Subject Name:DIGITAL COMMUNCIATIONS

Prepared by (Faculty (s) Name):B.SRAVANTHI/P.ASHOK KUMAR

Year and Sem, Department: III/I ECE

Unit-I: (Title)

Important points / Definitions:

1Source Alphabet: These are the letters digits or special characters available from information source

2.Symbol Rate: It is rate which information source generates source alphabets.it is normalyy represented in symbols/sec

3.Source Alphabet Probabilities:

Each source alphabet from the source has independent occurrence.

4.Information rate=Symbol rate * Source entropy

(BITS/SEC) (SYMBOLS/SEC) (BITS/SYMBOL)

5.BLOCK SIZE :This gives maximum no of distinct codewords that can be represented by source encoder.it depends upon maximum number of bits in codeword.

6.Efficiency of encoder :This is ratio of minimum source information rate to actual output data rate of source encoder.

7.Issues in digital Transmission:

8.Advantages of DC:

1.wide dynamic Range

2.Since channel coding is used,the errors can be detected and corrected in the receivers.

3.Since transmitted signal is digital,large amount of noise interference can be tolerated.

9.Shannon's theorem: It States that it is possible to transmit information with an small probablilty of error provided that information rate 'R' is less than or equal to a rate 'C' called channel capacity

OR

Given a source of M equally likely messageswith M>>1 Which is generating information at a Rate R.Given channel with channel capacity C.

Then R<C

10.The channel capacity of white bandlimited gaussian channel is

C=B log(1+S/N)bits/sec

11.Sampling Theorem:A continuous time signal can be completely represented in its samples and recovered back if sampling frequency is twice of highest frequency content of signal

Fs>2W

12.When the high frequency interferes with low frequency and appears as low frequency the that phenomenon is called aliasing.

13.Sample and hold circuit:It samples this signal at a rate fs.Sampling frequency fs is selected sufficiently above Nyquist rate to avoid aliasing i..e

fs≥2W

14.Quantizer:A q-level quantizer compares input x(nTs) with its fixed digital levels.It assigns any one of digital levels to x(nTs) to result in minimum distortion called Quantization error.

15.Reconctruction Filter:The output of S/H is passed through low pass reconstruction filter to get original data signal.It is impossible to reconstruct original signal x(t) because of permanent error introduced during quantization.

16.Uniform Quantization Types:

i)MidTread Quantizer

ii)MidRise Quantizer

iii)Biased Quantizer

17.Normalized noise Power or Quantization Error=δ^2/12

18.Maximum signal to Quantization noise ratio

$$S/N= 3P\frac{2^{2N}}{X^{2MAX}}$$

19.Signal to Quantization noise ratio for normalized values of power

$$\left(\frac{S}{n}\right)db \leq (4.8+6n)db$$

20.Differential Pulse code modulation:The values of present sample is predicted from past samples.The prediction may not be exact but it is very close to actual sample value.

21.Adaptive differential pulse code modulation:It uses adaptive Quantizer that has time varyng step size δ(n).

22.Delta Modulation:It transmits only one bit per one sample.That is present sample values is compared with previous sample value and the indication,whether the amplitude is increased or decreased is sent.

23.Adaptive Delta Modulation:To overcome Quantization errors due to slope overload and granular noise,the step size (δ) is made adaptive to variations in input signal x(t).In steep segmaent of signal x(t) step size is increased,when input is varyng slowly step size is reduced.

This method is called Adaptive delta modulation.

24.Slope overload Distortion:This distortion arises because of large dynamic range of input signal

25.Granular Noise:This distortion occurs when step size is too large compared to small variations in input signal

I.SHORT ANSWER QUESTIONS[2M]

1.What are the drawbacks of delta modulation? [MAY 2016]

2. Explain the need for non-uniform quantization in digital communication?[MAY 2016]

3.Compare PCM and DM. [OCT/NOV 2016]
4. Write the advantages of digital communication. [OCT/NOV 2016]

5.Compare the performance of PCM and DM system. [MAY 2017]
6.What is slope overload distortion? Explain. [MAY 2017]

7.Mention various types of errors caused by noise in communication channel. [MAY 2017]
8.What is the need for encoding the output of quantizer in a PCM system. [MAY 2019]

9. A certain low pass band limited signal x(t) is sampled and the spectrum of sampled version has the first guard band from 1500Hz to 1900Hz. Calculate the sampling frequency? What is the maximum frequency of the signal? [MAY 2019]
10. Mention the merits of DPCM?

11.state sampling theorem?

