11/11/13

15

Registration Number:

B.E. DEGREE (FULL TIME) END SEMESTER EXAMINATION – NOVEMBER 2013

ELECTRONICS AND COMMUNICATION ENGINEERING BRANCH

FIFTH SEMESTER – (REGULATIONS R 2008)

EC 9301 – DIGITAL COMMUNICATION TECHNIQUES

Duration : 3 Hours Max. Marks = 100

Answer **ALL** the questions.

PART- A (10 x 2 = 20 marks)

1. A binary PAM wave with a bit duration of 10 μs is to be transmitted over a baseband channel. Compare the transmission bandwidth required for Nyquist pulse shaping with that of Raised Cosine pulse shaping with roll-off $\alpha = 0.5$.
2. What features of a line coded waveform determine the bandwidth occupancy and the presence of DC content.
3. What is the main difference between Decision-directed and Non- Decision-directed approach for signal parameter estimation.
4. Highlight the logic of the Zero-Forcing algorithm for adaptive equalization and the corresponding drawbacks.
5. What is the difference between data compaction and data compression.
6. Highlight the trade-off between bandwidth efficiency and power efficiency using Shannon's information capacity theorem.
7. Briefly explain Constraint length with reference to convolutional codes.
8. What is the implication of Coding gain achieved by Error control codes.
9. Explain the difference between Euclidean distance and Hamming distance with an example.
10. With a suitable diagram illustrate Iterative decoding used in turbo decoders.

PART – B (5 x 16 = 80 marks)

11. (i) Explain the term Mutual Information for discrete and continuous systems. How is it related to the Channel Capacity. Compare Binary Symmetric Channel and a Binary Erasure Channel. Derive and estimate the Capacity for a Binary Symmetric Channel. (8)

(ii) Derive the Shannon's Information Capacity theorem for a continuous Gaussian channel subject to bandwidth and power constraints. Given a bandwidth of 3.4 KHz and a SNR of 20 dB, calculate the capacity. If source transmits 128 possible symbols with equal probabilities what is the maximum symbol rate for error-free transmission. (8)

12a. The generator polynomial of a (7,4) Hamming code is defined by,

$$g(X) = 1 + X^2 + X^3$$

Obtain the Generator matrix for systematic encoding. Draw the encoder circuit for systematic coding. Trace the message sequence (1 1 0 1) through the encoder circuit and obtain the systematic codeword for the same. Verify the obtained codeword using the polynomial division method.

'OR'

12b. Consider a rate – ½, non-systematic Convolutional Code with $g^{(1)} = \{ 1,0,1 \}$ and $g^{(2)} = \{ 1,1,1 \}$. Draw the encoder structure and obtain the trellis diagram corresponding to this encoder. Determine the encoder output corresponding to the data sequence { 1 1 0 }. Assume suitable number of tail bits to reset encoder. If the fourth bit of the encoded sequence is altered during transmission, demonstrate the error correcting capability using the Viterbi algorithm.

13a. (i) Why does Inter-Symbol Interference (ISI) occur in a communication channel ? Discuss the Nyquist criterion in detail for ISI free transmission. (8)

(ii) Consider a random binary sequence where bits are statistically independent and equally likely. Determine the power spectral density for the NRZ bipolar format and draw your inference. (8)

'OR'

13b. The binary data (0 1 1 1 0 0 1 0 1) are applied to the input of a Duo-binary encoder.

(i) Construct the Duo-binary encoder output assuming the use of a precoder in the transmitter and the corresponding receiver output. Assume the required previous bits to be 1. (5)

(ii) Sketch the time domain channel output waveforms for signaling at maximum rate over a channel having a maximum bandwidth of 75 KHz. (6)

(iii) Suppose due to error during transmission, the level produced by the third digit is reduced to zero, construct the new receiver output. (5)

14a. Justify the need for estimating the delay and the carrier phase as two different entitites. Suppose the real signal s(t) represents a modulated signal given by $s(t) = A \cos(2\pi f_c t)$, occurring every T secs, where A is zero-mean Gaussian with unity variance. Derive the Log Likelihood Function and the ML estimate for the carrier phase ϕ. Draw the block diagram of a receiver that incorporates the phase estimator.

'OR'

14b. Explain the necessity for an adaptive equalizer in practical systems with suitable examples. Let the tap weights of a tapped delay line equalizing filter with three taps be determined by transmitting a single impulse as a training signal. Let $\{x(k)\} = \{ -0.7, 0.1, 0.9, -0.2, 0.04 \}$ for k = -2, -1, 0, 1 and 2, respectively, denote the set of received samples corresponding to the single impulse sent through the channel. Use a Zero Forcing Algorithm to determine the tap weights. Using the weights determine the residual ISI and values of the equalizing pulse at the sample instants $k = \pm 2$ and ± 3.

15a. Demonstrate the Ungerboeck set partitioning for an 8-PSK signal set. Show a possible 4-state trellis mapping for the same. Estimate the coding gain achieved in comparison to the QPSK scheme.

'OR'

15b. A 2D single parity code is defined by $d_i \oplus d_j = p_{ij}$. The input data is assumed to be unbiased and the channel measurements obtained are as shown in the table below. The AWGN noise variance is 1.2.

x_1=0.75	x_2=0.05	x_{12} = 1.3
x_3=0.15	x_4=0.10	x_{34} = 1.0
x_{13}=2.0	x_{24}=0.5	-

Estimate the transmitted data using (i) Hard decision decoding and (ii) Soft decision decoding process based on LLR. Highlight any improvement achieved due to the soft decision decoding process.

****