

(REVISED COURSE)

(4 Hours)

[Total Marks : 100

- N.B. :** (1) Question No. 1 is **compulsory**.
 (2) Attempt any **four** questions out of remaining **six** questions.

1. Answer **all** the questions briefly :— 20
- State and Prove Nyquist Criterion for a band-limited channel with zero ISI.
 - Which are the different diversity techniques used to improve the performance of digital communication system.
 - Explain the working of a FHSS Transmitter and receiver, with a neat block diagram.
 - Find the generator matrix G, for a non-systematic (7, 4) cyclic code using generator polynomial $g(x) = x^3 + x^2 + 1$.
2. (a) Consider a convolutional encoder having the following impulse response : 12
- $$g_1 = \{ 1 \ 1 \ 0 \} \quad g_2 = \{ 1 \ 0 \ 1 \}, \quad g_3 = \{ 1, \ 1, \ 1 \}$$
- Find the codeword for the Msg sequence (1 1 0 0 1 0 1)
 - Draw its state diagram and code tree
 - Find its transfer function and free-distance of this code.
- (b) Discuss Viterbi algorithm for decoding of convolutional codes. 8
3. (a) Design a 'feedback shift-register-encoder' for an (8, 5) cyclic code with generator polynomial $g(x) = 1 + x + x^2 + x^3$. 12
- Using the encoder, find the codeword for the Msg : 1100011, in systematic form.
 - Consider the codeword generated in (i) as i/p to the decoder, find the syndrome.
- (b) Consider a (9, 5) linear block code with 8
- $$p_1 = m_1 + m_2 + m_4 + m_5$$
- $$p_2 = m_1 + m_3 + m_4 + m_5$$
- $$p_3 = m_1 + m_2 + m_3 + m_5$$
- $$p_4 = m_1 + m_2 + m_3 + m_4$$
- Show the generator matrix
 - Show the parity-check matrix
 - Find the codewords for Msg : 10011, 11001, 11011.
4. (a) Explain decision feedback equalizer. How does it solve ISI problem ? 10
- (b) Discuss mean-square-error criterion and explain LMS algorithm. 10

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5. (a) Explain the working of a Preset-equalizer with a neat sketch. What are its limitations? 8
 (b) Binary PAM is used to transmit information over an unequalized linear filter channel. 12
 When $a = 1$ is transmitted, the noise-free output of the demodulator is :

$$x_m = \begin{cases} 0.25 & m = 1 \\ 0.9 & m = 0 \\ 0.25 & m = -1 \\ -0.1 & m = -2 \\ 0 & \text{otherwise} \end{cases}$$

- (i) Design a 3-tap zero forcing linear equalizer so that the output is

$$q_m = \begin{cases} 1 & m = 0 \\ 0 & m = \pm 1 \end{cases}$$

- (ii) Determine q_m for $m = \pm 2, \pm 3$, and find the residual ISI.

6. (a) Explain how the time-synchronization of receiver spread spectrum signal may be achieved. 10
 (b) (i) Define the following : Frequency-selective channel, Frequency-non-selective channel, slowly-fading channel, Doppler frequency spread of the channel. 5
 (ii) A shortwave ionospheric radio channel is characterised by a multipath spread of $T_m = 5\text{ms}$ and a Doppler spread of $B_d = 0.1\text{ Hz}$. (a) Determine the coherence bandwidth and coherence time of the channel. (b) A signal transmitted over this channel has a bandwidth of $W = 50\text{ Hz}$ and a time duration of 20 Ms . Is this a frequency selective channel? Is the channel slowly fading? Justify your answer. 5

7. Write short notes on : (any four) :—

- (a) Convergence properties of LMS algorithm
 (b) Tapped-delay line channel Model
 (c) Synchronization in FHSS
 (d) Trellis coded modulation
 (e) FFT-based multicarrier system.

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