II.LONG ANSWER QUESTIONS[5M]

1) With neat block diagram, Explain the process of Sampling and Quantization in digital

communication. [MAY 2016]

2) Derive the expression for the Quantization error. [MAY 2016]

3. Explain about the noise in PCM systems. [MAY 2016]

4. Write the comparison between PCM and Analog modulation techniques. [MAY 2016]

5. What is Hartley Shannon law? And explain sampling theorem. [OCT/NOV 2016]

6. With a neat sketch describe ADPCM concept. [OCT/NOV 2016]

7. Explain the tradeoff between bandwidth and signal to noise ratio. [OCT/NOV 2016]

8. Distinguish between analog communication and digital communication. [OCT/NOV 2016]

9.A voice frequency signal band limited to 3kHz is transmitted with the use of the DM system. The pulse repetition frequency is 30,000 pulses per second, and the step size is 40mV. Determine the permissible speech signal amplitude to avoid slope overload. [MAY 2017]

10 Derive the expression for overall SNR in a ADM system. [MAY 2017]

11. In a binary PCM system, the output signal to quantizing noise ratio is to be held to a minimum of 40dB. Determine the number of required levels and find the corresponding output signal to quantization noise ratio. [MAY 2017]

12.Explain the modulation and demodulation procedure in DPCM system. [MAY 2017]

13.Explain how message signal is reconstructed from its samples. Also illustrate the affect of aliasing with a neat sketch. [MAY 2019]
14. A delta modulator with fixed step size of 0.75V is given a sinusoidal message signal. If the sampling frequency is 30 times the nyquist rate, determine the maximum permissible amplitude of the message signal if slope overload is to be avoided. [MAY 2019]

15.a) A voice frequency signal band limited to 3kHz is transmitted with the use of the DM system. The pulse repetition frequency is 60,000 pulses per second, and the step size is 60mV. Determine the permissible speech signal amplitude to avoid slope overload.
b) Draw the block diagram of adaptive delta modulator with continuously variable step size and explain. [MAY 2019]

16.Draw the block diagram of digital communication systemand explain each block in detail?

17Explain th advantages of digital communcication system over analog communcication system?
18.Explain the term quantization
19.Find the output signal due to quantization noise in pcm systems?

CHOOSE THE CORRECT ANSWER

1) In uniform quantization process

a. The step size remains same
b. Step size varies according to the values of the input signal
c. The quantizer has linear characteristics
d. Both a and c are correct

ANSWER: (d) Both a and c are correct

2) The process of converting the analog sample into discrete form is called

a. Modulation
b. Multiplexing
c. Quantization
d. Sampling

ANSWER:(c) Quantization

3) The characteristics of compressor in μ-law companding are

a. Continuous in nature
b. Logarithmic in nature
c. Linear in nature
d. Discrete in nature

ANSWER: (a) Continuous in nature

4) The modulation techniques used to convert analog signal into digital signal are

a. Pulse code modulation
b. Delta modulation
c. Adaptive delta modulation
d. All of the above

ANSWER: (d) All of the above

5) The sequence of operations in which PCM is done is

a. Sampling, quantizing, encoding
b. Quantizing, encoding, sampling
c. Quantizing, sampling, encoding
d. None of the above

ANSWER:(a) Sampling, quantizing, encoding

6) In PCM, the parameter varied in accordance with the amplitude of the modulating signal is

a. Amplitude
b. Frequency
c. Phase
d. None of the above

ANSWER: (d) None of the above

7) One of the disadvantages of PCM is

a. It requires large bandwidth
b. Very high noise
c. Cannot be decoded easily
d. All of the above

ANSWER: (a) It requires large bandwidth

8) The expression for bandwidth BW of a PCM system, where v is the number of bits per sample and fm is the modulating frequency, is given by

a. $BW \geq vfm$
b. $BW \leq vfm$

c. BW ≥ 2 vfm
d. BW ≥ 1/2 vfm
ANSWER: (a) BW ≥ vf_m
9) The error probability of a PCM is
a. Calculated using noise and inter symbol interference
b. Gaussian noise + error component due to inter symbol interference
c. Calculated using power spectral density
d. All of the above
ANSWER: (d) All of the above
10) In Delta modulation,
a. One bit per sample is transmitted
b. All the coded bits used for sampling are transmitted
c. The step size is fixed
d. Both a and c are correct
ANSWER: (d) Both a and c are correct
11) In digital transmission, the modulation technique that requires minimum bandwidth is
a. Delta modulation
b. PCM
c. DPCM
d. PAM
ANSWER: (a) Delta modulation
12) In Delta Modulation, the bit rate is
a. N times the sampling frequency
b. N times the modulating frequency
c. N times the nyquist criteria
d. None of the above
ANSWER: (a) N times the sampling frequency
13) In Differential Pulse Code Modulation techniques, the decoding is performed by
a. Accumulator
b. Sampler
c. PLL
d. Quantizer
ANSWER: (a) Accumulator
14) DPCM is a technique
a. To convert analog signal into digital signal
b. Where difference between successive samples of the analog signals are encoded into n-bit data streams
c. Where digital codes are the quantized values of the predicted value
d. All of the above
ANSWER: (d) All of the above
15) DPCM suffers from
a. Slope over load distortion
b. Quantization noise
c. Both a & b
d. None of the above
ANSWER:(c) Both a & b

UNIT 2
IMPORTANT POINTS

1. Error-control coding techniques are used to detect and/or correct errors that occur in the message transmission in a digital communication system.
2. The Hamming (7, 4) code is therefore a single error-correcting and double error-detecting code. More generally, a family of (n, k) linear block codes with parameters

Block length: $n = 2^m - 1$

Number of message bits: $k = 2^m - m - 1$

Number of parity bits: $n - k = m$

$d_{\min} = 3$

3. Let us consider some blocks of data, which contains **k** bits in each block. These bits are mapped with the blocks which has **n** bits in each block. Here **n** is greater than **k**. The transmitter adds redundant bits which are **(n-k)** bits. The ratio **k/n** is the **code rate**. It is denoted by **r** and the value of **r** is **r < 1**.

