CODING & INFORMATION THEORY
(ECEN 4102)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Entropy of a random variable is
(a) 0 (b)1 (c) Infinite (d) Cannot be determined.

(ii) Block codes are generated using
(a) Generator polynomial (b) Generator matrix
(c) Generator polynomial & matrix (d) None of the mentioned.

(iii) What are the conjugates of α^3 in GF (2^3)?
(a) α^6 and α^5 (b) α^5 and α^4
(c) α^3 and α^4 (d) α^4 and α^6.

(iv) For a Hamming distance of 5, how many errors can be detected?
(a) 2 (b)3 (c)4 (d) 5.

(v) What is the hamming weight for X= 1011101?
(a) 4 (b)5 (c)1 (d) 7.

(vi) What is the order of the field element α^{12} of GF (2^4)?
(a) 2 (b)3 (c)4 (d)5.

(vii) For decoding in convolution coding, in a code tree,
(a) Diverge upward when a bit is 0 and diverge downward when the bit is 1
(b) Diverge downward when a bit is 0 and diverge upward when the bit is 1
(c) Diverge left when a bit is 0 and diverge right when the bit is 1
(d) Diverge right when a bit is 0 and diverge left when the bit is 1.

(viii) A cyclic code can be generated using
(a) Generator polynomial
(b) Generator matrix
(c) Generator polynomial and generator matrix
(d) None of the above.

(ix) Viterbi algorithm performs _____ decoding of convolutional codes.
(a) Maximum likelihood (b) Maximum a posteriori
(c) Minimum square (d) Minimum mean square.

(x) What will be the amount of information if P(xi) = ¼?
(a)1bit (b)2bits (c)3bits (d)4 bits.

Group – B

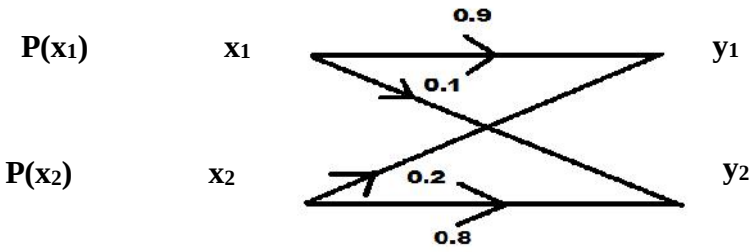
2. (a) Why is Huffman code called an optimum code?

(b) A DMS has five symbols x1, x2, x3, x4 and x5 with P(x1)=0.4, P(x2)=0.19, P(x3)=0.16, P(x4)=0.15 and P(x5)=0.1. Construct a Shanon Fano code for the source and calculate the code efficiency.

(c) What is conditional entropy?

3 +(5 + 2)+2=12

3. (a) Given a binary channel shown in the figure.



i) Find the channel matrix of the channel.
ii) Find $P(_{y1})$ and $P(_{y2})$ when $P(_{x1}) = P(_{x2}) = 0.5$
iii) Find the joint probabilities $P_{(x1,y2)}$ and $P_{(x2,y1)}$ when $P_{(x1)} = P_{(x2)} = 0.5$

(b) An analog signal band limited to 10 kHz is quantized in 8 levels of a PCM system with probabilities 1/4, 1/5, 1/5, 1/10, 1/10, 1/20, 1/20, 1/20 respectively. Calculate entropy and rate of information.

(c) For a lossless channel, prove that H(X|Y) = 0.

(2+2+2) + (2+2) +2 = 12

Group – C

4. (a) For a Hamming distance of 3, how many errors can be detected? How many errors can be corrected?

(b) Define G and H matrix and show that $G \cdot H^T = 0$

(c) Parity check matrix of linear block code is

$$H = \left|\begin{array}{ccc:ccc} 1 & 0 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 \end{array}\right|$$

(i) Determine the generator matrix

(ii) Assuming that a vector [111011] is received, find the correct data.

(2 + 2) + 4 + (2 + 2) = 12

5. (a) The parity check bits of a (7,4) block code are generated by $C5 = d_1 \oplus d_2 \oplus d_4$; $C_6 = d_1 \oplus d_3$; $C7 = d_1 \oplus d_3 \oplus d_4$

(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 v1 = [1011001] and v2 = [1111011]; find the correct code words.

(b) Derive the relation between syndrome S and the error vector E.

(3+ 3 + 3) + 3 = 12

Group – D

6. (a) For a systematic (7, 3) cyclic code determine the generator matrix and parity check matrix if $g(x) = x^4 + x^2 + x + 1$

(b) Code word polynomial c(x) belonging to the (7, 4) cyclic code with $g(x)=1 + x + x^3$ incurs errors so as to produce received polynomial v(x).

Find c(x) when

(i) $v(x) = x^5 + x^2 + 1$

(ii) $v(x) = x^6 + x^3 + 1$

6 + 6 = 12

7. (a) For a (2, 1, 2) convolution code, $g^0 = (111)$ and $g^1 = (101)$. Draw the encoder. Find the state diagram, for this convolution code.

(b) What is constraint length in convolution code?

(c) Consider a received codeword r = 11 11 10 01 10 at the instants of time j=0,1,2,3,4 respectively. Find the decoded codeword by applying any decoding scheme.

(2 + 3) + 2 + 5 = 12

Group – E

8. (a) Determine the Galois field elements of GF (2^4) for the corresponding polynomial $p(x) = x^4 + x + 1$.

(b) What do you mean by primitive element? α^{10}, α^7 are field elements of GF (2^4), determine their order and check whether or not they are primitive elements.
Find the minimal polynomial of α^5 in GF (2^3).

4 + (1 +2 + 2) + 3 = 12

9. Write short notes on (any three)
(i) Shannon-Fano code
(ii) Turbo codes
(iii) Hamming code
(iv) Source coding
(v) Golay code

(3 ×4) = 12

Department & Section	Submission Link
ECE A	https://classroom.google.com/u/0/w/MTIyODIzMjk4NDI0/tc/Mjc1MTI4NDIwNzAz
ECE B	https://classroom.google.com/u/1/w/MTUxODQ3NzA5Njg3/tc/Mjc0Njk4NjM5MzAw
ECE C	https://classroom.google.com/w/MTIyNzc0NjA1ODY3/tc/Mjc0MTcxMDAwNzUz

Department & Section	Submission Link (for Backlog)
ECE	https://classroom.google.com/w/MTIyNzc0NjA1ODY3/tc/Mjc0MTcxMDAwNzUz