VALLIAMMAI ENGINEERING COLLEGE

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

QUESTION BANK

SUBJECT: EC6501/ DIGITAL COMMUNICATION **SEM / YEAR : V / III**

UNIT - I

SAMPLING AND QUANTIZATION

Part A

1. State sampling theorem for low pass signals..
2. Compare uniform and non-uniform quantization.
3. Why is pre-filtering done before sampling?
4. What is natural sampling and flat-top sampling?
5. List out the components required for signal reconstruction
6. Define the term aliasing.
7. Compare DM and PCM.
8. What is meant by quantization?
9. What is the need for non-uniform quantization?
10. State any two non-uniform quantization rules.
11. Define quantization noise power.
12. Define Nyquist rate and Nyquist interval.
13. A signal is sampled at Nyquist rate of 8 KHz and is quantized using 8 bit uniform quantizer. Assuming SNR for a sinusoidal signal, calculate the bit rate, SNR and BW.
14. What is Companding?
15. Write µ-law of compression.
16. What is TDM?
17. Draw the block diagram of TDM.
18. What is the need for synchronization in TDM?
19. Define PAM
20. Write the advantages and disadvantages of TDM.

PART-B

1. State the sampling theorem. Explain the ideal sampling process with necessary expressions and diagrams. (16)
2. Explain
   (i) Natural Sampling and Flat-top Sampling (10)
   (ii) Sample and Hold circuit. (6)
3. The signal g(t) = 10 cos(20πt) cos(200πt) is sampled at the rate of 250 samples per second.
   (a) Determine the spectrum of the resulting sampled signal.
   (b) Specify the cut-off frequency of the ideal reconstruction filter so as to recover g(t) from its sampled version.
   (c) What is the Nyquist rate for g(t).
   (d) Explain the reconstruction process of a message from its samples. (16)
4. Explain the process of quantization and obtain an expression for signal to Quantization ratio in the case of a uniform quantizer. (16)
5. Explain the characteristics of Non-uniform quantization with diagrams. Also compare uniform and non-uniform quantization methods. (16)
6. Briefly discuss about quadrature sampling of band-pass signals. Derive the expression for SDR. (16)
7. Write short notes on
   (i) Analog companding and (8)
   (ii) (ii) Digital companding. (8)
8. With neat diagrams, Pulse Code Modulation and demodulation system.(16)
9. A compact disc (CD) records audio signals digitally using PCM. Assume the audio signal bandwidth to be 15 KHz.
   (a) What is the Nyquist rate?
   (b) If the Nyquist samples are quantized to L = 65, 536 levels and then binary coded, determine the number of bits required to encode a sample.
   (c) Assuming that the signal is sinusoidal and that the maximum signal amplitude is 1 volt; determine the quantization step and the signal-to-quantization noise ratio.
   (d) Determine the number of bits per second (bit/s) required to encode the audio signal.
   (e) For practical reasons, signals are sampled at above the Nyquist rate, as discussed in class. Practical CDs use 44,000 samples per second. For L = 65, 536 determine the number of bits per second required to encode the signal and the minimum bandwidth required to transmit the encoded signal.
10. What is PAM? Explain TDM process with necessary diagrams. (16)

UNIT - II

WAVEFORM CODING

Part A

1. Define prediction error.
2. State the 2 properties of linear prediction.
3. Differentiate PCM and DPCM.
4. What is prediction gain? State its significance.
5. What is delta modulation?
6. Mention the drawbacks of DM.
7. A speech signal with maximum frequency of 3.4 KHz and maximum amplitude of 1 V. this speech signal is applied to a delta modulator whose bit rate is set at 20 Kbps. Discuss the choice of an appropriate step size for the delta modulator.
8. The idle channel noise in a delta modulator is negligibly small. Justify the validity of this statement.
9. What is slope overload and granular noise?
10. State the principle of ADM.
11. Compare DM and ADM.
12. What are the objectives of speech coding?
13. Define ADPCM.
14. What are the different types of adaptive quantization?
15. Define APF.
16. Define APB.
17. What is the principle of linear predictive coder (LPC)?
18. Draw the model of LPC.
19. Mention the applications of LPC.
20. What is adaptive sub-band coding?