The **(n-k)** bits added here, are **parity bits**.

3. While using the hamming codes, extra parity bits are used to identify a single bit error. To get from one-bit pattern to the other, few bits are to be changed in the data. Such number of bits can be termed as **Hamming distance**. If the parity has a distance of 2, one-bit flip can be detected. But this can't be corrected. Also, any two bit flips cannot be detected.

5. The cyclic property of code words is that any cyclic-shift of a code word is also a code word. Cyclic codes follow this cyclic property.

For a linear code **C**, if every code word i.e., **C = (C1, C2, ... Cn)** from C has a cyclic right shift of components, it becomes a code word. This shift of right is equal to **n-1** cyclic left shifts. Hence, it is invariant under any shift. So, the linear code **C**, as it is invariant under any shift, can be called as a **Cyclic code**.

Cyclic codes are used for error correction. They are mainly used to correct double errors and burst errors.

These are the properties of Mutual information.

- Mutual information of a channel is symmetric.

  $$I(x;y) = I(y;x)$$

- Mutual information is non-negative.

  $$I(x;y) \geq 0$$

- Mutual information can be expressed in terms of entropy of the channel output.

  $$I(x;y) = H(y) - H(y \mid x)$$

Where $H(y \mid x)$ is a conditional entropy

- Mutual information of a channel is related to the joint entropy of the channel input and the channel output.

  $$I(x;y) = H(x)+H(y) - H(x,y)$$

4.

5. he maximum average mutual information, in an instant of a signaling interval, when transmitted by a discrete memoryless channel, the probabilities of the rate of maximum reliable transmission of data, can be understood as the **channel capacity**.
6. It is denoted by **C** and is measured in **bits per channel** use.
7. A source from which the data is being emitted at successive intervals, which is independent of previous values, can be termed as **discrete memoryless source**.
8. Proof A polynomial c(x) = c0 + c1x + . . . + cn−1x n−1 represents a code from C if c(x)h(x) = 0. For c(x)h(x) to be 0 the coefficients at x k , . . . , x n−1 must be zero, i.e. c0hk + c1hk−1 + . . . + ckh0 = 0 c1hk + c2hk−1 + . . . + ck+1h0 = 0
9. 10. Definition (Again!) Let r be a positive integer and let H be an r × (2r − 1) matrix whose columns are all distinct non-zero vectors of GF(r). Then the code having H as its parity-check matrix is called binary Hamming code denoted by Ham (r, 2).
10. An (n, k) convolution code (CC) is defined by an k × n generator matrix, entries of which are polynomials over F2. For example, G1 = [x 2 + 1, x 2 + x + 1]
11. For so-called Additive White Gaussian Noise (AWGN) channels, that well capture deep space channels, this limit is (so-called Shannon-Hartley theorem): R < W log „ 1 + S N « {bits per second} Shannon capacity sets a limit to the energy efficiency of the code
12. 13. **Constraint length**. In **convolutional codes** each output not only depends on the current input but also on previous inputs. The **constraint length** (symbolized by the letter K) is an integer that specifies the "memory" of the **code**.
13. 14. The **Viterbi algorithm** is the most resource-consuming, but it does the maximum likelihood decoding. It is most often used for decoding convolutional codes with constraint lengths k≤3, but values up to k=15 are used in practice.

I.SHORT ANSWER QUESTIONS[2M]

1. Derive the Expression for the Information Rate. [MAY 2016]

2. Explain in one sentence about (i) Block Size (ii) Linear block codes. [MAY 2016]

3. List out Properties of Cyclic Codes. [MAY 2016][OCT/NOV 2016]

4) Define Entropy[MAY 2016][MAY 2017]

5) Define conditional entropy. [MAY 2017]

6) Write the advantages of convolution codes[OCT/NOV 2016]

7. Define code rate of block code.[MAY 2017]

8.What is meant by syndrome in linear block code? [MAY 2019]

9. A Discrete Memory less Source X has five equally likely symbols. Construct Huffman code and calculate the efficiency of the code? [MAY 2019]

10.what is meant by systematic and non systematic? [MAY 2018]

11.what is meant by linear bock code? [MAY 2018]

II.LONG ANSWER QUESTIONS[5M]

1.Briefly explain about Variable length coding. [MAY 2016]

2. Explain in detail about Huffman coding and Lossy source code. [MAY 2016]

3.Write short notes on Hamming codes. [MAY 2016]

