METCE EXAMINATION, 2025

(1st Year 1st Semester)

Advanced Digital Communication

Full Marks: 100 **Time: 3 hours**

Answer all question under a particular CO in the same place. Also, answer all sub-parts of a specific question serially in the same place

CO-1
(Marks: 25)

Q1.a) State Nyquist's minimum bandwidth theorem for Inter Symbol Interference (ISI) free transmission. Identify the problems associated with this theorem from the implementation point of view. How can you mitigate this problem using Nyquist's Vestigial Symmetry Theorem? Explain with proper diagrams. [2+2+6]

b) Name the pulse-shaping filters which satisfy the above theorem. Write down the corresponding expressions of amplitude response for such filters to achieve ISI-free impulse transmission. Using block diagram, show, how these filters can be placed over a communication data link. Identify the disadvantages of Nyquist Pulse-shaping filters. [1+3+3+3]

c) Draw the impulse response of Gaussian Pulse Shaping filter for different values of 'BT' product, where, 'B' and 'T' represents the 3-dB bandwidth and symbol period respectively. [5]

CO-2
(Marks: 30)

Q2. a) Consider a linear adaptive equalizer having transversal structure. Explain, how, you will train this equalizer. Use proper block diagram and necessary mathematical expressions. [10]

b) Draw the block diagram of a Maximum Likelihood Sequence Estimation (MLSE) Equalizer and explain its principle of operation. [5]

Q3.a) Discuss the Least Mean Square (LMS) algorithm related to Adaptive Equalizer. [10]

b) How will you modify the above algorithm to obtain Variable Step Size (VSS) LMS algorithm? [5]

CO-3
(Marks: 30)
Answer any two questions

Q4. a) Represent the Non Orthogonal Multiple Access (NOMA) scheme in Downlink, incorporating a base station and 'k' number of User Equipment (UE) with Successive Interference Cancellation (SIC) receivers. Hence, mathematically derive the expression of Throughput for each UE. Also, define the Sum Capacity and Fairness Index for NOMA. [6+2]

b) State the mapping rules of Grouped Power Allocation (GPA) strategy of Superposition Mapping SM. Using this mapping rule develop a table consisting of input bit load, chips and output symbols. Given, Input bit load=4; Group size=2; Number of power levels=2. [2+5]

Q5. a) How can you obtain Minimum Shift Keying (MSK) modulation from Frequency Shift keying (FSK) modulation? Describe the operation of an MSK transmitter with the help of proper block diagram and necessary mathematical derivations. [4+6]

b) Compare the spectrum of MSK signal with those of QPSK/OQPSK and Gaussian MSK (GMSK) signals and list down your observations. [5]

Q6. a) Sketch the Multi Carrier (MC) equivalent model of an Orthogonal Frequency Division Multiplexing (OFDM) transmitter and explain its operation mathematically. [8]

b) State how, the problem of high PAPR poses a major challenge to the OFDM system. Discuss in brief, any one of the effective techniques to reduce the PAPR in OFDM system. [3+4]

CO-4
(Marks: 15)

Q7. a) Consider a wireless communication system, where information is transmitted from the source node 'S' to the destination node 'D' through an energy constrained intermediate relay node 'R'. Develop the system model considering Time Switching Relaying (TSR) protocol. Also, describe its operation. Hence, calculate the amount of energy harvested. [2+3+3]

c) Discuss, in brief, the motivation of Ultra Wide Band (UWB) communication. Describe any of the techniques which can be used for the generation of UWB pulses. [2+5]