Part B

1) What is DM? Explain the transmitter and receiver of DM system. (16)
2) Explain a DPCM system with the expressions and block diagram. Show that SNR of DPCM is better than that of PCM. (16)
3) Explain the noises in delta modulation systems. How to overcome this effect in Delta modulation? (16)
4) Describe temporal and spectral waveform encoding methods. (16)
5) With necessary diagrams, explain ADPCM system. (16)
6) Write short notes on
   (i) Adaptive quantization schemes
   (ii) Adaptive prediction schemes.
7) What is low bit rate speech coding? Draw the block diagram of adaptive sub-band coding scheme for speech signal and explain. (16)
8) Discuss about the structure of linear predictor. Also explain the process of prediction error. (16)
9) Explain the principle of LPC model with diagrams. (16)
10) Compare the various types of speech encoding techniques. (16)

UNIT - III

BASEBAND TRANSMISSION

Part – A

1. What is line coding?
2. Define transparency of a line code. Give two examples of line codes which are not transparent.
3. State any 4 properties of a line code.
4. What is Manchester code? Draw its format for the data 10011.
5. Draw the RZ-Bipolar line code for the data 110100.
6. Draw the NRZ and RZ code for the digital data 10110001.
7. What are the requirements of a line code?
8. What is ISI?
9. 'ISI can-not be avoided'. Justify the statement.
10. How does pulse shaping reduce ISI?
11. Draw the ideal and basic amplitude response of pulse waveforms.
12. Define roll-off factor.
13. State the Nyquist criterion for zero ISI.
14. What is Eye pattern? State any 2 applications of eye pattern..
15. What is equalization?
16. What is correlative coding?
17. Define duo binary system. What are the drawbacks of it?
18. Draw the block diagram of adaptive equalizer.
19. What are the methods used to implement adaptive equalizer?
20. Why do we need equalization filter?

Part B

1) Derive the power spectral density of polar RZ code and explain. (16)
2) Derive the expression for power spectral density of unipolar NRZ line code. Hence discuss its characteristics. (16)
3) (i) List and explain the properties of line codes. (8)

   (ii) Derive the power spectral density of Manchester code. (8)
4) Explain modified duo-binary signaling scheme with & without procedure. (16)
5) Explain how ISI occurs in base-band binary data transmission system. (16)
6) Describe the Nyquist criterion method for distortion less transmission. (16)
7) The Fourier transform P(f) of the basis pulse p(t) employed in a certain binary communication system is given by

$$P(f) = \begin{cases} 10^{-6}\left(1 - \frac{|f|}{10^6}\right) & if \quad 10^{-6} \le f(Hz) \le 10^6 \\ 0 & Otherwise \end{cases}$$

   (a) From the shape of P(f), explain whether this pulse satisfies the Nyquist criterion for ISI free transmission.
   (b) Determine p(t) and verify your result in part a.
   (c) If the pulse does satisfy the Nyquist criterion. What is the transmission rate (in bits/sec.) and what is the roll-off factor?

8) Explain the pulse shaping method to minimize ISI. (16)
9) Draw and explain the block diagram of duo-binary signaling scheme for controlled ISI. (16)
10) Briefly discuss about
   (i) Eye pattern. (8)
   (ii) Adaptive equalization. (8)

Unit - IV

DIGITAL MODULATION SCHEME

Part A

1. What is the need for geometric representation of signals?
2. Why we go for Gram- Schmidt orthogonalization procedure?
3. Define BPSK and DPSK.
4. Why is PSK always preferable over ASK in Coherent detection?
5. What are the drawbacks of binary PSK system?
6. A BFSK system employs two signaling frequencies f_1 and f_2. The lower frequency f_1 is 1200 Hz and signaling rate is 500 Baud. Calculate f_2.
7. What are the advantages of QPSK over PSK?
8. What is constellation diagram?
9. A BPSK system makes errors at the average rate of 100 errors per day. Data rate is 1 Kbps. The single-sided noise power spectral density is 10 W/Hz. Assume the system to be wide sense stationary, what is the average bit error probability?
10. Define QAM and draw its constellation diagram for M=8.
11. Write the special features of QAM.
12. Differentiate coherent and non-coherent detection.
13. Define spectral efficiency.
14. What is meant by symbol synchronization?
15. List out the difference between carrier recovery and clock recovery.
16. Compare the error probability for BPSK and QPSK.
17. What is the error probability of DPSK?
18. Write the features of DPSK.
19. What is meant by memoryless modulation?
20. Compare BER and SER