4. Explain about Error detection and Correction capabilities of Hamming codes. [MAY 2016]

5.Explain how Parity checking can be used for error detection or error correction. [MAY 2016]

6.For a linear block code, prove with example that: [MAY 2016]
i) The Syndrome depends only on error pattern and not on transmitted code word?
ii) All error patterns that differ by a codeword have the same syndrome

7.Explain Huffman coding with an example. [OCT/NOV 2016]

8.Describe the algebraic structure of cyclic codes. [OCT/NOV 2016]

9. Explain how to encode cyclic codes. [OCT/NOV 2016]

10.Give the matrix description for linear block codes. [OCT/NOV 2016]

11. Decode convolution process using viterbi algorithm. [OCT/NOV 2016]

12.Apply Shannon-Fano coding procedure of M=2 and M=3 [x]=[x1, x2, x3, x4, x5, x6, x7, x8] with probability [P]=[1/4, 1/8, 1/16, 1/16, 1/4, 1/16, 1/8 ,1/16]. [MAY 2017]

13 Compare code efficiency of Shanon Fano coding and Huffman coding when five source messages have probabilities m1=0.4, m2=0.15, m3=0.15, m4=0.15, m5=0.15. [MAY 2017]

14.Obtain the probability of bit error for coherently detected BPSK. [5+5] [MAY 2017]

15 We transmit either a 1 or a 0, and add redundancy by repeating the bit. (i) Show that if we transmit 11111 or 00000, then 2 errors can be corrected. (ii) Show that in general if we transmit the same bit 2t+1 times we can correct upto t errors. [MAY 2017]

16.What are code tree, code trellis and state diagrams for convolution encoders? [MAY 2017]

17.Design the encoder for the (7, 4) cyclic code generated by G(p)=p3+p2+1 and also verify the operation for any message vector. [MAY 2017]

18. Derive the steps involved in generation of linear block codes. Define and explain the properties of syndrome. [MAY 2017]

CHOOSE THE CORRECT ANSWER

1) Graphical representation of linear block code is known as
a. Pi graph
b. Matrix
c. Tanner graph
d. None of the above
ANSWER: (c) Tanner graph

2) A linear code
a. Sum of code words is also a code word
b. All-zero code word is a code word
c. Minimum hamming distance between two code words is equal to weight of any non zero code word
d. All of the above
ANSWER: (d) All of the above

3) For decoding in convolution coding, in a code tree,
a. Diverge upward when a bit is 0 and diverge downward when the bit is 1
b. Diverge downward when a bit is 0 and diverge upward when the bit is 1
c. Diverge left when a bit is 0 and diverge right when the bit is 1
d. Diverge right when a bit is 0 and diverge left when the bit is 1
ANSWER: (a)Diverge upward when a bit is 0 and diverge downward when the bit is 1

4) The code in convolution coding is generated using
a. EX-OR logic
b. AND logic
c. OR logic
d. None of the above
ANSWER: (a) EX-OR logic

5) Interleaving process permits a burst of B bits, with l as consecutive code bits and t errors when
a. $B \leq 2tl$
b. $B \geq tl$
c. $B \leq tl/2$
d. $B \leq tl$
ANSWER: (d) $B \leq tl$

6) For a (7, 4) block code, 7 is the total number of bits and 4 is the number of
a. Information bits
b. Redundant bits
c. Total bits- information bits
d. None of the above

ANSWER: (a) Information bits

7) Parity bit coding may not be used for

a. Error in more than single bit
b. Which bit is in error
c. Both a & b
d. None of the above

ANSWER: (c) Both a & b

8) Parity check bit coding is used for

a. Error correction
b. Error detection
c. Error correction and detection
d. None of the above

ANSWER: (b) Error detection

9) For hamming distance d_{min} and t errors in the received word, the condition to be able to correct the errors is

a. $2t + 1 \leq d_{min}$
b. $2t + 2 \leq d_{min}$
c. $2t + 1 \leq 2d_{min}$
d. Both a and b

ANSWER: (d) Both a and b

10) For hamming distance d_{min} and number of errors D, the condition for receiving invalid codeword is

a. $D \leq d_{min} + 1$
b. $D \leq d_{min} - 1$
c. $D \leq 1 - d_{min}$
d. $D \leq d_{min}$

ANSWER:(b) $D \leq d_{min} - 1$

11) Run Length Encoding is used for

a. Reducing the repeated string of characters
b. Bit error correction
c. Correction of error in multiple bits
d. All of the above

ANSWER: (a) Reducing the repeated string of characters

12) The prefix code is also known as

a. Instantaneous code
b. Block code
c. Convolutional code
d. Parity bit

ANSWER: (a) Instantaneous code

13) The minimum distance for unextended Golay code is

a. 8
b. 9
c. 7
d. 6

ANSWER: (c) 7

14) The Golay code (23,12) is a codeword of length 23 which may correct

a. 2 errors
b. 3 errors

c. 5 errors
d. 8 errors
ANSWER: (b) 3 errors
15) Orthogonality of two codes means
a. The integrated product of two different code words is zero
b. The integrated product of two different code words is one
c. The integrated product of two same code words is zero
d. None of the above
ANSWER: (a) The integrated product of two different code words is zero

