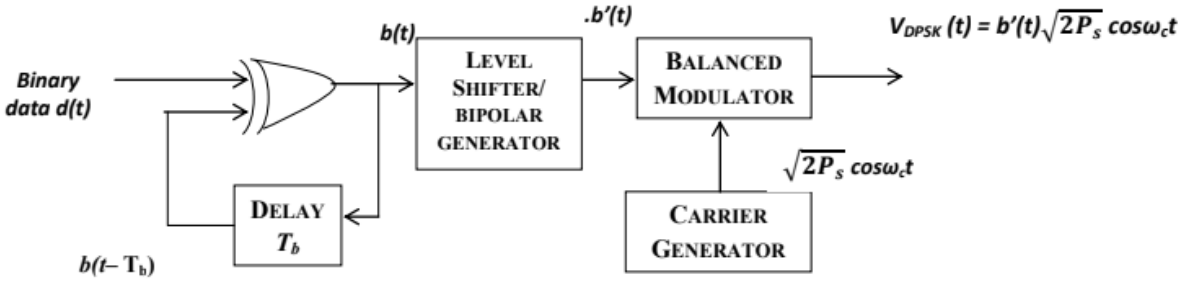


Fig. Granular noise

A more efficient approach of adapting the step-size, leading to **Adaptive Delta Modulation**

		(ADM) .	
Q. No.	**Sub Q. N.**	**Answers**	**Marking Scheme**
6.		**Attempt any TWO of the following :**	**12- Total Marks**
	a)	**State the Bandwidth requirement of (i) BPSK (ii) BFSK (iii)QPSK** **Explain the need of M-ary encoding. Draw the block diagram of M-ary FSK.**	**6M**
	Ans:	**Bandwidth :** BPSK = 2fb BFSK = 4fb QPSK = fb Where fb is Bit Frequency/Bit rate **Need of M-ary encoding** M-ary encoding- In an M-ary signaling scheme, we can send one of the M possible signals such as s1, s2...sm (t) during each signaling interval of duration of t seconds. The number of signals in an M is given as $M=2^N$. **Need of M-ary encoding for following reasons:**	**3M each for bandwidth requirement, 1M need of M-ary encoding and 2 M block diagram of M-ary FSK**

		1. Conservation of channel bandwidth. 2. Utilization of the additional bandwidth to provide increased noise immunity. **Block diagram of M-ary FSK Transmitter:** 	
	b)	**Explain the generation of DPSK using block diagram and waveforms.**	**6M**
	Ans:	The DPSK generation block diagram is shown below –  *Figure 3.16: DPSK Transmitter* **Explanation :-** The generation block diagram of DPSK signal is shown in Figure 3.16. The data stream to be transmitted, d(t), is applied to one input of an exclusive-OR logic gate. To the other gate input the output of the exclusive-OR gate b(t) delayed by time Tb allocated to one bit is applied.	**2 M for block diagram 2 M for explanation and 2 M for waveforms**

This second input is then b(t - Tb).

b(t) is applied to a level shifter which assigns a positive voltage level when b(t)

= 1 and a negative voltage level when b(t) = 0. The level shifter output is then applied to a

balanced modulator to which a carrier signal $\sqrt{2}P_s\cos\omega_c t$ is also applied.

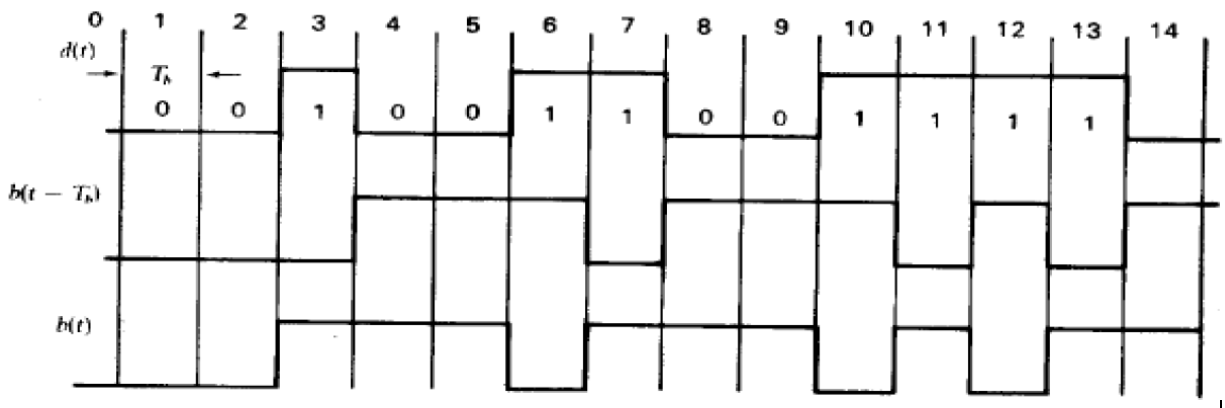
The modulator output, which is the transmitted signal is given by,

$V_{DPSK}(t) = b'(t)\cos\omega_c t$

$= (\pm 1)\cos\omega_c t$

$d(t)$		$b(t - T_b)$		$b(t)$	
logic level	voltage	logic level	voltage	logic level	voltage
0	−1	0	−1	0	−1
0	−1	1	1	1	1
1	1	0	−1	1	1
1	1	1	1	0	−1

Waveforms:



c) **Generate the Pseudo-noise sequence by the feedback register shown in Fig-1.** **6M**

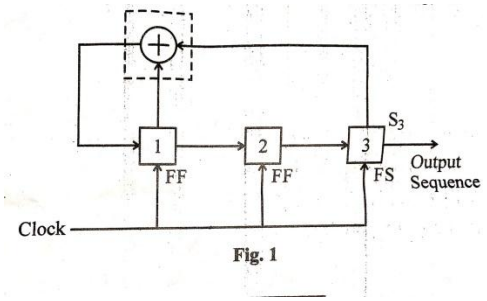


Fig. 1

Ans: Let initial value of shift register output i.e. Q3 Q2 Q1 = 0 0 1 (any initial value can be taken) **Pseudo-noise sequence Generation 6M**

Table is as shown below-

Clock Pulse	Shift Register Outputs			EX-OR Gate Output	PN Sequence
	Q3	Q2	Q1		Q3
0	0	0	1	1	0
1	0	1	1	1	0

2	1	1	1	0	1
3	1	1	0	1	1
4	1	0	1	0	1
5	0	1	0	0	0
6	1	0	0	1	1
7	0	0	1	1	0

The PN Sequence obtained at the output Q3 of flip-flop 3 is 0101110