

**ERROR CONTROL CODING FOR SECURE DATA TRANSMISSION
(ECEN 4123)**

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.*

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) The technique that may be used to increase average information per bit is
(a) Shannon-Fano algorithm (b) ASK
(c) FSK (d) Digital modulation technique
- (ii) The average information contained in a message is
(a) entropy (b) efficiency
(c) coded signal (d) none of the above
- (iii) Which among the following represents the code in which code words consists of message bits and parity bits separately?
(a) Block Codes (b) Systematic Codes
(c) Code Rate (d) Hamming Distance
- (iv) The coding efficiency is given by
(a) 1- Redundancy (b) 1+ Redundancy
(c) 1/Redundancy (d) none
- (v) For a (7, 4) block code, 7 is the total number of bits and 4 is the number of
(a) redundant bits (b) total bits- information bits
(c) information bits (d) none of the above
- (vi) The generator polynomial of a cyclic code is a factor of
(a) $x^n + 1$ (b) $x^{n-1} + 1$ (c) $x^{n+1} + 1$ (d) $x^{n+2} + 1$
- (vii) If $m = 3$, then length (n) of the BCH code
(a) 6 (b) 5 (c) 7 (d) none of these
- (viii) The properties of cyclic code is/are
(a) Linear (b) Cyclic (c) Both a and b (d) None of these
- (ix) Which of the following is not an error correction and detection code
(a) Block code (b) Convolution code
(c) Passive code (d) Turbo code

- (x) Viterbi algorithm applies the
 (a) maximum likelihood principle (b) minimum likelihood principle
 (c) maximum entropy principle (d) minimum entropy principle

Fill in the blanks with the correct word

- (xi) The Hamming distance between 110110110 & 110010011 is _____.
- (xii) For a (7, 4) cyclic code generated by $g(x) = x^3+x+1$, the syndrome for the error pattern $e(x) = x^5$ is _____.
- (xiii) The generator polynomial of a (7,4) cyclic code has a degree of _____.
- (xiv) The generator polynomial of (9,6) cyclic code must divide the polynomial _____.
- (xv) An example of the graphical representation of convolution encoding is _____.

Group - B

2. (a) Explain the term and their significance: Entropy, Mutual information, self information and channel capacity *[[CO1](Remember/LOCQ)]*
- (b) An analog signal band-limited to 5 KHz is quantized in 8 levels of a PCM system with probabilities $\frac{1}{4}, \frac{1}{5}, \frac{1}{5}, \frac{1}{10}, \frac{1}{10}, \frac{1}{20}, \frac{1}{20}$ and $\frac{1}{20}$ respectively. Calculate entropy and rate of information. *[[CO1,CO6](Evaluate/HOCQ)]*
 $(2 \times 4) + 4 = 12$

3. (a) A channel has the following channel matrix
- $$[P(Y|X)] = \begin{bmatrix} 0.65 & 0.35 & 0 \\ 0 & 0.2 & 0.8 \end{bmatrix}$$
- (i) Draw the channel diagram.
- (ii) If the source has equally likely outputs, compute the probabilities associated with the channel output. *[[CO2](Evaluate/HOCQ)]*
- (b) What is conditional probability? *[[CO2](Remember/LOCQ)]*
 $8 + 4 = 12$

Group - C

4. (a) Write down the properties of Linear Block Code. *[[CO3](Remember/LOCQ)]*
- (b) The parity check bits of a (7,4) block code are generated by $C_5 = d_1 \oplus d_2 \oplus d_4$; $C_6 = d_1 \oplus d_3$; $C_7 = d_1 \oplus d_3 \oplus d_4$;
- (i) Construct the corresponding Generator Matrix.
- (ii) Find the systematic code corresponding to the information bits [1100] and [1010].
- (iii) If the received words are $v_1 = [1011001]$ and $v_2 = [1111011]$ find the correct code words. *[[CO3,CO6](Apply/IOCQ)]*
 $3 + (3 + 3 + 3) = 12$
5. (a) Define Block codes. *[[CO3](Understand/LOCQ)]*

- (b) For (7,4) Hamming code construct the G -Matrix. Find the code for data (1010) [[CO3](Apply/IOCQ)]
- (c) Let C be a (5, 3) linear block code with generator matrix,
- $$G = \begin{bmatrix} 1 & 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 \end{bmatrix}$$
- (i) Reduce G to standard form. (ii) Find a parity-check matrix for C. [[CO3](Evaluate/HOCQ)]
- 2 + 4 + 6 = 12**

Group - D

6. (a) Determine systematic and non-systematic code words for $i = (111)$ for the (7, 3) code with $g(x) = x^4 + x^2 + x + 1$. [[CO3](Analyse/IOCQ)]
- (b) Given that $x^7 + 1 = (x+1)(x^3 + x^2 + 1)(x^3 + x + 1)$, determine the generator polynomials of all the cyclic codes with block length 7. [[CO4](Apply/LOCQ)]
- (2 + 4) + 6 = 12**
7. (a) Determine the Galois Field elements of $GF(2^4)$ for the corresponding polynomial $f(p) = p^4 + p + 1$ [[CO4](Analyse/HOCQ)]
- (b) Find the conjugates of α^6, α^4 in $GF(2^4)$. [[CO4](Apply/IOCQ)]
- 4 + (4 + 4) = 12**

Group - E

8. Write short notes on -Trellis Diagram, Turbo Codes, Viterbi Decoding, and Golay Code. [[CO5](Remember/LOCQ)]
- (3 + 3 + 3 + 3) = 12**
9. (a) For a (2,1,3) convolution code $g^0 = (0011)$ and $g^1 = (1011)$. Draw the encoder. Determine the complete code bits (until registers reach zero state). [[CO5,CO6](Apply/IOCQ)]
- (b) Draw the decoder circuit corresponding to the generator polynomial $g(D) = 1 + D^2 + D^3$ [[CO5,CO6](Apply/IOCQ)]
- (3 + 6) + 3 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	36	41	23