UNIT 3(BASE BAND TRANSMISSION)

IMPORTANT POINTS

UNIT 3

I.SHORT ANSWER QUESTIONS[2M]

1.List out the Advantages of Pass band Transmission over Baseband transmission. [MAY 2016]

2.What is the need of pulse shaping for optimum transmission in baseband transmission? Explain. [MAY 2016]

3. What is meant by Cross talk? Explain in detail about the causes for cross talk. [MAY 2016]
4. Define Baseband transmission. [OCT/NOV 2016]

5.Define processing gain and jamming margin[MAY 2017]

6. Explain the generation of PN sequence. [MAY 2017]

7. Write the properties of matched filter . [MAY 2019]

8) What is ISI? What are the causes of ISI? [MAY 2019]
9.What is intersymbol interference in baseband binary transmission system? [MAY 2018]
10.what is necessity of adaptive equalization? [MAY 2018]

II.LONG ANSWER QUESTIONS

1 Draw and explain the working of optimum receiver with a neat diagram. [OCT/NOV 2016]

2.EXPLAIN FSK? Draw the eye diagram of FSK? [OCT/NOV 2016]

3. Explain crosstalk concept. [OCT/NOV 2016]

4. What is raised cosine spectrum. Discuss how it helps to avoid ISI. [MAY 2019]
A PAM system has a uniform quantizer followed by a v-bit encoder. Show that the rms SNR is approximately given by (1.8+6v) dB. Assume sinusoidal input. [MAY 2019]
Or
Explain the roll of raised cosine spectrum in Nyquist pulse shaping with necessary waveforms and spectra?

5.a) Describe nyquist criterion for distortion less base band transmission.
b) A set of signals (k = 1,2,3,4) is given by $Sk(t) = \cos(wt+k\ \pi/2)$ $0 \leq t \leq k2\pi/2w = 0$
= 0 otherwise.
Use the Gram-Schmidt procedure to find and orthogonal set of functions in which the functions Sk(t) can be expanded. [MAY 2019]
6.Explain how the Residual effects of channel affect ISI? [MAY 2018]
7.What is Nyquist pulse shaping? [MAY 2018]

CHOOSE THE CORRECT ANSWER

1)The interference caused by the adjacent pulses in digital transmission is called
a. Inter symbol interference
b. White noise
c. Image frequency interference
d. Transit time noise
ANSWER: (a) Inter symbol interference
2) Eye pattern is
a. Is used to study ISI
b. May be seen on CRO
c. Resembles the shape of human eye
d. All of the above
ANSWER: (d) All of the above

3) The time interval over which the received signal may be sampled without error may be explained by
a. Width of eye opening of eye pattern
b. Rate of closure of eye of eye pattern
c. Height of the eye opening of eye pattern
d. All of the above
ANSWER:(a) Width of eye opening of eye pattern
04) For a noise to be white Gaussian noise, the optimum filter is known as
a. Low pass filter
b. Base band filter
c. Matched filter
d. Bessel filter
ANSWER:(c) Matched filter
05) Matched filters are used
a. For maximizing signal to noise ratio
b. For signal detection
c. In radar
d. All of the above
ANSWER: (d) All of the above
06) The number of bits of data transmitted per second is called
a. Data signaling rate
b. Modulation rate
c. Coding
d. None of the above
ANSWER: (a) Data signaling rate
07) Pulse shaping is done
a. to control Inter Symbol Interference
b. by limiting the bandwidth of transmission
c. after line coding and modulation of signal
d. All of the above
ANSWER: (d) All of the above
08) The criterion used for pulse shaping to avoid ISI is
a. Nyquist criterion
b. Quantization
c. Sample and hold
d. PLL
ANSWER: (a) Nyquist criterion
09) The filter used for pulse shaping is
a. Raised – cosine filter
b. Sinc shaped filter
c. Gaussian filter
d. All of the above
ANSWER: (d) All of the above
10) Roll – off factor is defined as
a. The bandwidth occupied beyond the Nyquist Bandwidth of the filter
b. The performance of the filter or device
c. Aliasing effect
d. None of the above

ANSWER: (a) The bandwidth occupied beyond the Nyquist Bandwidth of the filter
11) Nyquist criterion helps in
a. Transmitting the signal without ISI
b. Reduction in transmission bandwidth
c. Increase in transmission bandwidth
d. Both a and b
ANSWER: (d) Both a and b
12) The Nyquist theorem is
a. Relates the conditions in time domain and frequency domain
b. Helps in quantization
c. Limits the bandwidth requirement
d. Both a and c
ANSWER: (d) Both a and c
13) The difficulty in achieving the Nyquist criterion for system design is
a. There are abrupt transitions obtained at edges of the bands
b. Bandwidth criterion is not easily achieved
c. Filters are not available
d. None of the above
ANSWER: (a) There are abrupt transitions obtained at edges of the bands
14) Equalization in digital communication
a. Reduces inter symbol interference
b. Removes distortion caused due to channel
c. Is done using linear filters
d. All of the above
ANSWER: (d) All of the above
15) Zero forced equalizers are used for
a. Reducing ISI to zero
b. Sampling
c. Quantization
d. None of the abov
ANSWER: (a)Reducing ISI to zero

Unit 4(DIGITAL MODULATION TECHNIQUES)

IMPORTANT POINTS

1.Base band transmission:The digital data is transmitted over channel directly.There is no carrier or any modulation.