Part B

1. Describe with diagrams the generation and detection of coherent BFSK. Explain the probability of error for this scheme. (16)

2. Explain non coherent detection methods of binary frequency shift keying scheme. (16)

3. Explain the generation and detection of binary PSK. Also derive the probability of error for PSK. (16)

4. Compare the performance of various coherent and non-coherent digital detection systems. (16)

5. Discuss about coherent detection of QPSK and derive its power spectral density. (16)

6. With constellation diagram, explain the QAM transmitter. Also derive its power spectral density. (16)

7. A set of binary data is sent at the rate of R_b = 100 Kbps over a channel with 60 dB transmission loss and power spectral density $\eta = 10^{-12}$ W/Hz at the receiver. Determine the transmitted power for a bit error probability $P_e = 10^{-3}$ for the following modulation schemes.
   (i) FSK (iii) PSK
   (ii) DPSK (iv) 16 QAM

8. Explain the carrier synchronization methods with block diagrams. (16)

9. Briefly discuss about the Non-coherent detection of PSK and QPSK. (16)

10. Briefly discuss about the principle of DPSK system. (16)

UNIT- V

ERROR CONTROL CODING

Part A

1. State the channel coding theorem.
2. What are the objectives of channel coding?
3. Define coding efficiency.
4. Define Hamming distance and calculate its value for two code words 11100 and 11011.
5. Define Hamming weight and minimum distance.
6. State the significance of minimum distance of a block code.
7. State the principle of error free communication.
8. Define linear block codes.
9. Write syndrome properties of linear block codes.
10. What is Hamming codes?
11. Write the advantages and disadvantages of Hamming codes.
12. Define syndrome vector.
13. Mention the properties of cyclic code.
14. State any 2 properties of generator polynomial.
15. What are the advantages and disadvantages of cyclic code?
16. What is convolutional code? How is it different from block codes?
17. Mention the structural properties of a convolutional encoder.
18. What is meant by BCH code?
19. Define CRC codes.
20. What is Viterbi decoding scheme?

Part B

1. Construct a single error correcting (7, 4) linear block code and the corresponding decoding table. (16)
2. (i) Explain the generation of (n, k) blocks codes and how block codes can be used for error control. (10)
   (ii) Explain the syndrome decoder for cyclic codes. (6)
3. Consider a (7, 4) linear block code whose parity check matrix is given by

$$H = \begin{bmatrix} 1 & 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 1 & 0 & 0 & 1 \end{bmatrix}$$

   (i) Find the generator matrix.
   (ii) How many errors this code can detect?
   (iii) How many errors can this code be corrected?
   (iv) Draw circuit for encoder and syndrome computation. (16)
4. The generator polynomial of a (7, 4) Hamming code is defined by
$$g(D) = 1 + D^2 + D^3$$
   Develop the encoder and syndrome calculator for this code. (16)
5. (i) Find a generator polynomial for a (7, 4) cyclic code and hence find the code word for [1 1 0 0]. (8)
   (ii) Construct the encoder for (7, 4) cyclic codes. (8)
6. Explain how encoding is done by convolutional codes with an example. (16)
7. For (6, 3) systematic linear block code, the code word comprises I_1, I_2, I_3 and P_1, P_2, P_3 where the three parity check bits are formed from the information bits as follows:
$$P_1 = I_1 \oplus I_2$$
$$P_2 = I_1 \oplus I_3$$
$$P_3 = I_2 \oplus I_3$$
   Find: (i) Parity check matrix and generator matrix (3)
   (ii) All possible code words. (3)
   (iii) Minimum weight and minimum distance. (3)
   (iv) Error detecting and correcting capability of the code. (3)
   (v) If the received sequence is 101010, calculate the syndrome and decode the received sequence. (4)
8. Describe the steps involved in the generation of linear block codes. Define and explain properties of syndrome. (16)
9. Explain Viterbi algorithm to decode a convolutionally coded message.(16)
10. Design a convolutional coder of constraint length 6 and rate efficiency 1/2. Draw its tree diagram and trellis diagram. (16)