VALLIAMMAI ENGINEERING COLLEGE

SRM NAGAR, KATTANKULATHUR – 603 203.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

M.E., - COMMUNICATION SYSTEMS

FIRST YEAR / FIRST SEMESTER - BATCH: 2014-2016

CU7102 ADVANCED DIGITAL COMMUNICATION TECHNIQUES

SYLLABUS

CU7102 ADVANCED DIGITAL COMMUNICATION TECHNIQUES L T P C 3 0 0 3

COURSE OBJECTIVES

1. To understand the basics of signal-space analysis and digital transmission.
2. To understand the coherent and noncoherent receivers and its impact on different channel characteristics.
3. To understand Orthogonal Frequency Division Multiplexing.
4. To understand the different block coded and convolutional coded digital communication systems.
5. To understand the different Equalizers.

UNIT I COHERENT AND NON-COHERENT COMMUNICATION 9

Coherent receivers – Optimum receivers in WGN – IQ modulation & demodulation – Noncoherent receivers in random phase channels; MFSK receivers – Rayleigh and Rician channels – Partially coherent receivers – DPSK; M-PSK; M-DPSK--BER Performance Analysis. Carrier Synchronization- Bit .

UNIT II EQUALIZATION TECHNIQUES 9

Band Limited Channels- ISI – Nyquist Criterion- Controlled ISI-Partial Response signals- Equalization algorithms – Viterbi Algorithm – Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms.

UNIT III BLOCK CODED DIGITAL COMMUNICATION 9

Architecture and performance – Binary block codes; Orthogonal; Biorthogonal; Transorthogonal – Shannon's channel coding theorem; Channel capacity; Matched filter; Concepts of Spread spectrum communication – Coded BPSK and DPSK demodulators– Linear block codes; Hammning; Golay; Cyclic; BCH ; Reed – Solomon codes - Space time block codes

UNIT IV CONVOLUTIONAL CODED DIGITAL COMMUNICATION 9

Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram – Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding.

UNIT V OFDM 9

Generation of sub-carriers using the IFFT; Guard Time and Cyclic Extension; Windowing; OFDM signal processing; Peak Power Problem: PAP reduction schemes- Clipping, Filtering, Coding and Scrambling.

TOTAL: 45 PERIODS

REFERENCES:

1. *M.K.Simon, S.M.Hinedi and W.C.Lindsey, Digital communication techniques; Signalling and detection, Prentice Hall India, New Delhi. 1995.*
2. *Simon Haykin, Digital communications, John Wiley and sons, 1998*
3. *Bernard Sklar., 'Digital Communications', second edition, Pearson Education,2001.*
4. *\John G. Proakis., 'Digital Communication', 4 th edition, Mc Graw Hill Publication, 2001*
5. *Theodore S.Rappaport., 'Wireless Communications', 2nd edition, Pearson Education, 2002.*
6. *Stephen G. Wilson., 'Digital Modulation and Coding', First Indian Reprint ,Pearson Education, 2003.*
7. *. Richard Van Nee & Ramjee Prasad., 'OFDM for Multimedia Communications' Artech House Publication,*

UNIT I COHERENT AND NON-COHERENT COMMUNICATION

PART A

1. What is a Non-Coherent Receiver?
2. Define Rician Channel
3. Define Rayleigh Channel.
4. State the need for WGN.
5. Compare DPSK and PSK.
6. What are the merits and demerits of coherent receivers?
7. Define carrier synchronization
8. Enumerate the properties of Rician channel ?
9. What is the difference between coherent and non- coherent communication ?
10. What is partially coherent receiver?
11. Draw the power spectra for M-PSK and M-QAM modulation.
12. Draw the waveform communication model.
13. What is matched filter?
14. What is a M-PSK receiver?
15. What is the significance of optimum M-FSK receivers?
16. Draw the non-coherent receiver for equal energy signals using envelope detector.
17. Give the performance of Rayleigh channels
18. Give the performance of Rician channels
19. What is a M-ary waveform receiver?
20. Compare coherent and non coherent receivers.