2.Pass band transmission: The digital data modulates high frequency sinusoidal carrier.Hence it is called CW Modulation.

3.Coherent detection(synchronous detection):In this local carrier generated at receiver is phase locked with carrier at transmitter

4.Non Coherent detection(Envelope)detection: In this the receiver carrier need not be phase locked with transmitted carrier. but it has high probability of error.

5.Binary phase shift keyng :In BPSK binary symbol '1'and'0' modulate the phase of carrier

6.Frequency divider:The signal passed through frequency divider is divided by 2.The output of frequency divider is with frequency fo i..e $\cos(2\pi fot + \theta)$

7.Bit synchronizer and Integrator:The integrator integrates the signal over one bit period.The bit synchronizer takes care of starting and ending times of bit.

8.Bandwidth of BPSK Signal is

$$BW=2fb$$

9.Drawbacks of BPSK signal is Ambiguity in output signal

10.Differential phase shift keyng: DPSK the input sequence of binary inputs is modified such that next bit depends on previous bit. Therefore in the receiver the previous received bits are used to detect present bit.

11.In BPSK phase of carrier changes on both symbol '1' and '0'.where as in DPSK phase of the carrier changes only on symbol 1.

12.Bandwidth of DPSK Signal

$$BW=fb$$

13.Advantages of DPSK:

1)DPSK does not carrier at its receiver.hence complicated circuitry for generation of local carrier is avoided.

2)Bandwidth Requirement of DPSK is reduced compared to that of BPSK.

14.Disadvantages of DPSK:

1)The Probability of error or bit error rate is higher than od BPSK.

2)Since DPSK Uses 2 succesive bits for its reception,error in first bit creates error in second bit.hence error propagation in DPSK is more.

3)Noise Interference in DPSK is more.

15.Quadrature phase shift keyng:In QPSK ,2 Succesive bits in data sequence are grouped together.This reduces the bits rate of signaling rate(fb) and hence reduces bandwidth of channel.

16.Advantages of QPSK:

1)For same bit error rate,the bandwidth required by QPSK is reduced to half as compared to BPSK.

2)Because of reduced bandwidth,the information transmission rate of QPSK is higher.

3)Variations in OQPSK amplitude is not much.Hence carrier power almost remains constant.

17 ASK:The amplitude of Carrier is changed according to binary input signal.

18.FSK:The frequency of carrier is changed according to binary input signal

I.SHORT ANSWER QUESTIONS[2M]

1) Draw the Signal space Diagram of ASK. . [MAY 2016]
2. Define QPSK. [OCT/NOV 2016]

3. Draw the block diagram of the PLL. [OCT/NOV 2016]

4.Write the expression for baud rate of BPSK system. [MAY 2017]

5. Explain advantages of coherent digital modulation schemes. [MAY 2017]

6. Sketch the wave form of the FSK signal for the input binary sequence 1100100010. [MAY 2017]

7. Draw PSK and QPSK wave form of bit stream 10001010111. [MAY 2019]
8) Compare PSK and QAM. [MAY 2018]
9.Define Ask>[MAY 2018]
10.what is meant by DPSK? [MAY 2018]

II.LONG ANSWER QUESTIONS[5M]

1 With neat diagrams and equations, explain about PSK system. [MAY 2016]

2. Draw the space representation of BPSK. And also draw its waveforms? [MAY 2016]

3.The bit stream 1011100011 is to be transmitted using DPSK. Determine the encoded sequence and transmitted phase sequence. [MAY 2016]

4. Explain about DPSK system. And also give the comparison between DPSK and PSK. [MAY 2016]
5.Draw and explain the operating principle of ASK Modulator. [OCT/NOV 2016]
6) Describe the BPSK modulation technique with the help of a neat diagram. [OCT/NOV 2016,MAY 2019]
(Or)
Explain BPSK transmitter and receiver with a neat diagram?
7 Explain the DPSK modulation technique with the help of a neat sketch. [OCT/NOV 2016]
8 Explain the working of non-coherent FSK detector. [OCT/NOV 2016]
9.Derive the bit error probability of a coherent ASK signaling scheme. [MAY 2017/2019]
13.Explain frequency shift keying. Describe coherent detection of FSK signals. What should be the relationship between bit-rate and frequency-shift for a better performance? [MAY 2017]

14 Explain non coherent detection method of binary frequency shift keying scheme. [MAY 2017/2019]

15. Explain coherent detection of PSK signals and derive probability of error. [MAY 2017]
16 .Differentiate coherent and non-coherent detection techniques. [MAY 2017]
17.a) Explain non coherent ASK detector with neat circuit diagram. [MAY 2019]
18.Give a comparison between FSK and PSK schemes? [MAY 2018]