PART B

1. Discuss in detail the various aspects of the matched filter.
2. Compare the BER performance analysis of DPSK, M-PSK and M-DPSK.
3. With a suitable diagram explain the M-DPSK receiver.
4. With a neat block diagram explain the function of DPSK and MPSK demodulators.
5. Describe the function of M - FSK receiver.
6. What is a coherent receiver? Explain in detail
7. With a neat diagram explain the I-Q modulator and demodulator.

8. Describe the functions of MPSK
9. Explain the principle of optimum receiver used in WGN
10. Explain in detail the characteristics of Rayleigh channel.
11. Derive the probability of error for DPSK signaling scheme.
12. Briefly explain any one of the carrier synchronization techniques.
13. Explain about Carrier Synchronization & Symbol Synchronization.
14. Explain in detail the characteristics of Rician channel.

UNIT II EQUALIZATION TECHNIQUES

PART A

1. State Nyquist pulse shaping criterion for zero ISI.
2. Write down the transfer function H(f) for an raised cosine filter.
3. Mention the application of eye pattern..
4. What is meant by correlative coding?
5. What are the causes for ISI?
6. What is a multi dimensional signal? Give an example.
7. What is ZFE ? Enumerate its features ?
8. State Nyquist criterion . What does it signify ?
9. State Shannon's channel capacity theorem ?
10. Enumerate the significance of adaptive equalization algorithm.
11. Draw the block diagram of linear equalizer.
12. Compare decision feedback equalization and adaptive equalization algorithm.
13. Compare linear equalization and decision feedback equalization.
14. Give one example where adaptive equalization is required.
15. What is an eye pattern?
16. What is a DFE?
17. What is a band limited channel?
18. What are the methods used to suppress the ISI?
19. Define ISI and list at least two mitigation methods.
20. Mathematically express the Nyquist Criterion in frequency domain for pulse shaping to realize ISI free transmission

PART B

1. Explain the error probability of BPSK , Viterbi algorithm and Turbo coding.
2. Derive the decision rule for optimum demodulation of digital signal in the presence of IS I and AWGN.
3. What is ISI in communication channels ? Explain a method to suppress ISI.
4. Define and explain the parameters of eye diagram . Mention its usage in digital communication systems. How it is used to know the information about a channel.
5. a)What is a transversal equalizer ? Explain how can it be implemented .
   b)Explain the concept of LMS equalizer with a neat diagram . Mention its applications.

6. Explain the need for equalization. Explain different types of equalization techniques.Compare the equalization techniques.
7. Explain duobinary signaling scheme without and with precoder for controlled ISI
8. Write short notes on:
   i) LE-ZF ii). DFE – ZF iii) DFE iv) Adaptive equalization algorithm. v) Raised cosine
9. Derive the minimum mean squared error for zero forcing decision feedback equalizer (DFE-ZF)
10. Derive the transfer function and impulse response of duobinary systems which is used to control the ISI with appropriate diagram.
11. Explain about bandlimited channel with a neat block diagram.
12. The binary data 001101001 are applied to the input of duobinary system. Find the received output under the case without precoder and with precoder. Suppose the bit at second place is decoded erroneously construct the receiver output for the two cases.