CHOOSE THE CORRECT ANSWER

1.The transmission bandwidth of the raised cosine spectrum is given by
a. $B_t = 2w(1 + \alpha)$
b. $B_t = w(1 + \alpha)$
c. $B_t = 2w(1 + 2\alpha)$
d. $B_t = 2w(2 + \alpha)$
ANSWER: (a) $B_t = 2w(1 + \alpha)$
2) The preferred orthogonalization process for its numerical stability is
a. Gram- Schmidt process
b. House holder transformation
c. Optimization
d. All of the above
ANSWER: (b) House holder transformation
3) For two vectors to be orthonormal, the vectors are also said to be orthogonal. The reverse of the same
a. Is true
b. Is not true
c. Is not predictable
d. None of the above
ANSWER: (b) Is not true
4) Orthonormal set is a set of all vectors that are
a. Mutually orthonormal and are of unit length
b. Mutually orthonormal and of null length
c. Both a & b
d. None of the above
ANSWER: (a) Mutually orthonormal and are of unit length
5) In On-Off keying, the carrier signal is transmitted with signal value '1' and '0' indicates
a. No carrier
b. Half the carrier amplitude
c. Amplitude of modulating signal
d. None of the above
ANSWER: (a) No carrier
6) ASK modulated signal has the bandwidth
a. Same as the bandwidth of baseband signal
b. Half the bandwidth of baseband signal
c. Double the bandwidth of baseband signal
d. None of the above
ANSWER: (a) Same as the bandwidth of baseband signal
7) Coherent detection of binary ASK signal requires
a. Phase synchronization
b. Timing synchronization

c. Amplitude synchronization
d. Both a and b
ANSWER: (d) Both a and b
8) The probability of error of DPSK is _____ than that of BPSK.
a. Higher
b. Lower
c. Same
d. Not predictable
ANSWER: (a) Higher
9) In Binary Phase Shift Keying system, the binary symbols 1 and 0 are represented by carrier with phase shift of
a. Π/2
b. Π
c. 2Π
d. 0
ANSWER: (b) Π
10) BPSK system modulates at the rate of
a. 1 bit/ symbol
b. 2 bit/ symbol
c. 4 bit/ symbol
d. None of the above
ANSWER: (a) 1 bit/ symbol
11) The BPSK signal has +V volts and -V volts respectively to represent
a. 1 and 0 logic levels
b. 11 and 00 logic levels
c. 10 and 01 logic levels
d. 00 and 11 logic levels
ANSWER: (a) 1 and 0 logic levels
12) The binary waveform used to generate BPSK signal is encoded in
a. Bipolar NRZ format
b. Manchester coding
c. Differential coding
d. None of the above
ANSWER: (a) Bipolar NRZ format
13) The bandwidth of BFSK is _____ than BPSK.
a. Lower
b. Same
c. Higher
d. Not predictable
ANSWER: (c) Higher
14) In Binary FSK, mark and space respectively represent
a. 1 and 0
b. 0 and 1
c. 11 and 00
d. 00 and 11
ANSWER: (a) 1 and 0
15) The frequency shifts in the BFSK usually lies in the range

a. 50 to 1000 Hz
b. 100 to 2000 Hz
c. 200 to 500 Hz
d. 500 to 10 Hz
ANSWER: (a) 50 to 1000 Hz

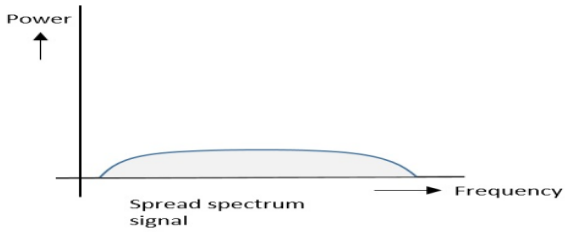
UNIT 5

IMPORTANT POINTS

1. A collective class of signaling techniques are employed before transmitting a signal to provide a secure communication, known as the **Spread Spectrum Modulation**.
2. The main advantage of spread spectrum communication technique is to prevent "interference" whether it is intentional or unintentional.
3. A coded sequence of **1s** and **0s** with certain auto-correlation properties, called as **Pseudo-Noise coding sequence** is used in spread spectrum techniques. It is a maximum-length sequence, which is a type of cyclic code.

4.The spread spectrum signals have the signal strength distributed as shown in the following frequency spectrum figure.

FHSS	DSSS / CDMA



5.This is frequency hopping technique, where the users are made to change the frequencies of usage, from one to another in a specified time interval, hence called as **frequency hopping**. For example, a frequency was allotted to sender 1 for a particular period of time. Now, after a while, sender 1 hops to the other frequency and sender 2 uses the first frequency, which was previously used by sender 1. This is called as **frequency reuse**.

6.Whenever a user wants to send data using this DSSS technique, each and every bit of the user data is multiplied by a secret code, called as **chipping code**.

Multiple frequencies are used	Single frequency is used
Hard to find the user's frequency at any instant of time	User frequency, once allotted is always the same
Frequency reuse is allowed	Frequency reuse is not allowed
Sender need not wait	Sender has to wait if the spectrum is busy
Power strength of the signal is high	Power strength of the signal is low
Stronger and penetrates through the obstacles	It is weaker compared to FHSS
It is never affected by interference	It can be affected by interference
It is cheaper	It is expensive

7.Comparison between FHSS and DSSS/CDMA

10. **Advantages of Spread Spectrum**

Following are the advantages of spread spectrum −

- Cross-talk elimination
- Better output with data integrity
- Reduced effect of multipath fading
- Better security

SHORT ANSWER QUESTIONS [2M]

1) Briefly explain about "Spread spectrum. [MAY 2016]

2) What is Frequency hopping spread spectrum? [MAY 2016][MAY 2018]

3) List out the applications of CDMA. [OCT/NOV 2016]

4)Define spread spectrum. List its uses. [OCT/NOV 2016]

5. A DSSS system has Tb= 4.095 ms and Tc = 1μs. Assume the probability of error is not required to exceed 10-5. Find jamming margin. [MAY 2019]

6. If N flip flops are used to generate the PN sequence and Tc is the chip period, what is

the maximum time after which the PN sequence repeats itself? [MAY 2019]

LONG ANSWER QUESTIONS[5M]

1.Explain the role of code division multiple access technique in present generation? [MAY 2016] [OCT/NOV 2016]

2. Give a brief history about direct sequence spread spectrum. [MAY 2016] [OCT/NOV 2016]

[OR]

3Derive the necessity of DSSS techniques. Draw the transmitter and receiver block diagram and explain. [MAY 2017]

4.Explain about PN-Sequences generation and their characteristics. [MAY 2016][OCT/NOV 2016/MAY 2019][may 2018]

5. What is meant by Synchronization? Why we require synchronization in spread spectrum? Explain in detail. [MAY 2016]

6. Describe the concept of Ranging using DSSS. [OCT/NOV 2016]
7. Write a note on CDMA[MAY 2017]
8.Explain the advantages ,disadvantages and applications of spread spectrum modulation. [MAY 2017/ 2019]

9.Discuss the frequency hopping spread spectrum technique in detail. [MAY 2017][MAY 2019]
10.How are spread spectrum signal and interfering signal made transparent to each other. [MAY 2019]
11.How is synchronization achieved in DSSS? [MAY 2019]

12. Write advantages, disadvantages and applications of spread spectrum modulation. [MAY 2019]
13.Draw the block diagram of spread spectrum systems?[MAY 2018]

CHOOSE THE CORRECT ANSWER

1.A pseudorandom code generator is called

A. hopping
B. carrier signals
C. frequency synthesizer
D. pseudorandom noise
E. Answer: (d)

2. Technique that uses M different carrier frequencies that are modulated by source signal is called

A. Multiplexing
B. Spreading
C. FHSS
D. DSSS

Answer: (c)

3.In Frequency Hopping Spread Spectrum (FHSS), sender and receiver can have privacy if hopping period is

A. short
B. long
C. zero
D. infinity

Answer: (A)

4. IEEE 802.11 Direct Sequence Spread Spectrum (DSSS) uses data rate of

A. 1 or 2 Mbps
B. 6 to 54 Mbps
C. 5.5 and 11 Mbps
D. 2 and 54 Mbps

Answer: (A)

5. Why spread spectrum technique is inefficient for a single user?
a) Large transmission bandwidth
b) Small transmission bandwidth
c) Fixed transmission bandwidth
d) Fixed null bandwidth

Answer: (A)

6. Which of the following is not a property of spread spectrum techniques?
a) Interference rejection capability
b) Multipath fading
c) Frequency planning elimination
d) Multiple user, multiple access interface

Answer: (b)

7. Which of the following is not a characteristic of PN sequence?
a) Nearly equal number of 0s and1s
b) Low correlation between shifted version of sequence
c) Non deterministic
d) Low cross-correlation between any two sequences

8. PN sequence can be generated using sequential logic circuits.
a) True
b) False

Answer : (A)

9.The period of a PN sequence produced by a linear m stage shift register cannot exceed _____ symbols.
a) 2m
b) m
c) 2m
d) 2m-1

Answer: (d)

10.DSSS system spreads the baseband signal by _____ the baseband pulses with a pseudo noise sequence.
a) Adding
b) Subtracting
c) Multiplying
d) Dividing

Answer☹C

11. Frequency hopping involves a periodic change of transmission _____
a) Signal
b) Frequency
c) Phase
d) Amplitude

Answer: (b)

12.What is the set of possible carrier frequencies in FH-SS?
a) Hopset
b) Hop

c) Chips
d) Symbols

Answer: (C)

13.The bandwidth of the channel used in the hopset is called _____
a) Hopping bandwidth
b) Total hopping bandwidth
c) Instantaneous bandwidth
d) 3 dB bandwidth

Answer: (c)