UNIT III BLOCK CODED DIGITAL COMMUNICATION

PART A

1. State Shannon's channel capacity theorem ?
2. What are the advantages and applications of Hamming codes ?
3. What is Golay code? What is extended Golay code?
4. What are the parameters affecting the performance of block coded communication system?
5. Draw the waveform representation of antipodal and orthogonal signals.
6. Mention the significance of trans-orthogonal code.
7. State Shannon's channel coding theorem.
8. Mention the infinite bandwidth Shannon Information transport limit.
9. A single sided bandwidth of a modem is 3.4 kHz. Calculate the channel capacity for the signal to noise ratio of 30dB.
10. A channel with a 1 mhz bandwidth has snr of 63. What is the bit rate and signal level?
11. Find the channel capacity using Shanno's formula. The spectrum of a channel is between 3 MHz and 4 MHz and SNR_{dB} = 24 dB.
12. What is free distance and coding gain?
13. Mention any four application of Spread spectrum communication.
14. Find out whether the given PN sequence {00 11101}is ML sequence or not?
15. When the PN sequence is called ML sequence?
16. Define LBC. When a LBC is called cyclic code?
17. When a (n,k) linear block code is called Hamming code?If the minimum hamming distance of a (n,k) linear block code is 3, then what is its minimum Hamming weight. And find out the hamming weight of the codes 101010 and 010101.
18. Mention properties of cyclic code. What are two fundamental properties of cyclic code?
19. What is RS code?For a 8 bit RS codes, determinethe block length,n.
20. Give the error detection and error correction capability of Hamming code.

PART B

1. Design a linear block code with a minimum distance of 3 and a message block size of 8 bits.
2. What is the basic concept of spread spectrum communication? Explain about FH – SS and DS-SS in detail with suitable diagram.
3. Derive the channel capacity for AWGN channel and the same for spread spectrum Communication if jamming margin is large.
4. What is a matched filter? Explain the different properties of it.
5. i) Differentiate cyclic codes from convolutional codes. ii) With a suitable example explain the Hamming and cyclic codes.
6. Explain about the architecture of coded digital communication system in detail.
7. Explain the architecture and performance of biorthogonal and transorthogonal codes in digital communication system.
8. a)Explain the architecture and performance of binary block codes with suitable example.
   b) Explain the error detecting and correcting capabilities of linear block code.
9. With a neat diagram, explain Reed-solomon encoding and decoding circuit. Discuss advantages disadvantages and application of the code.
10. a)Derive the expression for relating the matched filter theory to the channel capacity
    b) The parity check bits of a (8,4) block code are generated by, $C_5 = d_1 + d_2 + d_4$, $C_6 = d_1 + d_2 + d_3$, $C_7 = d_1 + d_3 + d_4$ and $C_8 = d_2 + d_3 + d_4$ where d_1, d_2, d_3 and d4 are message bits.
    1. Find the G and P matrix for this code.
    2. List all code vectors.
    3. Find all errors detecting and correcting capabilities of this code.
    4. Show that this code detects up to 3 errors only with suitable example.
11. For a (6, 3) code, generator matrix G is 100101; 010011; 001110. For all possible data words, find the corresponding code words and verify that the code is single error correcting code. Write the syndrome vector for the error pattern 000100.
12. The generator polynomial of a cyclic code is $G(p) = P^3 + P^2 + 1$. Find all the code vector for the code in non-systematic and systematic form. Draw the encoder and syndrome calculator. Also code the message vector 1000 and find the syndrome for the encoded message.

UNIT IV CONVOLUTIONAL CODED DIGITAL COMMUNICATION

PART A

1. What is convolutional code?
2. Mention the disadvantages of convolutional codes.
3. What is code tree for convolutional encoder? State its significance.
4. State the features of Trellis code.
5. Mention the applications of turbo coding.
6. What is meant by systematic convolutional code?
7. What is meant by constraint length and free distance for convolutional code?
8. Draw the convolutional encoder for $x_1 = m + m_1 + m_2$ and $x_2 = m + m_2$.
9. Define coding gain.

10. What is the code rate of (n,k) convolutional code?
11. Differentiate LBC and Convolutional codes.
12. Differentiate maximum likelihood decoding with Viterbi decoding.
13. List the decoding techniques using maximum likelihood.
14. What are disadvantages of sequential decoding?
15. When convolutional coding is preferred than block coding?
16. Define the term code tree.
17. Write down the rule for Maximum likelihood decoding.
18. Write down the encoded output of convolution code encoder for the given data polynomial $g^{(1)} = 1+D$, $g^{(2)} = 1+D+D^2$ and message = 0010
19. What are the advantages and applications of Hamming codes ?
20. How is a syndrome array constructed ?

PART B

1. With an example describe the following:
   (i) State diagram
   (ii) Tree diagram
   (iii) Trellis diagram.
2. Write short notes on the following:
   (i) Decoding technique using maximum likelihood.
   (ii) Turbo coding.
3. Derive the maximum likelihood decoding procedure using viterbi algorithm for coded BPSK modulation scheme.
4. For the given convolutional encoder determine (i) Dimension of the code, (ii) Code rate, iii) Constraint length (iv)Generating sequence and (v) Code the input message sequence m={ 1 1 0 1 1 1 0}
5. Explain the error probability performance for BPSK , Viterbi algorithm and turbo coding.
6. A convolutional encoder has single shift register with two stages three modulo – 2 adders and an output multiplexer. The following generator sequences are combined by the multiplexer to produce the encoder output.g_1 = (1, 0, 1) , g_2= (1 1 0) and g_3 = (1 1 1). i)Draw the block diagram of the encoder (ii)For the message sequence(1 0 0 1 1) Determine encoded sequence.
7. Mention the difference between tree and trellis diagram. A convolutional encoder has a single shift register with two stages (K=3), three modulo 2 adders and an output multiplexer. The generator sequences of the encoder are as follows. g_1 = (1, 0, 1) , g_2= (1 1 0) and g_3 = (1 1 1). Draw the block diagram and explain.
8. A convolutional code is described by the following generator sequence g_1 = (1, 0, 0) , g_2= (1 1 0) and g_3 = (1 1 1). i. Draw the encoder diagram for this code. ii. Draw the state and trellis diagram for this code. iii. Find the code word corresponding to the message sequence(1010101)
9. Draw the encoder structure of a parallel concatenated convolutional codes and explain it in detail
10. Consider a rate ½,constraint length-7 convolutional codes with free distance at 9. Calculate the asymptotic coding gain for binary input AWGN channel.
11. Explain the exhaustive search method of convolutional codes with a diagram. Mention its merits and demerits.
12. Explain in detail Trellis diagram with an example.

UNIT V OFDM

PART A

1. What do you mean by multicarrier transmission technique?
2. Define multicarrier OFDM modulation system.
3. What are the advantages of OFDM?
4. What are the disadvantages of multicarrier OFDM modulation system?
5. What is the purpose of cyclic prefix?
6. Mention the peak power problem reduction.
7. What is OFDM signal processing?
8. What is difference between OFDM and OFDMA ?
9. Define the peak to average power ratio for OFDM signals.
10. What is the need for Scrambling?
11. What is meant by clipping?
12. What is a filtering in OFDM?
13. What is meant by guard time ?
14. What is cyclic extension in OFDM?
15. What is windowing in OFDM?
16. What is delay spread?
17. What is meant by PAP?
18. Mention the significance of scrambling.
19. What is PPP?
20. What is OFDMA?

PART B

1. Explain how OFDM concept is emerged in multicarrier modulation technique.
2. Briefly explain about the OFDM multicarrier modulation technique with suitable diagrams.
3. What is PAP reduction techniques? Explain the scheme and compare their performance.
4. i) about the parameters required for OFDM system design. ii) Draw the block diagram of OFDM transmitter and receiver.Explain them in detail .
5. Discuss PAP reduction schemes with a neat diagram and explain its application.
6. Explain in detail of any two methods to reduce peak-to-average power ratio in multicarrier OFDM system.
7. Discuss the generation of subcarriers using the IFFT with a neat diagram .
8. Write about the following in detail.
    1. Guard time.
    2. Cyclic extension
    3. Windowing and
    4. Clipping in OFDM system.

9. Design a OFDM system for the following parameters.
   a. Total delay spread = 200 ns
   b. Bit rate = 400 Mbps
   c. Bandwidth $\leq$ 16 MHZ
10. Explain about scrambling technique with examples.
11. Draw the block diagram of a multicarrier OFDM digital communication system and explain function of each block in detail.
12. i) Compare and contrast OFDMA with other modulation technique.
    (ii) write notes on OFDM signal processing